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Natural Resource Program Center

Northeast Coastal and Barrier Network Assessment of Contaminant Threats

Gateway National Recreation Area

Natural Resource Technical Report NPS/NCBN/NRTR—2010/339



ON THE COVER
Herons and waterfowl feeding at East Pond on the Northeastern Bayside at Jamaica Bay Wildlife Refuge (John F. Kennedy Airport in background)
Photographed by Dr. Mark J. Ringenary

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Natural Resource Technical Report NPS/NCBN/NRTR—2010/339

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List of Abbreviations

AI	Active Ingredient
atm	Atmospheres
ATSDR	Agency for Toxic Substances and Disease registry
AUF	Area Use Factor
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
BW	Body Weight
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
C.I.	Confidence Interval
C.L.	Conficence Limit
COAST	Clean Ocean And Shore Trust
COC	Chemical of Concern
CRC	Contamination Reduction Corridor
CRZ	Contamination Reduction Zone
DDE	Primary persistent metabolite of DDT
DDT	Broad spectrum pesticide
DOT	Department of Transportation
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency
ERL	Expected Response Low
ERM	Expected Response Moderate/Medium
ERT	Emergency Response Team
FCM	Food Chain Multiplier
FIR	Food Intake Ratio
GATE	Gateway National Recreational Area
GFCI	Ground Fault Circuit Interrupter
GPS	Global Positioning System
hmw	High molecular weight
HQ	Hazard Quotient
HRJB	Hudson/ Raritan Estuary, Jamaica Bay
HRLB	Hudson/Raritan Estuary, Lower Bay
HRRB	Hudson/Raritan Estuary, Raritan Bay
HRUB	Hudson/Raritan Estuary, Upper Bay
IR	Ingestion Rate
K_{ow}	Octanol/water partitioning Coefficient
LD_{50}	Lethal Dose resulting in 50% death
lmw	Low molecular weight
LOAEL	Low Observable Adverse Effects Level
MGP	Manufactured Gas Plant
MLD	Million Liters a Day
MTBE	Methyltetbutylether (gasoline additive)
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration

List of Abbreviations (Continued)

NOAEL	No Observed Adverse Effects Level
NPL	National Priorities List
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NYCDEP	New York City Department of Environmental Protection
NYDEC	New York Department of Environmental Conservation
NYSH	New York Bight, Sandy Hook
PAH	Polyaromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PEL	Probable Effects Level
pH	Concentration of hydrogen ions
ppb	Parts per billion (ug/Kg or ug/L)
ppm	Parts per million (mg/Kg or mg/L or atmospheric # atoms/cubic meter air)
ppt	Parts per trillion
QA	Quality Assurance
QAWP	Quality Assurance Work Plans
QC	Quality Control
REMAP	Regional Environmental Monitoring and Assessment Program
SOP	Standard Operating Procedure
SQuiRT	Screening Quick References Tables
TCE	Trichloroethylene
TDI	Total Daily Intake (of a compound)
TEL	Threshold Effects Level
TEQ	Toxicity Equivalency Quotient
TOC	Total Organic Carbon
TRI	Toxic Release Inventory
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compounds
WPCP	Water Pollution Control Plant

Introduction

This report deals with the chemicals of concern (COCs) for Gateway National Recreational Area (GATE) and its surrounding waters and makes specific recommendations for monitoring plans. These recommendations are based on the ecosystems within the park and the specific chemical baseline inventory. Contaminant data has been reviewed from state, county, U.S. Environmental Protection Agency (USEPA), National Park Service (NPS), and National Oceanographic and Atmospheric Administration (NOAA) to prepare the data synthesis for this park. In Appendix 3 are the NOAA raw data tables along with USEPA Regional Environmental Monitoring and Assessment Program (REMAP) data that have been formatted to simplify examining the chemicals analyzed and their corresponding concentrations. Telephone and survey interviews, along with site visits, were conducted with NPS staff, and where appropriate, with county and regional U.S. Geological Survey (USGS) officials. Based on the recommended monitoring plans, the NPS staff will be able to assess threats to natural resources and whether the "vital signs" are improving or declining within the park boundaries over time as it relates to COCs.

It should be noted that due to the large amount of data for GATE this report only summarizes significant data from the major databases. Therefore, all USEPA REMAP data have been saved as an excel file and will be presented along with this report on a separate CD.

Detailed standard operating pProcedures (SOPs) for the methods of collection for different matrixes, specific analytical methods for different analytes, holding times, and decontamination approaches are described in a separate portion of this document (Appendix 2). A detailed description of how to use a simple hazard quotient (HQ) approach and a more sophisticated foodweb model for ecological based risk assessment (Sample 1996a) is also presented in Appendix 2.

General Physical Characteristics

GATE is a 26,000-acre (9000 acres in water) park located in the heart of the New York metropolitan area, and has about eight million visitors each year. GATE is heavily impacted by current and historic activities carried out in the NY/NJ Harbor estuary and surrounding municipalities. These bays are the drainage basin and may receive waters from much larger watershed areas (Figure 1). GATE extends through three New York City boroughs and into northern New Jersey. There are three main units for this park: the Staten Island Unit, the Sandy Hook Unit, and the Jamaica Bay Unit (Figure 1).

The NY/NJ Harbor estuary is a complex series of rivers draining into Raritan Bay and the Atlantic Ocean. New York City has over eight million inhabitants and over three million housing units (US Census 2004). The three boroughs that are directly adjacent to the New York parks include Queens (2,241,600 inhabitants), Brooklyn (2,472,523 inhabitants), and Staten Island (459,737 inhabitants). In addition, the NY/NJ Harbor Complex is the largest port on the East Coast. In 2005, over 84 million cargo tonnage moved through the port. Therefore, the GATE units are heavily impacted by the metropolitan area in which they are a part. COCs are constantly being introduced into the watershed from these activities. Historically deposited COCs are also being resuspended by natural events (e.g., storms) and dredging activities within the estuary.



Figure 1. Map of Gateway National Recreational Area and Watershed Area. (NPS)

Staten Island Unit

The Staten Island Unit is located on Staten Island's southeastern shore (Figure 2). There are three main sub-units of the Staten Island Unit: Fort Wadsworth, Miller Field (a former airfield), and Great Kills Park. Fort Wadsworth is located directly under the Verazonna Narrows Bridge and is one of the oldest military installations in the United States. In 1995, the last military tenant, the U.S. Navy, departed and officially turned Fort Wadsworth over to the Department of the Interior. In 1997, Fort Wadsworth opened to the public as part of Gateway National Recreation Area. The Park Service leases land to the Coast Guard and Army Reserve. On the park property there are residential areas for housing personnel and families. The park beach areas run along lower New York Bay. Fort Wadsworth is located north of the bridge and housed a heavily fortified gun battery.

Miller Field is located midway between Fort Wadsworth and the Great Kills Park. Miller Field was the site of an army airfield constructed in 1929. The base has also served as a training base, a Coast Guard artillery gun site, a Nike missile repair depot, and a U.S. Army special forces base. Today, Miller Field serves as mainly an athletic field for soccer and baseball. Still on the site are several hangers and other buildings. There is also a small beach area. The field is surrounded by residential housing.

Great Kills Park is the former site of a municipal landfill, and it is currently the site of a series of baseball fields and a model airplane landing field. Mixed perennial grasses and clover with common weeds are the primary plant species in the open field. The landfill is approximately 1.5 meters or more in thickness and is covered with Greatkills sandy loam and Gravesend Oldmill course sand. To the west and north of the park are urban residential areas (grass lawns, ornamental trees and hedges). The park is adjacent to the Oakwood Beach water pollution control plant (WPCP). The park slopes down (coastal shrub) to a beach area along the eastern edge beside Raritan Bay. The southern border of the park is an embayment, Great Kills Harbor, with several small marinas within the harbor.

Two small islands located off the eastern shoreline of Staten Island also belong to the Staten Island Unit: Swinburne and Hoffman Island (Figure 2). Both islands were created out of landfill materials in the late 1800s. Hoffman Island covers approximately 40,000 m^2 (10 acres), while Swinburne Island is about 16,000 m^2 (4 acres). The islands were used as quarantine stations to house immigrants with contagious diseases. Prior to and during World War II the islands were used by the United States Merchant Marines as training areas. In 1961, all buildings on Hoffman Island were raised, but several Quonset huts still remain on Swinburne Island. Today, the islands are the nesting area for a large number of wading birds, and the islands are closed to the public.



Figure 2. Map of Staten Island Unit of GATE. (NPS)

Sandy Hook Unit

The Sandy Hook Unit is a 2,044 acre barrier beach peninsula at the northern tip of the New Jersey shore that extends 7 miles northwest from New Jersey into the Lower New York Bay (Figure 1 and 3). To the west of Sandy Hook is Raritan Bay, and the Atlantic Ocean is located to the east (NPS 2004). The Navasink River and the Shrewsbury River empty into Sandy Hook Bay. Sandy Hook Bay separates Sandy Hook from the New Jersey Highlands. The shoreline of Sandy Hook has been altered drastically due to stabilization efforts. The narrowest section along the peninsula is known as the "critical zone." This narrow section is the result of beach erosion due to beach protection structures built over the years at Monmouth Beach and Sea Bight. These structures have prevented sand from reaching the southern end of Sandy Hook. However, the NPS has made efforts to place sand in the critical zone of Sandy Hook (NPS 2004). Sandy Hook includes 7 miles of ocean beaches, salt marshes, hiking trails, and a maritime holly forest. There are over 200 historic structures still standing within the park with approximately 120 of these located within the Fort Hancock area (Thomas 1988). Agencies using structures located within Fort Hancock include NOAA, New Jersey Marine Sciences Consortium, Brookdale Community College, and the Marine Academy of Science and Technology. The U.S. Coast Guard installation sits at the northern tip of Sandy Hook, immediately adjacent to the park, and houses about 300 military personnel and dependents. In addition to cultural and natural resources, the park provides recreational facilities, including opportunities for camping, fishing, swimming, sun-bathing, and picnicking (NPS 2003b).

There is a main road that runs the entire length of the park with side roads and parking areas for specific activities. The southern portion of the park is primarily undeveloped with only bath houses, an information center, and a small restaurant. The northern portion of Sandy Hook contains a concentration of buildings. The northern bay side has large boulders armoring the shore. There are a series of small *Spartina*/sand coves (Horseshoe Cove, Spermaceti Cove, Plum Island) along the bay side of the peninsula. The Atlantic Ocean side of the peninsula consists of large expanses of sandy beaches. There are a series of primary dunes in the northern areas, with secondary dunes leading into the barrier flats consisting of dwarf trees and shrubs (shrub-thicket zone).

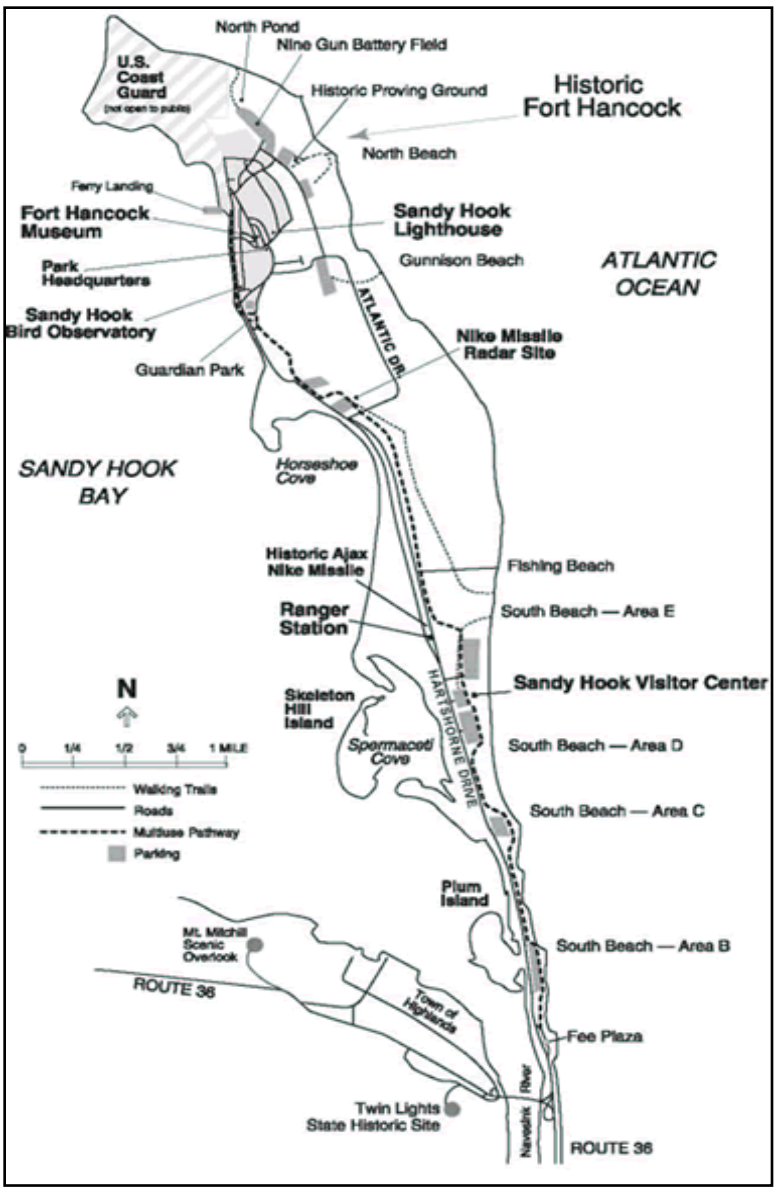


Figure 3. Map of Sandy Hook Unit of GATE**.** (NPS 2006)

Jamaica Bay Unit

The Jamaica Bay Unit is located along the southwestern tip of Long Island in Brooklyn and Queens, along the southwestern tip of Long Island (Figure 4). About 49 of the original 65 km² (12,000 of the original 16,000 acres) of wetlands in the bay have been filled in, mostly around the perimeter of the bay. Extensive areas of the bay have been dredged for navigation channels and to provide fill for airports and other construction projects. Most of Jamaica Bay proper and portions of the uplands and coastal beaches are part of Gateway National Recreational Area. This bay (over 26 square miles) is a major destination for migratory birds and home to aquatic wildlife. Jamaica Bay and Breezy Point have been designated as significant coastal fish and wildlife habitats, and the bay up to the high tide line was designated as a critical environmental area by the New York Department of State. The bay is bounded by the Belt Parkway to the north, JFK Airport to the east, Sheepshead Bay to the west, and the Atlantic Ocean to the south. The bay connects to the Atlantic Ocean through the Rockaway Inlet. Other sites within the park include: Floyd Bennett Field, Jacob Riis Park, Fort Tilden, Canarsie Pier, Breezy Point, Plumb Beach, and Bergen Beach (NPS 2006).

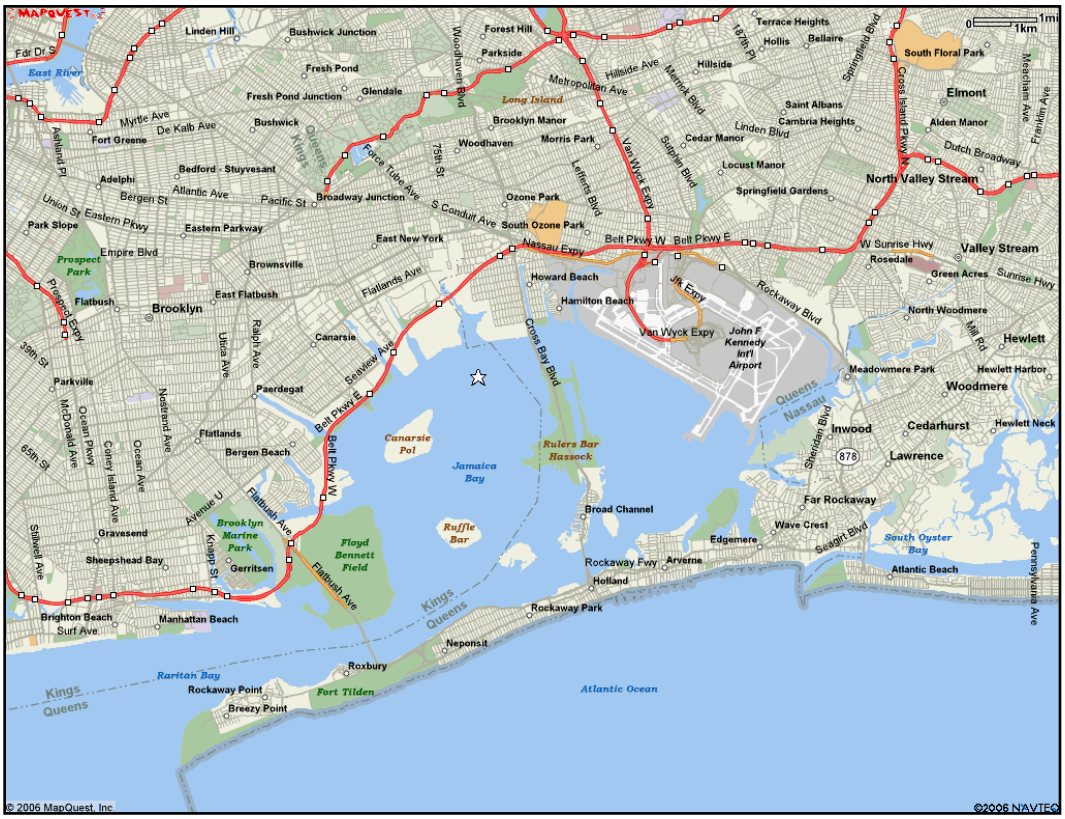


Figure 4. Map of Jamaica Bay and Surrounding Area. (MapQuest 2006)

Biological Habitats

Staten Island Unit

As discussed above, the Staten Island Unit is comprised of a number of individual parks that are along the southeastern shore line of Staten Island. There are three main subunits of the Staten Island Unit: Fort Wadsworth, Miller Field (a former airfield), and Great Kills Park. Fort Wadsworth is located on an upland plateau that leads down to the Hudson River and Raritan Bay. The park lies directly under the Verrazono Narrows Bridge. Fort Wadsworth is an urban habitat with grass lawns, ornamental trees, and hedges. The buildings are a mix of residential and business office complexes with large expanses of paved parking and surface roads. There are no major freshwater surface water sources at this location. There is a narrow sandy beach that is adjacent to the Hudson River and Raritan Bay. The flora is a mixed shrub thicket and deciduous trees leading from the roadway down to the sandy beach.

Miller Field is an open grassy area that is comprised of baseball and soccer fields. There is only a single line of pine trees along the southern edge of the field. The park is surrounded by residential areas on three sides and a small sandy beach area on the Raritan Bay side. There are two old hangers still present on the site, but no other major structures.

The Great Kills Harbor and Park includes large areas of disturbed common reed marsh with grassland and shrub thicket at Crookes Point dominated by bayberry (*Myrica pennsylvanica*), beach plum (*Prunus maritima*), sumac (*Rhus* spp.), hackberry (*Celtis occidentalis*), and black cherry (*Prunus serotina*). The landfill is a raised plateau with a grass and short weed covered cap. The outer shoreline follows a narrow, sandy, groined beach. A large area of flats in Great Kills Harbor extends southwest along the Staten Island Shoreline as far as Wolfe's Pond. According to the U.S. Fish and Wildlife Service (USFWS 1997), there are around 205 species of wildlife regularly using the waters and shore lands of Raritan Bay and Sandy Hook. Moderate sized flocks of scaup (*Aythya*) and American black duck (*Anas rubripes*) and smaller rafts of brant (*Branta bernicla*) appear along the Staten Island shoreline. The shorelines of Raritan Bay on Staten Island concentrate migratory shorebirds and neotropical migrant land birds. The peak months are June and August, and the primary concentration areas are Great Kills on Staten Island and the flats inside Sandy Hook. (USFWS 1997).

Another area of interest in GATE that is not often mentioned is Swinburne and Hoffman islands. The artificial islands are located 1.5 km east of Staten Island, NY and were constructed in the 19th century from sand dredged from New York Harbor. The islands are inaccessible to the public due to bird nesting. The islands' habitats are primarily of thick vegetation surrounded by rocky shoreline. Sixty-three percent of the flora, of both Islands combined, is non-native. The Asteraceae family, with 12 genera and 18 species is the largest family in the flora of both islands. A small number of grass species also make up the islands (Stalter 2002). The islands are undergoing rapid succession to deciduous forest, with tall shrubs encroaching on the few remaining grassy areas.

Sandy Hook Unit

Sandy Hook has areas of back dune habitat in the northern end, with dry sandy soils supporting shrubby vegetation. The area is dominated by winged sumac (*Rhus copallina*), bayberry, beach plum, and tree-of-heaven (*Ailanthus altissima*). Two distinct maritime forest areas occur in Sandy Hook, including a mixed-deciduous forest of about 90 hectares with dense vegetation dominated by American holly (*Ilex opaca*), black cherry, hackberry, serviceberry (*Amelanchier canadensis*), greenbrier (*Smilax rotundifolia*), and poison ivy (*Toxidendron radicans*). A second, smaller (25-hectare) forest occurs on the bay side of the peninsula with greater dominance by holly and red cedar (*Juniperus virginiana*). The backside of the spit consists of extensive tidal mud, sand flats, and saltmarsh dominated by low marsh cord grass inhabited by a variety of invertebrate species. There are a few small inland marsh areas dominated by common reed (USFWS 2006). The bay side has a number of finfish and shellfish species that are common to the bay area.

Jamaica Bay Unit

The Jamaica Bay area is made up of saltmarsh (9,000 acres), tidal flats, dredge spoil islands, dredged channels, and dredged basins. Some of the islands in the bay are composed of open field, shrub thicket, developing woodlands, and beach grass dune. Water depths in the bay average 4.9 meters with depths up to 12 meters (40 ft) in the deepest portions of the dredged channels and basins (NYS DOS 1992). Tidal currents exchange approximately one third of the volume of Jamaica Bay each semidiurnal cycle (Bopp et al. 1993). Freshwater inputs are estimated to total one half of one percent of the bay volume per day (O'Brien and Gere Engineers, Inc. 1990). Jamaica Bay provides numerous habitats for more than 300 species of birds (NPS 2003a). Jamaica Bay is also a productive area for finfish and shellfish. The area serves as a feeding area and nursery for winter flounder (*Pseudopleuronectes americanus*), summer flounder (*Paralichthys dentatus*), windowpane flounder (*Scophthalmus aquosus*), weakfish (*Cynoscion regalis*), bluefish (*Pomatomus saltatrix*), scup (*Stenotomus chrysops*), blueback herring (*Alosa aestivalis*), Atlantic cod (*Gadus morhua*), black sea bass (*Centropristis striata*), northern kingfish (*Menticirrhus saxatilis*), tautog (*Tautoga onitis*), and forage species such as Atlantic silversides (*Menidia menidia*), mummichogs (*Fundulus heteroclitus*), striped killfish (*Fundulus majalis*), Atlantic menhaden (*Brevoortia tyrannus*), bay anchovy (*Anchoa hepsetus*), and northern pipefish (*Syngnathus fucus*). In the past, Jamaica Bay was an important shellfishing area, but has been closed since the 1920s due to pollutant laws (NYS DOS 2003).

Source Inputs at GATE

Onsite Inputs

Terrestrial Sources

A number of the properties that have been acquired by the Park Service were formally used as defense sites, military installations. Several of the park subunits in GATE were either formally used as defense sites or military installations. Fort Wadsworth, Fort Hancock, and Fort Tilden were military sites for the defense of New York Harbor. Large gun batteries were present at all three of these sites. Nike missile installations were at Sandy Hook, Miller Field, and Fort Tilden. Currently there is a review and re-sampling by the military concerning these former sites. Due to the use of these former sites, there is a potential for the occurrence of munitions waste, fuel oil, rocket fuels, and industrial and municipal contaminants in landfill areas. Because of the sandy soil at the majority of these sites, leaching of chemical solvents such as benzene, naphthalene, trichloroethylene (TCE), and perchlorate into surficial groundwater has been reported, and they are currently being reevaluated by the military. Due to the current reevaluation of these locations it is not recommended that these locations be sampled.

Underground storage tank (UST) removal has been completed at Fort Wadsworth, Miller Field, North Channel Bridge, Jamaica Bay Visitor Center, Floyd Bennett Field, and Fort Tilden. The tank removal was completed in 2000. Contamination at Miller Field-Hanger 38 consisted of the following volatile organic compounds (VOCs): ethylbenzene (ND – 173 ppb), isopropylbenzene (ND-415 ppb), n-propylbenzene (ND-802 ppb), 1,3,5-trimethylbenzene (ND-2050 ppb), 1,2,4-trimethlbenzene (ND-2410 ppb), sec-butylbenzene (ND-1520 ppb), 4-isopropyltoluene (ND-1720 ppb), n-butylbenzene (ND-12,200 ppb) (Prestige Environmental 2000). The New York Department of Environmental Conservation (NYDEC) recommended cleanup objectives are 100 ppb for the VOCs listed above. Fluorene (ND- 5000 ppb) and phenanthrene (ND-17,000 ppb) exceeded NYDEC recommended cleanup objectives. The compounds listed above are typical of compounds present from fuel oil seepage into the soil. UST removal and remediation are still ongoing at the Sandy Hook Unit. According to information supplied, there are currently 29 USTs and 38 aboveground storage tanks. The new tanks have alarms and double wall construction.

Several of the park units have former municipal and industrial landfill sites that have been obtained by the park service. Even though these facilities have been capped, there is the chronic release of methane and other gases, volatilized mercury, contaminated leachate containing metals and petroleum products that enter surrounding waters or groundwater. A small landfill/dump was formerly located at Sandy Hook next to the Coast Guard Station. However, this former dump/landfill likely poses little or no threat, because the majority of the material has been removed. The Great Kills Park in the Staten Island Unit is a former municipal landfill that could result in the local contamination of the Great Kills Bay. At this particular site, along with other municipal landfills, radioactive materials may also be present from household (smoke detectors) and hospital solid waste and equipment. A radioactive source was recently detected at this landfill and is believed to be from hospital equipment that was disposed of without the removal of the radiation source. In collaboration with the New York City Department of Environmental Protection (NYCDEP), U.S. Corps of Engineers, and USEPA, the NPS will be obtaining almost 400 acres of capped landfill properties (former Fountain Avenue Landfill and Pennsylvania Avenue Landfill) along the northern shore of Jamaica Bay. The landfills are composed of tens of

millions of cubic meters of municipal and industrial waste deposited at the sites until the mid 1980s. This is a very large restoration project, and sampling will be carried out by the NYCDEP for the next 30 years as the landfill ages. In 2001, two piers were constructed to facilitate off-loading of treated capping material. The landfills are capped and permanent liners are in place. These landfills have been a very large source of heavy metals, petroleum products, VOCs, and other contaminants entering into Jamaica Bay and the surrounding creeks.

An onsite sewage treatment facility, which is operated by the NPS, is located at Sandy Hook. This facility processes all of the sewage (170,344 L/day weekdays 378,541L/day weekends) generated on the island. It is a secondary treatment facility with constructed wetlands for leach fields located on the island. Since 1990, the sludge has been land applied within concrete catchment areas with plant remediation and is removed offsite once a year. The sources of material are from homes, a small restaurant, government buildings, and the Coast Guard base at the tip of the peninsula. Hypochlorite is used to disinfect the sewage effluent prior to placing into the constructed wetland. Chlorinated organic compounds will be formed, but far fewer than if chlorine gas were used. Discussions are underway with the New Jersey Department of Environmental Protection (NJDEP) to utilize ultraviolet, or other techniques, for sterilization. The contaminants that would likely be present would be household related VOCs and some metals and would not likely pose a major threat to wildlife. In one sludge digester sample in 2005, the following metals were analyzed: molybdenum 370, arsenic <17.5, selenium <23.7, beryllium <0.5, cadmium < 2.0, chromium 15.0, copper 395, lead 25, nickel < 19.5, mercury <0.50 and zinc 650 ppm. At all other GATE locations the facilities are connected to a centralized sewage treatment facility offsite. There are no septic systems at any of the GATE facilities.

The large number of visitors to the parks, greater than 8 million, per year results in a large vehicular footprint at these locations.In order to accommodate this number of visitors, there are a large number of paved roads and parking areas throughout GATE. The contaminants collecting on these surfaces and washed off during rain storms would contribute to elevated levels of petroleum hydrocarbons, and some metals such as copper (brake pads 30% copper) and lead (gasoline).

Pesticide application for control of invasive species is coordinated through the NPS for all of the GATE locations. Pesticides are not used to control mosquitoes or flies at both the Staten Island Unit and Sandy Hook Unit. At the Fort Wadsworth location, pesticide and herbicide applications do occur on leased areas within the park. The areas treated are small and likely have little impact of pesticide burden for wildlife in the area. Although NPS properties are not sprayed in Jamaica Bay, adulticide spraying is conducted in nearby marshes when West Nile virus or encephalitis health concerns arise. Six compounds including malathione, methoprene, methoprene acid, piperonyl butoxide, resemethrin and sumithrin, are typically used to control mosquitoes (USGS 2005). The counties attempt to eliminate breeding areas by using biological controls, mosquito eating fish, and crustacean. Attempts are also made to control mosquitoes by using baits that effect juvenile stages.

Each of the GATE units have facilities where vehicles are stored and maintained and where loading and cleaning of pesticide application equipment occurs. The facilities also contain general paint and mechanical shops for metal working and fabrication. The areas are generally a series of warehouse structures with gravel or hardtop areas. These areas likely have elevated

VOCs, petroleum products, and metal levels from rusting equipment. Most of these areas are fenced off and pose limited exposure to wildlife. There is a potential however to contaminate shallow aquifers. The installation of a slurry pipeline is being planned along the main road at Sandy Hook, which will require additional heavy equipment that may contribute to petroleum hydrocarbons being deposited or spilt.

Surface Water

Although each of the GATE units abuts against either large bays or rivers, there is very limited surface water within the land portions of the park units. Small freshwater/brackish ponds are located at Sandy Hook (Niki Pond) and Jamaica Bay Units (Fort Tilden Pond). These ponds are likely fed from shallow groundwater aquifers. In the case of the Sandy Hook Unit, groundwater contaminated with munitions waste and solvents may contribute to low level contamination. For the Jamaica Bay ponds, atmospheric deposition and surface runoff are the likely sources of contamination to these small pond areas. Because of the proximity to densely populated areas, a major international airport (jet fuel components), and air quality (mercury, NO_x, SO_x) the concentrations in these ponds could be higher than would be expected from more remote locations (NY Academy of Sciences 2006).

The NPS carries out a water quality monitoring program examining surface waters adjacent to park properties (DNR 2006). The following parameters are monitored at 25 locations park wide: total and fecal coliforms, enterococcus bacteria, chlorophyll-a, conductivity, dissolved oxygen, water depths (Jamaica Bay only), nitrates, pH, phosphates, salinity, turbidity, and temperature. Combining these data with the data collected by the NYDEC and Clean Ocean and Shore Trust (COAST) (2006) allows for identification of areas that are periodically impacted by sewage related contamination. The areas would include the waters near the Great Kills, northeastern corner of Jamaica Bay, areas adjacent to Pennsylvania Avenue Landfill and at the southern end of Sandy Hook Bay. Although other chemicals were not assessed at these locations, it can be assumed that contaminants related to sewage and combined sewer outfalls such as, copper, personal care products, phthalates, and pharmaceuticals, would be elevated within these areas.

Groundwater

Shallow groundwater aquifers in the New Jersey/New York area do suffer from historical industrial activities that have resulted in VOCs being present in a number of the two states' aquifers in the GATE units (USGS 2006). The removal of the USTs at a number of the GATE units has eliminated further contamination of groundwater, but naphthalene, benzene, toluene, and xylenes are still being detected even in some previously remediated sites (Sandy Hook Unit). The water supply used at the Sandy Hook Unit is from a deep well. The deep groundwater aquifers 900 ft (274 m) under Sandy Hook do not appear to be contaminated based on current testing results (Wellhead Protection Plan PWSID NJ1331001). Using Method 624 for drinking water, all analytes were nondetect. Groundwater contamination at the formerly used defense sites remains an issue at Sandy Hook and potentially other GATE locations. The ongoing evaluation being funded by the military will better clarify the extent of groundwater contamination at these formerly used defense sites. Both the Staten Island and Jamaica Bay Units are supplied municipal waters from reservoirs from upstate New York and not local groundwater. Because there are few if any freshwater ponds and creeks that have groundwater as their source at these locations, there is little potential exposure to wildlife. Groundwater contamination from other

sources as discussed below from offsite inputs could contribute to groundwater contamination reaching the bay waters adjacent to the NPS lands.

Offsite Inputs

The wildlife inhabiting and migrating through the GATE Units are exposed to a variety of chemicals that have been historically deposited within the sediment (PCBs, dioxins/furans, DDT, mercury) or are being released continuously due to the high human population density and extensive industrial infrastructure (pharmaceuticals, petroleum production, shipping, etc.). The extensive offsite activities have a dramatic impact on COCs reaching wildlife living in GATE Unit properties.

A General Overview of Historical and Current Inputs of COCs

The drainage basin of the NY/NJ Harbor estuary encompasses about 16,300 square miles (Figure 1). The quality of the harbor and associated estuaries is affected by the land-use practices throughout this region. Non-point sources of pollution are sources of contaminants and particulates that accumulate over a broad area and enter the surface waters. Atmospheric deposition is a significant pathway of non-point sources in the New York region. Airborne mercury, nutrients, soot, and particulates result in an ongoing pollutant source entering into surface waters (NY Academy of Sciences 2006). The urbanized areas with their impermeable paved surfaces lead to runoff that contributes to oils, greases, metals, litter, and small particulates entering into surface waters. Historically, the NY/NJ Harbor estuary has supported heavy industry, large population growth, and extensive harbor related activities. There is a chemical legacy from both historic, as well as current activities, in and around the harbor. Figure 5 shows the watersheds impacting (in pink) the GATE Units along with the superfund sites in the NY/NJ Harbor watershed. There is a concentration of superfund sites that impact these watersheds and the GATE wildlife through direct exposure to contaminated soil, water, sediment, and consumption of contaminated prey species. Offsite COCs for the GATE wildlife would include PCBs, chlorinated dioxins and furans, petroleum products, heavy metals, and endocrine disrupting compounds (bisphenol A, steroids) based on historic and current inputs into NY/NJ Harbor estuary.

One of the major sources of PCBs in the Hudson River are primarily from activities of the General Electric manufacturing plants (1940-1977) that discharged an estimated 90,718 to 589,670 kilograms of PCBs into the Hudson River. However, there are other sources of PCBs entering into the watershed. There are 208 PCB congeners each with their own physical and chemical properties and toxicity. The PCBs in the Hudson River ecosystem are among the highest levels found in the United States. In 1984, the USEPA designated the lower 322 kilometers of the Hudson River as a superfund site. The PCB criteria are set by the individual states. Today the NYDEC enforces a “catch and release” program in the Upper Hudson River, while commercial fishing of striped bass (Morone saxatilis) in the Lower Hudson River remains in effect.

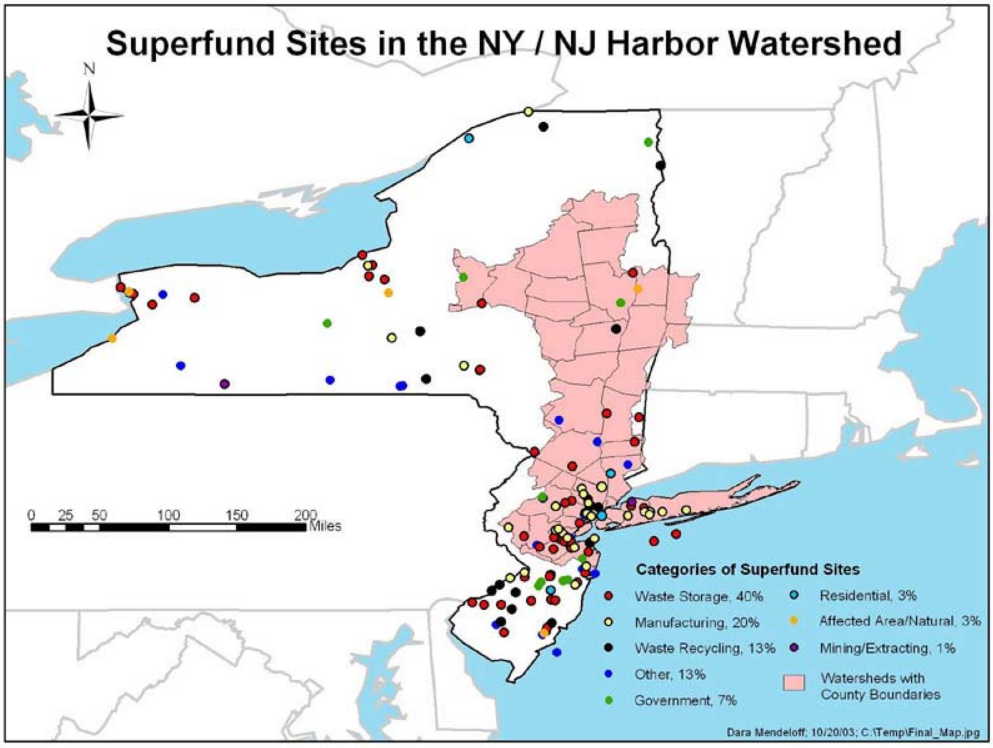


Figure 5. Superfund Sites in the NY/NJ Harbor Watershed. (NY Academy of Sciences 2006)

It is predicted that if no action were taken to remove PCBs that there would be a gradual depletion of PCBs in active surface sediments (Baker et al. 2001). Current plans are to dredge the Hudson River to speed recovery to non-toxic levels. There will likely be an increase in toxicityinitially that should decrease rapidly as “hot spots” are removed from the system. It has been estimated that dredging could result in a doubling of the current toxic levels in wildlife and then fall below toxic levels.

The chlorinated dioxin and furan contamination in the estuary is also a result of past and current inputs into the estuary. The largest single input into the estuary is due to the manufacturing of Agent Orange at the 80 Lister Avenue site located on the banks of the Passaic River. The facility alone is estimated to have released kilogram quantities of the most toxic congener of the dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) (Belton et al. 1988).

Just as with PCBs, there are a series of congeners (135) of dioxin and dibenzo furans that can be formed. The toxicity associated with each congener can be ranked as it relates to the most toxic congener 2,3,7,8-TCDD. In this way the complex mixtures that are present in environmental samples can be added to give a toxicity equivalency quotient (TEQ). There are different toxicity equivalency factors for each congener and there are specific toxicity equivalency factors for mammals, birds, and fish. This is an important point because all environmental samples are mixtures of these congeners, which are not equitoxic across the different animal groups.

There are a number of current day sources (coal fired incinerators, pharmaceuticals) for these compounds that continue to enter the watershed. Because of the mechanism of action of these compounds, they have a deleterious effect on the reproduction and development of organisms. It

is also important to note that a number of PCBs have dioxin-like activity, which also work through the same receptor and therefore through the same mechanism of action.

Mercury is also a major contaminant present in this estuary from historical use at locations at Piles Creek and in the Meadowlands along the Hackensack River. The locations were manufacturing facilities for thermometers and metal plating operations. The sediments are heavily contaminated and are a chronic source entering the estuary. Landfills are another major source of mercury, and it that can enter the estuary through volatilization upon incineration or break down into landfill leachate. The New Jersey Mercury Task Force (2002) has estimated that the mercury content of waste in place is 2.5 ppm and that there is an estimated 500,000 kg of mercury in New Jersey landfills (Aucott 2006). Atmospheric deposition from coal-fired plants are another source of mercury entering the estuary. For the Hudson, Raritan Bay area, Themelis and Gregory (2001) estimate that utility, industrial, and residential boilers contribute 873 kg/yr; emissions from iron and steel smelting contribute 644 kg/yr; waste-to-energy plants contribute 140 kg/yr; and sewage sludge incinerators contribute 152 kg/yr. It has been estimated that approximately one metric ton of mercury is entering the NY/NJ Harbor Estuary system from various sources every year (Themelis and Gregory 2001). Mercury being deposited into the sediment has decreased but is currently estimated as ranging from over 10 ppm to 0.7 ppm or less. This value is approaching the pre-industrial mercury levels for this region of 0.1-0.2 ppm (Bopp et al. 1993). Because of sedimentation patterns in the estuary and local sources there are a number of locations still at the toxic range for mercury to wildlife (Steinberg et al. 2004). As discussed below mercury remains a COC for this estuarine system.

Other metals that are elevated include copper, cadmium, nickel, lead, and silver (Steinberg et al. 2004). The sources for these include electroplating, chemical manufacturing, photographic operations, landfills, and sewage treatment facilities throughout the region. In addition to these sources, there are atmospheric inputs. The pre-industrial levels for these metals are presented in Table 1.

Table 1. Pre-Industrial Levels of Cu, Pb, Zn, Cr, and Hg.

Metal	Mean Shale Values (ppm)	Hudson River Values (ppm)
Copper (Cu)	45	20
Lead (Pb)	20	25
Zinc (Zn)	95	80
Chromium (Cr)	90	60
Mercury (Hg)	0.18	-

(Bopp et al. 1993)

Petroleum inputs into the estuary come from storage facilities, transfer locations, and shipping operations within the estuary. In addition, motor vehicles and roads release hydrocarbons into storm drains that eventually enter the estuary. There are numerous small spills of petroleum products that are not reported on a daily basis, and larger spills that impact the wetlands and estuaries (Figure 6). Although many of these spills occur in surface waters, a large portion of the oil ends up adhering to suspended particles and ultimately in the benthic sediment compartment. Petroleum hydrocarbons are a class of compounds that are COCs for wildlife inhabiting this estuary.

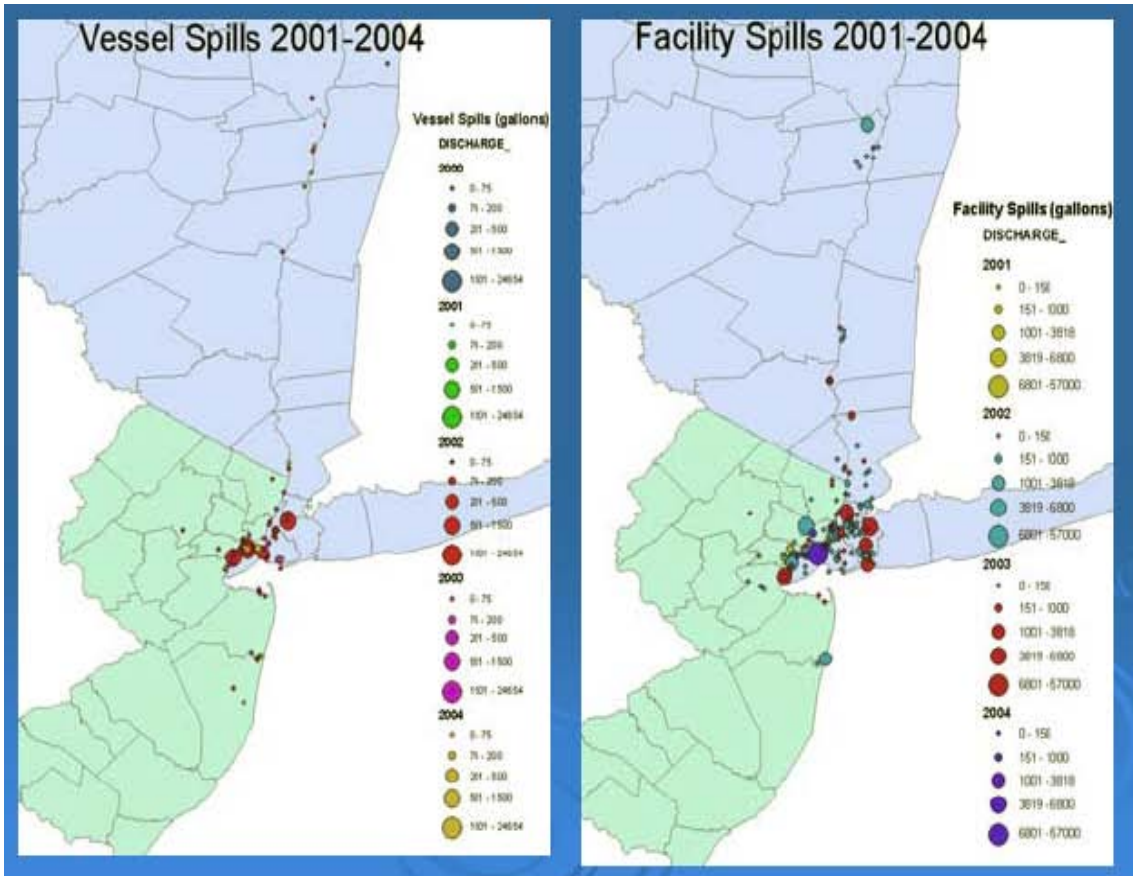


Figure 6. Oil Spills from Vessels and Facilities Reported in 2001-2004. http://www.seas.columbia.edu/earth/EECIndustrialEcology.html. (Panero 2006)

Due to the number of people living in the metropolitan area (8.5 million), there are a large number of sewage treatment plants that discharge directly into this system. Sewage treatment effluents are sources of metals, petroleum hydrocarbons, PCBs, chlorinated dioxins and furans, and nutrients. Along with the effluent, a number of endocrine disrupting compounds that affect aquatic species and piscivorous birds are released (IUPAC 2003; Nash et al. 2004; Mills and Chichester 2005). These compounds alter normal reproduction within these species and are hypothesized to be a contributing factor to declines in fish and avian species. This trend has been shown in Jamaica Bay where altered sex ratios in winter flounder and Atlantic silverside populations have been attributed to these compounds (nonylphenol and related compounds) entering through sewage treatments plants (Ferguson et al. 2001a,b; McElroy, personal communication, February 2006; Mena et al. 2006). Similar finding were reported from the Thames River in England where male fish were feminized (Purdon et al. 1994; Sumpter 1998) as well as from other water bodies receiving endocrine disrupting compounds (Nash et al. 2004; Mills and Chichester 2005).

The NY/NJ Harbor estuaries are heavily impacted by many compounds that will affect wildlife living on or near the park service lands. There is evidence that the contaminant levels are decreasing, but the concentrations in sediments and biota remain above levels that would result in toxicity.

Terrestrial Sources

Industrial and Non-Industrial Contributors to Chemicals of Concern:

Staten Island Unit: Fort Wadsworth, a former military installation, is located on the shore of the Staten Island Unit of GATE. Also located within this area is the Sun Chemical Corp., which is one of the largest producers of ink and pigment (Table 2). Barium compounds (2,313 kg/yr) and sodium nitrite (272 kg/yr) are transferred to Waste Broker Disposal for offsite waste disposal. A majority of regulated hazardous waste sites located around the Staten Island Unit of GATE consist of over 20 cleaners that may be contributors of VOCs, such as perchloroethylene and tetrachloroethylene. These facilities are potential hazardous waste sites regulated by the USEPA under the Resource Conservation and Recovery Act (USEPA 2006d). They also likely contribute contamination to the sewage treatment plant.

Table 2. USEPA – Toxic Release Inventory (TRI) for Staten Island (Fort Wadsworth).

Row #	Facility	TRIF ID	Fugitive Air Emissions (kg)	Point Source Air Emissions (kg)	Total Onsite Disposal or Other Releases (kg)	Total Offsite Disposal or Other Releases (kg)	Total Onsite and Offsite Disposal or Other Releases (kg)	Total Air Emissions (kg)
1	Sun Chemical Corp Rosebank Plant, 441 Tompkins Ave, Staten Island	10305 SNCH M441TO	54.4	54.4	108.9	6,940.0	7,048.8	108.9
	5-Nitro-o-Toluidine		NA	NA	NA	NA	NA	NA
	Barium Compounds		31.8	31.8	63.5	6,667.8	6,731.3	63.5
	Sodium Nitrite		22.7	22.7	45.4	272.2	317.5	45.4
	Total	3	54.4	54.4	108.9	6,940.0	7,048.8	108.9

(USEPA 2004b)

Sandy Hook: Located within the Sandy Hook unit of GATE is the U.S. Coast Guard Detachment and Fort Hancock, which was used for coastal defense until 1974. The site has private homes, as well as a fully functioning base (Table 3). Coast Guard cutters are moored at this location. They have a full maintenance facility. A small dump was located on this site, and received mixed solid waste. There is a firing range onsite that is used by state and federal agencies. Both water and sewage treatment is carried out by NPS operated facilities.

Less than a kilometer south of Sandy Hook Bay is the former Atlantic Highlands Manufactured Gas Plant (MGP), which is located within the Borough of Atlantic Highlands. This government facility was in operation from about 1910 to 1949 and extracted natural gas, such as methane and propane from coal, leaving heavier hydrocarbons behind as residue. These residues consisted primarily of polyaromatic hydrocarbons (PAHs) (ATSRD 2005). This facility would likely impact local flora and fauna at the site, but would have little impact off site due to the nature of the contamination.

Table 3. USEPA – TRI for Sandy Hook.

Row #	Facility	TRIF ID	Fugitive Air Emissions (kg)	Point Source Air Emissions (kg)	Total Onsite Disposal or Other Releases (kg)	Total Offsite Disposal or Other Releases (kg)	Total Onsite and Offsite Disposal or Other Releases (kg)	Total Air Emissions (kg)
1	U.S. Coast Guard Detachment Sandy Hook, 20 Crispin Rd, Highlands	07732SCSTG20CRI	0.5	0.0	129.7	.	129.7	0.5
	Lead Compounds		0.5	0.0	129.7	.	129.7	0.5
	Total	1	0.5	0.0	129.7	.	129.7	0.5

(USEPA 2004b)

Jamaica Bay: Over the past years, Jamaica Bay's ecosystem has been degraded through human encroachment and increased urbanization. According to the NPS (2003a), the salt-marsh islands of Jamaica Bay have been disappearing rapidly. The shoreline has been hardened by the construction of JFK airport on the northeast shore and the Shore (Belt) Parkway on the northwest shore (Figure 4). Also, the natural flow of water and sediment through the system has been altered due to dredging (NPS 2003a).

There are numerous former airfields and missile sites located throughout and around Jamaica Bay that were formerly private concerns but which have been turned over to the NPS. Both Floyd Bennett Field and Fort Tilden are part of GATE. Besides JFK airport, which is still in operation, Floyd Bennett Field and Fort Tilden are also located in Jamaica Bay (Table 4). Floyd Bennett Field, constructed in 1929 in Brooklyn, was New York City's first municipal airport. Naval operations began at Floyd Bennett Field in 1931. The runways have long been closed but are occasionally used for air shows. The New York Police Department, the New York City Department of Sanitation, and the United States Marine Corps use part of the Floyd Bennett Field (Freeman 2006). Located in the boroughs of Queens in Jamaica Bay, on the Rockaway Peninsula, is the former naval air station Fort Tilden. Some of the cold war missile site is still intact today, including the launcher area and the former Nike installation (Freeman 2006). COC from military and commercial activities include benzene, toluene, xylenes, jet fuels, perchlorate, and commercial gasolines. These activities result in contamination of soils, groundwater, and surface waters.

Table 4. USEPA – TRI for Jamaica Bay (JFK Airport).

Row #	Facility	TRIF ID	Fugitive Air Emissions (kg)	Point Source Air Emissions (kg)	Total Onsite Disposal or Other Releases (kg)	Total Offsite Disposal or Other Releases (kg)	Total Onsite and Offsite Disposal or Other Releases (kg)	Total Air Emissions (kg)
1	Allied New York Services Inc, JFK International Airport Building 90, Jamaica	10001GDNN WJFKIN	12.2	38.6	50.8	0.0	50.8	50.8
	Ethylbenzene		2.3	12.2	14.5	0.0	14.5	14.5
	Naphthalene		10.0	26.3	36.3	0.0	36.3	36.3
2	U.S. Customs Service Firing Range, JFK Building 77, Jamaica	11430SSCST MJFKBU	0.0	0.0	0.0	0.0	0.0	0.0
	Lead		0.0	0.0	0.0	0.0	0.0	0.0
	Total	3	12.2	38.6	50.8	0.0	50.8	50.8

(USEPA 2004b)

Landfills: Landfills are a source of both organic and inorganic compounds, which are present in the municipal and industrial solid waste and ash material that is often mixed in with solid waste. As the materials deposited into landfills and undergo breakdown, they release methane gas and other VOCs that may be volatized or partitioned into the leachate from the landfills. The organic compounds that are released both into the atmosphere and through the leachate are a reflection of the materials placed within any given landfill. Aucott (2006) estimated the heavy metal concentrations in municipal solid waste to be the 4-20 ppm cadmium, 77 ppm copper, 350 ppm chromium, 230-400 ppm lead, 1.5 ppm mercury, 57 ppm nickel, and 380 ppm zinc. With the exception of mercury, which can escape through volatilization, the other metals will move into the environment through landfill leachate or subsurface runoff. Shown in Table 5 are the values reported by Aucott (2006) taken from the USEPA LEACH 2000 database and values collected from three currently operating landfills in New Jersey (Table 5). What is striking is the much lower concentrations observed in the current leachates of NJ landfills, which likely reflect properly managed landfills. The LEACH 2000 numbers are a composite of leachates from many different landfills. However, the point remains that landfills, even after being closed, can contribute to metal loading into receiving waters.

Staten Island Unit: The Fresh Kills Landfill, which is thought to be one of the largest landfills in the world, spans more than 809 hectares (2,000 acres) of land across the western shore of Staten Island, New York, and it is located in an area of mixed residential, commercial, industrial, and recreational land uses (ATSDR 2000). Fresh Kills Landfill was closed in 2001. The Brookfield Avenue Landfill is located near the southeastern border of the Fresh Kills Landfill in Staten Island. This landfill is bounded on the south and west by Arthur Kill Road and Richmond Avenue, respectively; to the north by Richmond Creek; and to the east by the Colonial Square condominiums. Both of these landfills are located on the southwestern side of Staten Island. The The Agency for Toxic Substances and Disease Registry (ATSDR) report summarized the exposure pathways for humans associated with Fresh Kills Landfill and Brookfield Avenue

Landfill, and concludes that there is no significant exposure to humans living near the landfill. The ATSDR report does not make any recommendations concerning wildlife exposure.

There is evidence of groundwater and surface water contamination that would impact local aquatic and terrestrial habitats. In 1998, fishing, shellfishing, and crabbing in the area were prohibited. New York State has issued fish consumption advisories for all freshwaters and for Arthur Kill, into which Richmond Creek flows. The hazardous chemicals most often found in fish and shellfish from New York State sampling included metals, PCBs, dioxins, furans, pesticides, and PAHs. Many of these chemicals have been detected in the surface water and sediment in the vicinity of the Fresh Kills Landfill. The landfill is likely only one of many sources for these compounds. Groundwater on Staten Island has not been used for public supply since 1970, and currently is not used for drinking water. Cretaceous aquifer groundwater sampled during the remedial investigation had levels of contamination detected that pose no apparent public health hazard (ATSDR 2000). Without further testing, it is impossible to determine the impact of these landfills and their contaminants on wildlife in the vicinity of these landfills.

Detailed information of the chemicals released from these New York facilities can be obtained at: http://www.atsdr.cdc.gov/HAC/PHA/freshkills/fkl_toc.html and http://www.atsdr.cdc.gov/HAC/PHA/brookfield/bal_toc.html.

Table 5. Comparison of Heavy Metal Concentrations in Landfill Leachate.

Metal	No. Samples LEACH 2000[1]	Mean (mg/l) LEACH 2000	No Samples NJDEP	Range (mg/l) NJDEP
Arsenic	2,444	0.441	43	0.0074-0.055
Barium	1,779	0.866	NA[2]	NA
Cadmium	2,351	0.283	54	0.002-0.0053
Chromium	2,776	0.235	38	0.015-0.037
Lead	2,539	0.133	54	0.0025-0.026
Mercury	2,078	0.00715	35	0.00005-0.00009
Selenium	1,754	0.585	NA	NA
Silver	1,830	0.0537	NA	NA

(Aucott 2006)

1. The LEACH 2000 database represents over 200 landfills (Aucott 2006).
2. NA stands for not analyzed

Sandy Hook: Information for each landfill in New Jersey can be obtained from the NJDEP Solid and Hazardous Waste unit at: http://www.nj.gov/dep/dshw/lrm/landfill.htm. Located in Monmouth County is the Atlantic Highlands Landfill, which was a government supervised landfill. It occupied one hectare. It is not listed as a superfund site and is currently closed. Based on its location and size, this landfill does not likely pose any threat to wildlife at the Sandy Hook Unit.

Jamaica Bay: The NYCDEP and Corps of Engineers are involved in a multi-year project to remediate the Fountain (120 hectares) and Pennsylvania Avenue (44.5 hectares) landfills. The two landfills are bordered by the Belt Parkway on the north; Jamaica Bay on the south; Fresh Creek on the west; Hendrix Creek in the middle; and Spring Creek on the east. Onsite treatment systems will collect leachate that is pumped to the 26th Ward Water Pollution Control Plant. The landfills are comprised of tens of millions of cubic meters of municipal and industrial waste deposited at the sites until the mid-1980s. The Pennsylvania and Fountain Avenue landfills are in the final stages of remediation and will be converted into a 162 hectare parkland site along Jamaica Bay. The NYCDEP will manage the landfills for up to 30 years to ensure the landfill caps remain impermeable and that the leachates and toxic compounds emanating from the landfill are prevented from entering into the surrounding waters.

USEPA National Priorities List (NPL) Sites: Currently, all areas near the three GATE Units that can potentially have an impact on the park are either not listed on the USEPA NPL or are listed as "Non-NPL" sites. Table 6 lists the sites in Staten Island and Jamaica Bay that were identified by the USEPA NPL. No sites in New Jersey near Sandy Hook were mentioned on the NPL. More detailed information on NPL sites in New York and New Jersey can be obtained from the USEPA Basic Query Form: http://www.epa.gov/superfund/sites/query/basic.htm.

Surface Water

Shown in Figure 7 is a schematic that illustrates the general flow of major surface waters in the NY/NJ Harbor and traditional treatment plant and combined sewer outfalls. This schematic was taken from a report entitled "Water Quality in New Jersey Harbor Waters" written through NY/NJ COAST (2004), and it illustrates the relative millions of liters per day of flow from the various rivers and treatment and combined sewer outfalls inputs. It also illustrates the tidal nature of the region and the net flows into the Atlantic Ocean.

The NYCDEP has conducted water quality analysis at regularly sampled sites since 1909 (12 to 53 stations), and these data are available at http://www.nynjcoast.org/NYCDEPHarbor_survey/. The physical parameters collected at each site include water clarity, total suspended solids, tidal flow and current conditions, temperature, pH, and salinity. Other parameters collected at these locations include fecal and total coliform concentrations, dissolved oxygen, chlorophyll-a, and nutrient levels (NYCDEP 1997, NY/NJ COAST 2004). There has been continued improvement in a number of the water quality parameters (increased surface and benthic dissolved oxygen, decrease in fecal coliform counts, decrease in ammonia) that are resulting in re-establishment of shortnose sturgeon (*Acipenser brevirostrum*), and increased striped bass stocks along with opening of previously closed shellfish beds.

Table 6. NPL Status for Areas Staten Island and Jamaica Bay, New York.

Location	Site Name	NPL Status	Chemical of Concern
Staten Island	Arden Woods Estate	Non-NPL	NS[1]
Staten Island	Barge 210 Berman Nathan	Non-NPL	PAHs, PCBs, VOCs
Staten Island	Berman Enterproposes	Non-NPL	NS
Staten Island	Brookfield Ave. Landfill	Non-NPL	PAHs, Metals, Nitrates, VOCs
Staten Island	Chelsea Term (Positive Chem)	Non-NPL	NS
Staten Island	Huff Enterprises	Non-NPL	NS
Staten Island	Nassau Recycle Corp	Non-NPL	Non Ferous Metals, PAHs,
Inwood	Rockway Metal Products	Non-NPL	Heavy metals, VOCs
Brooklyn	All Plating Corporation	Non-NPL	Heavy metals, VOCs
Brooklyn	BCF Oil Refining Inc.	Non-NPL	PAHs, VOCs
Brooklyn	Hamilton Avenue Incinerator	Non-NPL	PAHs, Metals, Acid volatiles

(USEPA 2006b)
1. NS = not specified

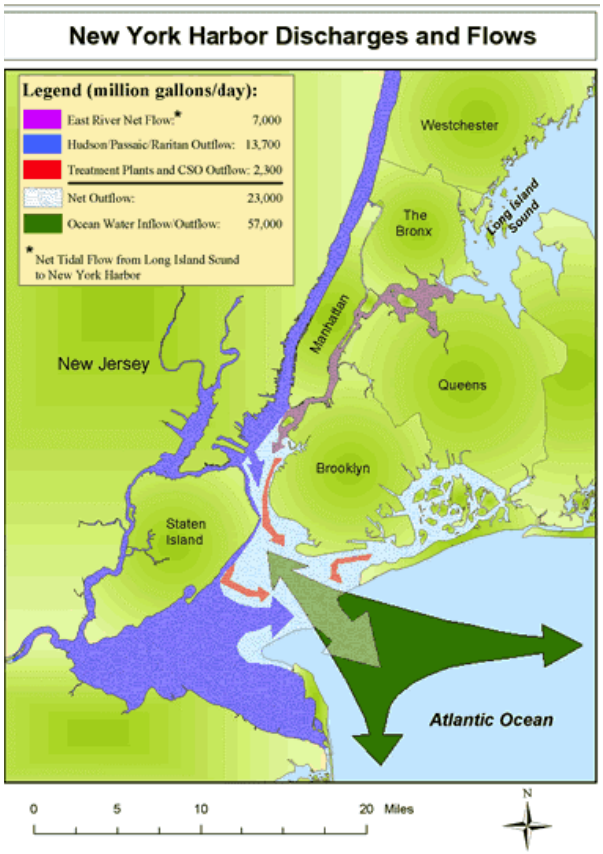


Figure 7. Estimated Discharge and Flow Volumes in the NY/NJ Harbor Estuary. (NY/NJ COAST 2004).

National Pollutant Discharge Elimination System (NPDES) Permitted Discharges: The harbors total mean flow is estimated to be 60.6 billion liters per day of freshwater, including 8.7 billion liters per day from wastewater treatment plants, storm drains, and combined sewer outfalls (NY/NJ COAST 2004). At least one major water body boarders each unit of the park's property making it one of the major routes of COC exposure to wildlife. COCs introduced into Jamaica Bay and the Raritan Bay from non-point and point sources can affect sediment, water quality, and biota within park borders. Industries discharging to surrounding surface waters, recreational boating, and oil or hazardous material spills that might occur within the watershed may also impact the biota.

Fourteen wastewater treatment plants are located throughout the five boroughs of New York City (Figure 7, NYDEP 2006a). In the GATE Units, wastewater treatment plants are located in drainage areas around Jamaica Bay and one on Staten Island (Table 7 and Figure 8). Because of combined sewage outfalls and limited retention capacity, these plants are forced to release raw or partially treated sewage. It has been reported that there are at least 27 significant WPCP in operation in the NY/NJ metropolitan region. It is estimated that 7.2 million gallons per day of treated wastewater is discharged into the NY/NJ Harbor Estuary. Areas with limited flushing or flow (i.e., Jamaica Bay) will have higher levels of COCs and nutrients from these facilities. Because of the watershed drainage, all of the wastewater treatment effluents make their way into the Lower New York Harbor and Raritan Bay prior to moving offshore. Local discharges to the park units will have higher effluent concentrations and local impact; this is especially true in Jamaica Bay. The Oakwood Beach facility discharges into Raritan Bay and an extended outfall pipe is currently under construction. Based on bacterial water quality data there is an area near the Great Kill Harbor that has elevated counts. These high counts are likely due to the Oakwood Beach facility and currents bringing bacteria from the New Jersey dischargers (Table 8) in the Arthur Kill and to drainage into the western part of Raritan Bay.

These wastewater treatment plant effluents continually discharge metal and organic compounds that are introduced from industry and households. This source is a chronic input into the system of a number of traditional (PCBs, PAHs, metals, VOCs) and emerging COCs (endocrine disrupters) (IUPAC 2003). The 14 WPCPs in New York have the total capacity to discharge 6,833 million liters a day (MLD) and in 2003 the mean daily flow was 5,027 MLD.

Oil and Gasoline Chemical Components: The Port of New York and New Jersey is the largest port facility in the region. Both containerized freight and oil refining and storage are growing rapidly. Because of the shipping activities, a primary concern to park resources is the threat of an oil spill or significant hydrocarbon release. Impairments to park resources can arise from the accumulated effects of small spills, and possibly from larger spills from facility releases, intentional releases, or a major tank spill. Small spills occur on a regular basis in all of the marinas and are likely to go unreported, but their cumulative effect is the overall degradation of the benthic environment and elevated water soluble fractions that could affect pelagic organisms and larval stages. Within Figure 7 are summarized data on spills from vessels and facilities within the watershed, which was reported by Panero (2006). There are significant spills that are occurring in the lower bay area almost on a continuous basis. This is not unexpected due to the large number of ships transporting petroleum hydrocarbons to the receiving facilities.

Table 7. New York Wastewater Treatment Plants at the Jamaica Bay Unit and Staten Island Unit.

Plant in Operation	Description	Chemicals of Concern
26th Ward WPCP (Jamaica Bay)	Plant in Operation: 1939 Design Capacity: 568 MLD Dewatering: Bower Bay Population Served: 848, 328 Receiving Water Body: Upper East River Drainage Area: 6,152 hectares, northeast section of Queens	Nutrients: ammonia, nitrites, nitrates, phosphorous. Metals, PCBs, PAHs, VOCs, pharmaceuticals and personal care products.
Jamaica WPCP (Jamaica Bay)	Plant Operation: 1903/1943 Design Capacity: 378.5 MLD Dewatering: Jamaica WPCP Population Served: 728,123 Receiving Waterbody: Jamaica Bay Drainage Area: 10.244 hectares, southern section of Queens	Nutrients: ammonia, nitrites, nitrates, phosphorous. Metals, PCBs, PAHs, VOCs, pharmaceuticals and personal care products.
Rockaway WPCP (Jamaica Bay)	Plant in Operation: 1952 Design Capacity: 170 MLD Dewatering: 26th Ward WPCP Population Served: 90,474 Receiving Waterbody: Jamaica Bay Drainage Area: 2,533 hectares, Rockaway Peninsula	Nutrients: ammonia, nitrites, nitrates, phosphorous. Metals, PCBs, PAHs, VOCs, pharmaceuticals and personal care products.
Coney Island WPCP (Jamaica Bay)	Plant in Operation: 1935 Design Capacity: 757 MLD Dewatering: Hunts Point Population Served: 684,569 Receiving Waterbody: Upper East River Drainage Area: 6,744 hectares, eastern section of the Bronx	Nutrients: ammonia, nitrites, nitrates, phosphorous. Metals, PCBs, PAHs, VOCs, pharmaceuticals and personal care products.
Oakwood Beach (Staten Island)	Plant in Operation: 1956 Design Capacity: 151 MLD Dewatering: Oakwood Beach WPCP Population Served: 244,918 Receiving Water Body: Lower New York Bay Drainage Area: 4,362 hectares, southern section of Staten Island	Nutrients: ammonia, nitrites, nitrates, phosphorous. Metals, PCBs, PAHs, VOCs, pharmaceuticals and personal care products.

(NYDEP 2006a).
PCB = polychlorinated biphenyls, PAH = polyaromatic hydrocarbons, VOCs = volatile organic compounds.

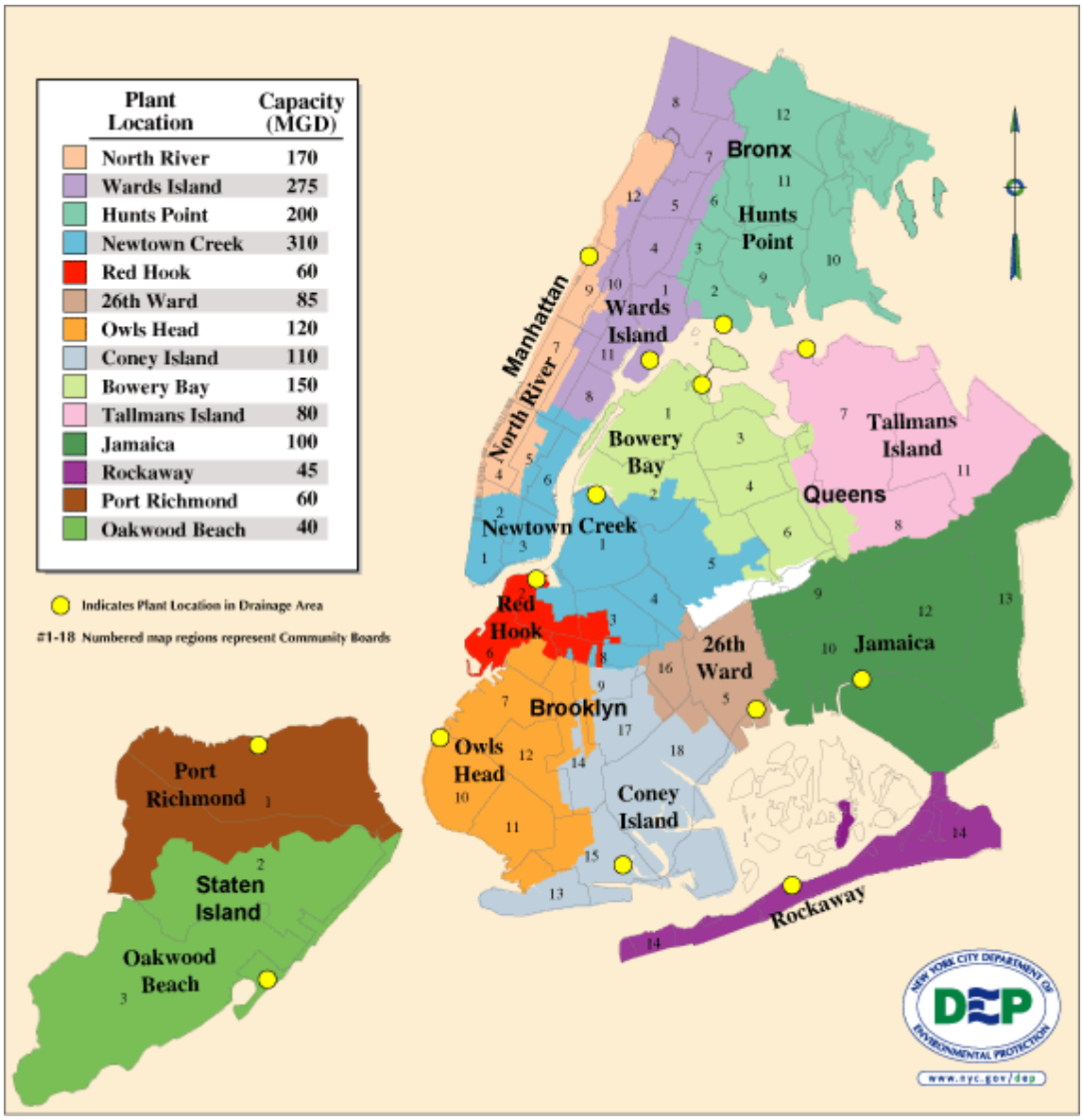


Figure 8. New York City Drainage Areas and Water Pollution Control Plants. (NYDEP 2006b)

Table 8. Major New Jersey WPCPs Discharging into NY/NJ Harbor.

NJ Plant in Operation	Description	Chemicals of Concern
Edgewater	Capacity 22.7 MLD (2003 11.4 MLD) Upgrade to Secondary 1989	Nutrients: ammonia, nitrites, nitrates, phosphorous. metals, PCBs, PAHs, pharmaceuticals and personal care products.
Passaic Valley	Capacity 1,249 MLD (2003 1086 MLD) Upgrade to Secondary 1988	Ibid.
North Bergen -Woodcliff	Capacity 11.4 MLD (2003 11.4 MLD) Upgrade to Secondary 1991	Ibid.
Adams Street (Hoboken)	Capacity 90.8 MLD (2003 45.4 MLD) Upgrade to Secondary 1994	Ibid.
River Road (West New York)	Capacity 37.9 MLD (2003 30.3MLD) Upgrade to Secondary 1992	Ibid.
Middlesex County Utility Authority	Capacity 556 MLD (2003 538 MLD) Upgrade to Secondary 1996	Ibid.
Joint Meeting of Essex & Union	Capacity 322 MLD (2003 276 MLD) Upgrade to Secondary 1996	Ibid.
Linden Roselle	Capacity 64.4 MLD (2003 53.0 MLD) Upgrade to Secondary 1989	Ibid.
Rahway Valley	Capacity 151 MLD (2003 125 MLD) Upgrade to Secondary 1991	Ibid.

Throughout the NY/NJ Harbor estuary there are numerous marinas, pump out stations and ferry terminals that would contribute to surface water contamination. The COCs from these marinas would include gasoline, diesel, copper, lead, and tributyltins.

Sandy Hook Unit: About a kilometer south of Sandy Hook Bay is the former Atlantic Highlands MGP. It had been in operation from 1910 to 1949. This facility extracted natural gas, such as methane and propane, from coal, leaving heavier hydrocarbons behind as residue, which consisted of PAHs (ATSRD 2005). The Navesink River is also a major boating and jet ski area that would contribute to hydrocarbon pollution into Sandy Hook Bay. Within Table 9 are listed the active New Jersey pollutant discharge elimination systems (NJPDES) near the park.

Jamaica Bay Unit: The JFK airport and the use of the Shore (Belt) Parkway around Jamaica Bay can cause wide spread oil and gasoline contamination. In the case of Jamaica Bay, leakage from USTs at JFK have resulted in PAH contamination of sediment in the western portion of the bay. The stormwater discharge pipes that empty into creeks and rivers entering Jamaica Bay also contribute hydrocarbon and metal contamination.

Pesticide Usage: Pesticide usage in both New Jersey (http://www.state.nj.us/dep/enforcement/pcp/) and New York (http://www.nyc.gov/html/doh/html/wnv/feis.shtml) are carried out at the county level with statewide oversight by USEPA. The major use of pesticides on a broad scale basis occurs for lawn care, golf courses, mosquito control and gypsy moth (*Lymantria dispar*) control. Today's agricultural pesticide inputs into the NY/NJ Harbor are low (454 to 4,536 kilograms active ingredient, AI) compared to the other sources. In the case of lawn care in Monmouth and Middlesex Counties in New Jersey, which lead into the Raritan Bay, between 32 to 58,967 kilograms of AI was applied to lawns in 2004 (NJDEP 2006). For lawn care, the percentage of total use and the most commonly used AIs were herbicides (78% /2,4-D), pesticides (15% /trichlorfor), and fungicides (6% /chlorothalonil).

In the case of mosquito control, both states recommend the use of larval baits, land use management, and biological controls, as opposed to aerial applications. Direct application to estuaries is prohibited unless there is a human health emergency. For mosquito control the pyrethins are the most commonly used adulticide, while Temophos, Maltione and Methoprene are also used. In the case of gypsy moth infestations, the current approved treatment is *B. thuringensis*/*B. sphaericus*, which is specific for the family of insects.

A large number of golf courses in New Jersey are located in Monmouth County (N = 27) and Middlesex County (N=11), which are in the NY/NJ Harbor watershed. According to the NJDEP, in 2002 Monmouth County applied 8,165 to 20,412 kg of pesticide to maintain the aesthetic appearance of the golf courses. The most common pesticides applied to golf courses was chlorothalonil, which is a fungicide (83%). In 2004, 3,175 to 5,443 kg of insecticides (9%) were applied in Monmouth County with chlorpyrifos being the most applied insecticide. The most frequently applied herbicide (6%) was 2,4-D. These contaminants have the potential to end up in the surface water through either surface runoff or groundwater, and as a result impact non-target species. There is a lack of experimental evidence as to the effects of these pesticides from combined sources entering into a complex estuary system such as the NY/NJ Harbor estuary.

Table 9. NJPDES Active Permit List (Monmouth County).

NJPDES Permit #	PI Number	Facility Name	Discharge Category Description	Chemicals of Concern
Highlands, NJ (near Sandy Hook)				
NJG0137006	54247	GATEWAY MARINA INC	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, VOCs
NJG0137316	54751	BAHRS RESTAURANT INC	Basic Industrial Stormwater GP - NJ0088315 (5G2)	Grease, VOCs detergents
NJG0147478	219792	TWIN LIGHTS MARINA	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, metals and VOCs
NJG0147885	202006	HIGHLANDS BORO	Tier A Municipal Stormwater General Permit	Oils, grease, metals and soot
Atlantic Highlands, NJ (near Sandy Hook)				
NJ0034924	46090	ATLANTIC HIGHLANDS WTP	Industrial Wastewater	VOCs
NJG0134929	49806	NEW JERSEY NATURAL GAS	General Permit GW Petro Prod Cleanup	PAHs, VOCs
NJG0149853	167066	ATLANTIC HIGHLANDS BORO	Tier A Municipal Stormwater General Permit	Oils, grease, metals and soot
NJG0156221	234346	SHELL SERVICE STATION #138291	General Permit GW Petro Prod Cleanup	PAHs, oils, grease, VOCs
NJG0158623	250566	ATLANTIC HIGHLANDS MUNICIPAL MARINA	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, VOCs
NJG0163881	285425	SEASTREAK - ATLANTIC HIGHLANDS MUN. HARBOR	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, VOCs

Table 9. NJPDES Active Permit List (Monmouth County).

NJPDES Permit #	PI Number	Facility Name	Discharge Category Description	Chemicals of Concern
Sandy Hook, NJ				
NJ0076694	47125	JAMES J HOWARD MARINE SCIENCES LAB	Industrial Wastewater	Grease, VOCs detergents
Fair Haven, NJ (Navesink River)				
NJG0115495	48252	FAIR HAVEN YACHT WORKS	Basic Industrial Stormwater GP - NJ0088315 (5G2)	Oils, grease, metals and soot
NJG0153991	191116	FAIR HAVEN BORO	Tier A Municipal Stormwater General Permit	Oils, grease, metals and soot
Rumson, NJ (Navesink River)				
NJG0116424	48327	OCEANIC MARINA	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, metals and VOCs
NJG0149071	213975	RUMSON BORO	Tier A Municipal Stormwater General Permit	Oils, grease, metals and soot
Red Bank, NJ (Navesink River)				
NJG0117340	48397	SEALS EASTERN INC	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, metals and VOCs
NJG0117439	48403	IRWINS YACHT WORKS INC	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, metals and VOCs
NJG0117790	48432	CENTRAL CONCRETE CORP	Concrete Products Manufacturing (GP)	Dust, metals, VOCs
NJG0132063	49577	MONMOUTH AFRC	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, metals and VOCs
NJG0150983	213267	RED BANK BORO	Tier A Municipal Stormwater General Permit	Oils, grease, metals and soot
Leonardo, NJ				
NJG0160636	261194	LEONARDO STATE MARINA	Basic Industrial Stormwater GP - NJ0088315 (5G2)	PAHs, oils, grease, metals and VOCs

(NJDEP 2003)

Groundwater

The USGS has reported on contamination found in both New Jersey and the New York areas. In addition, they have extensive information on individual contaminants and how they move through soil and within an aquifer (http://toxics.usgs.gov/investigations/chlorinated_solvents.html). There is extensive groundwater contamination of shallow aquifers from historical land use practices (agriculture, industrial uses, UST and others). The contaminants most commonly present are metals, methyltetbutylether (MTBE), toluene, benzene, xylenes, napthalenes, TCE, and nitrates (USGS 2006). Site-specific contaminants that are leachable can end up in the shallow aquifers.

On Staten Island one of the major sources for groundwater contamination is the Fresh Kills Landfill. Due to the hydrology the majority of contamination that reaches the aquifer or saturated zone moves into the Kills and does not impact the Staten Island Units.

According to the NYCDEP (2005), the groundwater system in New York City is comprised of 69 wells and provides drinking water to less than 100,000 people. Depending on water demand and availability, residents within the system receive groundwater or a mix of ground and surface waters. In 2005, the groundwater system (PWSID NY7011735) supplied an average of 8.3 MLD of drinking water from five wells, which is less than 1% of the city's total usage (NYCDEP 2005).

The groundwater system is located in southeastern Queens and covers an area of about 14.2 km^2. The system services Cambria Heights, Hollis, Holliswood, Jamaica, Kew Gardens, Queens Village, Richmond Hill, St. Albans, South Jamaica, and South Ozone Park (Table 10) (NYCDEP 2005).

Offsite groundwater contamination would not appear to be a major route of contaminants reaching the different park units and the wildlife.

Table 10. Wells in Operation in 2005.

Well #	Town	Aquifer	Depth (m)	Present Well Capacity (MLD)
5	Hollis	Magothy or Cretaceous Formation	83.82	6.55
23A	Cambria Heights	Magothy or Cretaceous Formation	110.34	8.71
32	South Ozone Park	Glacial or Post Jameco Formation	32.00	4.92
43A	Richmond Hill	Magothy or Cretaceous Formation	73.76	2.20
50A	Fresh Meadows	Magothy or Cretaceous Formation	77.42	5.45

(NYCDEP 2005)

Chemicals of Concern in Different Matrixes

The primary data sources for COCs were the USEPA EMAP, REMAP, and National Coastal Assessment database from the mid-Atlantic region and the NOAA Status and Trends Mussel Watch database. This region is data rich, which allows for the use of the HQ approach and extrapolation to wildlife (Sample et al. 1996). The intense sampling in this region is due to the high levels of contamination from land-based contamination sources. The large chemical and manufacturing industry that historically existed, and to a lesser extent today, is one reason for the intense sampling. Another reason was the realization that heavily contaminated sediments were moving up the food chain and posed human health risks. This is also the reason why there are fish advisories and closures in New York and New Jersey waterways. As stated earlier, the heavy usage of the port for commercial shipping and the need to keep channels dredged is another reason for the intense collection activity in this watershed.

It is not the purpose of this report to discuss the historical contamination of the estuary in great detail, but the major contributors of COCs in this estuary will be briefly discussed. Contamination of the Hudson River by PCBs has resulted in elevated levels throughout the estuary. Other sources of PCBs are the sewage treatment plants and historical sinks that are being released. The second major class of contaminants are the chlorinated dioxins and furans that have resulted in the Passaic River and Newark Bay being classified as superfund sites. The third class of contaminants are petroleum products spilled at the major refineries and storage facilities along the Arthur Kill, Newark Bay, and New York Harbor, as well as from sewage treatment facilities. Finally, mercury, has two land-based sources from the Hackensack River and Piles Creek in addition to the atmospheric deposition. There are a number of other metals that are COCs within the estuary. Large municipal and chemical landfills contribute a mixture of contaminants entering the estuary (see discussion above).

Sediment

USEPA REMAP Data

Harbor sediments are contaminant reservoirs, which can function as sinks of contaminants and result in chronic slow releases. Contaminated sediment can result in COCs entering foodwebs that can be a considerable threat to ecosystem wildlife. The USEPA REMAP data has demonstrated that the adverse changes in the system biota can be linked to elevated toxic contamination.

USEPA REMAP data were collected in 1993/1994 and 1998 to provide information on the extent of chemical contamination in the NY/NJ Harbor. In the summers of 1993 and 1994, 168 sites were sampled in the NY/NJ Harbor using a stratified random design. According to Adams et al. (1998), 14 sites where allocated for sampling in each year at each of the sub-basins. In 1998 sediment toxicity and sediment chemical concentrations were collected in four sub-basins of the harbor, surrounding 28 sampling stations in each sub-basin (Adams 2003).

Data compiled by Adams et al. (2003), from USEPA Region II (Figure 9), will be discussed in regards to COCs. The areas in this study are referred to as the NY/NJ Harbor and its sub-basins Jamaica Bay, Lower Harbor, and Upper Harbor. Even though Newark Bay and the Upper Bay

are not contiguous with GATE properties, their results are included because both bays empty into the bodies of water surrounding GATE units (Figure 10).

Due to the large number of USEPA sampling stations located within and around GATE, only a few representative stations around the three main park units were selected to obtain an understanding of what are the main contaminants of concern (Figures 11 and 12). Refer to Appendix 3 for sampling data on these specific locations. USEPA data for all stations located near GATE can be obtained from http://www.epa.gov/emap/.

The selection of the specific stations for Jamaica bay (Figure 11) was to examine stations near JFK Airport, drainage areas from Brooklyn, and the mouth of the bay. The selection of the stations for Sandy Hook represent the bay side, which has been shown to be a depositional area and close to Sandy Hook (Figure 12). The stations for Staten Island were selected because of their proximity to the Staten Island Unit.

Adams et al. (2003), summarized the results from a series of studies carried out by the USEPA in 1993/1994 and 1998. In the report, the areas of GATE are referred to as the Harbor and its sub-basins, which are Jamaica Bay, the Lower Bay, the Upper Bay, and Newark Bay. Figure 10 shows the sampling locations collected by the USEPA in 1998. The southern reaches of this system are influenced by freshwater inputs from several rivers: Passaic, Hackensack, and Hudson rivers. The contaminated sediments from these rivers make their way into sedimentation areas in Raritan Bay. Newark Bay and the Upper Bay are not the focus of this paper, however, these bodies of water empty into the waters, which surround the GATE units making it useful to also mention the data obtained from Newark Bay and the Upper Bay. The entire watershed and the chemical inputs from upstream can result in elevated levels of COCs impacting GATE wildlife.



Figure 9. REMAP Region II, NY/NJ Study Areas. (USEPA 1998)

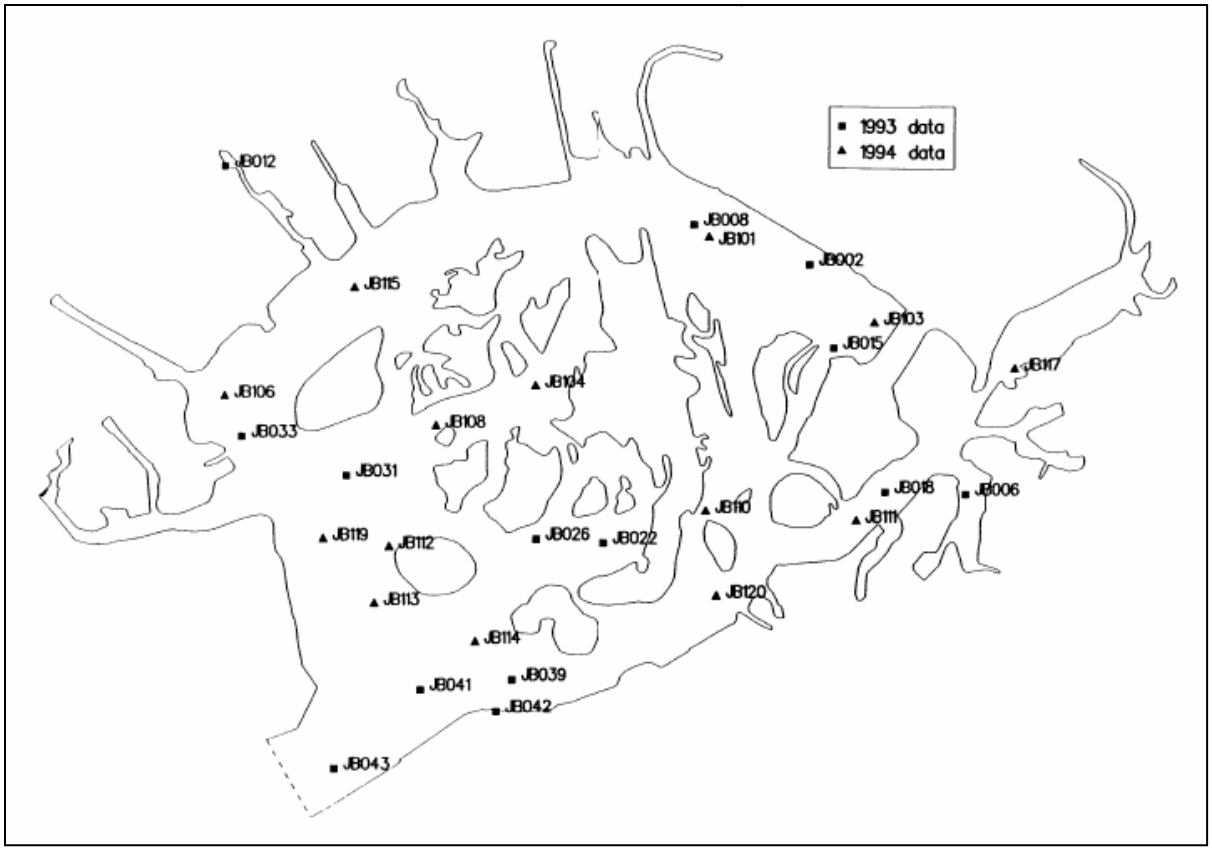


Figure 10. R-EMAP Summer 1993 and 1994 Sampling Locations, Jamaica Bay**. (Adams 2003)**
Note: Areas circled in red are stations where data were collected to get representative numbers for Jamaica Bay.

Despite dredging that may have occurred in some areas of the harbor, the mean percent silt-clay content in the NY/NJ Harbor and the sub-basins remained similar between sampling years (Table 11). Mean percent TOC values were similar between the NY/NJ Harbor and the sub-basins (Table 12). Therefore, changes in COC concentrations are not due to a shift in the amount of fine organic enriched sediments between the 1993/1994 and 1998 collections. The percentage total organic carbon throughout the region is fairly consistent (Table 12).

Table 13 compares mean values of contaminants in the NY/NJ Harbor, and sub-basins, between the 1993/1994 and 1998 studies. Even though a few of the areas (Newark Bay and the Upper Harbor) presented are not the focus of this report, it is important to mention the COCs detected in these areas drain into the water bodies affecting the units of GATE. As summarized by the USEPA study done by Adams et al. (2003), sediment samples show that the NY/NJ Harbor is extensively contaminated. Sediment values indicated cadmium, chromium, and chlordane have decreased, but mercury and DDT still surpass expected response moderate (ERM) values. Cadmium and antimony were the only metals not to exceed expected response low (ERL) values. According to Adams et al. (2003), seven of ten trace elements, that have existing ERL and ERM threshold values, were above or at ERL values. Chromium mean concentrations were equal to the ERL values and mercury exceeded ERM. Chlordane, total DDT, total PAHs, and high

molecular weight PAHs, and a few of the individual PAHs mean concentrations exceeded the ERL values. DDT exceeded ERM and ERL values. Compared to 50% in the 1993/1994 USEPA study, 45% of the 1998 harbor sediments had at least one contaminant above the ERM values. Screening values (ERL and ERM) were obtained from Long and Morgan (1991) and Long et al. (1995).

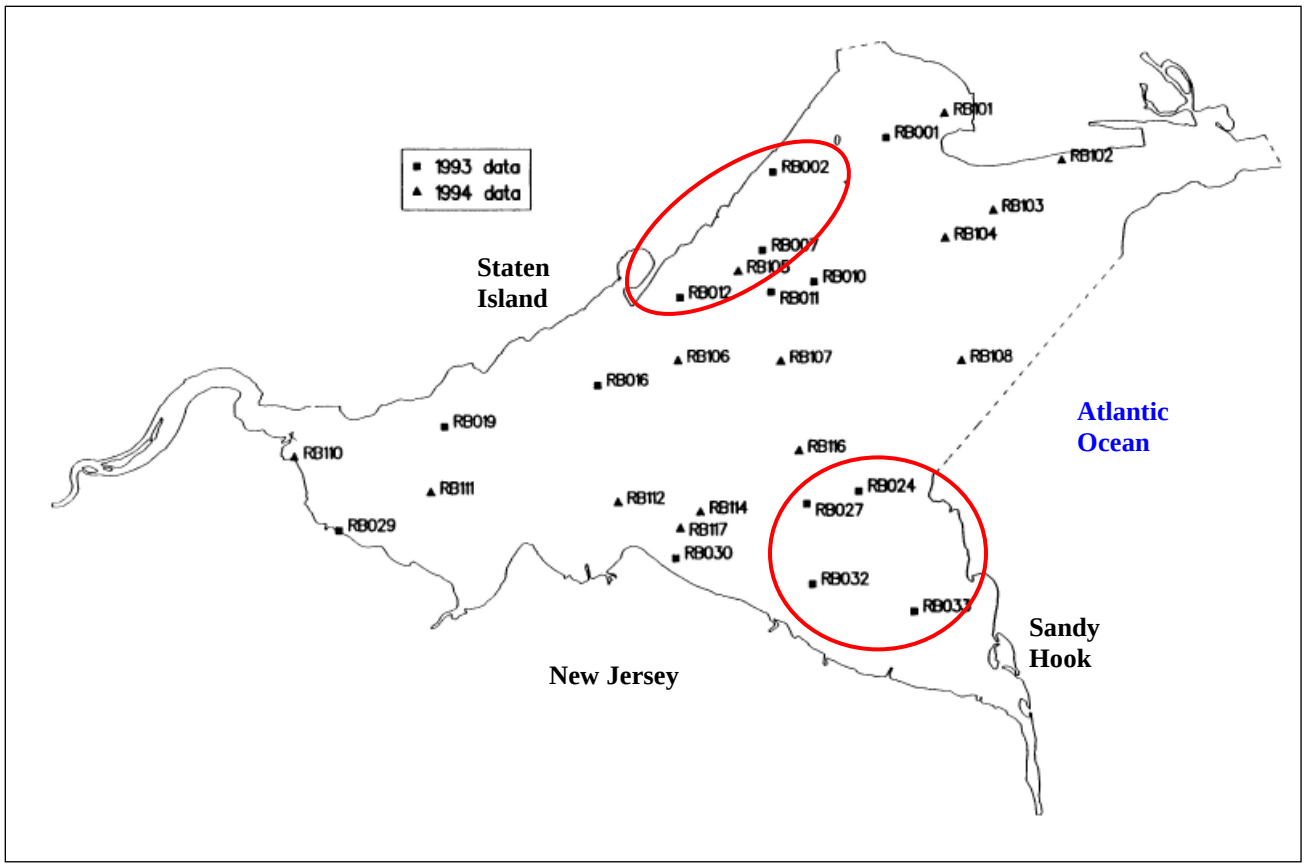


Figure 11. REMAP Summer 1993 and 1994 Sampling Locations, Raritan Bay. **(Adams 2003)**
Note: Areas circled in red are stations where data were collected to get representative numbers for Sandy Hook and northeastern Staten Island.

Table 11. Area-Weighted Means of % Silt-Clay (± 90% confidence intervals, C.I.) 1993/4 and 1998.

Area	1993/4	1998
Harbor	34.8 (± 6.1)	34.3 (± 3.1)
Jamaica Bay	30.3 (± 9.7)	37.5 (± 8.7)
Lower Harbor	26.8 (± 8.8)	27.3 (± 7.8)
Upper Harbor	51.0 (± 10.1)	50.4 (± 8.0)
Newark Bay	68.1 (± 8.6)	46.9 (± 7.3)

(Adams 2003)

Table 12. Area-Weighted Means of % TOC.

	Harbor	Jamaica Bay	Lower Harbor	Upper Harbor	Newark Bay
%TOC, dry wt. (± 90% C.I.)	2.3 (± 0.8)	2.6 (± 0.7)	1.7 (± 0.5)	3.8 (± 0.7)	2.5 (± 0.4)

(Adams 2003)

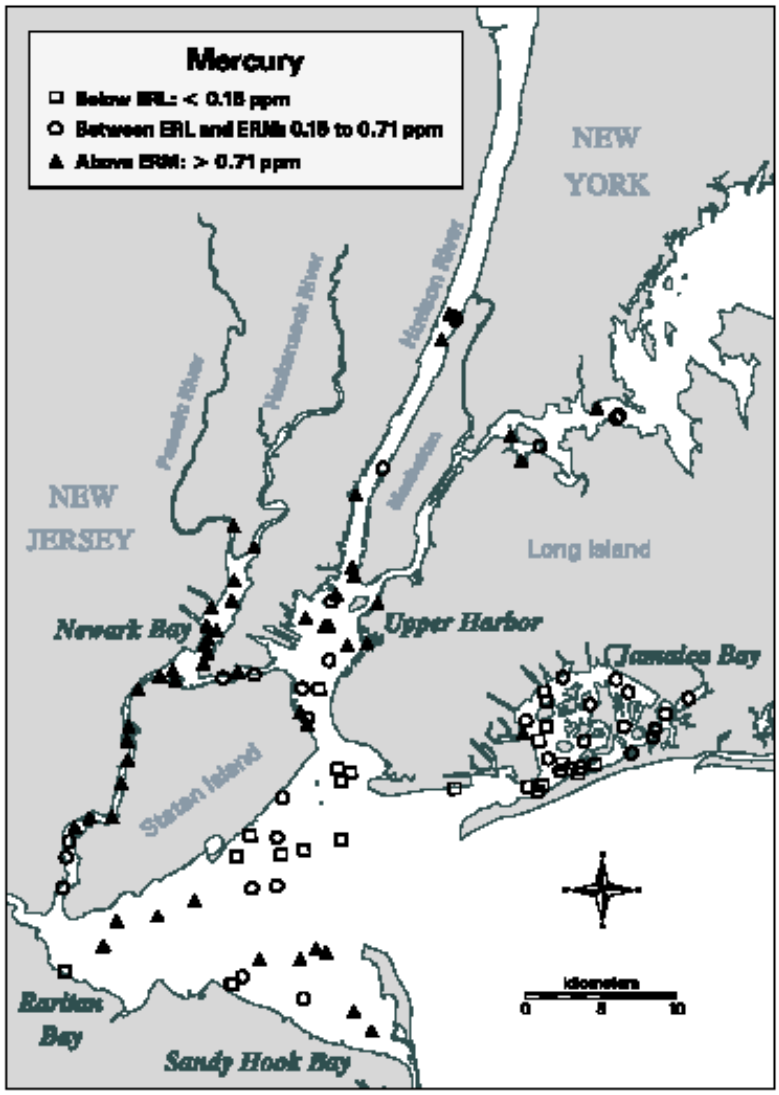


Figure 12. Distribution of Mercury Concentrations in 1998 by Station. **(Adams 2003)**

□ Below ERL: < 0.15ppm
○ Between ERL and ERM: 0.15 to 0.71ppm
▲ Above ERM: > 0.71ppm

Table 13. Area-Weighted Mean Sediment Contaminant Concentrations for 1993/1994 and 1998 Investigations (± 90% C.I.).

NA – not applicable
ND – not detected
* total metal in 1993/1994 and total recoverable in 1998

	Harbor		Jamaica Bay		Newark Bay		Lower Harbor		Upper Harbor	
METALS (ug/g,dry wt.)	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998
Aluminum	43456 ±4229	37490 ±5012	31862 ±3761	34736 ±4092	64633 ±4207	48375 ±3571	38706 ±6466	32611 ±5714	56705 ±4551	50100 ±3706
Antimony	1.49 ±0.48	1.13 ±0.58	0.84 ±0.52	0.65 ±0.14	6.27 ±6.80	2.13 ±0.47	1.24 ±0.30	1.01 ±0.26	1.11 ±0.18	1.42 ±0.39
Arsenic	10.33 ±2.05	9.26 ±1.67	5.07 ±1.26	6.85 ±1.66	25.51 ±20.15	13.51 ±1.93	10.01 ±2.49	9.40 ±2.40	9.04 ±1.14	8.62 ±0.94
Cadmium	0.79 ±0.13	0.67 ±0.43	0.95 ±0.53	0.58 ±0.15	2.52 ±0.58	1.81 ±0.40	0.54 ±0.18	0.45 ±0.14	0.93 ±0.18	1.06 ±0.25
Chromium	78.09 ±10.11	78.18 ±4.26	50.96 ±9.17	55.84 ±8.74	137.31 ±14.08	121.54 ±11.07	71.48 ±15.32	71.39 ±15.35	92.44 ±12.27	95.70 ±10.42
Copper*	72.53 ±17.40	47.64* ±3.72	55.15 ±35.09	34.54* ±10.34	226.69 ±105.28	141.61* ±31.40	47.29 ±16.01	43.5* ±15.92	110.12 ±57.65	81.25* ±20.08
Iron*	23483.6 ±2897.0	19651.0* ±72.53	16883.4 ±3230.7	15043.9* ±3471.4	33980.2 ±3830.8	23535.7* ±2432.2	22170.9 ±4405.9	18937.9* ±4526.3	27269.04 ±3208.9	22725.0* ±2261.5
Lead	78.84 ±12.83	82.23 ±4.81	63.29 ±37.42	57.00 ±13.29	193.92 ±60.70	137.72 ±21.19	63.78 ±17.47	65.26 ±17.27	96.55 ±18.40	128.33 ±34.16
Manganese	495.26 ±44.14	499.82 ±64.16	390.86 ±66.24	499.82 ±60.40	427.94 ±53.12	443.00 ±38.63	481.32 ±63.71	461.11 ±61.98	605.71 ±78.59	654.71 ±80.06
Mercury	0.74 ±0.14	0.86 ±0.54	0.29 ±0.13	0.34 ±0.09	2.59 ±0.58	2.70 ±0.49	0.61 ±0.21	0.67 ±0.24	0.80 ±0.16	1.10 ±0.21

Table 13. Area-Weighted Mean Sediment Contaminant Concentrations for 1993/1994 and 1998 Investigations (± 90% C.I.). (Continued)

NA – not applicable
ND – not detected
* total metal in 1993/1994 and total recoverable in 1998

B-1 Continued.	Harbor		Jamaica Bay		Newark Bay		Lower Harbor		Upper Harbor	
	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998
Nickel	24.07 ±2.90	25.17 ±2.20	17.80 ±10.31	18.82 ±3.09	50.81 ±8.72	39.01 ±3.39	20.08 ±4.03	21.84 ±3.99	30.92 ±3.80	33.98 ±3.59
Selenium	3.82 ±1.02	0.53 ±0.14	1.34 ±0.56	0.54 ±0.16	10.98 ±4.14	0.89 ±0.13	3.60 ±1.50	0.47 ±0.15	3.41 ±1.28	0.62 ±0.11
Silicon	354788 ±16077	328679 ±16789	349968 ±26009	334607 ±20405	315399 ±16061	319071 ±10002	367569 ±24327	352536 ±19006	330116 ±17836	308500 ±13062
Silver	1.59 ±0.30	1.57 ±0.74	1.14 ±0.42	1.09 ±0.31	2.98 ±0.61	2.52 ±0.33	1.29 ±0.44	1.28 ±0.46	2.28 ±0.46	2.40 ±0.33
Thallium	NA	0.302 ±0.05	NA	0.30 ±0.05	NA	0.41 ±0.05	NA	0.27 ±0.05	NA	0.37 ±0.04
Tin	4.96 ±1.54	10.30 ±5.07	2.84 ±1.43	2.72 ±0.51	15.29 ±13.27	18.15 ±3.60	3.43 ±1.40	6.68 ±2.06	7.45 ±4.44	13.66 8.59
Zinc	170.06 ±25.56	171.21 ±6.58	134.89 ±74.55	113.65 ±25.77	308.04 ±55.85	276.79 ±38.41	162.56 ±37.38	157.52 ±35.03	166.68 ±26.28	206.71 ±37.77
ORGANICS (ng/g,dry wt.)										
Parent DDT	9.57 ±9.38	11.49 ±1.35	0.92 ±0.15	0.11 ±0.18	132.97 ±147.29	175.86 ±135.35	1.28 ±0.31	0.19 ±0.18	0.99 ±0.19	0.71 ±1.17
Total DDD	14.16 ±5.98	4.46 ±2.77	2.83 ±1.32	0.60 ±0.69	122.41 ±89.5	46.72 ±26.9	5.71 ±2.60	1.74 ±1.08	11.94 ±3.60	1.49 ±1.42
DDE	8.53 ±2.54	4.25 ±1.22	3.18 ±1.60	3.05 ±1.25	65.20 ±35.7	24.88 ±9.89	4.04 ±1.66	3.36 ±1.14	7.32 ±2.04	1.18 ±1.09
Total DDT	31.59 ±16.6	20.87 ±2.12	5.95 ±2.90	3.76 ±1.73	320.31 ±257	258.04 ±174	10.28 ±4.52	5.30 ±2.02	19.84 ±5.07	3.38 ±3.02

Table 13. Area-Weighted Mean Sediment Contaminant Concentrations for 1993/1994 and 1998 Investigations (± 90% C.I.). (Continued)

NA – not applicable
ND – not detected
* total metal in 1993/1994 and total recoverable in 1998

B-1 Continued.	Harbor		Jamaica Bay		Newark Bay		Lower Harbor		Upper Harbor	
	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998
Chlordane	5.11 ±1.01	0.64 ±0.70	5.19 ±2.50	0.61 ±0.54	21.64 ±2.83	1.51 ±1.90	2.95 ±1.21	0.20 ±0.13	6.60 ±1.77	1.74 ±2.70
Dieldrin	0.80 ±0.12	0.02 ±0.13	0.73 ±0.35	ND	2.34 ±0.36	0.12 ±0.14	0.53 ±0.13	ND	1.19 ±0.33	0.08 ±0.14
Endrin	0.67 ±0.19	ND	0.47 ±0.04	ND	0.76 ±0.42	ND	0.51 ±0.05	ND	1.22 ±0.90	ND
Acenaphthene	82.78 ±65.43	36.93 ±3.98	45.05 ±48.02	3.57 ±4.13	92.82 ±30.15	67.14 ±31.46	17.81 ±5.69	2.43 ±2.78	294.62 ±312.96	147.86 ±106.62
Acenaphthylene	122.93 ±41.89	145.85 ±8.47	50.00 ±34.26	25.61 ±14.71	202.46 ±30.69	217.25 ±84.37	40.84 ±14.13	35.21 ±14.98	381.64 ±195.75	515.39 ±465.35
Anthracene	365.05 ±220.76	203.86 ±9.10	151.36 ±144.73	52.32 ±25.17	511.49 ±163.77	517.89 ±305.75	63.54 ±26.52	61.00 ±23.41	1335.14 ±1054.25	594.82 ±460.62
Benzo(a)anthracene	486.83 ±129.35	435.47 ±14.39	231.11 ±185.03	134.14 ±57.68	905.11 ±199.37	754.96 ±286.91	141.74 ±50.53	106.61 ±36.66	1525.6 ±593.1	1475.54 ±1398.60
Benzo(a)pyrene	303.05 ±83.12	571.24 ±16.34	138.96 ±111.32	123.61 ±74.25	516.92 ±79.50	1022.71 ±364.34	113.25 ±40.94	159.68 ±52.97	889.96 ±375.20	1889.11 ±1751.20
Benzo(b,k)fluoranthene	781.78 ±177.51	793.22 ±468.46	531.68 ±415.14	431.57 ±148.29	1669.94 ±264.54	1663.64 ±565.41	294.28 ±99.79	254.54 ±85.43	2107.79 ±769.94	2329.57 ±1750.4
Benzo(g,h,i)perylene	302.69 ±72.98	176.15 ±8.65	186.48 ±173.51	78.57 ±48.01	579.08 ±101.00	298.61 ±176.59	112.75 ±41.96	67.04 ±25.37	849.14 ±315.35	515.11 ±381.15
Biphenyl	32.16 ±11.74	13.97 ±2.61	38.86 ±42.83	5.18 ±3.55	45.73 ±7.67	24.14 ±6.70	15.02 ±4.21	4.82 ±3.43	77.14 ±51.31	42.71 ±25.28
Chrysene	544.76 ±145.85	470.95 ±14.70	313.48 ±271.91	174.32 ±67.00	1076.9 ±217.0	807.46 ±277.92	161.69 ±56.44	121.29 ±38.86	1653.2 ±664.7	1567.00 ±1455.40

Table 13. Area-Weighted Mean Sediment Contaminant Concentrations for 1993/1994 and 1998 Investigations (± 90% C.I.). (Continued)

NA – not applicable
ND – not detected
* total metal in 1993/1994 and total recoverable in 1998

Table B-1 Continued.	Harbor		Jamaica Bay		Newark Bay		Lower Harbor		Upper Harbor	
	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998
Dibenz(a,h)anthracene	79.42 ±31.10	NA	17.32 ±6.72	NA	146.12 ±25.41	NA	26.66 ±9.59	NA	247.84 ±146.29	NA
2,6-Dimethylnaphthalene	198.15 ±57.34	103.42 ±6.70	582.37 ±382.91	249.14 ±97.93	181.20 ±52.59	104.04 ±29.97	135.41 ±62.49	61.30 ±28.26	219.79 ±95.74	165.25 ±100.37
Fluoranthene	743.25 ±278.61	603.19 ±16.01	568.79 ±481.83	273.93 ±105.42	1280.0 ±397.6	1341.11 ±564.11	201.34 ±80.22	201.79 ±65.30	2308.0 ±1292.0	1748.64 ±1520.30
Fluorene	176.41 ±182.11	38.43 ±4.70	77.62 ±87.06	2.79 ±4.58	107.72 ±23.17	79.32 ±50.95	28.20 ±13.07	7.00 ±8.44	693.43 ±873.05	137.75 ±105.90
Ideno(1,2,3-c,d) pyrene	291.62 ±90.08	143.74 ±9.00	132.04 ±106.36	32.68 ±39.33	575.81 ±74.23	248.64 ±205.51	117.62 ±42.01	32.79 ±20.82	806.89 ±409.94	499.79 ±474.65
2-Methylnaphthalene	89.91 ±42.02	44.81 ±4.62	95.08 ±122.30	12.46 ±6.95	114.36 ±21.63	67.29 ±18.34	33.04 ±13.05	17.79 ±9.20	253.21 ±189.86	134.86 ±94.79
1-Methylnaphthalene	46.37 ±24.30	25.55 ±3.41	59.61 ±81.69	0.96 ±1.59	47.24 ±6.97	31.75 ±9.52	15.16 ±4.83	2.11 ±2.47	135.10 ±109.67	106.20 ±75.66
1-Methylphenanthrene	156.10 ±88.28	44.03 ±5.02	130.93 ±187.12	ND	150.03 ±84.70	75.36 ±90.80	9.65 ±3.57	0.19 ±0.32	615.18 ±414.55	187.89 ±204.98
Naphthalene	163.96 ±100.34	81.79 ±5.81	96.04 ±92.26	31.96 ±11.28	217.87 ±28.42	140.36 ±40.25	48.90 ±16.84	36.61 ±16.30	528.57 ±477.41	224.04 ±133.01
Perylene	333.54 ±113.69	270.29 ±10.81	113.98 ±55.94	117.05 ±43.34	608.35 ±173.42	549.82 ±165.28	127.84 ±47.68	89.18 ±30.08	975.43 ±523.23	805.57 ±699.14
Phenanthrene	628.06 ±520.48	307.76 ±10.46	363.98 ±412.31	129.18 ±43.60	417.30 ±61.09	676.50 ±286.28	116.85 ±45.44	118.29 ±46.65	2368.6 ±2489.5	852.68 ±470.65
Pyrene	767.60 ±269.73	746.74 ±18.02	508.73 ±440.02	288.75 ±116.98	1144.7 ±288.8	1284.32 ±436.20	202.19 ±77.94	207.39 ±66.24	2491.0 ±1255.0	2431.89 ±2106.70

Table 13. Area-Weighted Mean Sediment Contaminant Concentrations for 1993/1994 and 1998 Investigations (± 90% C.I.). (Continued)

NA – not applicable
ND – not detected
* total metal in 1993/1994 and total recoverable in 1998

B-1 Continued.	Harbor		Jamaica Bay		Newark Bay		Lower Harbor		Upper Harbor	
	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998	1993/4	1998
2,3,5-Trimethylnaphthalene	47.00 ±29.87	4.79 ±1.75	183.02 ±287.39	ND	70.47 ±37.44	1.68 ±2.76	9.82 ±2.60	ND	91.21 ±57.89	22.49 ±25.91
Total PAHs	7177.4 ±2607.9	5327.08 ±47.55	4838.5 ±4279.8	2103.47 ±790.81	11471 ±1836.3	10195.82 ±3637.5	2179.2 ±723.5	1605.97 ±532.19	22141 ±12165	16627.29 ±13969

(Adams 2003)

Table 14 summarizes Jamaica Bay and the Lower Harbor, areas significant to this report. As the data indicates, both arsenic and zinc exceeded ERL values in both 1993/1994 and 1998 studies in the Lower Harbor. Copper, lead, mercury, and silver exceeded ERL values in both studies in Jamaica Bay and the Lower Harbor. The mentioned metals, plus cadmium, all exceeded threshold effects level (TEL) values (NOAA SQuiRT, Buchman 1999). Out of the organics in sediment that were detected, DDE, total DDT, chlordane, dieldrin, endrin, acenaphthene, acenaphthylene, anthracene, fluorine, 2-methylthalene, phenanthrene, and total PAHs exceeded ERL values (Table 15). Chlordane, dieldrin, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, and total PAHs exceeded TEL values for sediments (NOAA SQuiRT).

Sediment data show that mercury had the highest percent of area that exceeded ERM values (Figure 13). In Jamaica Bay the 3.57% (± 5.75 C.I.) of the area exceeded ERMs in 1998 as compared to 4% (± 0-13 C.I.) in 1993/1994. The area of the Lower Bay in which mercury in sediment exceeded ERM values 29% (± 17-42 C.I.) in 1993/1994 and there was a slight increase to 32.14% (± 14.47 C.I.) in 1998 (Adams 2003).

Chlorinated dioxins and furans were not determined in the harbor or Newark Bay in the 1993/1994 samples. Chlorinated dioxins and furans were determined in sediment samples from all these additional locations in the 1998 collections. Chlorinated dioxins and furans are usually present as mixtures of congeners in the sediments and other matrixes (Van den Berg et al. 1998). Shown in Table 16 are the most toxic of the congeners and these levels could result in adverse effects to wildlife.

USEPA National Coastal Assessment Data

Another database used in this report is the USEPA National Coastal Assessment (NCA), Figure 9. The USEPA NCA is an initiative of the EMAP, and is a partnership of several federal and state environmental agencies. More detailed information can be obtained from the EPA-NCA database at http://oaspub.epa.gov/coastal/coast.search.

The data in Table 17 reinforces the fact that a suite of metals (silver, arsenic, chromium, copper, mercury, nickel, zinc), pesticides (dieldrin), and petroleum products in sediments are at levels above the TEL and in many cases the ERL for both Raritan Bay and Sandy Hook. Neither of the Jamaica Bay samples were above the sediment threshold limit value data. It should be noted that no tissue data for GATE was available through the USEPA NCA database.

Table 14. Area-Weighted Mean Sediment Contaminant Concentrations for Metals the 1993/1994 and 1998 Investigations (µg/g).

			Jamaica Bay		Lower Harbor	
Metal	**TEL[1]**	**ERL[2]**	**1993/1994**	**1998**	**1993/1994**	**1998**
Aluminum			31862	34736	38706	32611
			(± 3761)	(± 4092)	(± 6466)	(± 5714)
Antimony		2.00	0.84	0.65	1.24	1.01
			(± 0.52)	(± 0.14)	(± 0.30)	(± 0.26)
Arsenic	7.24	8.20	5.07	6.85	**10.01**	**9.40**
			(± 1.26)	(± 1.66)	(± 2.49)	(± 2.40)
Cadmium	0.676	1.20	**0.95**	0.58	0.54	0.45
			(± 0.53)	(± 0.15)	(± 0.18)	(± 0.14)
Chromium	52.30	81.00	50.96	**55.84**	71.48	71.39
			(± 9.17)	(± 8.74)	(± 15.32)	(± 15.35)
Copper[3]	18.70	34.00	**55.15**	**34.54***	**47.29**	**43.50***
			(± 35.09)	(± 10.34)	(± 16.01)	(± 15.92)
Iron[3]			16883.40	15043.90*	22170.90	18937.90*
			(± 3230.70)	(± 3471.40)	(± 4405.9)	(± 4526.30)
Lead	30.24	46.70	**63.29**	**57.00**	**63.78**	**65.26**
			(± 37.42)	(± 13.29)	(± 17.47)	(± 17.27)
Manganese			390.86	499.82	481.32	461.11
			(± 66.24)	(± 60.40)	(± 63.71)	(± 61.98)
Mercury	0.13	0.15	**0.29**	**0.34**	**0.61**	**0.67**
			(± 0.13)	(± 0.09)	(± 0.21)	(± 0.24)
Nickel	15.90	20.90	**17.80**	**18.28**	**20.08**	**21.84**
			(± 10.31)	(± 3.09)	(± 4.03)	(± 3.99)
Selenium			1.34	0.54	3.60	0.47
			(± 0.56)	(± 0.16)	(± 1.50)	(± 0.15)
Silicon			349968.00	334607.00	367569	352536.00
			(± 26009.00)	(± 20405.00)	(± 24327.00)	(± 19006.00)
Silver	0.73	1.00	**1.14**	**1.09**	**1.29**	**1.28**
			(± 0.42)	(± 0.31)	(± 0.44)	(± 0.46)
Thallium			NA	0.30	NA	0.27
				(± 0.05)		(± 0.05)

Table 14. Area-Weighted Mean Sediment Contaminant Concentrations for Metals the 1993/4 and 1998 Investigations (µg/g). (Continued)

			Jamaica Bay		Lower Harbor	
Metal	**TEL[1]**	**ERL[2]**	**1993/1994**	**1998**	**1993/1994**	**1998**
Tin			2.84	2.72	3.43	6.68
			(± 1.43)	(± 0.51)	(± 1.40)	(± 2.06)
Zinc	124.00	150.00	**134.89**	113.65	**162.56**	**157.52**
			(± 74.55)	(± 25.77)	(± 37.38)	(± 35.03)

(Adams 2003)

1. TEL:Threshold Effects Level (NOAA SQuiRT)
2. ERL: Expected Response Low (Long and Morgan, 1991; Long et al., 1995)
3. total metal in 1993/1994 and total recoverable in 1998

± represent 90% C.I.
NA = not analyzed
ND = not detected

Red: Analyte concentration is above the ERL (Long and Morgan)
Blue: Analyte concentration is above the TEL (NOAA SQuiRT))
Pink: Anayte concentration above both the ERL and TEL

Table 15. Area-Weighted Mean Sediment Contaminant Concentrations for Organics the 1993/1994 and 1998 Investigations (ng/g).

Organics	TEL*	ERL**	Jamaica Bay		Lower Harbor	
			1993/4	1998	1993/4	1998
Parent DDT			0.92 (± 0.15)	0.11 (± 0.18)	1.28 (± 0.31)	0.19 (± 0.18)
total DDD			2.83 (± 1.32)	0.60 (± 0.69)	5.71 (± 2.60)	1.74 (± 1.08)
DDE		2.00	***3.18*** (± 1.60)	***3.05*** (± 1.25)	***4.04*** (± 1.66)	***3.36*** (± 1.14)
Total DDT	3.89	1.58	***5.95*** (± 2.90)	***3.76*** (± 1.73)	***10.28*** (± 4.52)	***5.30*** (± 2.02)
Chlordane	2.26	0.5	***5.19*** (± 2.50)	***0.61*** (± 0.54)	***2.95*** (± 1.21)	0.20 (± 0.13)
Dieldrin	0.715	0.02	0.73 (± 0.35)	ND	0.53 (± 0.13)	ND
Endrin		0.02	0.47 (± 0.04)	ND	0.51 (± 0.05)	ND
Acenaphthene	6.71	16	***45.05*** (± 48.02)	3.57 (± 4.13)	***17.81*** (± 5.69)	2.43 (± 2.78)
Acenaphthylene	5.87	44.00	***50.00*** (± 34.26)	***25.61*** (± 14.71)	***40.84*** (± 14.13)	***35.21*** (± 14.98)
Anthracene	46.85	85.3	***151.36*** (± 144.73)	***52.32*** (± 25.17)	***63.54*** (± 26.52)	***61.00*** (± 32.41)
Benzo(a)anthracene	74.83	261.00	***231.11*** (± 185.03)	***134.14*** (± 57.68)	***141.74*** (± 50.53)	***106.61*** (± 36.66)
Benzo(a)pyrene	88.81	430.00	***138.96*** (± 111.32)	***123.61*** (± 74.25)	***113.25*** (± 40.94)	***159.68*** (± 52.97)
Benzo(b,k)fluoranthene			531.68 (± 415.14)	431.57 (± 148.29)	294.28 (± 99.79)	254.54 (± 85.43)
Benzo(g,h,i)perylene			186.48 (± 173.51)	78.57 (± 48.01)	112.75 (± 41.96)	67.04 (± 25.37)
Biphenyl			38.86 (± 42.83)	5.18 (± 3.55)	15.02 (± 4.21)	4.82 (± 3.43)
Chrysene	107.77	384.00	***313.48*** (± 271.91)	***174.32*** (± 67.00)	***161.69*** (± 56.44)	***121.29*** (± 38.86)

Table 15. Area-Weighted Mean Sediment Contaminant Concentrations for Organics the 1993/1994and1998 Investigations (ng/g). (Continued)

Organics	TEL*	ERL**	Jamaica Bay		Lower Harbor	
			1993/4	1998	1993/4	1998
Dibenz(a,h)anthracene	6.22	63.40	17.32 (± 6.72)	NA	26.66 (± 9.59)	NA
2,6-Dimethylnaphtalene			582.37 (± 382.91)	249.14 (± 97.93)	135.41 (± 62.49)	61.30 (± 28.26)
Fluoranthene	112.82	600.00	**568.79** (± 481.83)	**273.93** (± 105.42)	**201.34** (± 80.22)	**201.79** (± 65.30)
Fluorene	21.17	19.00	**77.62** (± 87.06)	2.79 (± 4.58)	**28.20** (± 13.07)	7.00 (± 8.44)
Ideno(1,2,3-c,d)pyrene			132.04 (± 106.36)	32.68 (± 39.33)	117.62 (± 42.01)	32.79 (± 20.82)
2-Methylnaphthalene	20.21	70.00	**95.08** (± 122.30)	12.46 (± 6.95)	**33.04** (± 13.05)	17.79 (± 9.20)
1-Methylnaphthalene			59.61 (± 81.69)	0.96 (± 1.59)	15.16 (± 4.83)	2.11 (± 2.47)
1-Methylphenanthrene			130.93 (± 187.12)	ND	9.65 (± 3.57)	0.19 (± 0.32)
Naphthalene	34.57	160.00	**96.04** (± 92.26)	31.96 (± 11.28)	**48.9** (± 16.84)	**36.61** (± 16.30)
Perylene			113.98 (± 55.94)	117.05 (± 43.34)	127.84 (± 47.68)	89.18 (± 30.08)
Phenanthrene	86.68	240.00	**363.98** (± 412.31)	**129.18** (± 43.60)	**116.85** (± 45.44)	**118.29** (± 46.65)
Pyrene	152.66	665.00	**508.73** (± 440.02)	**288.75** (± 116.98)	**202.19** (± 77.94)	**207.39** (± 66.24)
2,3,5-trimethylnaphthalene			183.02 (± 287.39)	ND	9.82 (± 2.60)	ND
Total PAHs	1684.1	4022.00	**4838.50** (± 4279.80)	**2103.47** (± 790.81)	**2179.20** (± 723.50)	1605.97 (± 532.19)

(Adams 2003)

* TEL: Threshold Effects Level (NOAA SQuiRT)
** ERL: Expected Response Low (Long and Morgan 1991; Long et al. 1995)
± represent 90% C.I.
NA = not analyzed
ND = not detected

Red: Analyte concentration is above the ERL (Long and Morgan)
Blue: Analyte concentration is above the TEL (NOAA SQuiRT))
Pink: Anayte concentration above both the ERL and TEL

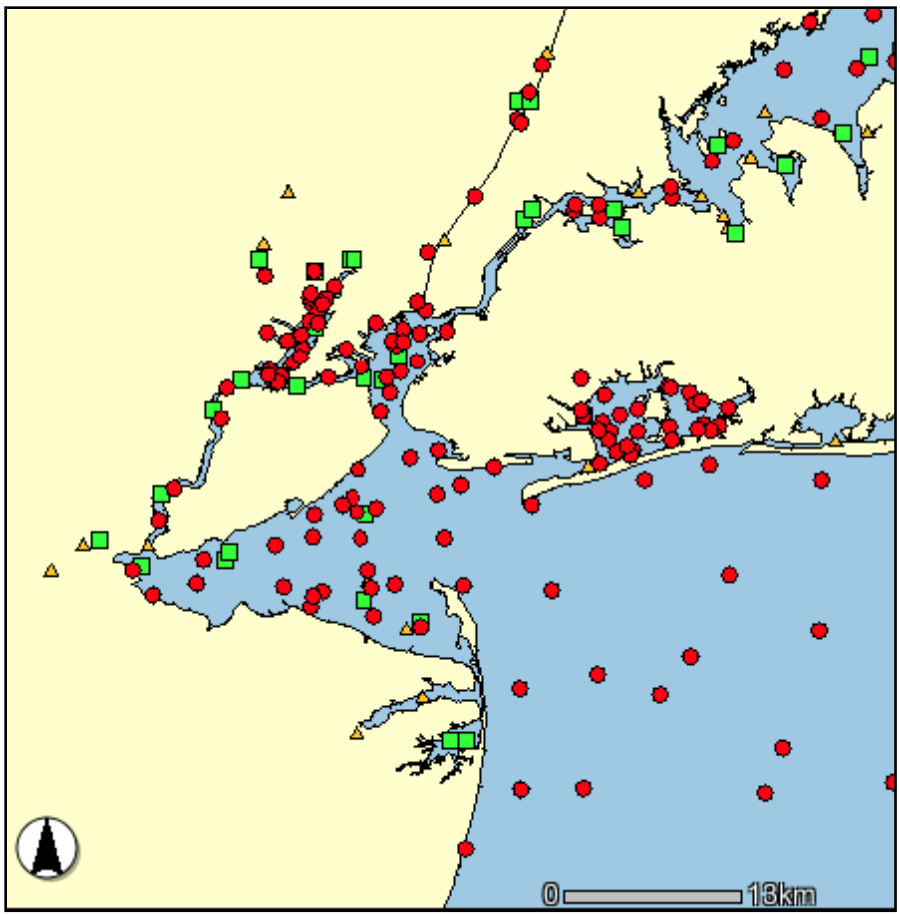


Figure 13. USEPA Sampling Stations**. (USEPA 2003)**

- REMAP stations (1993-1994)
- REMAP stations (1993-1994)
- National Coastal Assessment Northeast (2000)

Table 16. Mean Sediment Concentrations of 2,3,7,8-TCDD and Dioxin/Furan TEQs (± 90% C.L.).

	2,3,7,8-TCDD (ng/kg, dry wt.)	
Area	1993/4	1998
Harbor	-	6.5 (± 1.6)
Jamaica Bay	4.0 (± 2.6)	1.6 (± 0.9)
Lower Harbor	7.5 (± 3.4)	3.0 (± 1.7)
Upper Harbor	5.5 (± 1.8)	6.4 (± 2.7)
Newark Bay	Not analyzed	49.0 (± 24.6)

(Adams 2003)

Table 17. USEPA Sediment Analyte Data (2000 and 2001): National Coastal Assessment-Northeast/New York (reported in ng/g dry weight).

NY00-0029-A (Jamaica Bay- New York): Sample from 2000; Lat: 40.573, Long: -73.884
NY01-0032-A (Jamaica Bay-New York): Sample from 2001; Lat: 40.627, Long: -73.882
NJ00-0003-B (Sandy Hook- New Jersey): Sample from 2000; Lat: 40.435, Long: -74.038
NJ01-0006-A (Raritan Bay- New Jersey): Sample from 2001; Lat: 40.482, Long: -74.240

	NY00-0029-A		NY01-0032-A		NJ00-0003-B		NJ01-0006-A		
Analyte	Analyte Concentration	Detection Limit	Analyte Concentration	Detection Limit	Analyte Concentration	Detection Limit	Analyte Concentration	Detection Limit	Units
Acenaphthene	0.68		0.07		22		15		ng/g
Acenaphthlylene	0.23		0.05		67		56		ng/g
Silver	0	1	0	1	4		3.9		ug/g
Aluminum	232		1320		62000		69100		ug/g
Aldrin	0	1	0	1	0	0.51	0	0.59	ng/g
Anthracene	0.57		0.24		120		110		ng/g
Arsenic	0	1	1		20		22		ug/g
Benz(a)anthracene	1.11		0.58		330		280		ng/g
Benzo(a)pyrene	1.38		0.8		440		370		ng/g
Benzo(b)fluoranthene	2.01		0.91		660		440		ng/g
Benzo(k)fluoranthene	0.71		0.29		220		100		ng/g
Benzo(g,h,i)perylene	1.11		0.43		320		260		ng/g
Biphenyl	0.62		0.08		20		13		ng/g
Cadmium	0	1	0	1	1.4		0.9		ug/g
Chrysene	0.8		0.52		380		280		ng/g
alpha- Chlordane	ND	ND	ND	ND	1.4		1.4		ng/g
Chromium	1		5		170		137		ug/g
Copper	0	1	4		150		151		ug/g
Dibenzothiophene	0.83		0		25		20		ng/g
Dibenz(a,h)anthracene	0.25		0		73		64		ng/g
Dieldrin	0	1	0	1	1.4		1.2		ng/g
2,6-dimethylnaphthalene	1.05		0.09		21		17		ng/g
Endosulfan I	0	3	0	3	0	0.8	0	0.92	ng/g
Endosulfan II	0	2	0	1	0	0.8	0	0.92	ng/g
Endosulfan	0	1	0	1	0	0.22	0	0.26	ng/g
Endrin	0	1	0	1	0	0.48	0	0.55	ng/g
Iron	873		3310		55000		52200		ug/g
Fluoranthene	3.63		1.13		520		450		ng/g
Fluorene	1.57		0.1		39		28		ng/g
Heptachlor	0	1	0	1	0	0.48	0	0.55	ng/g
Heptachlor epoxide	0	1	0	1	0	0.48	0	0.55	ng/g
Hexachlorobenzene	0	1	0	1	0.46		0.41		ng/g
Mercury	0	0.1	0	0.05	1.7		1.69		ug/g
Indeno(1,2,3-c,d)pyrene	0.95		0.56		340		260		ng/g
Lindane	0	1	0	1	0	0.35	0	0.4	ng/g
1-methylnaphthalene	0.58		0.08		24		16		ng/g
2-methylnaphthalene	1.18		0.15		49		33		ng/g
1-methylphenanthrene	0.5		0.12		50		35		ng/g
Mirex	0	1	0	1	0.54		0.74		ng/g
Manganese	33		85		590		540		ug/g
Naphthalene	0.99		0.16		61		51		ng/g
Nickel	0	1	3		45		42		ug/g
2,4'-DDD	0	1	0	1	3.1		6.9		ng/g
2,4'-DDE	0	1	0	1	0	0.8	9.4		ng/g
2,4'-DDT	0	1	5		0	0.8	0	0.92	ng/g
Lead	2		0	1	140		178		ug/g
2,2',4,5,5'-pentachlorobiphenyl	0	1	0	1	9.1		8.9		ng/g
2,3,3',4,4'-pentachlorobiphenyl	0	1	0	1	5		4.3		ng/g
2,3',4,4',5-pentachlorobiphenyl	0	1	0	1	13		11		ng/g
3,3',4,4',5-pentachlorobiphenyl	0	1	0	1	0	0.63	0	0.72	ng/g
2,2',3,3',4,4'-hexachlorobiphenyl	0	1	0	1	2.1		2.1		ng/g
2,2',3,4,4',5'-hexachlorobiphenyl	0	1	0	1	12		12		ng/g
2,2',4,4',5,5'-hexachlorobiphenyl	1		0	1	14		14		ng/g
2,2',3,3',4,4',5-heptachlorobiphenyl	0	1	0	1	3.4		4.6		ng/g
2,2',5-trichlorobiphenyl	0	1	0	1	4.8		7.6		ng/g
2,2',3,4,4',5,5'-heptachlorobiphenyl	0	1	0	1	5.7		5.6		ng/g
2,2',3,4',5,5',6-heptachlorobiphenyl	0	1	0	1	4.8		4.4		ng/g
2,2',3,3',4,4',5,6-octachlorobiphenyl	0	1	0	1	2.2		0.59	0.64	ng/g

Table 17. USEPA Sediment Analyte Data (2000 and 2001): National Coastal Assessment-Northeast/New York. (Continued)

NY00-0029-A (Jamaica Bay- New York): Sample from 2000; Lat: 40.573, Long: -73.884
NY01-0032-A (Jamaica Bay-New York): Sample from 2001; Lat: 40.627, Long: -73.882
NJ00-0003-B (Sandy Hook- New Jersey): Sample from 2000; Lat: 40.435, Long: -74.038
NJ01-0006-A (Raritan Bay- New Jersey): Sample from 2001; Lat: 40.482, Long: -74.240

2,2',3,3',4,4',5,5',6-nonachlorobiphenyl	0	1	0	1	1.9		2.2		ng/g
decachlorobiphenyl	0	1	0	1	2.8		2.1		ng/g
2,4,4'-trichlorobiphenyl	0	1	0	1	17		13		ng/g
2,2',3,5'-tetrachlorobiphenyl	0	1	2.6		6.4		4.5		ng/g
2,2',5,5'-tetrachlorobiphenyl	0	1	1.3		8.6		7.6		ng/g
2,3',4,4'-tetrachlorobiphenyl	0	1	0	1	14		11		ng/g
3,3',4,4'-tetrachlorobiphenyl	0	1	0	1	0	0.8	0	0.92	ng/g
2,4'-dichlorobiphenyl	0	1	0	1	3.2		4.1		ng/g
Phenanthrene	3.9		0.54		**ND**	**ND**	**ND**	**ND**	ng/g
4,4'-DDD	**ND**	**ND**	**ND**	**ND**	9.1		24		ng/g
4,4'-DDE	0	1	0	1	10		17		ng/g
4,4'-DDT	0	1	0	1	0.5	1.1	1.6		ng/g
Pyrene	2.28		1.27		***640***		***470***		ng/g
Antimony	0	1	1		1.8		2.9		ug/g
Selenium	0	1	0	1	1.1		1.12		ug/g
Tin	**ND**	**ND**	**ND**	**ND**	21		27.1		ug/g
trans-Nonachlor	0	1	0	1	1.4		1.5		ng/g
Toxaphene	0	100	0	100	0	32	0	37	ng/g
2,3,5-trimethylnaphthalene	0		0		8		4.9		ng/g
Zinc	7		14		***360***		***311***		ug/g

(USEPA 2006a)
NOTES:
Value set to 0 when concentration is undetectable and equal to or less than the detection limit; MDL may be listed; user may decide to use another value.
Failed QA criteria. An interference was noted in the blank analysis performed with the sample; caution is advised in interpreting the result.

NOAA Status and Trends Data - Sediment

The NOAA Mussel Watch Program, under the NOAA National Status and Trends Program, analyzes chemical and biological contaminant trends in sediment (as well as bivalve tissue, see next section) collected at over 280 coastal sites from 1986 to present. Our report will only use data from stations in the mid-Atlantic region (Figure 14). These stations include Hudson/Raritan Estuary, Upper Bay (HRUB); Hudson/Raritan Estuary, Lower Bay (HRLB); Hudson/Raritan Estuary, Raritan Bay (HRRB); Hudson/Raritan Estuary, Jamaica Bay (HRJB); and New York Bight, Sandy Hook (NYSH). More detailed data can be obtained from the NOAA Mussel Watch database at http://www8.nos.noaa.gov/cit/nsandt/download/mw_monitoring.aspx. Table 18 summarizes the COCs that were above the ERL and TEL values compared to the different data sets.

Tissue Levels and Biological Effects

NOAA Status and Trends Data

The bivalve tissue concentrations for a number of compounds found at the various locations throughout the NY/NJ Harbor are shown in Figures 15-36. The values reported give an indication of the bioavailability of various COCs at specific locations that are located close to the various units of GATE: NYSH – Sandy Hook, HRLB + HRRB – Staten Island, HRJB – Jamaica Bay. Wildlife living in this region are exposed to multiple COCs, and although the COC may work through different mechanisms of action, they are rarely examined as a complex mixture. Although they are presented as individual compounds or classes of compounds, their impact is

likely at least additive. Where multiple critical steps are blocked in a biochemical or developmental pathway, greater than additive effects can result. The complex mixture of COCs that exist in this ecosystem pose a unique hazard to wildlife living in this region.

The historical and current PCB contamination throughout the harbor show declining values, but these values are still at concentrations that would impact wildlife in the area. Figure 15 shows which of the total PCBs are accumulating in the bivalves. There has been a decrease from the late 1980s, but the levels are still in the 300 to 500 ppb total PCB range. Animals that feed upon these organisms would accumulate these lipophilic compounds, resulting in behavioral and reproductive effects. Although dioxin and dibenzofurans are not analyzed in the NOAA samples, these compounds are also present and would add to the hazards posed by organisms who consume these organisms. Planned and proposed dredging activities in the Hudson River (PCB contamination) and Passaic River/Newark Bay (dioxins and dibenzofurans) will resuspend historically contaminated sediments. Resuspension will result in a temporary spike in levels in downstream sediment, suspended sediment, and biological tissue residues. This spike will likely translate into elevated levels in upper trophic level fish and aquatic feeding avian species.

The NY/NJ Harbor is one of the most active ports in the United States. There are also a number of refineries and oil depots located on the New Jersey and New York waterfronts. In addition, there are a number of small motorcrafts that use these waters. The presence of both low molecular weight (lmw PAHs) (Figure 16) and high molecular weight hydrocarbons (hmw PAHs) (Figure 20) in bivalve tissues reflect the presence of these chemicals in the water column and suspended sediment. The lmw PAHs are generally associated with the lighter more refined petroleum products. Figures 17-19 show the presence of acenaphthylene, naphthalene, and anthracene, respectively. The hmw PAHs are associated with both heavier crude oils and incinerator products. Representative hmw PAHs are shown in Figures 21-23. Spikes within the graphs would likely indicate spills that occurred within those areas. The patterns would be consistent with heavy shipping traffic and the presence of oil storage facilities. Sewer outfalls are also contributing to these levels from the combined sources within New York City and surrounding urban areas.

The total butyltins (Figure 24) are decreasing in the bivalve tissue at all of the sites examined from the earliest samples. The Sandy Hook values have not become statistically different (Mann-Whitney) over the past ten years than those collected prior to 1995. The butyltin levels are above levels that have been reported to adversely effect mollusk (Buchanan 2001). The total DDT (Figure 25), dieldrin (Figure 26), and total chlodanes (Figure 27) have all decreased significantly when compared to values in the late 1980s and early 1990s.

The concentration of metals in the bivalve tissues show variability between the different sites. Cadmium (Figure 28) concentrations in 2004 varied between approximately one to two ug/g dry weight among the different sites. The Cd levels have statistically decreased at the Sandy Hook location (Mann-Whitney $p = 0.026$), while at Jamaica Bay and the Lower Bay they were not statistically decreasing. The chromium tissue levels (Figure 29) were not statistically different between samples collected prior to 1995 and those collected after 1995 for all sites. The concentrations have been trending up but are not statistically different. The copper values (Figure 33) are also not statistically different between tissue levels prior to 1995 and those collected after 1995. As with chromium, the highest copper levels have been observed in the past ten years. The

mercury values (Figure 31) have remained in the range of 0.2 to 0.3 ng/g dry weight and are not statistically different between samples collected prior to 1995 and those collected after 1995 for any of the locations. The silver levels at Sandy Hook and Jamaica Bay (Figure 30) were statistically higher in the past ten years. The silver values in bivalves near Staten Island were not statistically different. Arsenic (Figure 32), nickel (Figure 35), lead (Figure 34) and zinc (Figure 36) tissue levels were not statistically different between pre and post 1995 samples. The findings in the bivalve tissue are in general agreement with sediment trends reported by USEPA for regions in the harbor (Adams 2003).

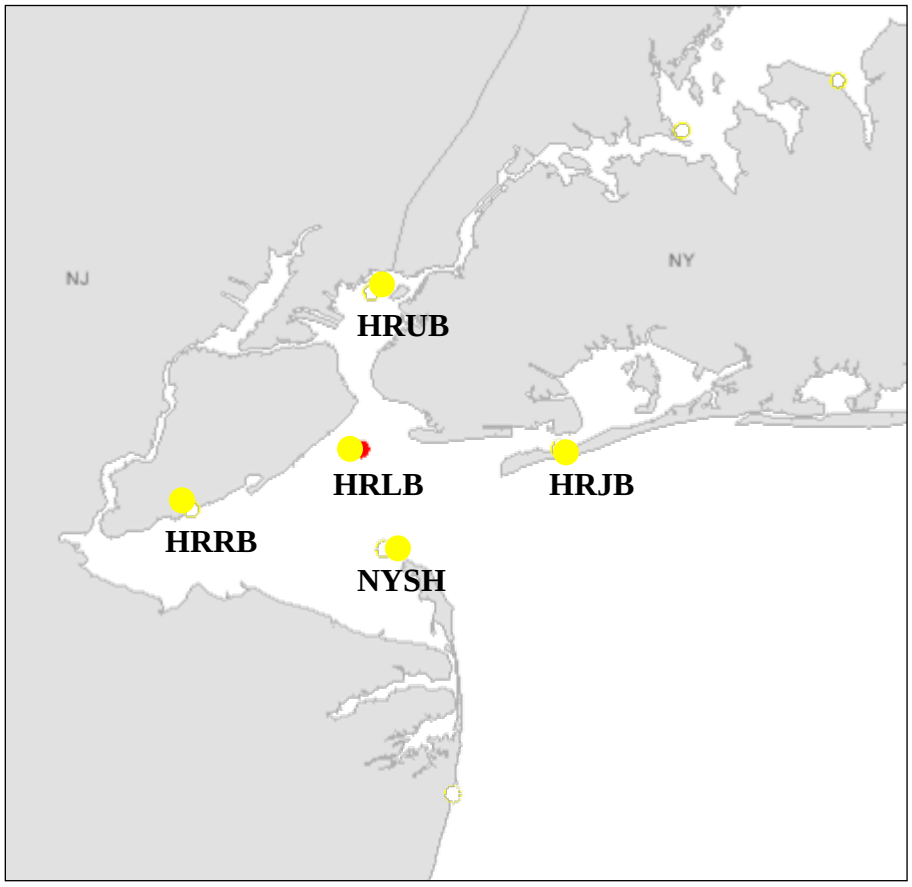


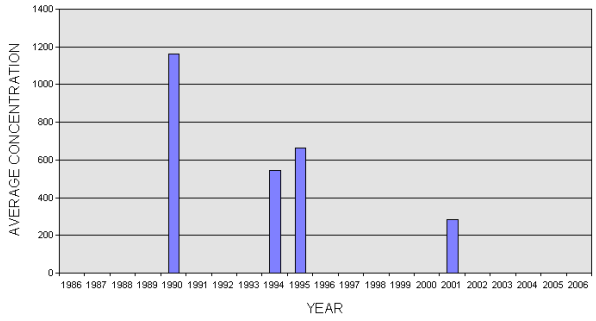
Figure 14. GATE Mussel Watch Sites. (NOAA 2006)

Table 18. Comparison of Sediment COCs between Databases.

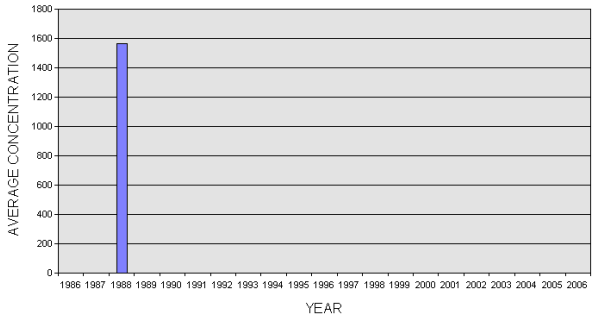
Analyte	1993/4 EPA-REMAP	1998 EPA-REMAP	2000 EPA-NCA	2001 EPA-NCA	NOAA
Acenaphthene	0	0	+	+	+
Acenaphthylene	0	+	+	+	+
Anthracene	0	+	+	+	+
Arsenic	+	0	+	+	+
Benz(a)anthracene	0	+	+	+	+
Benzo(a)pyrene	0	+	+	+	+
Cadmium	+	0	0	+	+
Chromium	+	0	+	+	+
Chrysene	+	+	+	+	+
Copper	+	0	+	+	+
Dibenzo(a,h)anthracene	0	0	+	+	+
Dieldrin	+	0	+	+	+
Fluoranthene	0	+	+	+	+
Fluorene	0	0	+	+	+
Lead	+	0	+	+	+
Mercury	+	0	+	+	+
2-Methylnaphthalene	0	+	0	0	+
1-methylphenanthrene	0	0	+	+	0
Naphthalene	0	+	+	+	+
Nickel	+	0	+	+	+
Phenanthrene	0	+	0	0	+
Pyrene	0	+	+	+	+
Silver	+	0	0	+	+
Total DDT	0	0	0	0	+
Total PAH	0	0	0	0	+
Total PAHhmw (4 or more rings)	0	0	0	0	+
Total PAHlmw (2-3 rings)	0	0	0	0	+
Total PCBcg	0	0	0	0	+
Zinc	+	0	+	+	+

+ : Concentration levels of analyze were above ERL and TEL values (NOAA SQuiRT)
0 : Concentrations were not above ERL and TEL values (NOAA SQuiRT)
NCA: National Coastal Assessment

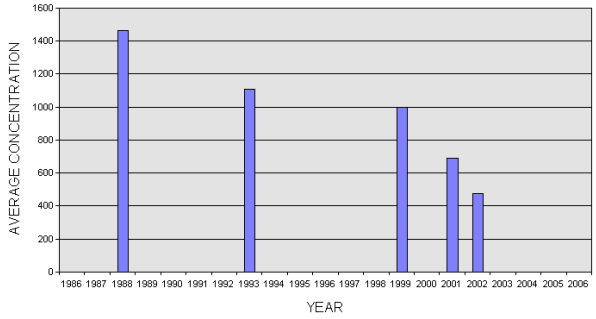
Total PCB – HRRB



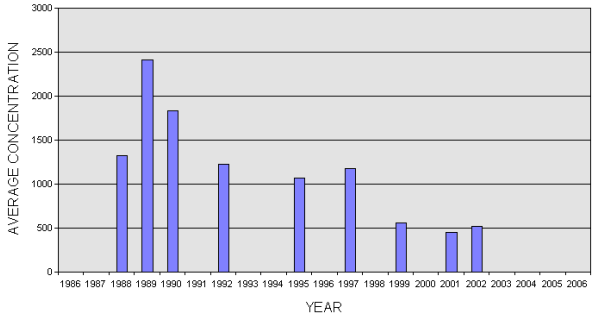
Total PCB – HRUB



Total PCB – HRLB



Total PCB – NYSH



Total PCB – HRJB

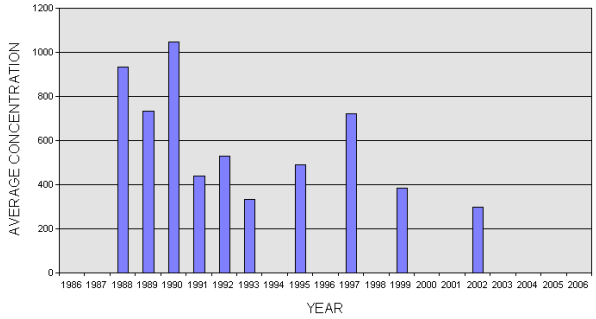
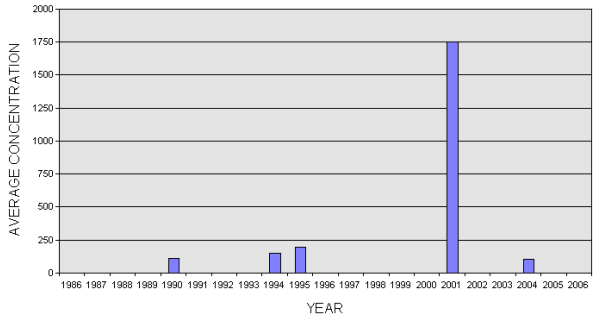


Figure 15. Total PCB Concentrations (ng/dry g) in Tissue at GATE. (NOAA 2006)

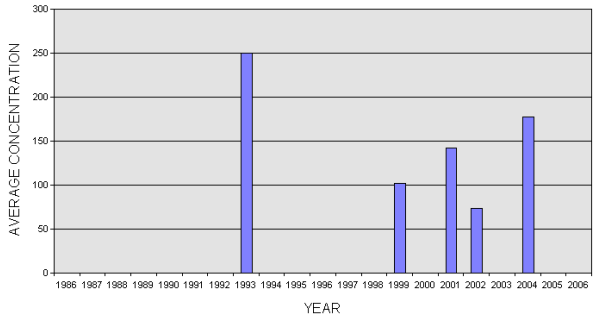
Total PAH [lmw] – HRRB



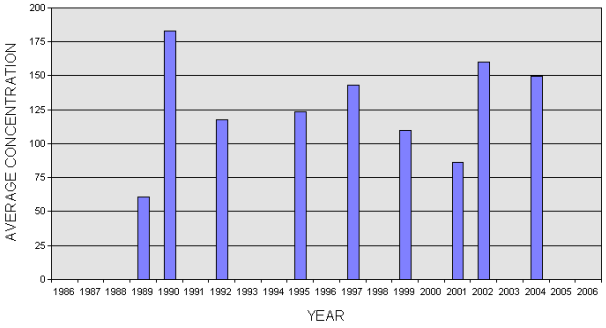
Total PAH [lmw] – HRUB

"No tissue data available."

Total PAH [lmw] – HRLB



Total PAH [lmw] – NYSH



Total PAH [lmw] – HRJB

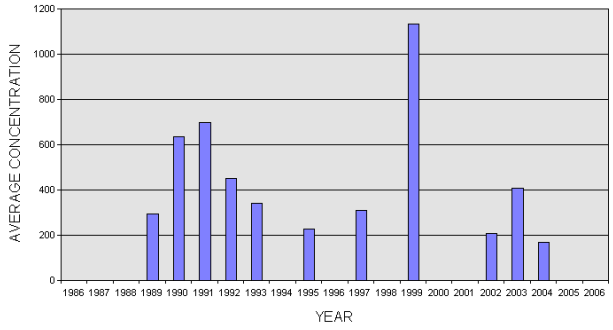
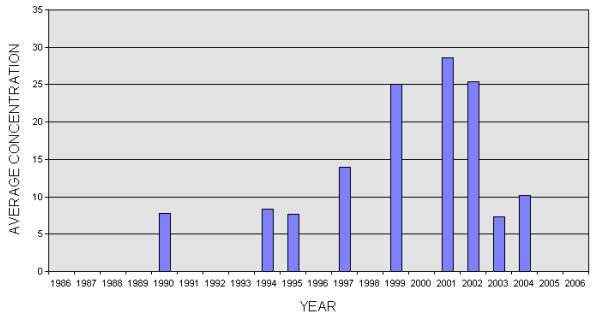
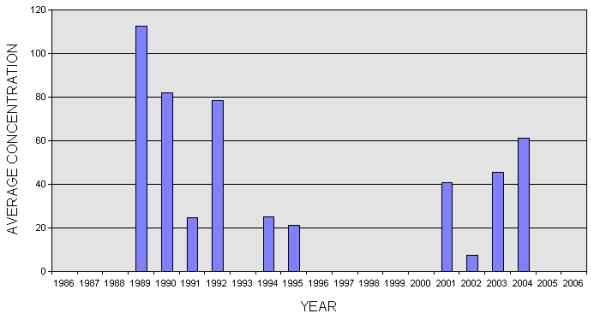


Figure 16. Total PAH [lmw] (2-3 Rings) Concentration (ng/dry g) in Tissue at GATE**. (NOAA 2006).**

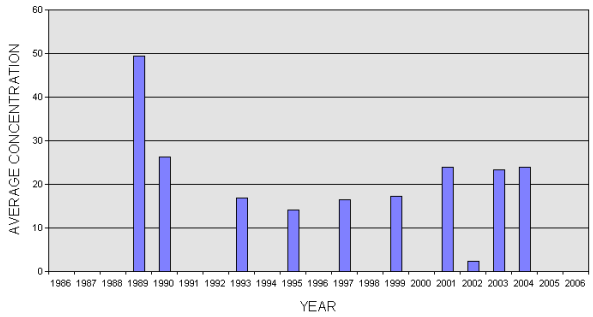
Acenaphthylene - HRRB



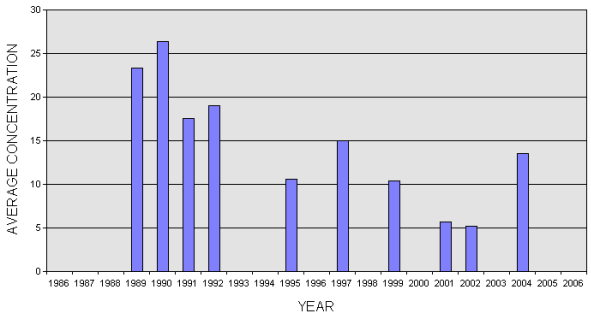
Acenaphthylene – HRUB



Acenaphthylene – HRLB



Acenaphthylene – NYSH



Acenaphthylene – HRJB

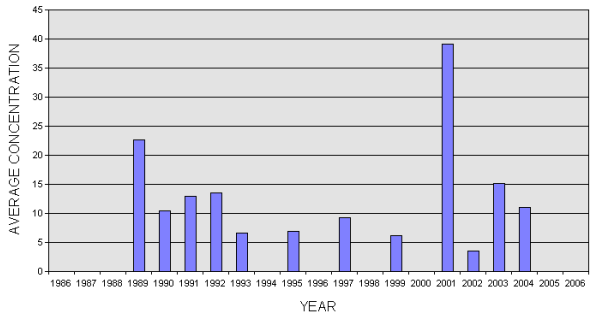
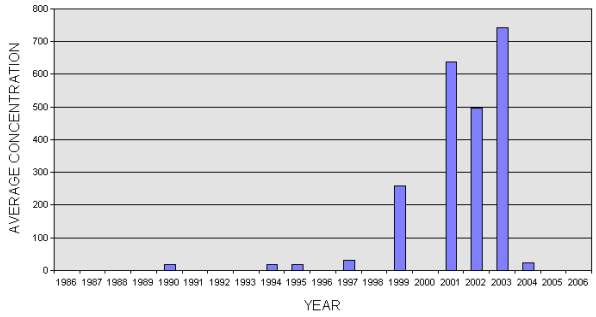
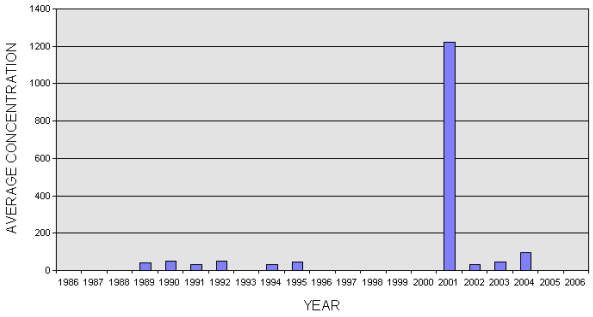


Figure 17. Acenaphthylene Concentration (ng/dry g) in Tissue at GATE**. (NOAA 2006)**

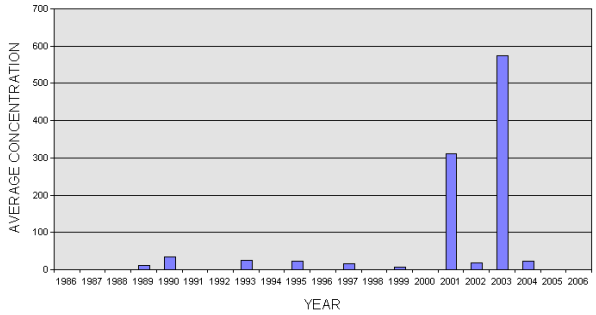
Naphthalene – HRRB



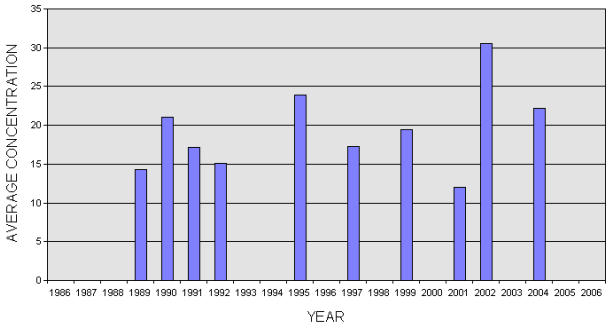
Naphthalene – HRUB



Naphthalene – HRLB



Naphthalene – NYSH



Naphthalene – HRJB

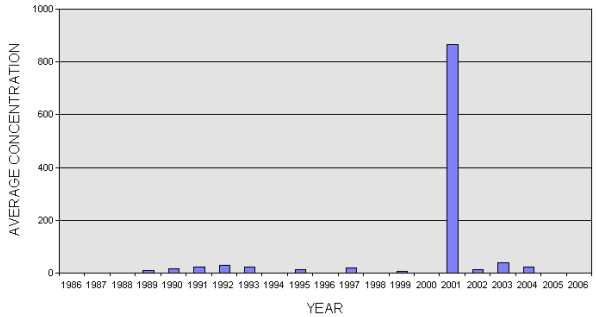
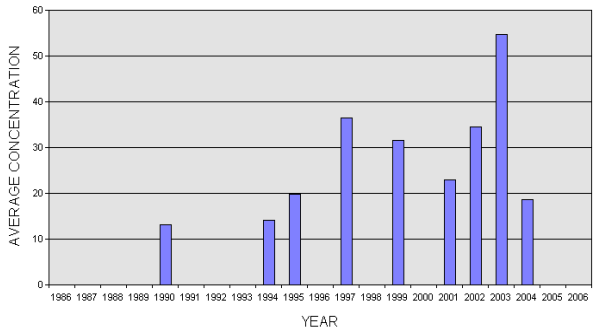
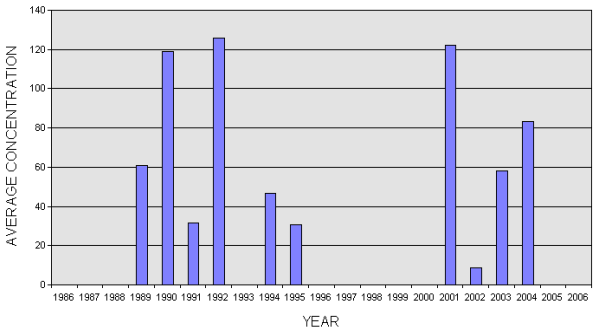


Figure 18. Naphthalene Concentration (ng/dry g) in Tissue at GATE**.** (NOAA 2006)

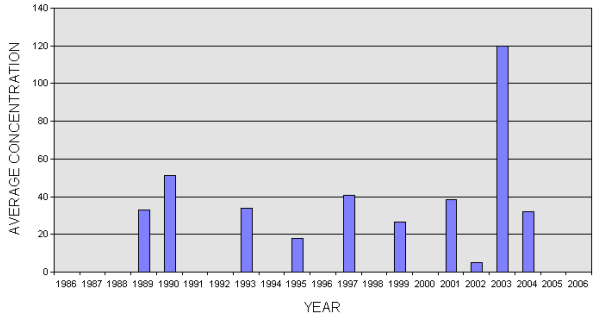
Anthracene – HRRB



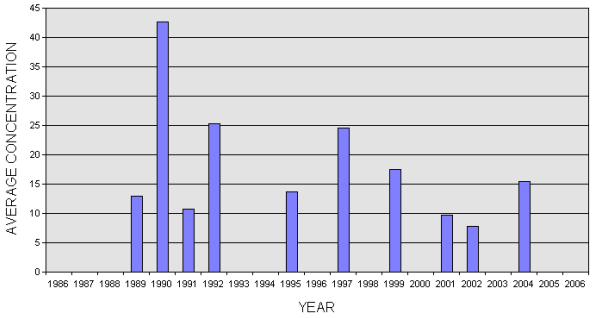
Anthracene – HRUB



Anthracene – HRLB



Anthracene – NYSH



Anthracene – HRJB

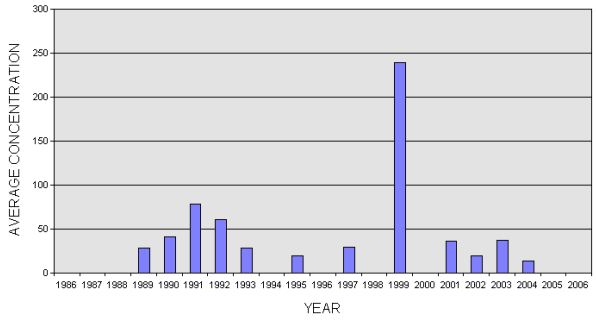
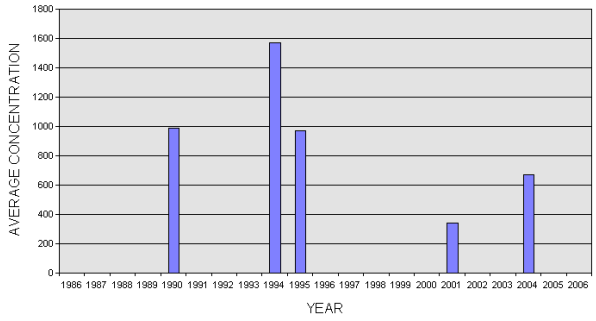


Figure 19. Anthracene Concentration (ng/dry g) in Tissue at GATE**. (**NOAA 2006)

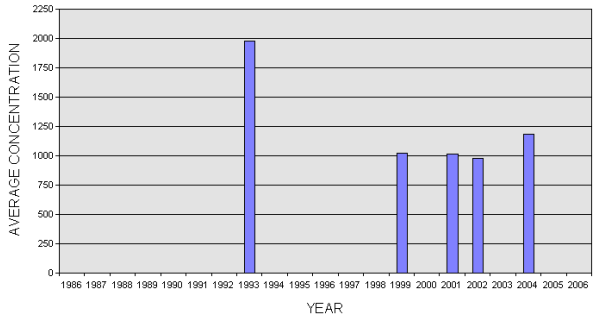
Total PAH [hmw] – HRRB



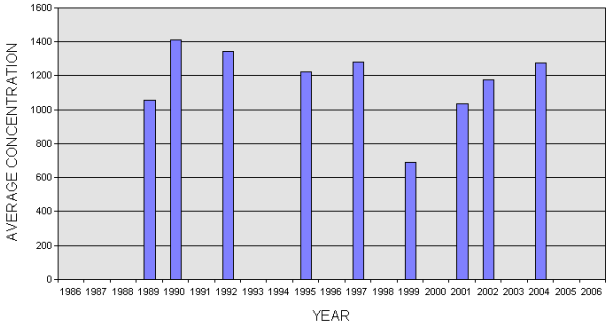
Total PAH [hmw] – HRUB

"No tissue data available."

Total PAH [hmw] – HRLB



Total PAH [hmw] – NYSH



Total PAH [hmw] – HRJB

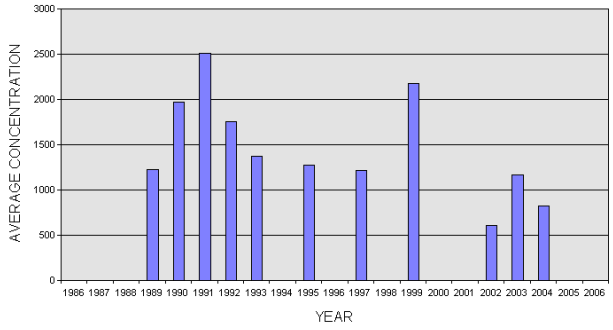
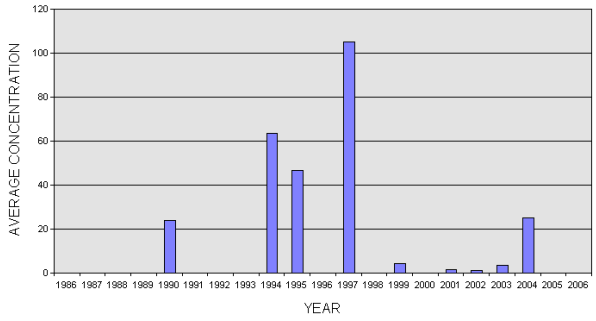
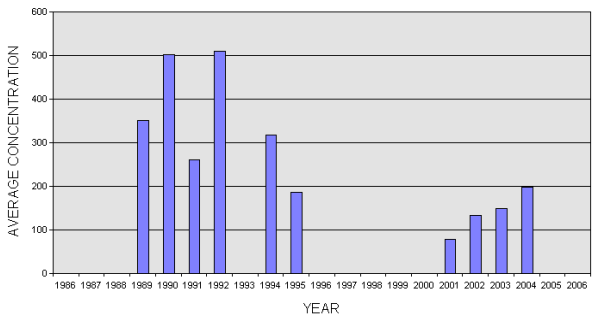


Figure 20. Total PAH [hmw] (4 or More Rings) Concentration (ng/dry g) in Tissue at GATE. (NOAA 2006)

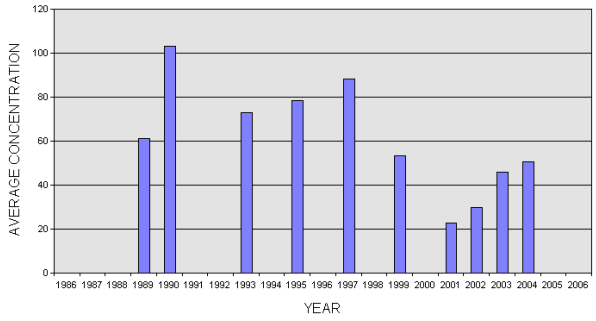
Benzo(a)pyrene – HRRB



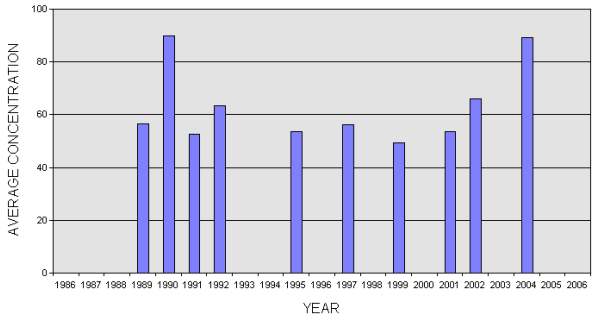
Benzo(a)pyrene – HRUB



Benzo(a)pyrene – HRLB



Benzo(a)pyrene – NYSH



Benzo(a)pyrene – HRJB

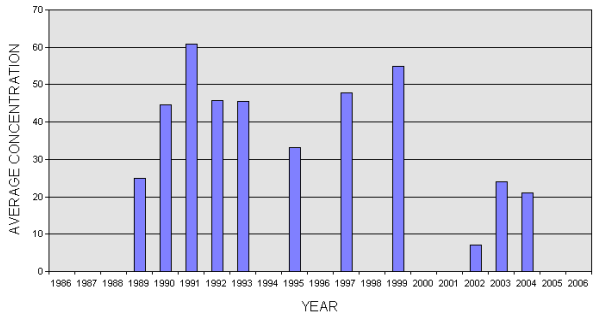
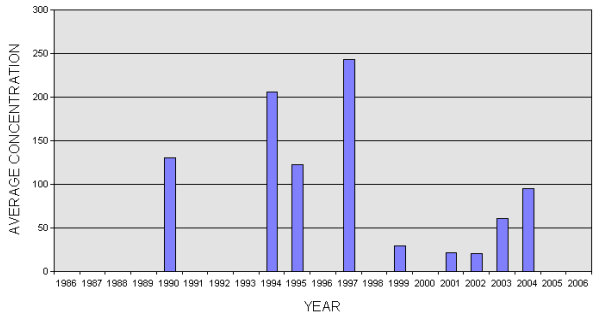
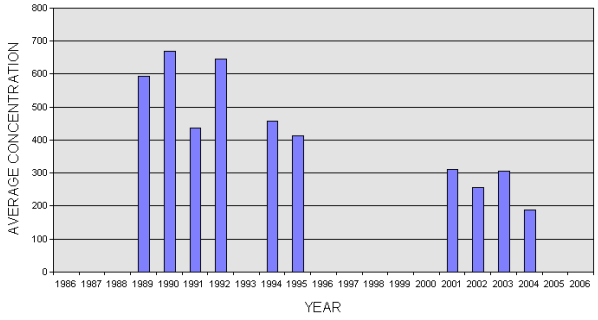


Figure 21. Benzo[a]pyrene Concentration (ng/dry g) in Tissue at GATE**.** (NOAA 2006)

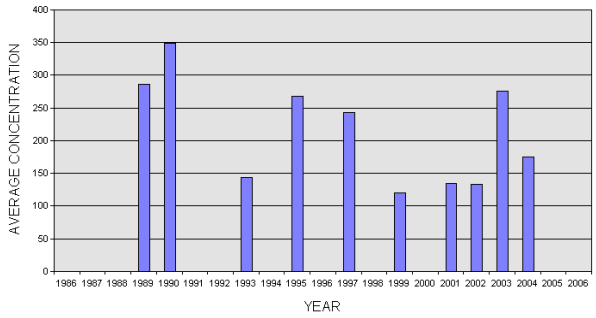
Chrysene – HRRB



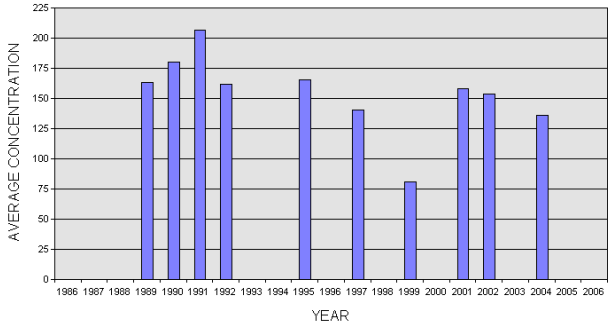
Chrysene – HRUB



Chrysene – HRLB



Chrysene – NYSH



Chrysene – HRJB

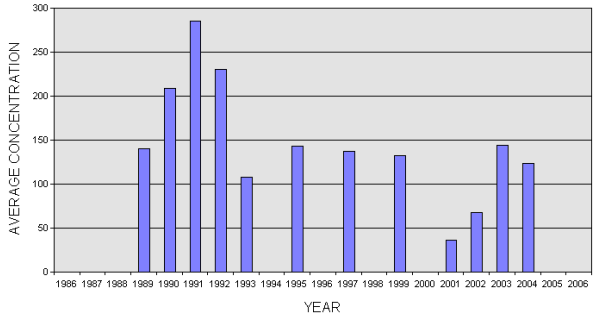
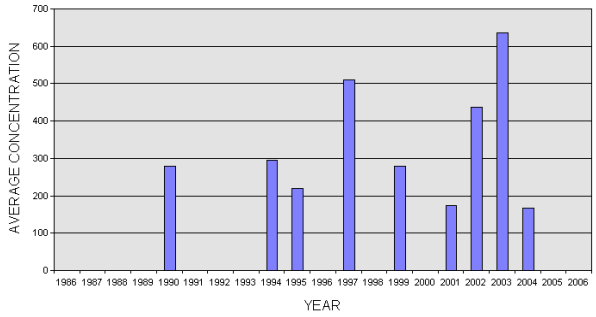
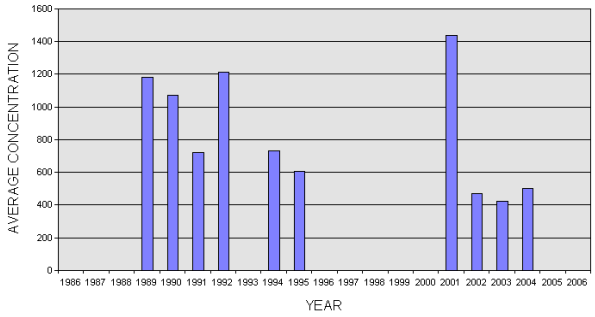


Figure 22. Chrysene Concentration (ng/dry g) in Tissue at GATE (NOAA 2006).

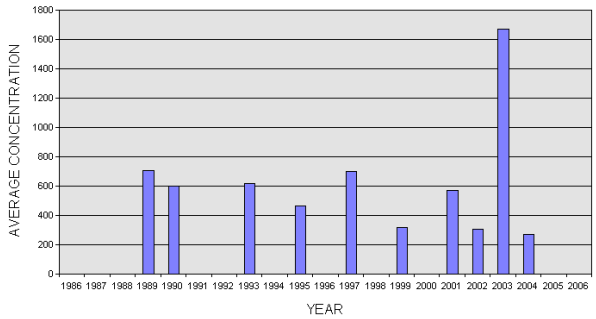
Pyrene – HRRB



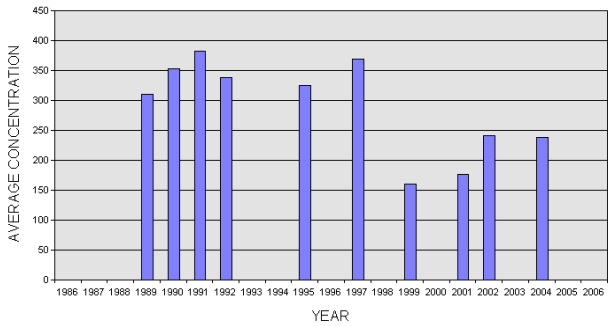
Pyrene – HRUB



Pyrene – HRLB



Pyrene – NYSH



Pyrene – HRJB

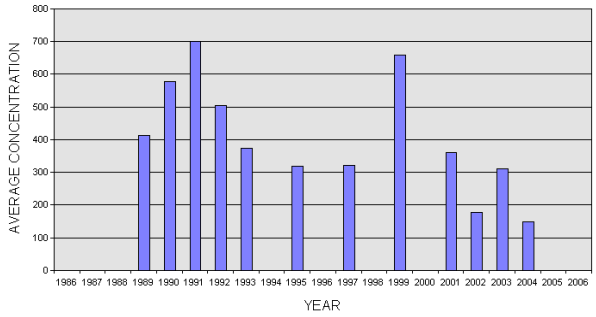
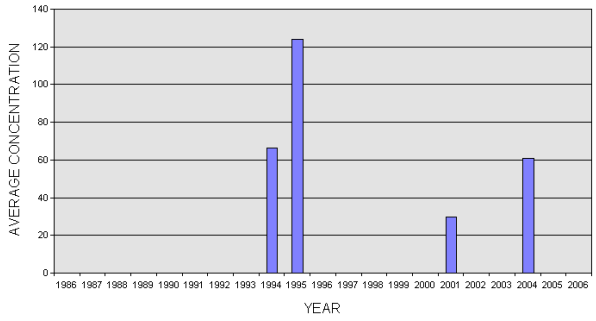


Figure 23. Pyrene Concentration (ng/dry g) in Tissue at GATE. (NOAA 2006)

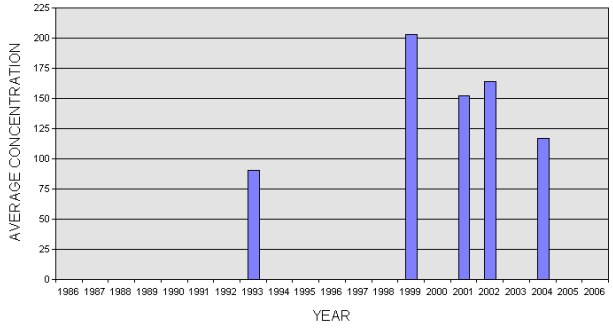
Total Butyltins – HRRB



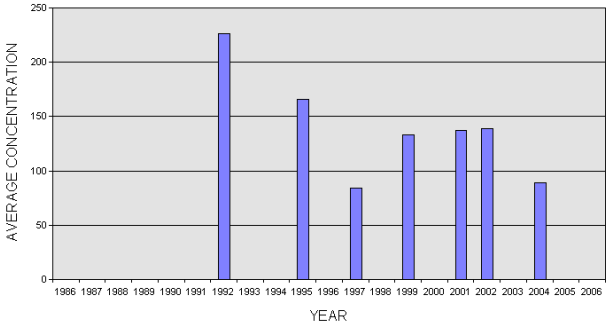
Total Butyltins – HRUB

"No tissue data available."

Total Butyltins – HRLB



Total Butyltins – NYSH



Total Butyltins – HRJB

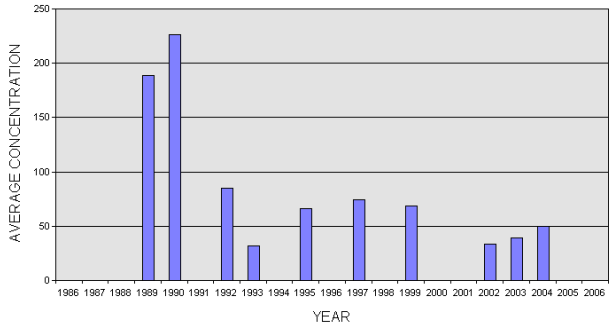
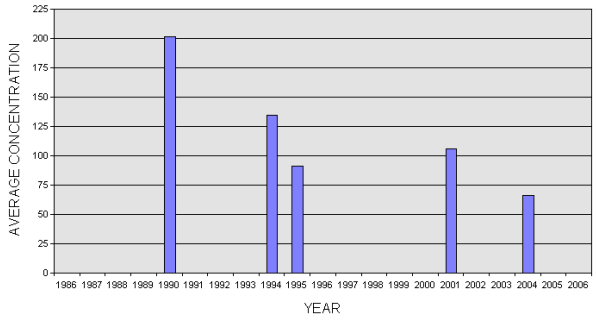
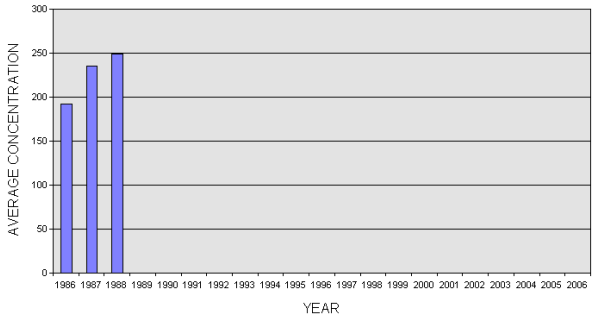


Figure 24. Total Butyltins Concentration (ng/dry g) in Tissue at GATE. (NOAA 2006)

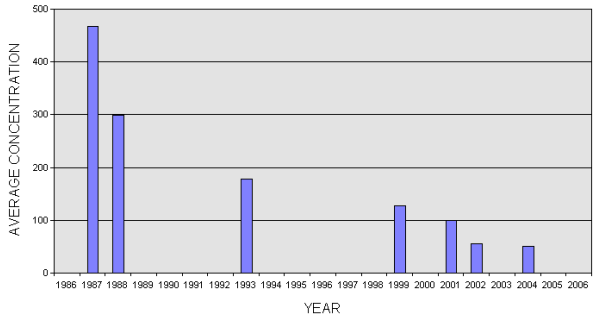
Total DDT – HRRB



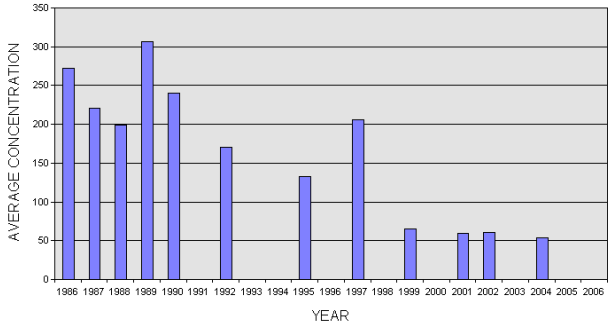
Total DDT – HRUB



Total DDT – HRLB



Total DDT – NYSH



Total DDT – HRJB

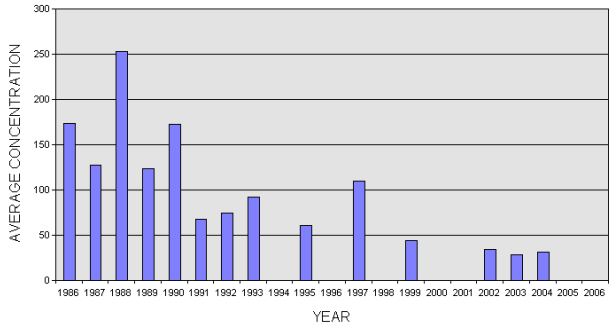
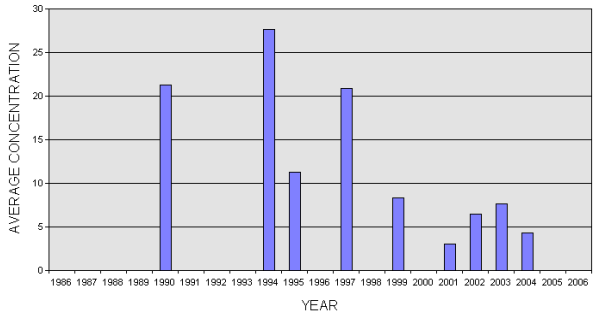


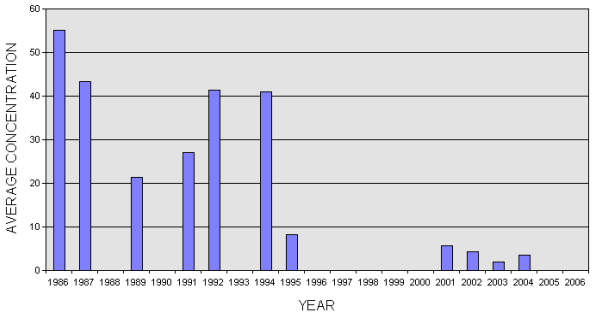
Figure 25. Total DDT Concentration (ng/dry g) in Tissue at GATE. (NOAA 2006)

Dieldrin – HRRB

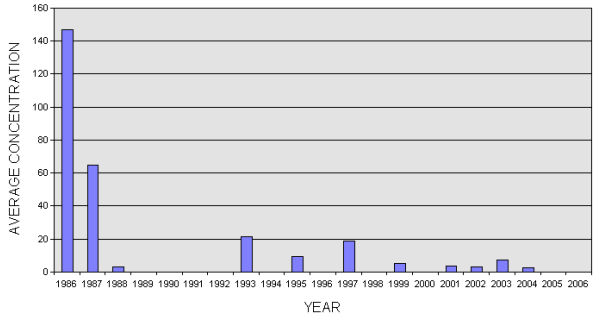
Dieldrin – HRUB



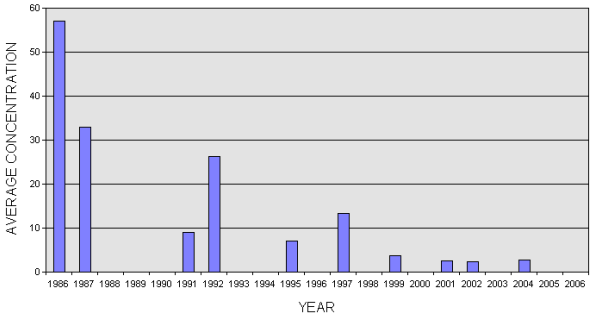
Dieldrin – HRLB



Dieldrin – NYSH



Dieldrin – HRJB



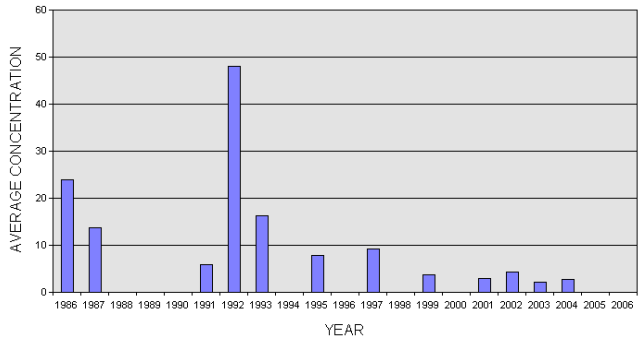
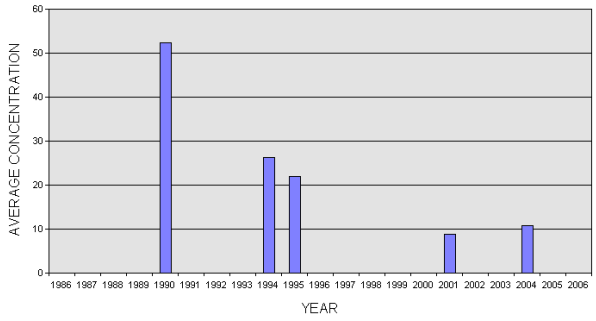
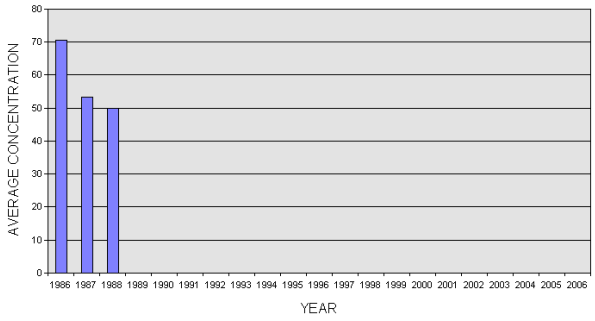


Figure 26. Dieldrin Concentration (ng/dry g) in Tissue at GATE. (NOAA 2006)

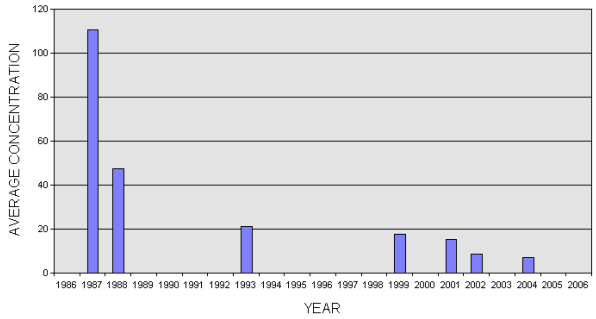
Total Chlordanes – HRRB



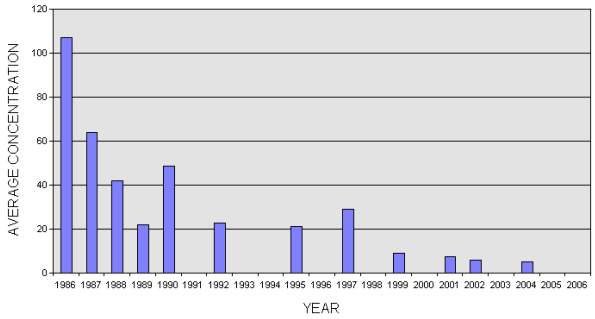
Total Chlordanes – HRUB



Total Chlordanes –HRLB



Total Chlordanes – NYSH



Total Chlordanes – HRJB

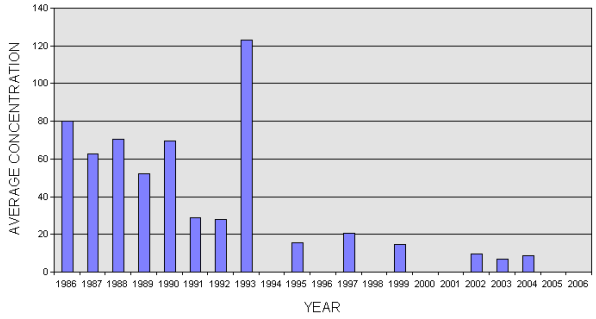
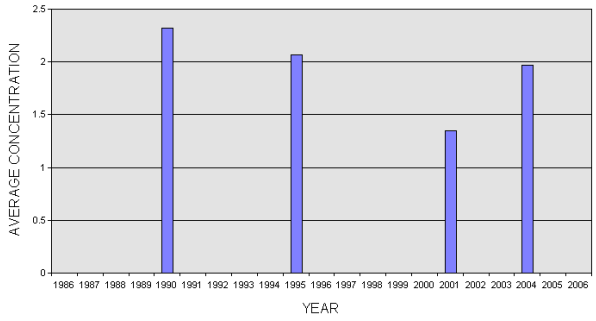
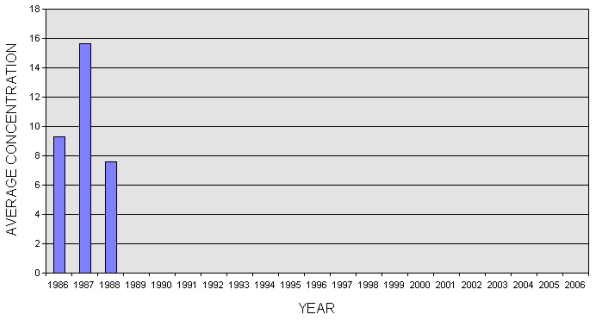


Figure 27. Total Chlordanes Concentrations (ng/dry g) in Tissue at GATE. (NOAA 2006)

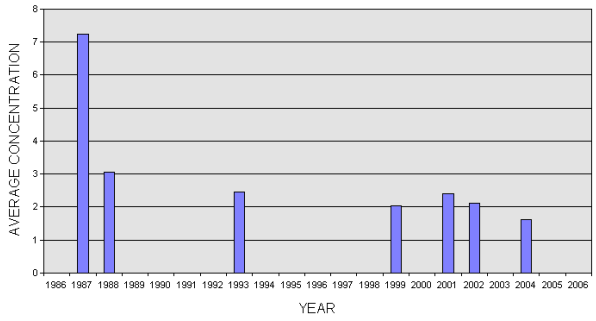
Total Cd – HRRB



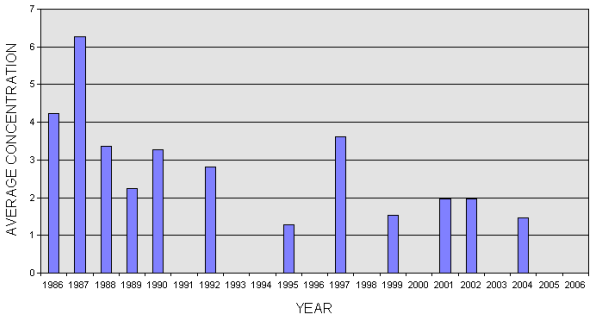
Total Cd – HRUB



Total Cd – HRLB



Total Cd – NYSH



Total Cd – HRJB

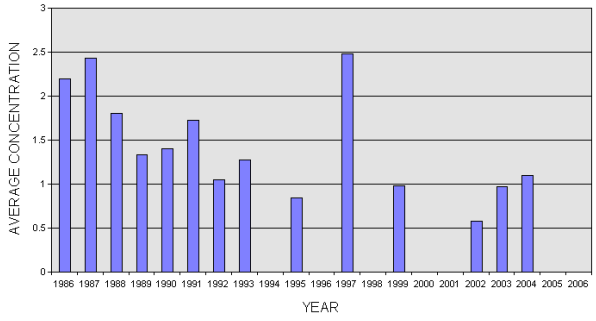
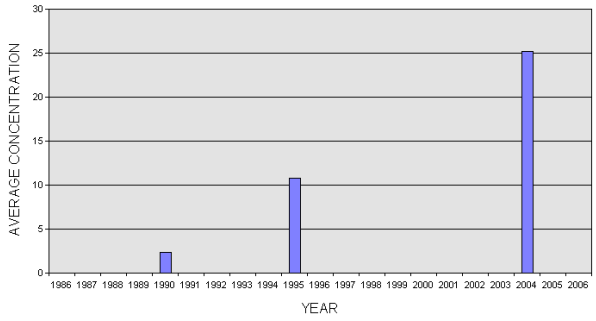
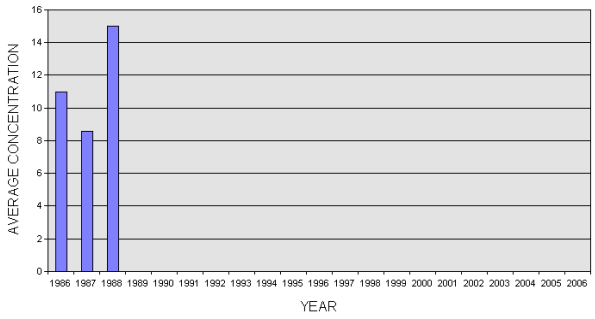


Figure 28. Cadmium Concentration (µg/dry g) in Tissue at GATE. (NOAA 2006)

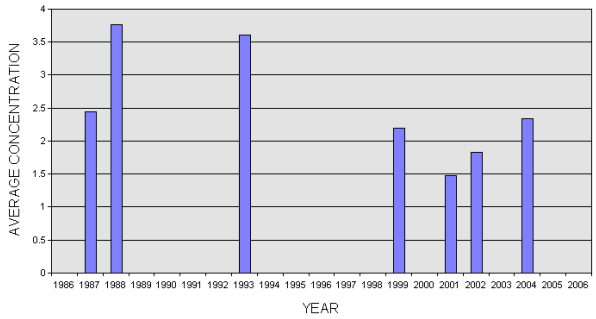
Total Cr – HRRB



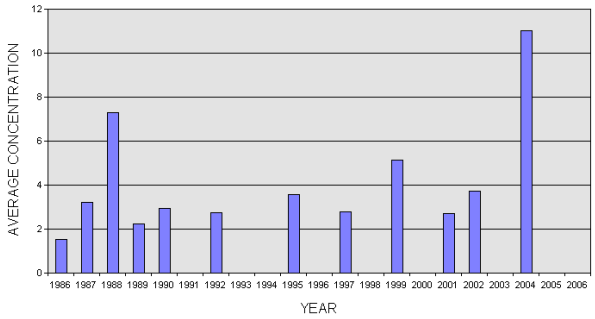
Total Cr – HRUB



Total Cr – HRLB



Total Cr – NYSH



Total Cr – HRJB

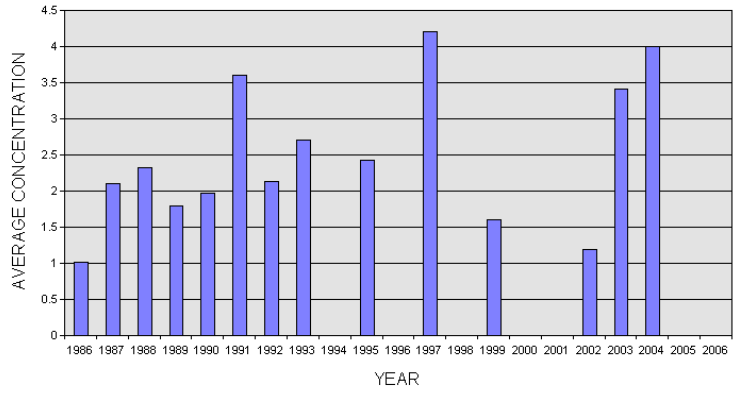
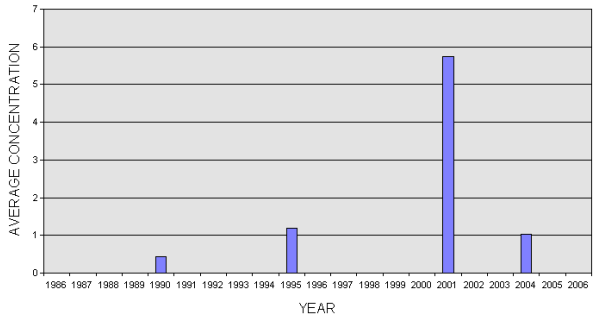
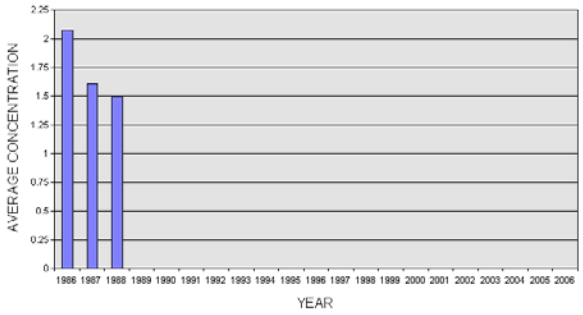


Figure 29. Total Chromium Concentration (µg/dry g) in Tissue at GATE. (NOAA 2006)

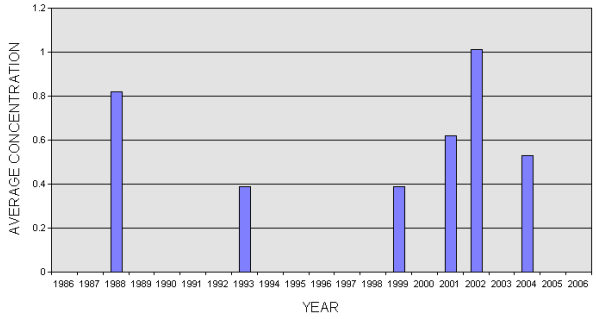
Total Ag – HRRB



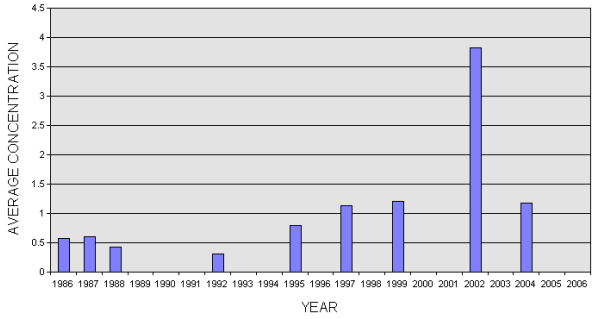
Total Ag – HRUB



Total Ag – HRLB



Total Ag – NYSH



Total Ag – HRJB

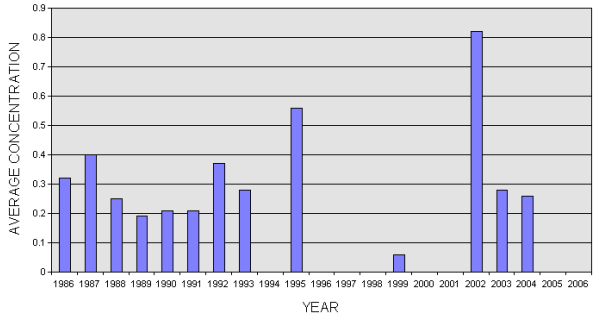
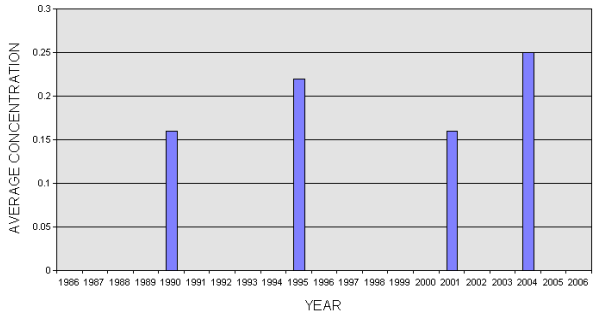
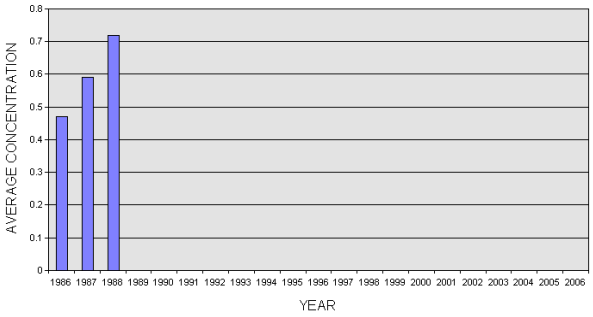


Figure 30. Total Silver (µg/dry g) in Tissue at GATE. (NOAA 2006)

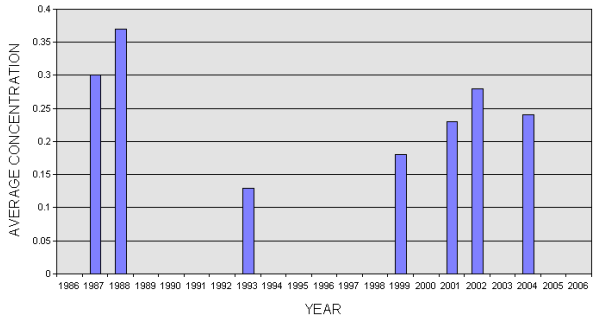
Total Hg – HRRB



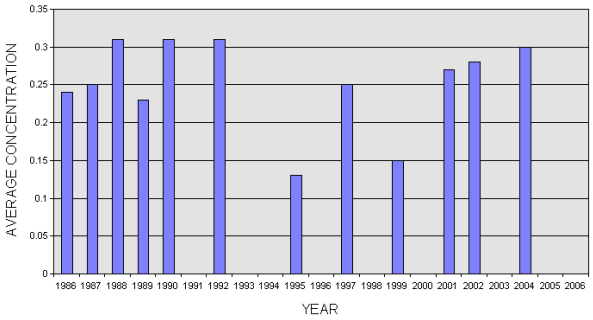
Total Hg – HRUB



Total Hg – HRLB



Total Hg – NYSH



Total Hg – HRJB

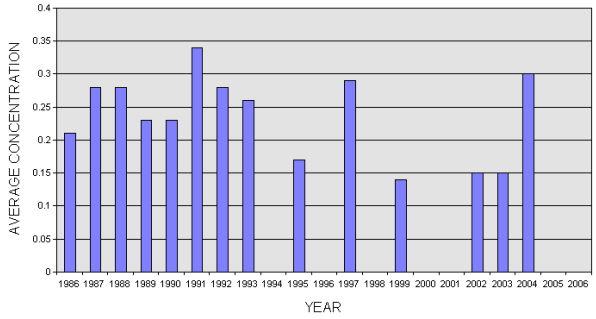
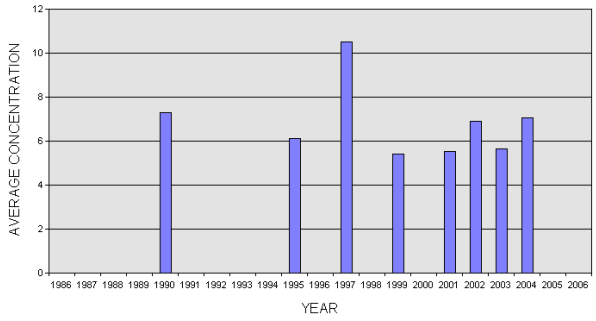
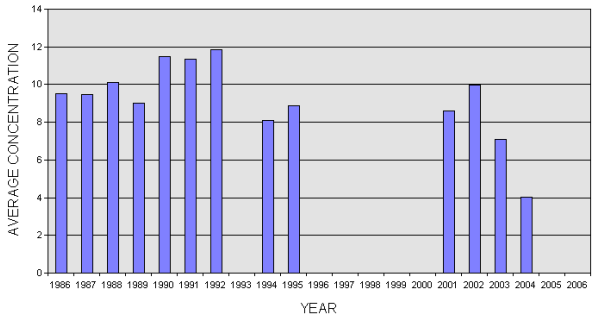


Figure 31. Total Mercury (µg/dry g) in Tissue at GATE. (NOAA 2006)

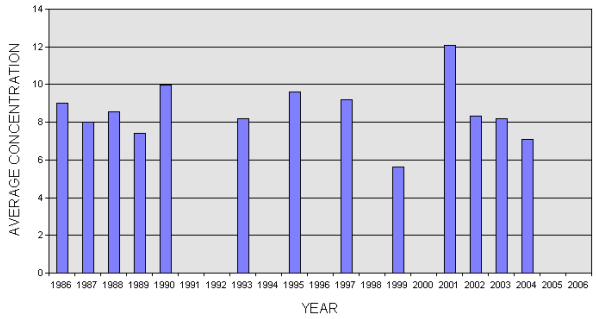
As – HRRB



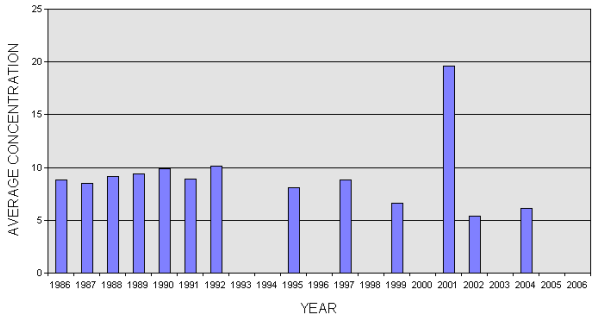
As – HRUB



As – HRLB



As – NYSH



As – HRJB

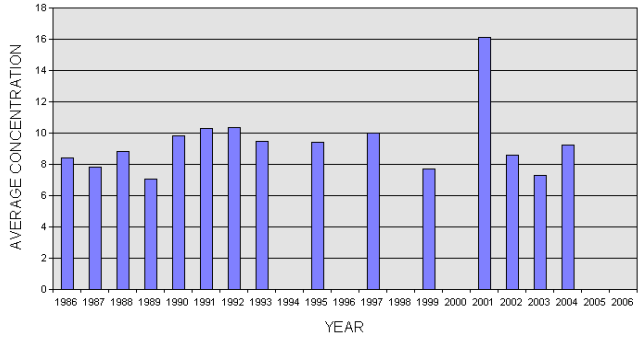
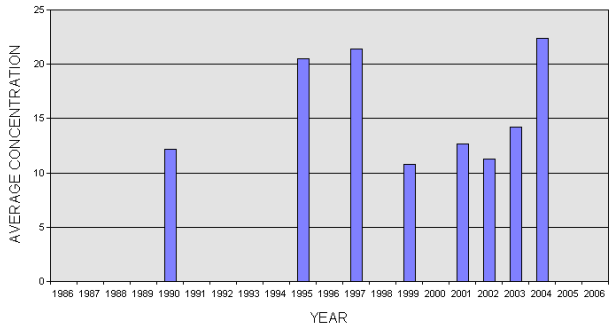
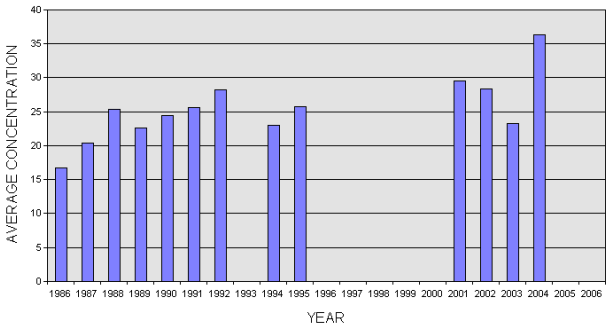


Figure 32. Arsenic Concentration (µg/dry g) in Tissue at GATE. (NOAA 2006)

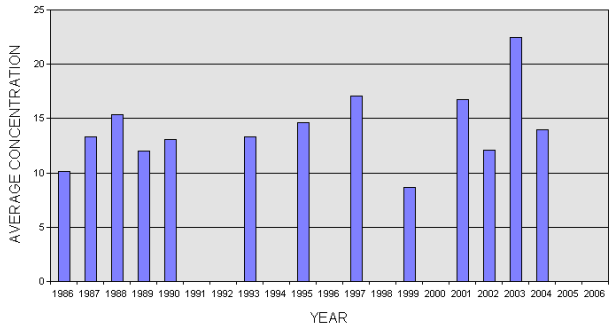
Cu – HRRB



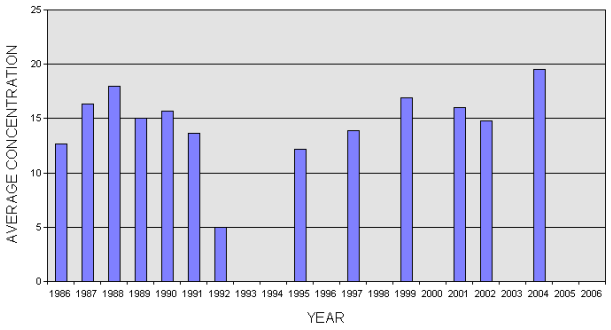
Cu – HRUB



Cu – HRLB



Cu – NYSH



Cu – HRJB

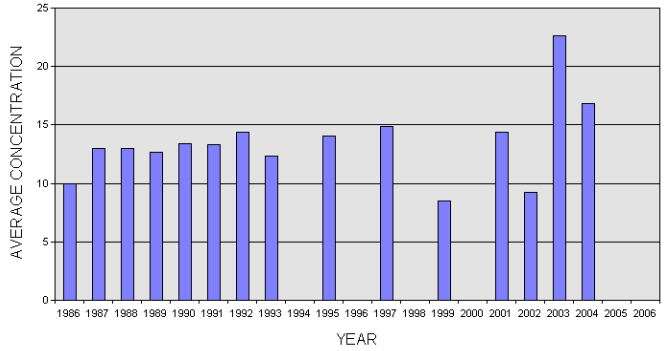
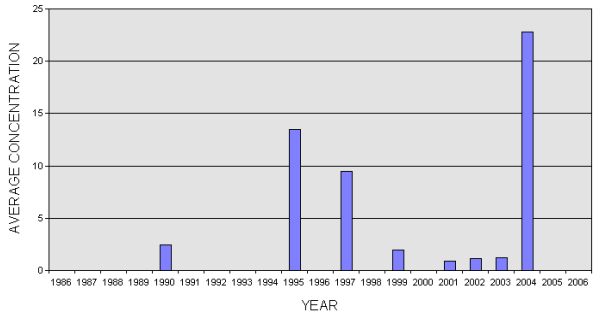
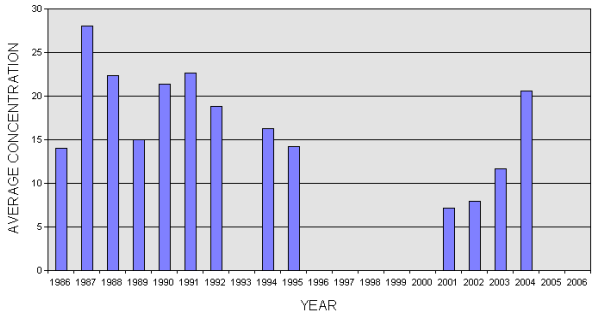


Figure 33. Copper Concentration (µg/dry g) in Tissue at GATE. (NOAA 2006)

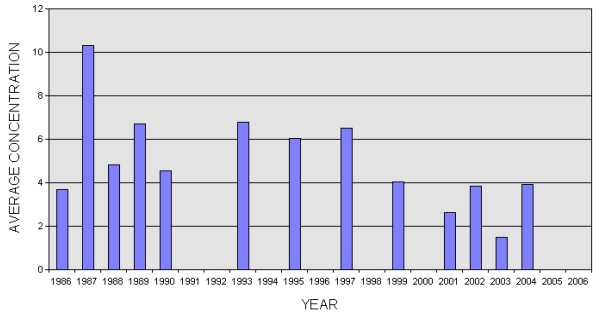
Pb – HRRB



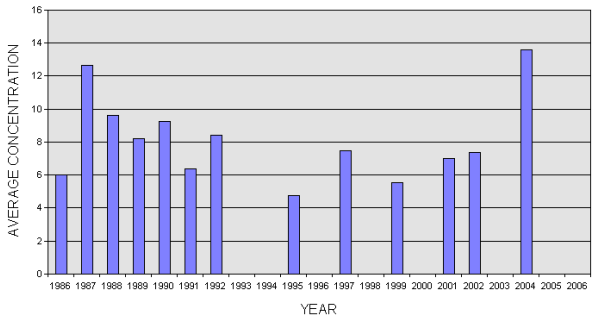
Pb – HRUB



Pb – HRLB



Pb – NYSH



Pb – HRJB

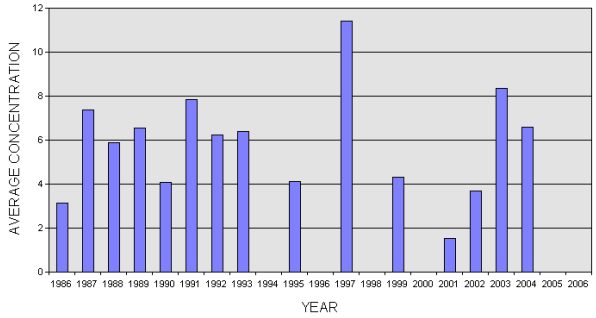
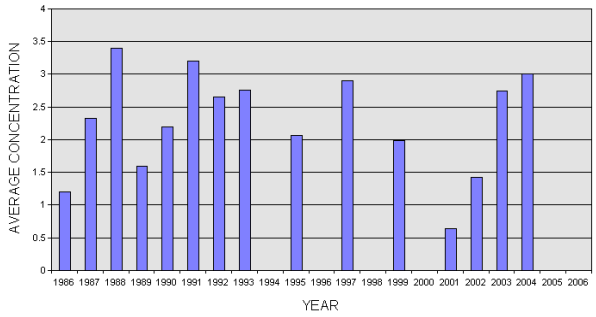
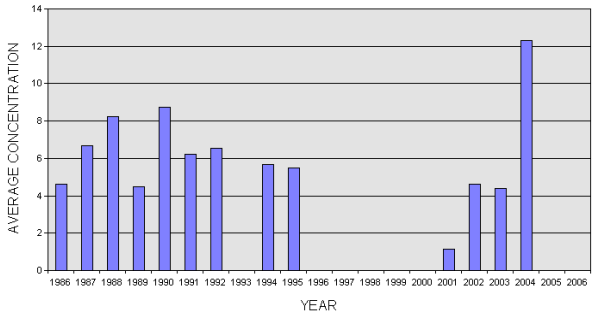


Figure 34. Lead Concentration (µg/dry g) in Tissue at GATE. (NOAA 2006)

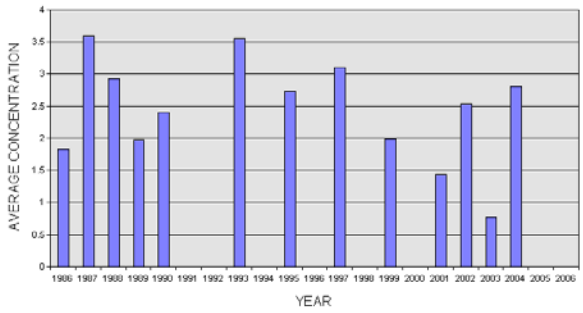
Ni – HRRB



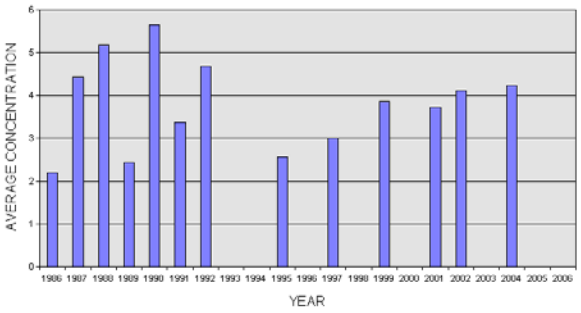
Ni – HRUB



Ni – HRLB



Ni – NYSH



Ni – HRJB

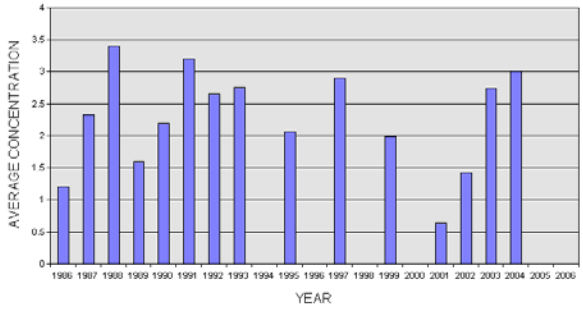
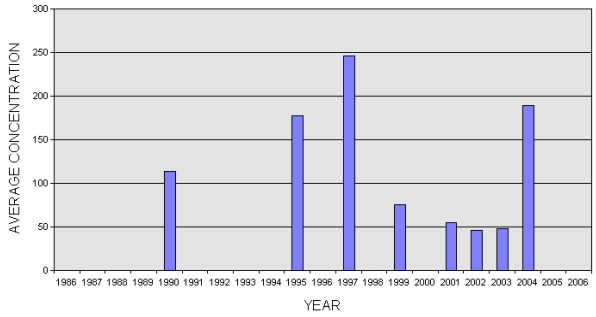
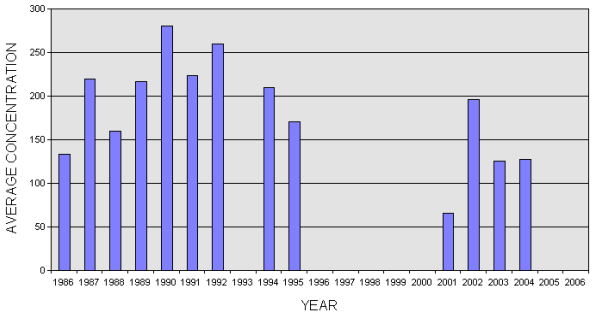


Figure 35. Nickel Concentration (µg/dry g) in Tissue at GATE. (NOAA 2006)

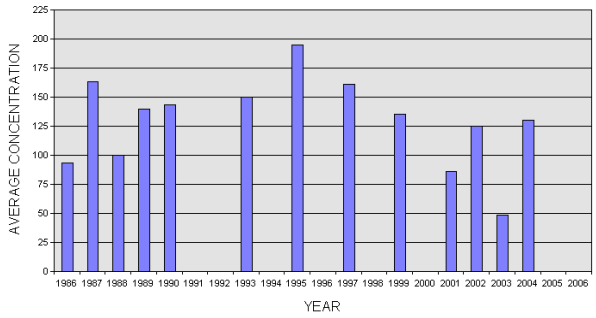
Zn – HRRB



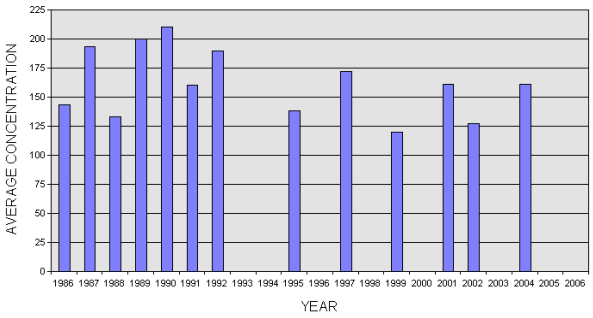
Zn – HRUB



Zn – HRLB



Zn – NYSH



Zn – HRJB

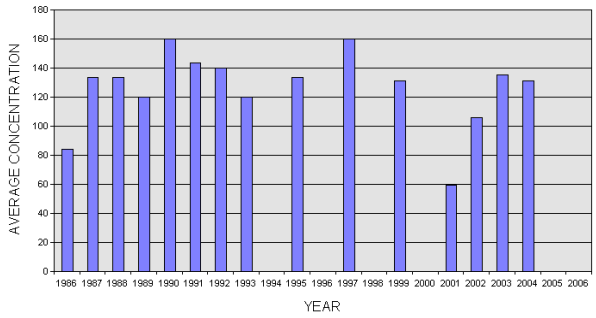


Figure 36. Zinc Concentration (µg/dry g) in Tissue at GATE. (NOAA 2006)

Benthic Sediment Toxicity

Sediment toxicity was evaluated by using *Ampelisca abdita* and *Photobacterium phosphoreum* (Tables 19-21). The station numbers correspond to the locations sampled by USEPA in the vicinity of each of the GATE units. If percent survival, compared to the survival in controls, was less than 80%, then the sediment was considered toxic. If the percent survival was less than 60%, the sediment was considered highly toxic. There was no statistically significant change in mean percent survival between the 1993/1994 and 1998 studies. (Adams 2003)

In five of the 11 sites in the 1993/1994 sampling in Jamaica Bay, the *Ampelisca* had survival less than 80%. There was no toxicity associated with the Staten Island Unit. In the Sandy Hook Unit, one of four sites is toxic to benthic organisms (Table 19).

In the 1998 sample, one of five samples were significantly toxic to *Ampelisca* (Table 20). There was no toxicity seen with this organism for the sites at Staten Island or Sandy Hook. Based on the biological responses there has been some improvement in Jamaica Bay and the Sandy Hook sediment from 1993/1994 sampling until 1998.

Based on microtoxic toxicity test data, there were sediments that were toxic to the fluorescent bacteria. In the Jamaica Bay Unit, seven of 11 stations had significant sediment associated toxicity. None of the four stations near the Staten Island Unit showed any toxicity. In the Sandy Hook area, two of the four stations showed a significant effect on microtox bacterium (Table 21).

Table 19. Amphipod Sediment Toxicity Test Data, REMAP 1993-1994 NY/NJ Harbor Data.

Station	Date	Species	SURV	SURV_P
Jamaica Bay Unit				
JB002	14SEP93	*Ampelisca abdita*	96	93
JB008	14SEP93	*Ampelisca abdita*	53	51
JB015	15SEP93	*Ampelisca abdita*	38	37
JB039	08SEP93	*Ampelisca abdita*	38	36
JB041	09SEP93	*Ampelisca abdita*	69	69
JB042	17SEP93	*Ampelisca abdita*	103	94
JB043	09SEP93	*Ampelisca abdita*	74	73
JB101	09SEP94	*Ampelisca abdita*	98	93
JB103	12SEP94	*Ampelisca abdita*	93	89
JB114	08SEP94	*Ampelisca abdita*	97	92
JB115	06SEP94	*Ampelisca abdita*	94	93
Raritan Bay/Staten Island Unit				
RB002	12AUG93	*Ampelisca abdita*	95	92
RB007	12AUG93	*Ampelisca abdita*	97	94
RB012	15AUG93	*Ampelisca abdita*	96	93
RB105	04AUG94	*Ampelisca abdita*	98	92
Raritan Bay/Sandy Hook Unit				
RB024	17AUG93	*Ampelisca abdita*	63	62
RB027	19AUG93	*Ampelisca abdita*	93	91
RB032	19AUG93	*Ampelisca abdita*	98	96
RB033	19AUG93	*Ampelisca abdita*	93	91

(USEPA 1997c)

Variables:

STATION	Station name
DATE	Sample collection date
SPECIES	Sediment toxicity test species
SURV %	Survival (sample mean as % of control)
SURV_P	Percent survival
JB	Jamaica Bay area
RB	Raritan Bay area

Table 20. Amphipod Sediment Toxicity Test Data, REMAP 1998 NY/NJ Harbor Data.

STATION	DATE	SPECIES	RESULT	SIGNIFICANCE
Jamaica Bay Unit				
JB008	8/4/98	*Ampelisca abdita*	62	Significant
JB039	8/1/98	*Ampelisca abdita*	100	Not significant
JB041	8/1/98	*Ampelisca abdita*	93	Not significant
JB042	8/1/98	*Ampelisca abdita*	101	Not significant
JB043	7/17/98	*Ampelisca abdita*	89	Not significant
Raritan Bay/Staten Island Unit				
RB002	7/6/98	*Ampelisca abdita*	103	Not significant
RB007	7/6/98	*Ampelisca abdita*	101	Not significant
RB012	7/25/98	*Ampelisca abdita*	98	Not significant
Raritan Bay/Sandy Hook Unit				
RB024	7/21/98	*Ampelisca abdita*	93	Not significant
RB027	7/21/98	*Ampelisca abdita*	100	Not significant
RB032	7/28/98	*Ampelisca abdita*	99	Not significant
RB033	7/23/98	*Ampelisca abdita*	98	Not significant

(USEPA 2004a)

Variables:

STATION	Station name
DATE	Sample collection date
SPECIES	Sediment toxicity test species
RESULT	% Survival (sample mean as % of control)
SIGNIFICANCE	Sig. different (p<.05) from control
JB	Jamaica Bay area
RB	Raritan Bay area

Table 21. Microtox Toxicity Test Data, REMAP 1993-1994 NY/NJ Harbor Data.

STATION	DATE	SPECIES	EC50	SIG
Jamaica Bay Unit				
JB002	14SEP93	*Photobacterium phosphoreum*	308	0
JB008	14SEP93	*Photobacterium phosphoreum*	41	1
JB015	15SEP93	*Photobacterium phosphoreum*	17	1
JB039	08SEP93	*Photobacterium phosphoreum*	45	1
JB041	09SEP93	*Photobacterium phosphoreum*	39	1
JB042	17SEP93	*Photobacterium phosphoreum*	1071	0
JB043	09SEP93	*Photobacterium phosphoreum*	65	1
JB101	09SEP94	*Photobacterium phosphoreum*	17	1
JB103	12SEP94	*Photobacterium phosphoreum*	13	1
JB114	08SEP94	*Photobacterium phosphoreum*	97	0
JB115	06SEP94	*Photobacterium phosphoreum*	632	0
Raritan Bay/Staten Island Unit				
RB002	12AUG93	*Photobacterium phosphoreum*	805	0
RB007	12AUG93	*Photobacterium phosphoreum*	753	0
RB012	15AUG93	*Photobacterium phosphoreum*	1031	0
RB105	04AUG94	*Photobacterium phosphoreum*	448	0
Raritan Bay/Sandy Hook Unit				
RB024	17AUG93	*Photobacterium phosphoreum*	146	0
RB027	19AUG93	*Photobacterium phosphoreum*	65	1
RB032	19AUG93	*Photobacterium phosphoreum*	1258	0
RB033	19AUG93	*Photobacterium phosphoreum*	57	1

(USEPA 1997c)

Variables:

STATION	Station name
DATE	Sample collection date
SPECIES	Toxicity test species
EC50	EC50 value (% light inhibition)
SIG	Microtox significance (1=significant)
JB	Jamaica Bay area
RB	Raritan Bay area

Cormorant Studies

The cormorant has been used as a key ecosystem indicator for the Great Lakes due to its sensitivity to organochlorine contaminants. The double crested cormorant (*Phalacrocorax auritus*) is known to feed on harbor estuary fish during their rearing and breeding seasons in the New York Harbor. It should be noted that there is a lack of information available on the adverse effects of the detected chemicals. A study done by Parsons (2003) uses the cormorant as an environmental indicator of chemical residues within the New York Harbor estuary; this study includes Swinburne Island, Shooters Island, and Gardiners Island. This study focuses on data from Swinburne Island, which is located outside of the Staten Island Unit of GATE. In the 1990s, cormorants had less than optimum reproductive success with the occurrence of deformed chicks. PCB and DDE are considered to be the main causes (Parsons 2003).

Mercury and methylmercury were detected in egg, down, feather, and blood samples. Mercury was mostly comprised of methylmercury in all tissue types (87-100%). It is unknown what tissue levels of mercury are associated with adverse effects in cormorants. Parsons suggests that it is unlikely that mercury exposure at any of the sites significantly contributed to acute toxicity in cormorants. Cadmium levels were low in egg and down samples (Parsons 2003).

PAH was detected in all plasma and egg samples. In this study, PAH levels in eggs exceeded 0.036-0.018 ng/g wet weight, the toxic level of PAH in mallard (*Anas platyrhynchos*) eggs. Chrysene was present in all egg and plasma samples, as well. Naphthalene comprised about 70% of total PAH in egg tissue and 53-65% of total PAH in plasma. Phenanthrene comprised 8-17%, and biphenyl comprised 6-11% of total PAH in plasma (Parsons 2003).

Parsons detected chlorinated pesticides in tissue samples but not at levels that would produce adverse effects. High concentrations of DDE were found in egg samples at Swinburne with mean values ranging from 1.78-3.6 µg/g (wet weight) Other chlorinated pesticides were detected below levels reported in other environmental field studies (Parsons 2003).

Lower levels of PCB arochlor were detected in Swinburne Island compared to the others in the New York estuary. Plasma and egg samples on Swinburne were dominated by AR1260. (Parsons 2003)

Parsons' study suggests that cormorants in the New York estuary are at risk for deleterious effects due to PCB exposure. Values from Parson's study include PCB levels of 3.6-6.8 µg/g; 104-322 pg/g TCDD equivalents; 349 ng/g congener 105; and 1,760 ng/g congener 126 (Parsons 2003). To protect aquatic species and birds, PCB cleanup standards range from 0.20-1.00 ppm with the majority less than 0.50 ppm. The NOAA standard is set at 0.02 ppm. In order to protect the most sensitive wildlife (otter—*Lutrinea*—and mink—*Mustela*) to PCBs, USEPA has set the whole body burden to be between 0.03-0.30 ppm (USEPA 2000). This whole body number translates to 0.012-0.12 ppm for fish fillets (Baker et al. 2001).

The USEPA has quantified toxicity equivalency factors for each congener to give an estimation of total dioxin/furan toxicity in fish and birds (Adams 2003). Adams et al. (2003) showed that dioxin and furan levels in all the harbor sub-basins ranged from 2.5 to 57.1 ppt equivalents for fish and 12.3 to 78.1 for birds. This value does not include the co-planar PCB congeners that also act through a similar mechanism. However, even though levels seemed to have decreased

between the 1993/1994 and 1998 studies, it was not statistically significant, Table 22 (Adams 2003).

Parsons' study was able to detect most dioxins and furans in egg samples from all the islands. The chemical 2,3,7,8 – tetrachlorodibenzo-p-dioxin was detected at higher levels in eggs and plasma on Swinburne Island. TCDD and OCDD contributed 40-50% of total dioxins and furans in egg samples at Swinburne. Comparable to studies done in other regions, TCDD concentrations in eggs ranged from 6-60 pg/g wet weight. The mean concentration of TCDF in eggs ranged from 0.2-0.4 pg/g wet weight, which is lower in comparison to other studies according to Parsons (2003). Embryo mortality and some deformities may occur in cormorant eggs in TCDD concentrations from 5.3-22 pg/g, which is where most eggs samples fell (Parsons 2003). The TEQ values would indicate that both fish and birds in this region are likely impacted by these compounds especially as it relates to reproductive success.

Miscelanious Studies

There have been numerous studies that have examined the levels of dioxins and dibenzofurans in a number of species within this harbor estuary system. What these studies continue to point out is that the levels in aquatic organisms within the system are some of the highest in the country and the world. The NJDEP has reported that the levels of dioxins and furans are elevated in blue crabs (*Callinectes sapidus*) within the estuary and even in lobsters (*Nephropidae*) within the New York Bite area (Belton et al. 1985; Belton et al. 1988; Rappe et al. 1991). There are few studies that have examined the impacts of these compounds on aquatic organisms other than fish species (Cooper 1989; Giesy et al. 2002; Peterson et al. 1993). These compounds alter normal reproduction in invertebrates, as well as in higher organisms. Based on laboratory and field studies, the levels present in the crustacean and bivalve mollusks (total body dose 2 pg/g 2,3,7,8-TCDD American oyster) in the NY/NJ Harbor are having deleterious effects on reproductive success (Wintermyer and Cooper 2003; Wintermyer and Cooper 2007).

The wildlife living in the NY/NJ Harbor estuary are constantly being exposed to a number of COCs that are present in the sediment, water, and air (Steinberg et al. 2004). These include a number of heavy metals, PAHs, persistent organic compounds, and new emerging compounds. In a number of the cases previously discussed, levels are above a threshold level value that has been associated with adverse effects. Because wildlife are being exposed to a large mixture of compounds and the toxicity threshold values are generated on a single compound basis, the impact of mixtures is not well understood.

Table 22. 2,3,7,8-TCDD Sediment, Fish, and Bird concentrations.

	Sediment 2,3,7,8-TCDD (ng/kg, dry wt.)		TEQs (fish)[1]	TEQs (birds)
	1993/4	1998	1998	1998
Harbor	-	6.5 (± 1.6)	9.7 (± 2.0)	22.5 (± 3.1)
Jamaica Bay	4.0 (± 2.6)	1.6 (± 0.9)	2.5 (± 1.2)	12.3 (± 5.0)
Lower Harbor	7.5 (± 3.4)	3.0 (± 1.7)	5.0 (± 2.8)	15.1 (± 7.4)
Upper Harbor	5.5 (± 1.8)	6.4 (± 2.7)	12.4 (± 3.7)	32.5 (± 9.1)
Newark Bay	Not analyzed	49.0 (± 24.6)	57.1 (± 26.7)	78.1 (± 31.9)

1. Source Adams 2003 and TEQ = Toxicity Equivalent Quotient.

Recommended Sampling for Monitoring Purposes

Very detailed protocols for collection of samples, quality assessment/quality control recommendations and ways to interpret the data are discussed in Appendix 1. In Appendix 2 are the specific protocols used by USEPA Emergency Response Team (ERT) for decontamination of equipment, collection SOPs and accepted analysis methods for metals and organic compounds. This section will concentrate on the proposed sampling to be carried out at GATE for each of the individual units.

Staten Island Unit

Table 23 describes the recommended samples to be collected at the Staten Island Unit. In the case of Miller Field, no sampling is recommended due to the current use as sports fields and the lack of significant wildlife at this location. In addition, remediation by Hydro-Geo Corporation at the site for both soil and groundwater indicate levels below concentrations of concern for wildlife (Laney and Uminiski 2000). The Staten Island Units USTs have been remediated and there is no further need for sampling at these locations (Cuzzolino, personnel communication, March 2006). This was confirmed by reviewing consulting reports for each UST removed.

Table 23 lists the recommended samples for the Staten Island Units. Sample numbers 1-5 are located at the Great Kills Park. The bay adjacent to the park is important to migratory and local waterfowl. As described above, this park was a former municipal landfill, and needs a better characterization of its contaminants. Sample (SIU-1) is investigative and will give an indication of the levels of metals, organic and radioactive compounds underneath the cap. This sample may help to identify COC for this particular landfill. The analysis for radioactive species is based on the detection of concentrated radioactive material at the site from a recent aerial flyover (USDI/NPS 2005). The landfill is adjacent to the Great Kills Park basin, and biota sampling (SIU-2) should be conducted along the edge closest to the landfill and or adjacent to visible seepage areas. The biota that should be sampled should include the blue mussel (*Mytilus edulis*) or another bivalve that may be present, such as the ribbed mussel (*Geukensia demissa*). These values can be compared to the NOAA Status and Trends data from bivalves collected from nearby waters. In addition to the bivalves, mummichogs (*Fundulus heteroclitus*) should be collected as the representative prey species in the area. At or near the same location as the biota samples, sediment samples (SIU-3) should be collected using a Ponar grab sampler. The same analytes should be collected as the two previous samples. The leachate or seep (SIU-4) should also be sampled coming out of the landfill. Comparisons can be made between the four samples to see if compounds present within the landfill are reaching the surrounding aquatic biota and sediments. The marina, which is located on the eastern side of the bay, should be sampled for compounds that have been shown to be present in marina sediments. Therefore, sample SIU5 is an investigative sample to determine the level of contamination in the marina sediments.

Swinburne and Hoffman Islands are man-made islands that are off the coast of Staten Island and are owned by the NPS. They are not accesible to the public and offer the opportunity to evaluate the health of organisms in an isolated environment. The sampling that is being proposed is limited to Swinburne Island due to previous work on bird populations inhabiting this island

Table 23. Recommended Samples for the Staten Island Unit of GATE
(1) All method numbers refer to EPA SW-846 with exception of radiation determination which uses Standard Methods for Examination of Water and Wastewater 18th Ed. (2) Initial sample and 5 yr. interval**.**

Matrix	**Analyte (1)**		**Number of Samples/Type**		**Frequency[2]/Method**	**Location on Site**
(Number)	**(Method #)[1]**					
Soil (SIU-1)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling	Great Kills Park Landfill
	Imw PAHs	(8100, 8275A)			Soil core below cap	
	hmw PAHs	(8100, 8275A)				
	VOCs	(8240)				
	Pesticides	(8270D)				
	Radiation	(7010, 7500 Standard Methods Waste & Waste Water 18th Ed.)				
Biota (SIU-2)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling	Great Kills Park Basin
	Imw PAHs	(8100, 8275A)			*Mytilus edulis* or *Geukensis demissa*	
	hmw PAHs	(8100, 8275A)			Prey finfish *Fundulus heteroclitus*	
	VOCs	(8240)				
	Pesticides	(8270D)				
	Radiation	(7010, 7500 Standard Methods Waste & Waste Water 18th Ed)				
Sediment (SIU-3)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling Ponar Grab	Great Kills Park Basin adjacent to landfill seeps
	Imw PAHs	(8100, 8275A)				
	hmw PAHs	(8100, 8275A)				
	VOCs	(8240)				
	Pesticides	(8270D)				
	Radiation	(7010, 7500 Standard Methods Waste & Waste Water 18th Ed)				
Leachate (SIU-4)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling Glass Jars	Great Kills Park Basin landfill seeps or leachate collection area
	Imw/ hmw PAHs	(8100, 8275A)				
	VOCs	(8240)				
	Pesticides	(8270D)				
	Radiation	(7010, 7500 Standard Methods Waste & Waste Water 18th)				

Table 23. Recommended Samples for the Staten Island Unit of GATE
(1) All method numbers refer to EPA SW-846 with exception of radiation determination which uses Standard Methods for Examination of Water and Wastewater 18th Ed. (2) Initial sample and 5 yr. interval. (Continued)

Matrix	**Analyte (1)**		**Number of Samples/Type**		**Frequency[2]/Method**	**Location on Site**
(Number)	**(Method #)**[1]					
Sediment (SIU-5)	Lead,	(7000, 7010)	3	Composite	Investigative sampling	Great Kills Park Marina Area
	Imw/ hmw PAHs	(8100, 8275A)			Ponar Grab	
	Organotin cmpd	(7000, 7010)				
	Organics Compounds (PAHs, PCBs)	(8260B, 8021B,)				
Soil (SIU–6)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling 1/ Core Sample (Top 0-3 inches	Swinburne Island (near nesting areas)
	Organics Compounds (PAHs, PCBs)	(8260B, 8021B,)				
Biota (SIU–7)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling	Swinburne Island (near nesting area used by Parsons 2003)
	Imw PAHs/hmw PAHs	(8100, 8275A)			*Fundulus heteroclitus*	
	PAHs, PCBs	(8100, 8275A)			and bivalve mollusk M. *edulis*	
	VOCs	(8240)			Cormorant (blood and egg	
	Pesticides	(8270D)			Samples Parson 2003)	
Sediment (SIU-8)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling	Swinburne Island (near nesting area)
	Imw PAHs	(8100, 8275A)			Ponar Grab	
	hmw PAHs	(8100, 8275A)				
	VOCs	(8240)				
	Pesticides	(8270D)				

Table 23. Recommended Samples for the Staten Island Unit of GATE. (1) All method numbers refer to EPA SW-846 with exception of radiation determination which uses Standard Methods for Examination of Water and Wastewater 18th Ed. (2) Initial sample and 5 yr. interval. (Continued)

Matrix	**Analyte (1)**		**Number of Samples/Type**		**Frequency[2]/Method**	**Location on Site**
(Number)	**(Method #)**[1]					
Soil (SIU-9)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling	Fort Wadsworth underneath the Verrazanno Bridge.
	Imw / hmw PAHs	(8100, 8275A)			Core Sample (Top 0-3 inches)	
	VOCs	(8240)				
	Pesticides	(8270D)				
Soil (SIU-10)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling	Fort Wadsworth 3 different open field locations: lawn in front of Fort Wadsworth, park in residential area, baseball field near bridge
	Imw / hmw PAHs	(8100, 8275A)			Core Sample (Top 0-3 inches)	
	Pesticides	(8270D)				

(Parsons 2003) and the paucity of data on Hoffman Island. The soil (SIU-6), biota (SIU-7), and sediment (SIU-8) will allow for a baseline of contamination to be established at Swinburne Island. The sampling should be concentrated near the comorant nesting areas that were previous sampled by Parsons (2003). The first set of samples (SIU-6) will be a composite from the soil near the breeding area. This will allow the researchers to see what contaminants are currently present in the surface soil on this man-made island. The biota sample (SIU-7) will include local bivalve mollusks and small prey mummichogs. This sample will allow for a determination of local contamination to the nesting area. It is realized that these birds eat larger prey and likely travel to surrounding areas to forage. These values can be compared to samples collected from USEPA and NOAA data sets. It is also recommended that blood samples and egg samples be collected at a five-year increment on Swinburne Island to monitor the levels in these top predator birds. Based on Parson's study, the individual compounds are at or above the threshold for toxicity and it is important to monitor this trend. Because there are multiple compounds within the eggs and blood samples at these levels, additive and synergistic effects could result in population effects on these birds.

At Fort Wadsworth, it is recommended that an investigative sampling of soil (SUI-9) directly under the Verazanno Narrows Bridge. This will indicate what contaminants are from maintenance of the bridge and from traffic utilizing the bridge. The USTs at Fort Wadsworth have been removed and both soil and groundwater samples have been tested and would pose no threat to wildlife. There are no ponds or streams in this portion of the park that would warrant sampling. Sampling that occurs along the shoreline is not recommended because data from NOAA and USEPA already exist. The other investigative sample that is being proposed is a soil sample from open field areas within the park (SUI-10). The three locations would consist of the large grassy area in front of Fort Wadsworth, a small park area south and west of the Verrazano Bridge Toll area in the residential area, and the third the baseball field south of the Verrazano Bridge. These three composite samples will allow for comparison of contaminants in different open grassy areas within the park.

Sandy Hook Unit

Table 24 lists the proposed sampling locations for the Sandy Hook Unit for GATE. The baseline sampling to be carried out along the Atlantic Ocean beaches will include a series of sediment (SHU-1) and biota samples (SHU-2) between the high tide and low tide mark. The biota to be sampled will be known food items consumed by the piping plovers (*Charadrius melodus*). Because these are baseline samples, the full suite of contaminants will be examined. Samples to be collected along Sandy Hook Bay will include composite sediment samples (SHU-3) and tissue samples (SHU-4) from *Mytilus edulis* and *Fundulus heteroclitus*. The samples will be collected from Plum Island, Spemaceti Cove and Horseshoe Cove.

Located adjacent to the U.S. Coast Guard base, there was a reported abandoned dump site that it is recommended be sampled (SHU-5). Due to the unknown materials that may have been dumped and later removed, a surface soil sample is being recommended. Also associated with the U.S. Coast Guard is a docking area that should be sampled for sediment contamination (SHU- 6). The sample can be collected from the marina area. This sample can also be compared to SHU-3 to see what differences the marina activities have on sediment chemical concentrations.

Table 24. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Sandy Hook Unit (SHU)
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals.

Matrix	**Analyte (1)**		**Number of Samples/Type (2)**		**Frequency/Method**	**Location on Site**
(Number)	(Method #)					
Sediment (SHU-1)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling	Atlantic Ocean Beach (North, middle and southern). Collect between high tide & low tide mark.
	Imw /hmw PAHs	(8100, 8275A)			1-3/ Ponar Grab	I composite South Beach
	VOCs	(8240)				1 composite Mid Beach
	Pesticides	(8270D)				1 composite North Beach
	PCBs	(8275)				
	Dioxins/Furans	(8290)				
Biota (SHU-2)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling 1-3/ Isopods & small crustacea as fed on by Piping plovers prey	Atlantic Ocean Beach (North, middle and southern). Collect between high tide & low tide mark.
	Imw /hmw PAHs	(8100, 8275A)				I composite South Beach
	VOCs	(8240)				1 composite Mid Beach
	Pesticides	(8270D)				1 composite North Beach
	PCBs	(8275)				
	Dioxins/Furans	(8290)				
Sediment (SHU3)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling 1 / Ponar Grab	Sandy Hook Bay side at three lagoon locations high organic content areas.
	Imw /hmw PAHs	(8100, 8275A)				1 composite at Plum Island
	VOCs	(8240)				1 composite at Spermaceti Cove
	Pesticides	(8270D)				1 composite at Horseshoe Cove
	PCBs	(8275)				
	Dioxins/Furans	(8290)				

Table 24. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Sandy Hook Unit (SHU)
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals. (Continued)

Matrix	**Analyte (1)**		**Number of Samples/Type (2)**		**Frequency/Method**	**Location on Site**
(Number)	(Method #)					
Biota (SHU-4)	Heavy Metals	(7000, 7010, 6010B, 6020A)	6	Composite	Investigative sampling	Sandy Hook Bay side at three locations.
	Imw /hmw PAHs	(8100, 8275A)			*Mytilus edulis*	1 composite at Plum Island
	VOCs	(8240)			Prey finfish *Fundulus heteroclitus*	1 composite at Spermaceti Cove
	Pesticides	(8270D)				1 composite at Horseshoe Cove
	PCBs	(8275)				
	Dioxins/Furans	(8290)				
Soil (SHU-5)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative Sample	Abandoned dump site
	Imw /hmw PAHs	(8100, 8275A)			Core Sampler (Top 0-3 inches)	Located adjacent to US Coast Guard Base
	VOCs	(8240)				
	Pesticides	(8270D)				
	PCBs	(8275)				
Sediment (SHU-6)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling 1 / Ponar Grab	US Coast Guard Docking Areas
	Imw /hmw PAHs	(8100, 8275A)				
	VOCs	(8240)				
	Pesticides	(8270D)				
	PCBs	(8275)				
	Dioxins/Furans	(8290)				

Table 24. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Sandy Hook Unit (SHU)
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals. (Continued)

Matrix	Analyte (1)		Number of Samples/Type (2)		Frequency/Method	Location on Site
(Number)	(Method #)					
Soil (SHU-7)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative Sample Core Sampler (Top 0-3	Maintenance and Shop Area
	Imw /hmw PAHs	(8100, 8275A)			inches)	
	VOCs	(8240)				
	Pesticides	(8270D)				
	PCBs	(8275)				
Gr. Water (SHU-8)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling	Existing monitoring wells #1, #3 and pore water.
	Imw / hmw PAHs	(8100, 8275A)			Ground water sample	
	VOCs	(8240)			In and near sewage	
	Pesticides	(8270D)			lagoon	
	Steroidal Cmpd	(IUPAC 2003 Holland 2003)				
Soil (SHU-9)	Heavy Metals	(7000, 7010, 6010B, 6020A)	1	Composite	Investigative sampling	Sludge Drying Beds and surface sediment from on-site lagoons from existing Treatment Plant
	Imw / hmw PAHs	(8100, 8275A)			Surface sample	
	VOCs	(8240)				
	Pesticides	(8270D)				
	Steroidal Cmpd	(IUPAC 2003 Holland 2003)				

Table 24. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Sandy Hook Unit (SHU)
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals. (Continued)

Matrix	Analyte (1)		Number of Samples/Type (2)		Frequency/Method	Location on Site
(Number)	(Method #)					
Sediment (SHU-10)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling 1 / Ponar Grab	North Pond Near Nine Gun Battery
	Imw /hmw PAHs	(8100, 8275A)				
	VOCs	(8240)				
	Pesticides	(8270D)				
	PCBs	(8275)				
	Munitions/					
Sediment (SHU-11)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative sampling 1 / Ponar Grab	Nike Pond Near Nike Missile Radar Site
	Imw /hmw PAHs	(8100, 8275A)				
	VOCs	(8240)				
	Pesticides	(8270D)				
	PCBs	(8275)				
Soil (SHU-12)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Investigative Sample Core Sampler (Top 0-3	Parade Ground Lawn areas behind
	Imw /hmw PAHs	(8100, 8275A)			inches)	Kessler Road and Officers Quarters
	VOCs	(8240)				
	Pesticides	(8270D)				
	PCBs	(8275)				

Soil samples should be collected from the maintenance and shop area (SHU-7). Core samples (0 to 228.6 millimeters) should be taken and evaluated for the full suite of contaminants. This is an area where abandoned equipment has been stored, as well as where repairs are made to motor vehicles and metal fabrication. It is likely that there will be areas with high levels of petroleum hydrocarbons and other contaminants. What is not known is the historical contamination at this site prior to the NPS taking over the Sandy Hook Unit.

Samples SHU-8 and SHU-9 deal with the activities currently ongoing at the onsite sewage treatment facility. The groundwater samples (SHU-8) should be taken from existing wells #1 and #3. These wells were selected because of their locations relative to groundwater flow from the site. The third sample is a pore water sample (in-situ samplers or semi-permeable membrane, see Appendix 2) to obtain subsurface levels of the leachate. Current samples are being taken for nutrient and water quality parameters, and this would expand the compounds examined. The surficial soil sample (SHU-9) will be taken directly from the sludge drying beds.

Samples SHU-10 and SHU-11 are sediment samples to be collected from two naturally occurring ponds located on Sandy Hook. Nike Pond, near the Nike missile radar site is proposed for testing to determine what contaminants may be present from historical use of the site. Groundwater in the area has been previously reported to contain VOCs. North Pond, near Nine Gun Battery had not been tested previously for contaminants and is in the vicinity of a former gun battery, Coast Guard Station, and Nike missile locations. Migrating bird populations have been reported to heavily utilize the North Pond.

Sample SHU-12 is a series of composite soil samples taken from the parade ground area behind the officers quarters and Kessler Road. This is an investigative sample to determine what contaminants are present in a large open grassy area.

Jamaica Bay Unit

Table 25 lists the proposed sampling locations for the Jamaica Bay Unit for GATE. The baseline sampling to be carried out along the Atlantic Ocean beaches will include a series of sediment (JBU-1) and biota samples (JBU-2) between the high tide and low tide mark using a random grid approach (see Appendix 1). The biota to be sampled will be known food items consumed by the piping plovers. Since these are baseline samples, the full suite of contaminants will be examined.

Samples to be collected along Jamaica Bay will include composite sediment samples (JBU-3) and tissue samples (JBU-4) from *Fundulus heteroclitus*. The samples will be collected from locations that cover the entire perimeter of Jamaica Bay. These locations were also selected to correspond to locations used for water quality monitoring and to track areas with specific inputs.

Sediment samples (JBU-5) from ponds located at various locations in the Jamaica Bay Unit will allow for evaluating baseline levels at these locations. The East and West ponds (JBU-5a and JBU-5b) are located at the wildlife refuge and will allow for evaluating what chemicals are potentially accumulating in the sediment from the nearby rail line and roads. The Fort Tilden Pond (JBU-5c) is located at the former Nike military base and will allow for determining if chemicals are present in the sediment from historical contamination.

Table 25. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Jamaica Bay Unit (JBU)
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals.

Matrix	**Analyte (1)**		**Number of Samples/Type (2)**		**Frequency/Method**	**Location on Site**
(Number)	**(Method #)**					
Sediment (JBU-1)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling	Atlantic Ocean Beach. Collect between high tide & low tide mark..
	Imw /hmw PAHs	(8100, 8275A)			1-3/ Ponar Grab	I composite Riis Park (ALT 1)
	VOCs	(8240)				1 composite Fort Tilden
	Pesticides	(8270D)				1 composite Breezy Point (ALT 2)
	PCBs	(8275)				
	Dioxins/Furans	(8290)				
Biota (JBU-2)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling	Atlantic Ocean Beach. Collect between high tide & low tide mark.
	Imw /hmw PAHs	(8100, 8275A)			1-3/ Isopods & small crustacea prey of Piping plovers	I composite Riis Park (ALT 1)
	VOCs	(8240)			prey	1 composite Fort Tilden
	Pesticides	(8270D)				1 composite Breezy Point (ALT 2)
	PCBs	(8275)				
	Dioxins/Furans	(8290)				

Table 25. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Jamaica Bay Unit (JBU)
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals. (Continued)

Matrix	**Analyte (1)**		**Number of Samples/Type (2)**		**Frequency/Method**	**Location on Site**
(Number)	**(Method #)**					
Sediment (JBU-3)	Heavy Metals	(7000, 7010, 6010B, 6020A)	9	Composite	Baseline Sampling 1-3 / Ponar Grab	Jamaica Bay Sediment Locations
	Imw /hmw PAHs	(8100, 8275A)				1 composite at Riis Landing (JB-21)
	VOCs	(8240)				1 composite at Beach Channel (JB-15)
	Pesticides	(8270D)				1 composite at Jo-Co Marsh (JB-12)
	PCBs	(8275)				1 composite at Bergen Basin Inlet (JB-16)
	Dioxins/Furans	(8290)				1 composite at Fresh Creek (JB-6A)
	Nonyphenol & metabolites	Ferguson et. al., 2001.				1 composite at Floyd Bennett Field
						1 composite at Dead Horse Bay
						1 composite at East Pond/Grassy Bay
						1 composite at Pumpkin Patch Channel

Table 25. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Jamaica Bay Unit (JBU)
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals. (Continued)

Matrix	**Analyte (1)**		**Number of Samples/Type (2)**		**Frequency/Method**	**Location on Site**
(Number)	**(Method #)**					
Biota (JBU-4)	Heavy Metals		9	Composite	Baseline Sampling 1-3	Jamaica Bay Prey Species
	Imw /hmw PAHs	(8100, 8275A)			Prey finfish *Fundulus heteroclitus* Trap/Net	1 composite at Riis Landing (JB-21)
	VOCs	(8240)				1 composite at Beach Channel (JB-15)
	Pesticides	(8270D)				1 composite at Jo-Co Marsh (JB-12)
	PCBs	(8275)				1 composite at Bergen Basin Inlet (JB-16)
	Dioxins/Furans	(8290)				1 composite at Fresh Creek (JB-6A)
						1 composite at Floyd Bennett Field
						1 composite at Dead Horse Bay
						1 composite at East Pond/Grassy Bay
						1 composite at Pumpkin Patch Channel

Table 25. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Jamaica Bay Unit (JBU).
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals. (Continued)

Matrix	**Analyte (1)**		**Number of Samples/Type (2)**		**Frequency/Method**	**Location on Site**
(Number)	**(Method #)**					
Sediment (JBU-5)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling 1-3 / Ponar Grab	Jamaica Bay Pond Sites
	Imw /hmw PAHs	(8100, 8275A)				1 composite at East Pond – Wildlife Refuge
	VOCs	(8240)				1 composite at West Pond – Wildlife Refuge
	Pesticides	(8270D)				1 composite at Fort Tilden Pond
	PCBs	(8275)				
	Dioxins/Furans	(8290)				
Soil (JBU-6)	Heavy Metals	(7000, 7010, 6010B, 6020A)	4	Composite	Baseline Sampling 1-3 / Ponar Grab	Parking Area Drainage
	Imw /hmw PAHs	(8100, 8275A)				Ryan Visitor Center
	VOCs	(8240)				Jacob Riis Parking Area
						Fort Tilden Visitor Center
						Wildlife Refuge Visitor Center

Table 25. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Jamaica Bay Unit (JBU).
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals. (Continued)

Matrix	**Analyte (1)**		**Number of Samples/Type (2)**		**Frequency/Method**	**Location on Site**
(Number)	**(Method #)**					
Soil (JBU-7)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling	Floyd Bennett Field
	Imw /hmw PAHs	(8100, 8275A)			1-3/ Surface soil	Camping and open grasslands
	VOCs	(8240)				
	Pesticides	(8270D)				
Soil (JBU-8)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling	Wildlife Refuge
	Imw /hmw PAHs	(8100, 8275A)			1-3/ Surface soil	Adjacent to the railroad tracks
	VOCs	(8240)				
	Pesticides	(8270D)				
	PCBs	(8275)				
	Dioxins/Furans	(8290)				
Soil (JBU-9)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling	Jacob Riis Park
	Imw /hmw PAHs	(8100, 8275A)			1-3/ Surface soil	Gulf Course
	VOCs	(8240)				
	Pesticides	(8270D)				
Soil (JBU-10)	Heavy Metals	(7000, 7010, 6010B, 6020A)	3	Composite	Baseline Sampling	Breezy Point
	Imw /hmw PAHs	(8100, 8275A)			1-3/ Surface soil	
	VOCs	(8240)				
	Pesticides	(8270D)				
	PCBs	(8275)				

Table 25. Recommendations for Sampling to Examine Chemicals of Concern in Different Matrix in Jamaica Bay Unit (JBU).
(1) All method numbers refer to EPA SW-846 (2) 1 - 3 Means sample in the first year then at three to five yr intervals. (Continued)

Matrix	**Analyte (1)**		**Number of Samples/Type (2)**		**Frequency/Method**	**Location on Site**
(Number)	**(Method #)**					
Soil (JBU-11)	Heavy Metals	(7000, 7010, 6010B, 6020A)	6	Composite	Baseline Sampling	Pennsylvania Ave. Landfill &
	Imw /hmw PAHs	(8100, 8275A)			1-3/ Soil at leachate	Fountain Ave. Landfill
	VOCs	(8240)			breakthrough sites on landfill sides	
	Pesticides	(8270D)				
	PCBs	(8275)				
	Dioxins/Furans	(8290)				
	Radioactivity	(7010, 7500 Standard Methods Waste & Waste Water 18th Ed)				

Soil samples (JBU-6) near the main parking areas or visitor centers will allow for determining what impact these structures and visitor's vehicles are having on surrounding soil drainage areas. Soil samples collected from Floyd Bennett Field (JBU-7) will allow for a determination of the baseline levels of contaminants in the open grassy area adjacent to the camping areas. Because there is a rail line that runs next to the Wildlife Refuge, it is recommended that samples of soil be collected adjacent to this area (JBU-8). Soil samples should be collected at the Jacob Riis Park Gulf Course (JBU-9). The maintenance of golf courses often requires the use of a number of pesticides that are both organic and metal based. Soil samples for baseline sampling are also being recommended for Breezy Point (JBU-10). Soil samples (JBU-11) from both Pennsylvania Ave. Landfill and Fountain Ave. Landfill near leachate areas along the sides of the landfills are recommended to be collected. Comparisons can be made between these different soil samples to obtain a baseline level of contaminants from different locations within the park properties. If elevated levels are detected then additional sampling and possible remediation can be recommended.

Management Recommendation

Because of the extensive amount of sampling that has and continues to be carried out by the USEPA, NOAA and other agencies offsite, all new NPS sampling efforts should be reviewed thoroughly to determine if necessary. As new data are collected by these organizations and becomes available, they should be analyzed for trends and how the findings might impact the wildlife living in and around the park locations.

Where appropriate, sampling locations selected for contaminant monitoring should be collocated with the samples collected as part of the water quality monitoring program at GATE. This will allow for comparison of water quality data and levels of COCs.

All GATE units should continue active conversion of all UST units to double walled and alarmed systems to indicate if there is any break in the tanks for spill protection.

Historic landfill areas in the park should be the subject of a more extensive use-history assessment. NPS or the responsible regulatory agency (at responsible party's expense) should maintain long-term monitoring of species and receiving waters adjacent to these landfills on a five year basis to see if the breakdown of landfill components are changing or moving offsite. Funding for such activities should be setup at the time of transfer so that the cost is not bourne by the NPS. The same approach should be used when accepting former military properties. There should be an established process in place to ensure that data collected at these sites are reviewed by park personnel in order to effectively manage potential risks.

Continued monitoring and comparisons across GATE units of contaminants in commorant as an upper trophic level indicator for movement and accumulation of contaminants is recommended.

Natural resource inventory and monitoring protocols should be developed or adapted to examine alterations to ecosystems that may be caused by anthropogenic activities or contamination.

Educational materials on using non-lead based fishing tackle should be developed and efforts to make the alternative tackle available for fishing community should be pursued within GATE.

Repair and construction projects of bridges and roadways over waterways adjacent to GATE Units should be evaluated as to their potential adverse impacts to wildlife within the area. GATE staff should actively review all development projects and recommend measures that would prevent petroleum products, metals and paint from reaching the water or surrounding soil.

Vehicle maintenance and storage areas should have nonporous floors or slabs in parking and storage areas with catchments or slopping designs that will collect gasoline, oil, pesticides and other contaminants for offsite disposal. This will prevent PAHs and other contaminants from reaching the soil and possibly the surface and groundwater.

Because of the potential health risk to workers at the sewage treatment plant at Sandy Hook, an alternative method should be employed for chlorinating the sewage. This suggestion is being made because it was suggested that there have been fractures in the current system generation tank, which is a potential hazard to the workers. If similar systems are used in other locations

they should also be either modified or an alternative method implemented for decreasing bacterial counts.

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Appendix 1: Hazard Quotient Approaches and Sampling Protocols for Screening Level Evaluations for Chemicals of Concern at National Parks

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1.0 Introduction

Appendix 1 gives a brief overview of ecological risk assessment approaches and standard sample collection methods that can be employed at the National Parks for various matrixes and compounds. It is not our intention to recreate the wheel, but to incorporate methods that are generally accepted by the scientific community. Many of the sampling protocols cited are from a number of different agencies (USEPA Emergency Response Team website, NOAA Status and Trends, and the New Jersey Department of Environmental Protection). The methods described in these documents are standard methods and would be appropriate for use by the National Park Service. The standard operating procedures (SOPs) are slightly different for each agency, but the basic approaches and quality assurance and quality controls (QA/QC) are comparable. Appendix 1 is not exhaustive, but attempts to bring together in a single location, SOPs that can be used by park personnel involved in chemical of concern (COC) evaluations. In some instances, the recommendation of one protocol over another is based on our own experience or bias, and is only a recommendation. The detailed protocols are presented in Appendix 2.

The National Park Service (NPS) has a website wherein a number of commonly occurring compounds are discussed, from a broad basis incorporating human and rodent information, and where available, wildlife and plant toxicity data (Environmental Contaminants Encyclopedia, Ed. Roy Irwin (www.nature.nps.gov/hazardssafety/toxic/). The general mechanism of toxicity is also presented and can be applied to a wide variety of wildlife. In many instances the mechanism of action of a COC will result in similar effects across a wide variety of flora and fauna due to similar biochemical pathways. The ECOTOX database (http://cfpub.epa.gov/ecotox/) released in 2000 by the USEPA and managed by the USEPA Duluth Laboratory has extensive ecological data both for terrestrial and aquatic species, as well as greater detail than what is described in this appendix. For chemical, physical, and fate data on specific compound the CHEMFATE database (http://www.syrres.com/eSc/chemfate.htm), maintained by Syracuse Research Corporation, is also a reference source. Another valuable resource for using screening benchmarks is available from Oak Ridge National Laboratory, which describes ecological risk analysis including guidance, tools, and applications (www.esd.ornl.gov/programs/ ecorisk/ecorisk.html). The Agency for Toxic Substances and Disease Registry provides individual chemical Toxicological Profiles (www.atsdr.cdc.gov/). The USEPA ECOTOX Database provides toxicology data on individual compounds for aquatic and terrestrial life (www.epa.gov/med/Prods_Pubs/ecotox.htm).

2.0 Routes of Entry of Pollutants into Ecosystems

This is a simple overview of the fate and transport of COCs (Suter 1993). It is important for any ecological based assessments to realize that COCs can enter an ecosystem by many routes (transport through air, water, or soil/sediments) from point and non-point sources. The fate of the COC can be impacted by a number of physical parameters of the receiving area. Any park, whether small or large, is part of a larger watershed and airshed, with many different inputs. Therefore, it is essential that the park lands properties be examined in relationship to their surrounding environs. Establishing a baseline level of chemicals present on the park lands and waters is important to be able to determine increases or decreases in a particular chemical. Because a number of chemicals occur naturally, it is important to understand the naturally occurring levels. The plants and animals that are present at the parks and surrounding areas are important in assessing the potential impact of specific COCs on the organisms. Because of the diversity of the plant and animals (ecological receptors), it is impossible to assess each species independently. It is vital, therefore, to identify representative or surrogate species that can be used to assess potential impacts on larger groups of organisms. This is one of the underlying principles for historical and continued collection of Mussel Watch Data (oysters, mussels, and clams). The use of a surrogate species may not always be the most sensitive organisms, but they do allow for evaluation of a single species over multiple years as an indicator of improvement, constantcy, or deterioration of the organisms' exposure and possible health. If such a species is identified, it should be used as an indicator species for that park. For example, there are specific plant species that are very sensitive to ozone, while other plants show no toxicity at much higher atmospheric concentrations. In that particular case, the most sensitive species would become the plant species that sets the lowest observable adverse effects level (LOAEL) in the atmosphere. If this sensitive species approach is taken then it will protect other more resistant species in the park. The natural resource surveys and inventories at the park can give information on population level changes and the trends can be compared with chemical level exposures.

In the above paragraph, COCs were discussed, but it also must be realized that individual species can be impacted by non-chemical stressors that can have deleterious effects. Physical parameters such as pH, alkalinity, salinity, dissolved oxygen, water transparency, and temperature can result in the loss of species and be important stressors affecting an organisms response. It should be recognized that physical parameters often limit distributions of organisms. Therefore, plants and animals living in an ecosystem can be impacted both by physical parameters, as well as COCs. Because of this fact, the USEPA's (1992) Framework for Ecological Risk Assessment includes "stressor response" which would include physical parameters as do later EPA documents (USEPA 1993, 1997a, 1998). A classic example is the effect of pH in freshwater systems and the loss of species dependent on pH tolerances. These physical parameters are easily measured and should be incorporated into any monitoring plan since they have profound effects on bioavailability and uptake (Rand and Petrocelli 1985; Schwarzenbach et al. 2003).

The selection of the animals and plants to be used in the risk assessment will be in some cases site specific because of the unique species present at the park or the surrounding area. Generally, there will be both terrestrial and aquatic species and associated toxicity data used for determining which if any COCs pose a hazard. The selected species may also be used as indicator species that can be collected and analyzed for COCs. The sampling may be done to determine if COCs are reaching elevated levels. This will also allow for COC trends to be developed. Samples of water, soil, sediment and air may be conducted in concert or as independent samples to establish reference or baseline levels. In many parks, there is no plan in place. High volume air samples and semi-permeable membrane water and soil samples could be added if grab samples would not be able to detect COCs (Huckins et. al. 1990; Petty et. al. 2000; Sun et al. 2008).

2.1 Fate and Transport

Pollutants can enter an ecosystem through both human activities, and naturally occurring processes (weathering of rocks, volcanic activity, and others). While knowledge of sources will give you important information on the type of contaminants your environment might be exposed to, the concentration or dose of a compound will dictate the response observed in the wild. As all toxicologists know “the dose makes the poison,” and once this level has been exceeded, toxicity may be observed. In all of the different matrices (surface and groundwater, sediments, and terrestrial soil), there are both point and non-point sources of contamination. Ecosystems are impacted from contamination contributed from atmospheric, terrestrial and aquatic sources. Below is a brief description of sources of contaminants entering into the different media, also shown in Figure 1.

The conceptual diagram shown in Figure 2 illustrates the requirement that the chemical can be bound or in a free state during exposure. Generally, if the compound is sequestered in a particle it is not available to be taken up by an organism since the compound must be free to be able to be transported across a biological membrane. A number of factors, such as charge and size, can determine whether a compound will be taken up by an organism. Once inside the cell, the compound can be metabolized, stored or excreted. If the compound reaches a target tissue where it causes toxicity at sufficient concentration then sublethal or lethal effects may be observed (Klassen and Rozman 1991). The physical chemical environments in which they exist can dramatically alter the chemical species that is available for accumulation (Spacie and Hamelink 1985). These general principles apply to organic compounds as well as metallic compounds.

Atmospheric contamination can enter the terrestrial soil and surface waters through precipitation (wet deposition) or from suspended particulates (dry deposition). There can be a contribution from both the terrestrial soil compartment and the surface water compartment into the atmosphere via particle suspension and volatilization processes. The contamination of the terrestrial soil from atmospheric deposition or from crustal compounds (background) can flow into the surface waters and end up in suspension or depositing on the bottom as sediment. Groundwater can become contaminated from compounds leaching into the groundwater. Surface waters can also contaminate groundwater when they are in direct contact (e.g., saltwater intrusion) or as the groundwater is being recharged. Groundwater contamination can reach surface waters in the basal flow of rivers and through seeps. The ability of a compound to move between these different compartments is determined by the physical chemical properties of the individual compound. Biotic factors can result in modifying the amount of a COC that could be releases from any of these compartments. Regional point sources of contamination can result in contamination spreading into several of these compartments.

The movement of contaminants through the different matrices and ultimately into plants and animals (environmental fate) is determined by the physical characteristics of the compound and the environmental compartment it is entering (Figure 2). Bioavailability is an important concept that determines what levels of specific compounds will be present in the biota inhabiting contaminated and non-contaminated environments. Bioavailability is determined by many factors that determine how much of the compound or metal is in a free state that can be taken up by an organism or plant. Physical-chemical properties of the matrix into which a compound is associated and the properties of the surrounding medium will affect the level of compound that is free to be taken up by the organism. Factors such as pH, total organic carbon, and acid volatile sulfides can dramatically affect the uptake of a compound. A full discussion of release from a specific matrix and the uptake mechanisms based on characteristics of a metal or organic compound are too complicated for this appendix (Casarett and Doull 1991, 1996, 2008; Jorgensen et al. 1991; Schwarzenbach et al. 2003).

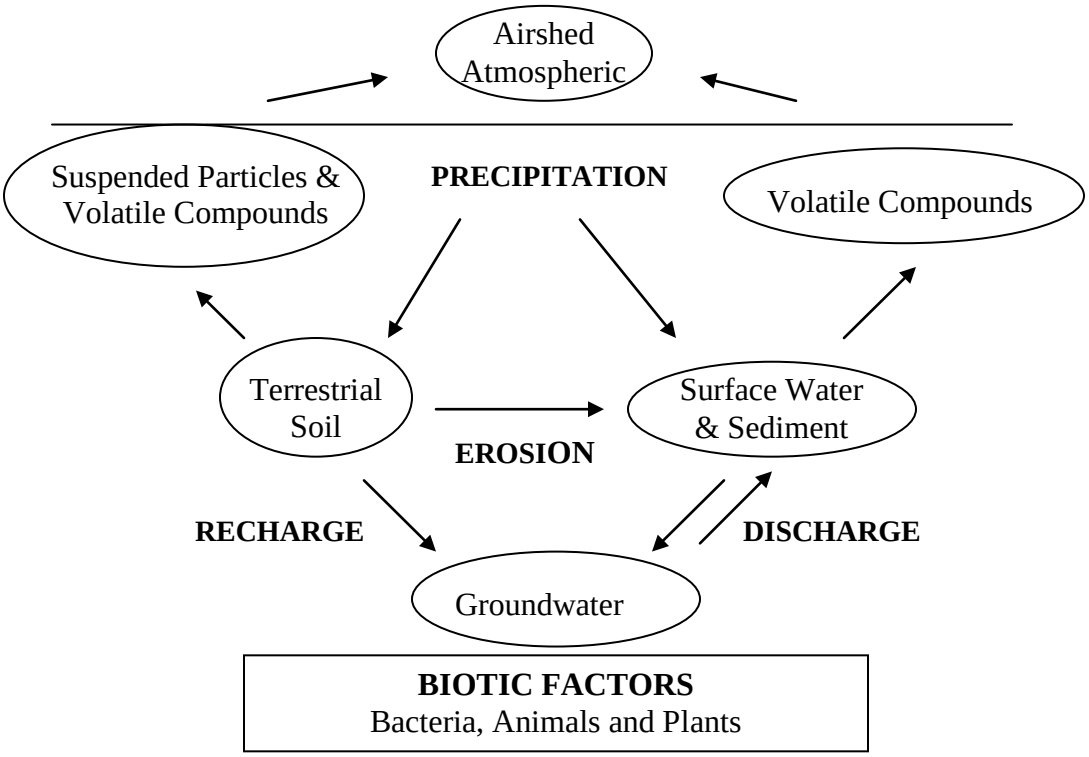


Figure 1. Pathways for Contaminant Movement (Arrows) Between the Different Matrixes Comprising the Ecosystem. Biotic factors can modify fate and transport of contaminants within an ecosystem by increasing or decreasing bioavailability.

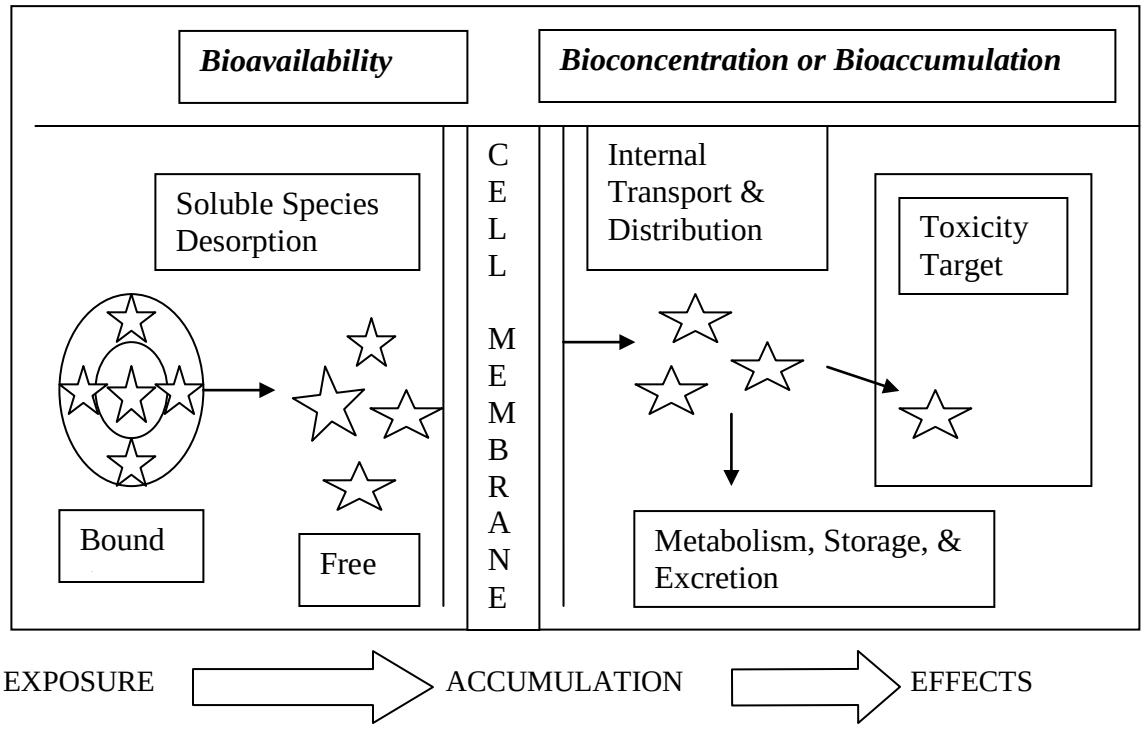


Figure 2. Conceptual Diagram for Evaluating Bioavailability to Organisms from a Compound (Stars) Present in the Environment in a Bound (NOT BIOAVAILABLE) and Free State (BIOAVAILABLE) for Exposure, Uptake across the Biological Membrane Resulting in Bioaccumulation within the Organism, and Subsequent Internal Transport and Distribution. The compound can undergo metabolism, storage and excretion. A metabolite or the parent compound could interact at the toxicity target site resulting in sublethal or lethal effects.

A critical physical characteristic of a compound is polarity, which will determine the compound's affinity for polar (water) and non-polar (lipids and non-polar materials) matrixes. In the case of water, oxygen draws electrons away from the two hydrogen atoms, which creates a partial negative charge on the oxygen and a partial positive charge on the hydrogen atoms. Because of the polar nature of water, cations and anions (i.e., positively and negatively charged compounds) are attracted to water and are soluble. These include inorganic salts (alkali earth metals) and polar organic compounds containing polar groups (e.g., alcohols, acids, and amines). Compounds that are not polar generally will partition into non-polar compartments that contain lipids (such as living organisms) and organic carbon (organic enriched particles). An important property of chemicals, which is used in estimating the potential to accumulate into living organisms is the octanol/water partitioning coefficient (K_{ow}). As the name implies, it is the concentration of a compound in octanol divided by the concentration of the compound in the water phase at equilibrium. This is a measure of the hydrophobicity of the compound. This value can be used to estimate the bioconcentration of compounds into organisms. In a similar fashion, compounds will partition between the different compartments described in Figure 1 based on physical chemical properties of the compound (e.g., Henry's constant relating distribution of volatile compounds between air and water and soil).

The residence time of the parent compound and its metabolites are determined by the compound's molecular stability. There are many methods by which a compound can be broken down in the environment (e.g., hydrolysis, auto-oxidation, photolysis, and enzymatic biotransformation). The rate of breakdown of a compound will determine the half-life in any particular medium. Persistent organic pollutants are generally recalcitrant to physical, chemical, and biochemical transformation (e.g., DDT/DDE, PCBs, and dioxins). However, in some instances metabolism (e.g., Benzo(a)pyrene, dieldrin) and photolysis (e.g., petroleum hydrocarbons) can result in activation of a compound to reactive chemical species that can result in cellular transformation leading to cancer, developmental effect, or acute toxicity.

Metals are non-biodegradable and do not breakdown in a similar fashion to organic compounds in the environment. Metals can exist as multiple converting species that are determined by the environmental chemistry of the medium they are located in. In the case of metal contaminants, they also are persistent and their ionization state will affect their residence time and transport within the environment (USEPA 2007). USEPA's Framework for Metal Risk Assessment (http://www.epa.gov/osa/metalsframework) is a document that discusses in great detail each of these issues, and should be referred to when dealing with metal risk assessments (USEPA 2007). In the case of mercury, the metabolism to methyl mercury results in at least one bioavailable and toxic form of the metal. Metals that are deposited onto the soil or into sediment can have very long residence times and may become mineralized. It is important to note that geological deposit and the earth's crust are comprised of a number of metals that contribute to the general background concentrations for a specific region even without anthropogenic contributions. Background levels of metals in Northeast soils and in the earth's crust are summarized in Table 1. Background metal concentrations can vary over several orders of magnitude based on the soil type, geography and other factors. Additional sources of regional and state soil metal levels can be obtained from USEPA ecological soil screening levels document (USEPA 2003). The site-specific assessments proposed for the parks will involve only a single geographic area of concern and the regional values can be used for comparison to values obtained within the park. There are also "ambient concentrations" provided on a state-by-state basis (Sanders 2003).

2.1.1 Atmospheric

The airshed that overlies a watershed can contribute large quantities of contaminants that are associated with particle deposition, gases or dissolved in rain or snow. The sources of contamination can be from both local, as well as long distance transport. Incineration of waste and production of energy using coal

and other sources can contribute to atmospheric contamination. Other sources include internal combustion engines, pesticide use on production agriculture, and volatile organic compounds that are used in refrigerants, solvents, and industrial processes. The magnitude of toxic chemical releases that may occur on a yearly basis into the atmosphere is often not appreciated, nor the resident time that these contaminants have in the atmosphere (Loganathan and Kannan 1994; Kannan et al. 2007). From anthropogenic sources it is estimated that 5.4 billion metric tons of CO_2, 89.3 million metric tons of SO_x, 60.7 million metric tons of NO_x, and 0.98 million metric tons of chlorofluorocarbons (CFCs). Regional and local sources often contribute to higher local concentrations and corresponding higher concentrations entering surface water, soils, and biota.

2.1.2 Soil

Contamination of soil can occur through deliberate contamination from dumping of industrial and municipal wastes (metals, organic compound radioactive material), direct application of pesticides or herbicides, application of sewage sludge (heavy metals, nitrates, phosphates, detergents), and other soil amendments, and atmospheric deposition of long and short range contaminants (metals, sulfur dioxide, nitrogen oxides, dioxins and furans and other organic compounds). The soil characteristics (organic content, buffering capacity) can affect the fate of the contaminants deposited on the soil and their impact on flora and fauna. Erosion of soils is one of the major means by which contaminated soils can reach surface waters and also contribute to sediment contamination. Because watersheds represent large drainage basins, upstream soil contamination can impact downstream water and sediment quality as it is deposited at the mouth of the rivers and bays or simply deposited in a slow moving portion of a stream. In many instances, acceptable levels of soil contamination are based on human and terrestrial wildlife risk assessments, and exposure is assessed differently for terrestrial pathways. However, those same concentrations in soils, when deposited into aquatic systems can cause a different response to aquatic organisms. In some instances, studies indicate aquatic organisms are more sensitive to certain compounds in sediments, when the same level in soils would not elicit a response in terrestrial organisms.

For metals, it must be recognized that they naturally occur in the earth's crust and represent non-anthropogenic background levels. Listed in Table 1 are typical background soil metal concentrations reported for the earth's crust and in the footnote values for the Northeastern states. The footnote values represent the range of these metals from samples collected throughout the Northeast. The values in this table allow for a quick reference benchmark for comparison to soil samples collected at a park site. It should be emphasized that these are just general numbers and regional background levels should be consulted if park land values appear to be elevated. Background levels can be directly compared to samples to determine if the samples are significantly higher, and could indicate a local source. The actual concentrations would then have to be examined to see if the levels are at a toxic threshold level or higher, and determine what actions might be taken. Another approach to obtain reference background soil data is to use the Natural Resource Conservation Surface's County Soils Publication and Maps to identify similar soil type in an unaltered location and collect a reference sample from this location.

Table 1. Levels Reported in the Earth's Crust (parts per million).[1]

Atomic Number	Element	Crustal Average	Atomic Number	Element	Crustal Average
1	H	1,400	45	Rh	0.005
3	Li	20	46	Pd	0.01
4	Be	2.8	47	Ag	0.07
5	B	10	48	Cd[2]	0.2
6	C	200	49	In	0.1
7	N	20	50	Sn	2
8	O	466,000	51	Sb	0.2
9	F	625	52	Te	0.01
11	Na	28,300	53	I	0.5
12	Mg	20,900	55	Cs	3
13	Al	81,300	56	Ba	425
14	Si	277,200	57	La	30
15	P	1,050	58	Ce	60
16	S	260	59	Pr	8.2
17	Cl	130	60	Nd	28
19	K	25,900	62	Sm	6.0
20	Ca	36,300	63	Eu	1.2
21	Sc	22	64	Gd	5.4
22	Ti	4,400	65	Tb	0.9
23	V	135	66	Dy	3.0
24	Cr	100	67	Ho	1.2
25	Mn	950	68	Er	2.8
26	Fe	50,000	69	Tm	0.5
27	Co	25	70	Yb	3.4
28	Ni[2]	75	71	Lu	0.5
29	Cu[2]	55	72	Hf	3
30	Zn[2]	70	73	Ta	2
31	Ga	15	74	W	1.5
32	Ge	1.5	75	Re	0.001
33	As	1.8	76	Os	0.005
34	Se	0.05	77	Ir	0.001
35	Br	2.5	78	Pr	0.01
37	Rb	90	79	Au	0.004
38	Sr	375	80	Hg	0.08
39	Y	33	82	Pb[2]	13
40	Zr	165	83	Bi	0.2
41	Nb	20	90	Th	7.2
42	Mo	7	92	U	1.8
44	Ru	0.01			

[1]Values taken from Mason B. Principals of Geochemistry, Third Edition.

[2]Values are ppm mg/kg and the source is from NE-1001 Application of sewage biosolids to agricultural soils in the Northeast: long-term impacts and benefit uses. http://www.lgu.umd.edu/lgu_v2/homepages/pub.cfm?trackID=31
Ranges determined from ME (n=27),NJ (n=114),NY (n=74) and PA (n=40): Ni 8.4-41.2, Cu 11-64.8,Zn 29.2-83.8, Cd 0.09-0.173 and Pb 12.6-19.6.

2.1.3 Surface Water

Surface waters receive anthropogenic (man-made) inputs from atmospheric deposition, non-point source runoff from terrestrial sources (petroleum products from automobiles, road salt, etc.), and point source discharges (sewage treatment plants, industrial discharge, landfill leachate, etc.). There are also natural sources of contaminants such as the earth's crust and natural processes (petroleum seeps, volcanism) that release compounds and metals into water and into the atmosphere. Transport in water can occur either by being in solution or in suspension as a micelle, an electrically charged particle formed by an aggregate of molecule, or associated with particulate matter. Compounds and metals can absorb onto particulate matter in suspension and some of these contaminant-enriched particles will eventually settle out in bottom sediment. In rivers, pollutants can be transported over great distances where they can enter into estuaries and ultimately the oceans. Contaminants associated with eroding soil can be a major source of chemicals entering into surface waters. Release of pollutants into moving surface water is followed by dilution and in some cases degradation. The point of entrance will normally represent the area where the highest concentration is observed, followed by a concentration gradient downstream. The stream flow and physical characteristics may result in depositional areas that should be sampled. In some instances, such as sewage outfalls, there may be a change in the biota upstream from the outfall when compared to biota present downstream from the outfall. The difference from upstream to downstream biota may reflect a contaminant or physico-chemical parameters that impact the biota. In the case of small lakes and ponds, where there is no major outlet, chemicals may buildup in these waters. It is also important to understand that freshwater and saltwater organisms may respond differently to the same compound, and because of this the no observed adverse effect levels (NOAELs) are often different. The surface waters and the associated particulate fractions are sinks for accumulating contaminants as they move from upland into estuaries and into the oceans. Surface waters can be contaminated from many different sources resulting in many anthropogenic compounds being present.

2.1.4 Sediment

Sediment can be either suspended in the water column and or deposited along the bottoms of rivers, estuaries, and depositional areas in the ocean. Sediment originates from the contribution of soil washing into the surface waters and from breakdown of organic matter in the receiving waters. Sediment can become contaminated from land sources, as well as from contaminants that accumulate in organisms and adhere to the sediment from the water column. The physical and chemical characteristics of the sediment will influence the amount of contamination associated with it. Sediments with high organic content and charge will have elevated levels of organic and metals, respectively. The smaller the particle size the greater the surface area to volume ratio and the higher the contaminant enrichment. Therefore, sediments with large grain size containing mainly sand will have little or no metals or organic contaminants associated with them. Sediment particle size also influences contaminant bioavailability. Bioavailability can be reduced in clay and silt sediments compared to coarser sediments. Thus, when conducting sediment analyses, it is important to evaluate both grain size and total organic carbon (TOC).

2.1.5 Groundwater

Groundwater is water located below the surface of the soil and can be found in soil pores (sometimes called pore water) or fractures in the geological deposited soils. An aquifer is a saturated zone where usable quantities of water can be withdrawn. Groundwater is recharged from rainwater leaching into the subsurface areas. Groundwater, unlike surface water, flows very slowly and discharges into seeps or springs that feed into surface waters, sometimes over decades. Therefore, contamination that reached the aquifer decades ago may only now be discharged into rivers and springs. In any one area, there can be several aquifers that are confined to different depths by geological formations. Generally, the shallow aquifers are at greatest risk of contamination. Contamination of groundwater can occur from pollutants

seeping into the soil and leaching into the groundwater. Contamination can flow from septic fields, underground storage tanks, direct injection into deep wells, or leaching from surface soil applications. The rate at which a contaminant leaches into an aquifer is determined by the soil characteristics. A general rule is that sandy soil allows for easier penetration of contaminants than higher organic containing soils. Aquifers that are below bedrock areas can become contaminated through cracks and fissures in the rock or contamination on abandoned wells. Contaminants entering the groundwater can include metals, volatile organic compounds, petroleum products, and leachable pesticides. Once contamination of an aquifer occurs it is very difficult to remediate the contaminants. Degradation and mineralization of contaminants in aquifers occurs very slowly because of the lack of bacteria, light, and oxygen tension. Because of the slow recharge of aquifers, dilution of the contamination is minimal. Movement within the aquifer is determined in part by the polarity of the compound.

3.0 Ecological Risk Assessment

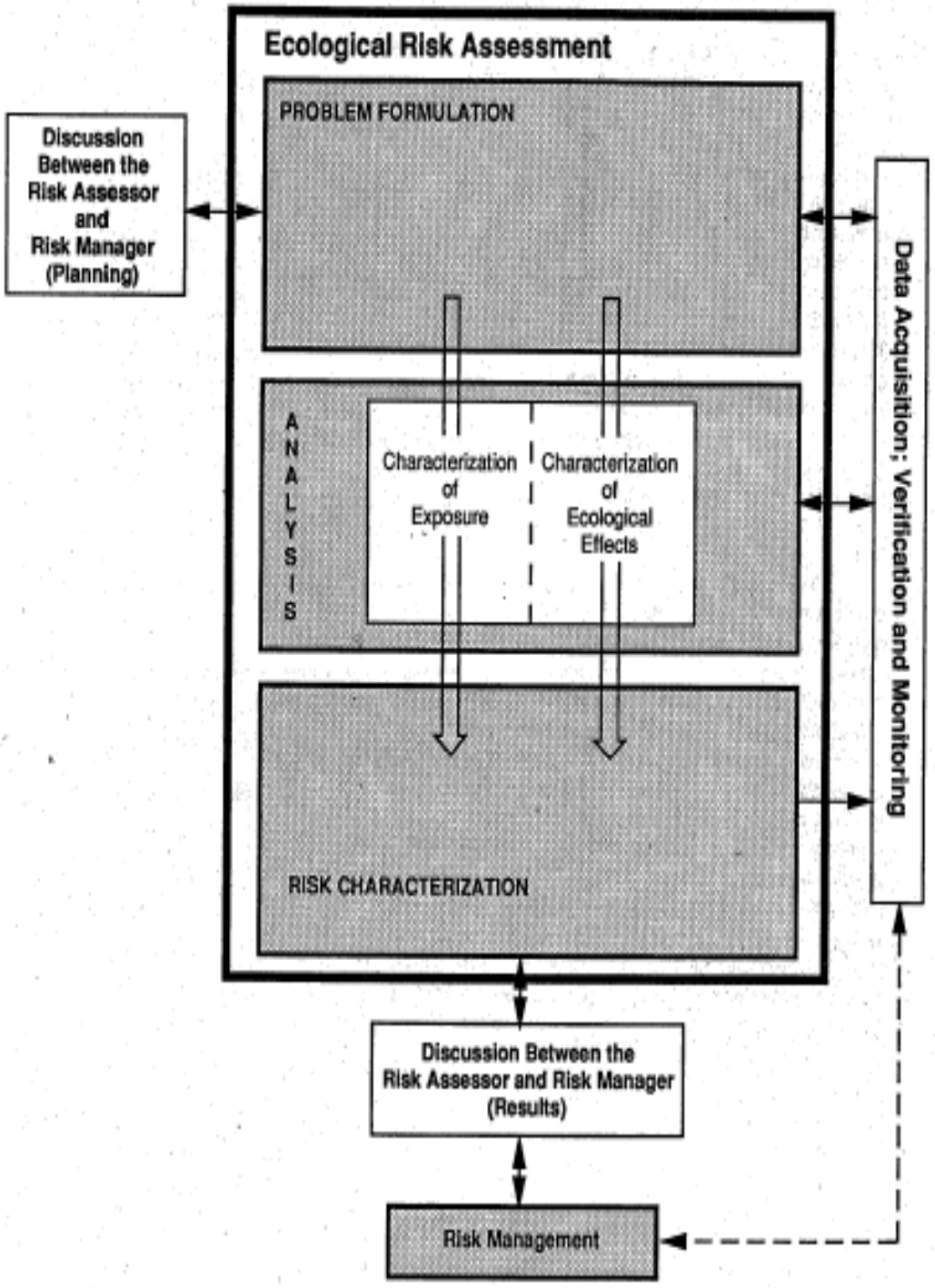
The basic underlying principle of an ecological risk assessment is based on the USEPA Guidelines for Ecological Risk Assessment (USEPA 1998). For each park it is necessary to follow a step-wise approach to evaluating potential hazards from COCs to the terrestrial and aquatic wildlife and flora. The general approach has been adopted by USEPA (1998) where there is the problem formulation where integration of available information on each park's potential COCs is carried out (Figure 3). Because each park is unique in its location and its surroundings, each require an inventory of existing threats. This can take the form of a general information questionnaire (see Appendix 2, Survey Instrument) and gathering general information about the park from literature, databases, and the internet. The analysis phase will attempt to obtain measurement for COCs (exposure analysis) or unusual abiotic conditions (stressor response profile) that exist either on or adjacent to the parks. The last phase is the risk characterization (risk estimation). The final approach is to make scientific based management recommendations that may include the following: 1) no action necessary as COCs fall below any level of concern; 2) identify specific targeted baseline sampling for historical reference for any future incident; 3) specific targeted sampling approaches for confirming elevated COCs; and 4) remediation of contaminated sites or engineering modifications to reduce impact. The amount of available information on COCs present in the biota and the different environmental matrices the parks and offsite (problem formulation and analysis phase) will affect the extent and uncertainty of the risk characterization that can be made and what management options are available. There is a need to follow up on any action that is taken to determine if the species at risk are remaining the same, increasing or decreasing. Population surveys can be a valuable long-term monitoring tool when coupled with analysis of chemical and non-chemical stressors.

3.1 Screening Level for Ecological Risk Assessment

It must be realized that a "hazard" in toxicology is determined by the risk of a compound causing an adverse effect and actual exposure to that compound (Risk×Exposure=Hazard). The risk component incorporates a specified exposure dose under specific conditions. Therefore, there is no hazard if a COC has no adverse effect at a specific dose/concentration (risk component). If the organism does not come into contact with the chemical (exposure component) than there is no hazard and the compound is not a COC. In either event, there will be no adverse effect to wildlife or plants. Although there are many approaches to estimating hazards including estimating the movement through fate and transport models and food webs, those methods are beyond the scope of this appendix and project. If the concentration of a COC in an organism is greater than the environmental media (soil, water, or sediment) it is living in, then the COC is said to bioconcentrate. When the organisms COC burden is from both environmental media and food intake, then the COC is said to bioaccumulate. Biomagnification of a COC occurs when each trophic level in the food web has a higher amount of COC than the trophic level below (Newman and Unger. 2003).

Bioconcentration (BCF) and bioaccumulation (BAF) factors are two parameters that are important in both terrestrial and aquatic organisms for assessing the hazard based on steady state

Figure 3. Proposed Guidelines for Ecological Risk Assessment.



(USEPA 1992, 1997a)

body burden. The steady state tissue concentrations represent the maximum levels that are expected based on a particular level of exposure. The steady state level is achieved by the accumulation, distribution, metabolism, and elimination of a compound within an organism (Figure 2).

BCF = concentration in organism / concentration in ambient medium *Eq. 1*

BAF = concentration in organism / concentration in food and external media X(ingested prey/water/soil/sediment) *Eq.2*

In aquatic ecosystems where the main route of exposure is through the water column, the BCF is an appropriate means to estimate body burdens. If food, abiotic, media and ambient water concentrations are important exposure routes then Eq 2 should be used to calculate the BAF. In the case of terrestrial organisms, BCFs and BAFs can also be calculated. Although not dealt with in this report, atmospheric exposure to terrestrial wildlife can result in a steady state BCF from airborne exposure. In the majority of cases, the BAF (Eq 2) is the appropriate value to be calculated for terrestrial wildlife.

Most wildlife do not remain on a contaminated site or consume only contaminated food, which would result in an area use factor (AUF) of less than one. In order to be conservative, an AUF equal to one is used for all calculations. An AUF of one assumes that the organism ingests contaminated food or water for their entire life. While this assumption simplifies the assessment, due to the mobility and the diverse diets of most wildlife it is likely to overestimate the actual exposure experienced. It should be remembered, however, that the purpose of the screening assessment is to identify potential risks and data gaps to be filled. As more data are collected these assumptions can be modified to reflect the actual amount of time that a species spends within a specified area or park.

Our analysis involved an evaluation of the ecological risks of environmental contaminants based on a two-tiered approach. This approach follows closely with that reported by Sample (1996). In the hazard quotient (HQ) approach discussed below, the concentrations of the contaminants in the environments are compared to the NOAEL. These screening ecotoxicity values are based on literature surveys for values that have been reported to cause no adverse effect NOAEL or the LOAEL in different media.

The second approach incorporates the exposure of oral ingestion of contaminated media to reach a dose. This approach gives a benchmark that is either exceeded or not, based on known adverse effects in organisms compared to their determined dose. This approach is simple yet allows new information to be incorporated as new studies are carried out that better define the NOAEL or LOAEL values (Crane and Newman 2000). When these values are less than the toxicological benchmarks, the contaminant should be excluded from any further consideration. This process assumes there are no contributions from other compounds to increase the mixture toxicity.

3.2 Hazard Quotient Approach (HQ)

Ecological risks of environmental contaminants at the parks and evaluated with a two-tiered process. This approach follows closely that proposed by Sutter (1996). In the first tier, a screening assessment is performed where concentrations of contaminants in the environment are compared to NOAEL-based toxicological benchmarks. These benchmarks represent concentrations of chemicals (i.e., concentrations presumed to be non-hazardous to the biota) in environmental media (water, sediment, soil, food, etc.) that should not result in an adverse effect. One of the principal sources for the values that are used for this calculation is the NOAA Screening Quick Reference Tables (SQuiRT), which are available online at http://www.response.restoration.noaa.gov/book_shelf/122_squirt_cards.pdf for reference. If site-specific values or more recent literature-based information is available then these values can be used for screening purposes. Within the NOAA SQuiRT tables are background levels for inorganic and organic compounds

in freshwater and marine sediments, fresh and saline surface water and groundwater. These tables also give different effect levels: threshold effects levels (TEL), probable effects level (PEL), and effect range medium (ERM. The NOAA document also contains two tables summarizing specific extraction and detection methods for inorganic trace elements and organic compounds and a summary table listing appropriate containers for each analyte, preservation methods, maximum holding times, and required sample size.

In practice, when contaminant concentrations in food, water, soil, and sediment resources are less than the threshold toxicological benchmarks, the contaminants may be excluded from further consideration. As stated above, this assumes no additive or synergistic effects from similar contaminants. The PEL and ERM values allow for comparison to the increasing likelihood of an effect on the biota. In the case of sediment values, the levels are provided both for freshwater and marine sediments for inorganic and organic compounds sampled by NOAA. Another source for freshwater sediment screening values is MacDonald et al. (2000). To determine which contaminants pose a risk, an HQ is calculated, where HQ=media concentration/benchmark. If the HQ≥1, contaminant concentrations are sufficiently high that they may produce adverse effects. This basically means that the concentration observed in the environment is greater than or equal to a threshold or known effects level (i.e., PEL or ERM) and there is an increased likelihood that the compound may have an adverse effect on the organism and warrant further investigation. An HQ<1 means there is no risk based on the laboratory derived values.

EXAMPLE CALCULATION: Values in ppb (ug/Kg) dry weight.

	Threshold Effects Level (TEL)	Probable Effects Level (PEL)	Effects Range Medium (ERM)	Source
Arsenic	7,240	41,600	70,000	NOAA SQUIRT
Arsenic sample value sediment 40,000 ppb	40,000/7240 = 5.5 TEL HQ > 1	40000/41600=0.96 PEL HQ < 1	40000/70000=0.57 ERM HQ < 1	

In this example arsenic would be considered a chemical of concern since it was above the TEL value. If the PEL and ERM had HQ>1 the detected concentration would indicate a probability of increasing toxic responses to benthic organisms. Scientific judgment needs to be exercised when multiple compounds of similar mechanisms of toxicity may be present in a sample or another factor may result in greater sensitivity of the organism to a contaminant.

Therefore, if the concentration of a contaminant exceeds a benchmark, HQ≥1 that contaminant should be retained as a COC. Conversely, if the HQ<1, the contaminant would not be retained as a COC.

3.3 Estimating Body Burdens for Comparison to NOAELs for Wildlife

Calculations can be made to determine on a daily basis the amount of a contaminant that an organism is being exposed to from its food, water or other ingestion exposure routes (e.g., sediment or soil). In this approach, both inhalation exposure and dermal adsorption are not included in the daily intake which can underestimate exposure, but normally the conservative assumptions made in estimating the other major exposure routes may negate the need to be concerned with other routes of exposure. Dermal exposure needs to be included when amphibians and reptiles are the organisms of concern. The daily exposure estimations based on known or estimated levels of a contaminant can be calculated using standard calculations and based on literature-derived life history data.

The total body burden can then be compared to LOAELs from literature studies or estimated from other reported endpoints (LOAEL, or a dose resulting in 50% death (LD_{50}). One approach to estimate a LOAEL from a NOAEL is to apply an uncertainty factor of 10 to the values.

LOAEL = NOAEL multiplied by an uncertainty factor of 10 *Eq.3*

In the case where there is only LD_{50} data, either examine the slope of the line and extrapolate to the x-axis, or apply a larger uncertainty factor (100 or 1000) to estimate the total body burden. The difficulty with extrapolating from these values is that the degree of uncertainty is greatly increased, but if no other value exists it may be the only alternative to estimate whether a contaminant potentially poses a risk.

The presentation of toxicity data on an mg/kg body weight (BW)/day basis allows comparisons to the calculated levels for a particular species of interest. If the levels that are calculated exceed the LOAEL then the levels in these matrices would pose a hazard to that particular species, and be considered a COC. When calculating these values care must be taken to convert any dry weight concentrations to wet weight by applying the appropriate water content values for specific prey species (see Table 6) or the value determined by the analytical laboratory at the time of analysis.

4.0 Trophic Level Evaluation

Trophic level evaluation is not required for all compounds, because there are certain characteristics which preclude biomagnification up the food web. Compounds that are rapidly metabolized, poorly absorbed from the gastrointestinal track or epidermis, or rapidly eliminated generally need not be examined in a trophic model. In these cases, the compound can be compared to the LOAEL for determining if the concentrations are above a threshold of concern (as described in the previous section). In the case of trophic level evaluations, the organism impacted is studied through direct contact with environmental matrixes and through their food sources (bioaccumulation). Therefore, when calculating the daily intake of a compound, the sources of the contaminants include water, sediment/soil, and food. Airborne exposure is not included in these calculations. In this way, representative organisms at different trophic levels can be selected, and their daily intake calculated and compared to effects levels. By using this approach, the total daily intake can be calculated using both empirical data from organisms collected on or offsite, or through estimated prey body burdens or matrix values. When the total daily intake of a compound (TDI) from all the sources is calculated, these values can be compared to the LOAEL value derived from the literature. When the TDI exceeds this benchmark effects value, the compound should be considered a COC. This is a highly conservative approach because it assumes that all of the food consumed is contaminated at a set level and that there is 100% uptake and retention. In the real world, it is unlikely that an organism will be exposed continuously to contaminated sediment/soil and prey at a constant level; there is never 100% uptake due to metabolism and elimination pathways. This conservative approach will help protect wildlife especially when tissue dose data for specific organisms is lacking.

In some instances where there are virtually no data on a chemical, the approach undertaken may have to be very simplistic. The aquatic food chain multiplier (FCM) described below is such an approach. If a large amount of data is available on emperical matrix values (i.e., water, sediment, or soil contaminant concentrations) and lower trophic level prey dose, then a better estimate of the predator dose can be calculated using the estimated dose from all source inputs. Because of the complexity of food webs even in the simplest of ecosystems, there is a need to select sentinel organisms that can represent large classes of organisms and reflect the ecosystems being evaluated when evaluating compounds that have a potential to bioaccumulate.

4.1 Estimating Aquatic Organisms' Body Burdens

If the BCF is not available for a specific compound then the following relationship developed by Lyman et al. (1982) can be used based on the octanol-water partitioning equation (P_{oct} is the partitioning coefficient for octanol-water).

$$Log_{10}\, BCF = 0.76\, Log_{10}\, P_{oct} - 0.23 \qquad \text{Eq. 4}$$

In a similar fashion the BCF can be calculated from the water solubility of a compound as reported by Lyman et al. (1982).

$$Log_{10}\, BCF = 2.791 - 0.564\, Log_{10}\, Water\ Solubility\ (mg/L) \qquad \text{Eq. 5}$$

Equation 4 and 5 will estimate BCF values, but tissue and matrix concentrations are more accurate for empirical BCF determinations.

4.2. Aquatic Food Chain Multiplier (FCM)

The FCM is a very simplistic approach where the concentration in a matrix is used to estimate the level in biota at different trophic levels. This approach does not differentiate between a BCF and a BAF. The differences between a BCF and BAF have been previously discussed (Screening Level for Ecological Risk Assessment).

To estimate the tissue concentration in different trophic levels the only information needed is the Log_{10} K_{ow} for a chemical of interest (Sample et al. 1996). Although the FCM is a very simple approach, it is based on the assumption that the primary uptake route of these compounds is through passive diffusion, which is controlled by the lipophilicity of the compound. It is a conservative estimate since it assumes 100% uptake and does not take into account factors affecting absorption, metabolism or elimination for different species. Estimates can be made for concentrations in zooplankton (trophic level 2), small fish (trophic level 3), and piscivorous fish and top predators (trophic level 4). Table 2 shows the multipliers for estimating the amount of a compound that will accumulate in each of the higher trophic level organisms based on the Log_{10} K_{ow}. The FCM approach may be applicable for some metals if the organo-metallic forms (i.e., methylmercury) are known to be biomagnified in higher trophic levels based on Log_{10} K_{ow} (USEPA 1995).

Table 1, located in Appendix 2, is a compilation of the Log_{10} K_{ow} values and calculated concentration factors for each trophic level for the compounds that are routinely analyzed for by NOAA and USEPA. The FCM approach is useful when there is a new compound that is identified and there is very little data on levels in higher trophic level organisms. By obtaining the Log_{10} K_{ow} from the literature or even doing a simple partitioning experiment one can obtain this value. It must be realized that depending on the method from which it was derived there can be differences in the actual K_{ow} values; however, they are generally similar. This value is then used to determine what multipliers (Table 2) are to be used for each trophic level. This is an approach that does not take into consideration any elimination pathways, and will overestimate tissue levels when metabolism does play a major role. The estimated FCM tissue value can then be compared to the LOAEL value determined from literature values.

For example, if a new compound has a Log_{10} K_{ow}=6.0 (see Table 2 for multipliers for each trophic level) and is detected at 10 mg/L in water, then it is assumed that zooplankton (level 2) will have 10 mg/kg body levels (1 x 10 mg/kg since one liter equals one kilogram). Trophic level 3 organisms would have 105.56 mg/kg and level 4 would have 159.96 mg/kg. Based on the estimated total dose these values can then be compared to LOAEL and or NOAEL values for representative species.

If for some reason there is no known $K_{ow,}$ then an alternative would be to find a compound with a

Table 2. Aquatic Food Chain Multipliers (Taken from Sample et al., 1997 which was modified from EPA 1993).

Trophic level 2=zooplankton;
Trophic level 3=small fish;
Trophic level 4=piscivorous fish, including top predators.

Log K_{ow}	Prey Trophic Level 2	Prey Trophic Level 3	Prey Trophic Level 4
2.0	1	1.005	1.000
2.5	1	1.010	1.002
3.0	1	1.028	1.007
3.1	1	1.034	1.007
3.2	1	1.042	1.009
3.3	1	1.053	1.012
3.4	1	1.067	1.014
3.5	1	1.083	1.019
3.6	1	1.103	1.023
3.7	1	1.128	1.033
3.8	1	1.161	1.042
3.9	1	1.202	1.054
4.0	1	1.253	1.072
4.1	1	1.315	1.096
4.2	1	1.380	1.130
4.3	1	1.491	1.178
4.4	1	1.614	1.242
4.5	1	1.766	1.334
4.6	1	1.950	1.459
4.7	1	2.175	1.633
4.8	1	2.452	1.871
4.9	1	2.780	2.193
5.0	1	3.181	2.612
5.1	1	3.643	3.162
5.2	1	4.188	3.873
5.3	1	4.803	4.742
5.4	1	5.502	5.821
5.5	1	6.266	7.079
5.6	1	7.096	8.551
5.7	1	7.962	10.209
5.8	1	8.841	12.050
5.9	1	9.716	13.964
6.0	1	10.556	15.996
6.1	1	11.337	17.783
6.2	1	12.064	19.907
6.3	1	12.691	21.677

Table 2. Aquatic Food Chain Multipliers (Taken from Sample et al., 1997 which was modified from EPA 1993) (continued).

Trophic level 2=zooplankton;
Trophic level 3=small fish;
Trophic level 4=piscivorous fish, including top predators.

Log K_{ow}	Prey Trophic Level 2	Prey Trophic Level 3	Prey Trophic Level 4
6.4	1	13.228	23.281
6.5	1	13.662	24.604
6.6	1	13.980	25.645
6.7	1	14.223	26.363
6.8	1	14.355	26.669
6.9	1	14.388	26.669
7.0	1	14.305	26.242
7.1	1	14.142	25.468
7.2	1	13.852	24.322
7.3	1	13.474	22.856
7.4	1	12.987	21.038
7.5	1	21.517	18.967
7.6	1	11.708	16.749
7.7	1	10.914	14.388
7.8	1	10.069	12.050
7.9	1	9.162	9.840
8.0	1	8.222	7.798
8.1	1	7.278	6.012
8.2	1	6.361	4.519
8.3	1	5.489	3.311
8.4	1	4.683	2.371
8.5	1	3.949	1.663
8.6	1	3.296	1.146
8.7	1	2.732	0.778
8.8	1	2.246	0.521
8.9	1	1.837	0.345
9.0	1	1.493	0.226

similar structure and use that compound's K_{ow} for the estimation. These estimates can also be used for calculating levels in higher trophic level organism as described. It is important to realize that the more assumptions that are made, the less reliable the calculated body burdens. That is why it is critical to not rely solely on these estimates without empirically determined tissue levels from field samples.

Table 3 shows examples of calculated values for chemical BAF values for trophic level 3 and 4 organisms. These calculations are based on Eq. 4 and the FCM values presented in Table 2. The full list of compounds sampled by NOAA and USEPA are presented in Appendix 2, Table 1.

As shown in Table 3, acetone would not be expected to bioaccumulate into higher trophic levels. Both aldrin and benzo(a)pyrene would be assumed to accumulate into the higher trophic level organisms. This model assumes that for most trace metals that there is no bioaccumulation in higher trophic levels. Care should be exercised when there is evidence for specific metal bioaccumulation from prey species or where the metal may not be bioavailable such as with Cd (DiToro et al. 1992). In the case of organo-metals, there can be bioaccumulation in higher organisms, as seen with methyl mercury (USEPA 1997b). Selenium is also accumulated due to its similarity to calcium and using transporters and sequestration areas within the cell (Peterson and Nebeker 1992). Using this method, the calculation of tissue concentrations can be used in estimating body burdens in these trophic level organisms for comparison to LOAELs to calculate a HQ. These values can also be used to estimate concentrations in prey species for terrestrial mammals and piscivorous birds.

4.3 Terrestrial Organisms (Wildlife and Plants)

Wildlife is exposed to contaminants through the ingestion of food, the drinking of water, the breathing of air, and direct contact with the skin. In the evaluations being carried out for this project, both dermal absorption and inhalation will not be considered as major exposure pathways of terrestrial organisms to metals or organic compounds. Therefore, the major routes of exposure are through the oral route, which would include food, water, and ingested soil and sediment (Table 4). All values are expressed in terms of a body weight-normalized daily dose or mg/kg body weight per day (mg/kgBW/d). An estimated food intake rate (FIR) would be calculated as shown below.

$$FIR = \frac{(C_f \times IR) + (C_w \times IR) + (C_s \times IR)}{BW} \qquad Eq.6$$

FIR = food intake rate - estimated (mg/kg/d)
C_f = concentration in food -wet weight basis (mg/kg)
C_w = concentration in water (mg/L)
C_s = concentration in soil or sediment (mg/kg)
IR = ingestion rate (kg/d)
BW = body weight (kg)

Table 3. Selected Compounds for Determining Trophic Level BAFs.

Chemical	Log_{10} K_{ow}	BCF[1]	Trophic Level 3[2] FCM	Trophic Level 3 BAF	Trophic Level 4 FCM	Trophic Level 4 BAF
Acetone	-0.24	0.39	1	0.39	1	0.39
Aldrin	6.5	51286.14	13.66	7000000[5]	24.604	13000000[5]
Benzo(a)pyrene	6.11	25917.91	11.34	294000[5]	17.783	461000[5]
Mercury (Methyl Mercury)[3]				27900.00		140000.00
Selenium[4]				2600.00		6800.00

1. BCF calculated using Eq. 4.
2. Level 3=small fish, Level 4=piscivorous fish, including top predators.
3. Literature citation EPA 1995.
4. Peterson and Nebeker 1992.
5. Rounded off values

Table 4. Reference Values for Representative Terrestrial Mammalian Species.

Species	Body Weight (kg)	Food Intake (kg/day)	Water Intake (L/day)	Soil Consumption Rate (kg/day)
White-footed mouse	0.022	0.0034	0.0066	0.000068
Eastern cottontail	1.2	0.237	0.116	0.015
Mink	1.0	0.137	0.099	Negligible
Red fox	4.5	0.45	0.38	0.0126
Whitetail deer	56.5	1.74	3.7	0.0348

(Modified from Sample et al. 1996)

Because wildlife does not consume dry food, these estimates must be adjusted to account for the water content of food. Water content of selected wildlife foods are given in the Wildlife Exposures Factors Handbook (USEPA 1993), and in Table 5. This adjustment is important because most analytical data generated today are on a dry-weight basis. Therefore, the concentrations used for the calculations must be decreased by the percentage of water content. When calculating the food that is consumed it must be realized that most organisms consume a variety of organisms and plant species, and this will affect their estimated daily intake. It is unlikely that there will be data on each of these food types, but when estimating the daily intake, assumptions will have to be made based on best available data. This also would indicate data gaps that if resolved would be helpful in estimating exposure and whether the tissue does approach levels of concern.

Water consumption rates are available for some species of mammalian wildlife (Table 5). Water ingestion in the equation is included when water is a route of exposure for a primary contaminant of concern. Since this is a conservative approach, if a range of data is available, either use the highest value observed or use a mean for the values.

For the terrestrial environment, the animals that were selected are listed in Table 6 and their food sources in Table 6-8. Sample et al. (1996) list data for a much larger number of animals than are presented in this appendix. The terrestrial mammals selected for discussion in this report were selected on the basis that they are commonly present at the parks and represent species that are exposed to compounds through different routes: white-footed mouse (*Peromyscus leucopus*), Eastern cottontail (*Sylvilagus floridanus*), mink (*Mustela vison*), red fox (*Vulpes vulpes*), and white-tailed deer (*Odocoiles virginianus*).

The food intake rates in Table 4 are based on dry weight and must be converted to a wet weight basis. The amount of water present in various classes of organisms was modified from Sample (1994) and represent averages within a group. In order to simplify the calculation, a single recommended value is shown in Table 5 along with the range of reported values.

EXAMPLE CALCULATION: For example if the mink consumed 0.137 kg/day (Table 4) of aquatic invertebrates then the wet weight value would be 0.685 kg/day. The dry mass equals one fifth of the total weight (wet weight consumed=0.137 kg x 5) Table 6. The same approach is used when multiple species comprise the diet of the animal of interest and requires that the total diet be proportioned to the type of prey consumed and corrected for water content.

Prey (0.137 kg/day) [Table 4]	Mink Diet [Table 6]	Water Content [Table 5]	Dry Wt (kg/day)	Wet Wt kg/day
Mammals	46%	68%	0.063	0.197
Fish & Invertebrates	31%	75% (70-80%)	0.042	0.168
Amphibians	13%	85%	0.018	0.120
Birds	10%	68%`	0.014	0.044
Total	100%	-------	0.137	0.529

Table 5. Estimated Water Content for Various Types of Food Types. Recommended values were based on professional judgment and values reported by sample (1994).

Food Type	Recommended Water Content (%)	Ranges (%)
Aquatic invertebrates	80	71-87
Aquatic vertebrates	70	68-75
Aquatic plants	85	84-87
Terrestrial invertebrates	70	61-84
Mammals	68	NR
Birds	68	67-68
Reptiles	66	NR
Amphibians	85	NR
Terrestrial plants leaves	80	70-88
Terrestrial seeds/dry grass	9	7-10

NR = not reported

Table 6. Diet Composition of Representative Terrestrial Mammals Likely to be Encountered at Park Locations.

Species	Diet Composition	Percentage (%)
White-footed mouse	Seeds, fruit, vegetation	34-67
	Arthropods	30-57
Eastern cottontail	Herbaceous plants	100
Mink	Mammals	46
	Fish & invertebrates	31
	Amphibians	13
	Birds	10
Red fox	Mammals	70
	Birds	12
	Plants	10
	Insects	1
	Msc.	remainder
White-tailed deer	Herbaceous plants	100

Table 7. Avian Species That Are Recommended for Estimating Exposure Concentrations.

Species	Body weight (kg)	Food Intake (kg/day)	Water Intake (L/day)	Soil/Sediment Consumption (kg/day)
American robin	0.077	0.093	0.0106	0.0019
American woodcock	0.198	0.15	0.02	0.0156
Belted kingfisher	0.148	0.075	0.016	Negligible[1]
Great blue heron	2.39	0.42	0.1058	Negligible[1]
Red-tailed hawk	1.126	0.109	0.064	Negligible[1]
Osprey	1.5	0.3	0.077	Negligible[1]

1. Piscivorous birds assumed to be negligible and red-tailed hawk consuming mammalian prey. Piscivorous birds may be exposed to entrained sediments in the prey item.

Table 8. Diet Composition of Representative Avian Species Likely to be Encountered at Park Locations.

Species	Diet Composition	Percentage (%)
American robin	Fruit (seasonal)	7-83
	Invertebrates	8-93
American woodcock	Primarily earthworms	58-98
Belted kingfisher	Cyprinids & other fish	86.6
	Crayfish	13.3
Great blue heron	Fish (Predominantly)	100
	Other invertebrates, birds, and small mammals	
Red-tailed hawk	Small mammals	78.5
	Bird	8.5
	Snake	13.0
Osprey	Fish (Predominantly)	100

If there is no food ingestion rate (IR) data available for birds or mammals, then another approach employing (Eq. 8-12) allometric regression models based on metabolic rate is used (Nagy 1987). The BW is on a kg wet or live weight basis.

$IR = 0.0687\ (BW)^{0.022}$	*Placental mammals*	*Eq. 7*
$IR = 0.0306\ (BW)^{0.564}$	*Rodents*	*Eq. 8*
$IR = 0.0875(BW)^{0.727}$	*Herbivores*	*Eq. 9*
$IR = 0.0582(BW)^{0.651}$	*Birds*	*Eq. 10*
$IR = 0.141(BW)^{0.850}$	*Passerine birds*	*Eq.11*

Because this is a screening exercise, in many instances contamination concentrations in the food is not available, and in these circumstances estimates must be generated from existing abiotic data or regional concentrations. In these cases, uptake factors can be used to estimate the values in the food or water (Eq. 2 & 4). The same can be done from organism data by back calculating to media concentrations (Eq. 2). As seen in Table 2, tissue concentrations for aquatic species can be estimated from the $Log_{10}\ K_{ow}$ for any compound. These estimated concentrations can be used for evaluating the daily intake by specific organisms that consume these food organisms.

In the case of the American robin, there is seasonal variation in the foods that are consumed. However, when available, the earthworm is their primary food source. For a detailed approach to estimate earthworm concentrations, refer to Appendix 2. The same is true for the American woodcock with the earthworm being a major food item. Also, in the case of the great blue heron, osprey, and belted kingfisher, an assumption that can be made is that 100% of their prey consists of trophic level 3 and 4 fish. If there are data available on the proportion of the diet from a number of different organisms, these percentages can be used to approximate the contribution of the COC by the different prey items.

4.4 Terrestrial Plant Contamination

Estimating the amount of chemical uptake and adherence to plant material is a very complicated exercise, due in part to the variety of plants and the diversity of chemicals being applied and present in the atmosphere (Appendix 2, Calculating Uptake into Terrestrial Vegetation). In the case of direct application of a chemical (e.g., pesticide), the estimated chemical concentration can be calculated and this value used as the worst case scenario for foliar concentrations. These values can be used for estimating exposure to herbivores and omnivores. If there is concern of a compound on plant material that is being consumed, then it is recommended that the plant material be sampled directly. This will allow for “site specific” determinations that will be directly applicable to the parks.

5.0 Sample Collection and Analytical Techniques

COCs can be divided into general categories that include radionuclide, inorganic, and organic compounds. Within each of these categories there are many subgroups that may have specific common characteristics. The techniques for quantification of these compounds are generally specific and have been approved by national organizations (USEPA, NOAA, ASTM) and are rigorously followed. Any specific technique will establish which analytes will be analyzed and at what detection limit. There are also specific matrix protocols because the specific matrix will change the extractability, recovery and limit of detection of the analyte (Appendix 2,Table 4). It is critical to determine which analytes are to be tested and what is the level of detection needed.

Just as important as the analytical technique (federal or state agency approved protocols) and lab selection (state and federal certified for analytic technique) is the field collection method (Table 9 & 10, Appendix 2 - General Field Sampling Guidelines). The protocols contained in Appendix 2 have been taken directly from the USEPA Emergency Response Team website and the individual SOPs are listed http://www.ert.org/mainContent.asp?section=Products&subsection=List. Because many compounds are ubiquitous, it is essential that the method of collection not introduce the analyte of interest into the sample from a spurious source. Cross contamination of samples will result in artifacts due to handling and not due to the presence of a COC (Appendix 2 - Sampling Equipment Decontamination). It is important to follow the recommended decontamination procedures, highest purity of solvents and appropriate field sample controls. Another important factor is the dissimilar holding times that are acceptable for the different COCs (Table 10). If a sample is analyzed after an unacceptable holding time (determined by analytical protocol), the results are suspect because of potential loss of analyte or parent chemical alteration.

5.1 Sampling Design

The goals of the sampling design include (1) support a decision whether a contaminant level exceeds a threshold of unacceptable hazard, (2) identify the location of “hot spots” (3) characterize the nature and extent of the contamination, and (4) determine trends in contamination levels. Prior to conducting any sample collections, a full SOP for the sampling procedures, QA/QC samples, sample storage, analytical method, and data analysis (statistics and data usage) should be outlined in detail. Any deviation from the SOP should be noted in a bound sample log. All notes and information collected while sampling should be written in the log book, and signed and dated at the bottom of each page by the person entering the information. If a misstatement or an incorrect entry is entered it should be crossed out with a single line and then initialed by the person changing the entry. All entries need to be in waterproof pen. All personnel involved in the sampling protocol need to have read the protocol and understand the procedures being carried out.

The sampling design is critical to evaluate how representative a sampling strategy is to determining the extent of a given COC at any location (USEPA 2002a). Probability-based sampling involves collection of samples in a nonsystematic fashion from the entire park. Systematic sampling involves collection of samples based on a grid or a pattern, which has been previously statistically established. If possible, the number of samples to be collected can be determined from preliminary sampling and statistics. When judgmental sampling is performed, samples are collected only from portions of the park that are most likely to be contaminated based on expert knowledge or professional judgment and from a reference site. A grid design can be used for judgmental sampling as well. This latter approach is the one that will likely be used at most parks if for no other reason than decreased number and cost of sample analysis. Under some circumstances a combination of approaches may be used. There is no absolute number of samples that is required to establish the level of a COC at any location. It is important for comparative purposes

that a minimum of three discrete independent samples with a subset of duplicates be collected at the designated site location. This will allow for, at a minimum, a mean and standard deviation to be determined, as well as for a statistical analysis to be performed (Student t-test). To prevent sample loss or the influence of outlier values, it is suggested that four to six discrete samples be collected. Increased sample number size will generally reduce the influence of any one outlier; however, sample analysis may limit the number of samples (dioxin like compounds and PCBs cost ~$1,500 per sample) that can be analyzed. For a detailed description of sampling design and statistical interpretation refer to USEPA (2002).

Collection of duplicate or split samples can be used in place of samples that may be lost or damaged. The cost of the sampling campaign is quite high and it is often cheaper to collect the duplicate samples at the time of initial sampling than having to resample the site. For this program, it is being recommended that specific sites within the park be sampled based on suspected introduction of COCs or for the protection of an important natural resource in case of a spill (judgmental sampling). In the case of a spill situation, the samples should include reference samples outside of the spill area, samples at the point of the spill, and samples along the expected concentration gradient of the spill. There is no set number of sample sites, but an adequate number of sites should be sampled to delineate the extent of the spill.

5.2 Discrete or Composite Samples

The two most common types of sample collection are either discrete grab samples or composites of samples collected over an area or a specified time period. The matrix being sampled along with the sampling design strategy will influence the type of sample collected. As the name implies grab samples are taken at a single point in time from the matrix being sampled. This is a discrete sample that will relay the concentration within the matrix at this single point in time and location. A composite sample is a mixture of numerous individual samples that are well mixed and then sampled for analysis. The rational for using a composite sample is that there can be variability in field samples and a composite would give an averaged concentration in the matrix. A composite sample can dilute contaminant result, so it should be noted that if you have an elevated composite sample you may wish to resample with a discrete sampling design to better understand contaminant distribution. This can be achieved if individual samples that comprise the composite can be stored until it is determined whether a point estimate is needed. Chain of custody for any sample is a critical requirement when collecting any sample. It is also important to understand for different statistics are required when comparing individual discrete samples versus composite samples (Newman and Unger 2003; USEPA 2002a).

Atmospheric sampling composite samples are usually collected because of the traditionally low levels of contaminants. There are many different types of samplers from passive designed units (wet and dry samplers, semi permeable membranes) to low volume (carbon filter mini-pumps) and high volume throughput samplers (different filter materials depending on COC). Again, the specific COC will determine the material used to trap the COC or the specific type of sampler (see Appendix 2).

As with air sampling, water sampling (surface and groundwater) can be done either using a single grab type sample or a composite sampler that collects discrete samples for a designated period of time. The composite gives an average of the COC over the time period and results in an average concentration (smoothing out highs and lows). A 24 hour composite sampler is commonly used at sewage treatment or effluent sampling to establish the average concentration over a 24 hour period. Composite sampling allows for a larger volume of sample to be collected that can be used for either analytical or biological toxicity testing. General methods for collection of surface and groundwater samples are summarized in Appendix 2 Surface Water Sampling and Groundwater Well Sampling.

In the case of soil samples, vegetation is removed and surface or core samples at various depths can be obtained. Because of spatial variability of contaminates it is important to composite samples from a specific area. A recommended protocol is to use discrete sampling from a square meter and combining five sub-samples taken from the four corners and the center of the square meter. In the case of sediment sampling, three or more cores or benthic grab samples from each location should comprise the composite. One approach in a small boat using a ponar is to sample from three locations within the boat. In larger vessels and or using larger sampling devices multiple samples from the stern of the boat can be used to make a composite sample. Another advantage to the composite sample is that there is a sufficient amount to collect duplicate samples that may be used (if needed) or as QA/QC samples. Within Appendix 2 are extensive protocols for sediment and soil sampling.

Within Table 9 are summarized the analytical methods for each of the different matrices. Table 10 summarizes for each class of analytes being examined in a specific matrix the required container, preservation method and recommended holding times. Prior to any sampling campaign contact should be made to the analytical laboratory and to determine if they have any specific requirements. What are shown in Table 10 are the generally accepted parameters. To have sufficient material for laboratory "spiking" for determining recoveries (two matrix spikes and one travel blank) and precision (eight matrix spikes) additional samples should be collected at the time of sampling. Sample size can be established following discussions with the laboratory conducting the analysis. In preparation of a spill incident, containers should be onsite along with appropriate collecting devices and identified certified laboratories that can conduct the analysis.

Breaches of protocol for analytical techniques, holding times, cross contamination, individual sample identity, and integrity (chain of custody) can result in the data being suspect and unusable for general monitoring, publication and or litigation purposes. Quality Control and Quality
Assurance Work Plan must be followed for the entire project from planning of sample collection, to analysis and interpretation.

Table 9. Recommended Analytical Methods by Matrix Being Analyzed.

Analyte	Method Number	Instrument	Matrix
PAHs	8270D	GC/MS	S, SD, X
PCBs	8270D	GC/MS	S, SD, X
Total petroleum hydrocarbon	8015B 418.1	GC/MS GC/FID	S, SD, X
Pest/PCB	8080/SW-846 608	GC/MS	S, SD, X W
Oil + grease	5520A+F	IR & Fluorescence	W
Dioxins/furans	8280B 8290A	GC/MS	S, SD, X
Metals	EPA-600/CFR40 7000B 7010 6010B SW-846	Flame AA ICP	W S, SD, X
VOA	8240/SW-846 624/CLP	GC/MS	S, SD W
Grain size	ASTM D422-63	NA	S, SD
Total organic carbon	SW 846-9060	NA	S, SD

S=soil, SD=sediment, W=water, X=tissue, NA=not applicable, VOA=volatile organic analysis

Table 10. Summary of Collection and Holding Requirements Based on Analyte and Specimen.

Analytical Parameter	Matrix[1]	Container Type & Volume[2]	Preservation	Holding Times
Pest/PCB	S	8 oz glass ~500 g	4° C	7/40 days
TAL metals	S	8 oz glass ~10-100g	4 ° C	6 months
TAL metals	XE	8 oz glass ~10-100g	≤ 0 ° C	6 months
Pest/PCB	XE	8 oz glass~10-100g	≤ 0 ° C	7/40 days
Pest/PCB	XM	Foil/Ziploc ~500g	≤ 0 ° C	7/40 days
TAL metals	XM	Foil/Ziploc ~100g	≤ 0 ° C	6 months
Pest/PCB	SD	8 oz glass ~500g	4 ° C	7/40 days
TAL metals	SD	4 oz glass ~100g	4 ° C	6 months
Pest/PCB	XF	Foil/Ziploc ~500g	≤ 0 ° C	7/40 days
TAL metals	XF	Foil/Ziploc ~500g	≤ 0 ° C	6 months
Pest/PCB	XI	Foil/Ziploc ~100g	≤ 0 ° C	7/40 days
TAL metals	XI	Foil/Ziploc ~100g	≤ 0 ° C	6 months
Pest/PCB	W	1 L amber~1000 ml	4 ° C	7/40 days
TAL metals	W	1 L poly ~1000 ml	4 ° C	6 months
Lipids	X	Foil/Ziploc ~1-10g	NA	7 days
Grain size	S,SD	32 oz glass ~10-1000g	NA	NA
TOC	S,SD	8 oz glass ~1-10g	4 ° C	28 days

1. Matrix: S=soil, W=water, SD=sediment, XE=earthworm tissue, XF=forage fish, XI=invertebrate, X=animal lipids, XM=mammal

2. The container type is indicated but the amount needed is determined by the selected analytical technique and anticipated concentration level. The values listed in the table are recommendations (Dr. Brian Buckley personnel communication EOHSI analytical Laboratory), and actual amounts should be discussed with the analytical laboratory carrying out the analysis. Actual amounts collected can affect the detection limit for the sample.

6.0 Conclusion

Appendix 1 is a primer for assessing which chemicals may pose a threat to wildlife on NPS properties, and how samples should be collected and analyzed. Appendix 1 is presented in a manner that will allow National Park personnel to become familiar with the basic principles that underlie an environmental screening approach and to determine if a chemical concentration poses any hazard to wildlife species. It cannot be emphasized enough that the approach proposed in this chapter is a simplified approach to a very complex problem. In most environmental samples there are complex mixtures of compounds that can be assessed on an individual chemical basis, but there are likely complex chemical interactions that will influence the toxicity. Although much of Appendix 1 deals with individual compounds and their effects, most environmental situations have multiple contaminants. These contaminants, although dealt with on an individual compound by compound basis in toxicology, do not preclude the possibility that chemical compounds can result in less than additive, additive, or greater than additive effects when an organism is exposed to multiple chemicals from an environmental mixture. An exception occurs when the chemicals act through a common mechanism and the literature supports an additive approach. This is the case for dioxin-like compounds, but in the majority of cases such information is not available (Van den Berg et al. 2006). The difficulty in dealing with complex mixtures is that there is no way short of testing the mixture to determine how the chemicals interact in the biological system. The reader should also appreciate that both chemical contamination and species have a spotty distribution in the environment, which can affect the establishment of baseline values. The specific examples provided allow NPS staff to see how the equations are applied to determine if a compound is above a benchmark level that could adversely impact wildlife. It is important in any assessment to understand the activities that historically or presently (offsite and onsite) introduce chemicals into the exposure pathways of plants and animals within a park area. With this information and an understanding about the critical habitats and species an assessment can be made to predict if an adverse effect may result. It is important that both the personnel conducting chemical analysis and the natural resource personnel work together to assess impacts.

Appendix 2: Hazard Quotient Approaches and Sampling Protocols (continued)

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1.0 Chemicals Analyzed During Routine Sampling

One of the largest and continuous data sets that exist for bivalve mollusks can be obtained from the NOAA Status and Trends data for estuarine environments around the country. The data set goes back to 1986 and contains data for sediment and tissue values for only a few years over this period. Tissue data is available for most of the sites on a two to five year basis. The two bivalve species that are collected at these sites are the blue mussel (*Mytilus edulis*) and the Eastern oyster (*Crassostrea virginica*). Since these are filter-feeding bivalves, they will accumulate contaminants from chemicals adhering to particulates and food organisms (algae). These data can be used to make three different interpretations concerning the waters to which the bivalves are exposed. First, this data set is useful for examining temporal trends at a given site from 1986 to present for both trace metals and organic contaminants. Selecting specific sites that are in or near park locations enables a determination to be made concerning the trends in chemical concentrations in these organisms. These trends can be used as an indicator for the improvement in a specific watershed, no change in tissue levels, or an upward trend for a particular compound. A second use for these data can be the calculation of what the suspended sediment or particulate phase concentrations are for a specific compound. The assumption being made is that this calculated particulate phase value is equivalent to actual bulk sediment, which is likely a conservative assumption. This number can be compared to the sediment matrix benchmarks and a HQ derived. This is based on site specific BAF values generated when comparing the sediment to the tissue concentrations. If the estimated sediment concentration is greater than the NOAEL for sediment, then the specific compound should be considered a COC.

Site Specific BAF=Tissue Concentration/Sediment Concentration
Estimated Sediment Concentration=Tissue Concentration/Site Specific BAF *Eq. 1*

Third, the tissue concentrations can be used to establish exposure from food ingestion by mammals and birds that have bivalves as a portion of their diets. These data along with that generated in other trophic level organisms can be used to estimate a higher trophic levels organism's exposure through ingestion.

The EPA has also begun a long-term monitoring program that is examining not only chemical concentrations in sediment but also in fish and crustaceans inhabiting estuarine and near shore areas along the United States. There is also a biological component that examines toxicity associated with sediment and surface water. These data are useful when attempting to establish, whether there is an impact from multiple contaminants that may be present in an environmental sample. Examining whole organism toxicity allows for the total impact of all of the bioavailable compounds to be assessed as to whether there is an impact on the organism. These responses can be sublethal and lethal responses.

Other data sets that are useful include data from state and local authorities that have conducted regional or local collections. Local industry and federal government installations also are sources of contaminant information. NPS surveys are also useful in establishing the extent and number of COCs at any one location.

1.1 Calculation Uptake into Terrestrial Vegetation

Travis and Arms (1988) reported that uptake into vegetation from soil contaminated with organic compounds can be calculated by with Eq. 13. The concentration in the plant (B_v) is inversely proportional to the square-root of the octanol-partioning coefficient (K_{ow}).

$$Log_{10} B_v = 1.588 - 0.578 \, Log_{10} K_{ow} \qquad \text{Eq. 2}$$

A recent reevaluation of this approach has supported the initial assumptions with several minor qualifications (Birak et al. 2001). Compounds that are readily metabolized will be overestimated in the plant material; the concentration of compounds with a Log_{10} K_{ow} greater than 6.5 may be overestimated in the plants.

In the case of elements present in soil, the concentration in plants can be estimated using specific elemental transport parameters developed by Baes et al. (1984) for both the vegetative and non-vegetative portions of plants. These values were developed to estimate the amount of transfer to agricultural crops and are a good tool for estimating soil to plant uptake. The transfer coefficients were derived to represent the ratio of the elemental concentration in the plant and soil at harvest, and were broken down into vegetative portions and non-vegetative (reproductive) portions (Table 2). To calculate the concentration in the plant, multiply the transfer coefficient of the specific element by the soil dry-weight concentration. Multiplication by a factor of four for conversion from dry to wet weight should be used for non-grain or grasses. For grains and dry grasses a factor of 1.1 should be used (Table 6, Appendix 1).

Within Table 1 are derived equations for estimating uptake by plants for a number of routinely sampled metals. Derived equations for a number of organic compounds are shown in Table 2. These tables were obtained from the ECOTOX database (http://cfpub.epa.gov/ecotox/).

1.2 Earthworm Uptake

Earthworms (oligochaeta) are an important food source for a number of vertebrate species and may comprise the majority of their food intake. Secondary poisoning from contaminated worms has been reported (Sheppard et al. 1997). Uptake of organic compounds can be estimated based on the method of Menzie et al. (1992) as shown in the equation below.

$$UF = (Y_L)/(0.66 \times f_{oc}) \qquad \text{Eq. 2}$$

UF=uptake factor
Y_L=earthworm lipid content (if not measured assume 0.84%)
f_{oc}=organic carbon content of soil

The soil organic carbon should be measured on a site by site basis. If this information is not available, estimations can be made based on the soil conservation information available from the U.S. Department of Agriculture Natural Resources Conservation Service Web Soil Survey (http://soils.usda.gov/).

Table 1. Summary of Compounds Routinely Analyzed for by NOAA and USEPA and Calculated Trophic Level BAFs.

Analyte	Class	Log Kow	Kow	BCF*	Trohic Level 3 FCM	Trohic Level 3 BAF	Trohic Level 4 FCM	Trohic Level 4 BAF	Carcinogen	Mutagen	Teratogen	Reference
1,2,3,4-Tetrachlorobenzene	Pesticide	4.67	4.68E+04	2.09E+03	2.175	4.54E+03	1.633	3.41E+03				5
1,6,7-Trimethylnaphthalene	PAH	4.30	2.00E+04	1.09E+03	1.491	1.63E+03	1.178	1.29E+03	X			7
1-Methylnaphthalene	PAH	3.84	6.87E+03	4.88E+02	1.161	5.67E+02	1.042	5.08E+02	X			1
1-Methylphenanthrene	PAH	5.04	1.09E+05	3.98E+03	3.181	1.27E+04	2.612	1.04E+04	X			1
2,4'-DDD	Pesticide	6.20	1.58E+06	3.03E+04	12.064	3.66E+05	19.907	6.04E+05	X			1
2,4'-DDE	Pesticide	7.00	1.00E+07	1.23E+05	14.305	1.76E+06	26.242	3.23E+06	X			1
2,4'-DDT	Pesticide	6.19	1.55E+06	2.98E+04	12.064	3.60E+05	19.907	5.93E+05	X	X		1
2,6-Dimethylnaphthalene	PAH	4.37	2.36E+04	1.23E+03	1.614	1.99E+03	1.242	1.53E+03	X			1
2-Methylnaphthalene	PAH	3.86	7.19E+03	5.05E+02	1.202	6.07E+02	1.054	5.33E+02	X			1
4,4'-DDD	Pesticide	6.20	1.58E+06	3.03E+04	12.064	3.66E+05	19.907	6.04E+05	X			1
4,4'-DDE	Pesticide	7.00	1.00E+07	1.23E+05	14.305	1.76E+06	26.424	3.25E+06	X			1
4,4'-DDT	Pesticide	6.19	1.55E+06	2.98E+04	12.064	3.60E+05	19.907	5.93E+05	X	X		1
Acenaphthene	PAH	4.01	1.03E+04	6.57E+02	1.253	8.23E+02	1.072	7.04E+02	X			1
Acenaphthylene	PAH	3.22	1.67E+03	1.65E+02	1.042	1.72E+02	1.009	1.66E+02	X			1
Aldrin	Pesticide	5.66	4.57E+05	1.18E+04	7.962	9.39E+04	10.209	1.20E+05	X			1
Alpha-Chlordane	Pesticide	6.00	1.00E+06	2.14E+04	10.556	2.26E+05	15.996	3.42E+05	X			6
Alpha-Hexachlorocyclohexane	Pesticide	3.80	6.31E+03	4.45E+02	1.161	5.17E+02	1.042	4.64E+02	X			8
Aluminum	Metal	NA	NA	NA	NA	NA	NA	NA				2
Anthracene	PAH	4.53	3.42E+04	1.63E+03	1.766	2.88E+03	1.334	2.18E+03	X			1
Antimony	Metal	NA	NA	NA	NA	NA	NA	NA				2
Arsenic	Metal	NA	NA	NA	NA	NA	NA	NA	X			2
Benz[a]anthracene	PAH	5.67	4.71E+05	1.20E+04	7.962	9.55E+04	10.209	1.23E+05	X			1
Benzo[a]pyrene	PAH	6.11	1.28E+06	2.59E+04	11.337	2.94E+05	17.783	4.61E+05	X			1
Benzo[b]fluoranthene	PAH	6.27	1.85E+06	3.43E+04	12.691	4.35E+05	21.677	7.43E+05	X			1
Benzo[e]pyrene	PAH	6.14	1.36E+06	2.71E+04	11.337	3.07E+05	17.783	4.82E+05	X			1
Benzo[g,h,i]perylene	PAH	6.51	3.21E+06	5.22E+04	13.662	7.13E+05	24.604	1.28E+06	X			1
Benzo[k]fluoranthene	PAH	6.29	1.95E+06	3.55E+04	12.691	4.51E+05	21.677	7.70E+05	X			1
Beta-Hexachlorocyclohexane	Pesticide	3.78	6.03E+03	4.39E+02	1.161	5.10E+02	1.042	4.57E+02	X			8
Biphenyl	PAH	3.95	8.91E+03	5.92E+02	1.253	7.41E+02	1.072	6.34E+02	X			1
C1-Chrysenes	PAH	6.42	2.63E+06	4.46E+04	13.228	5.90E+05	23.281	1.04E+06	X			7
C1-Dibenzothiophenes	PAH	NA	NA	NA	NA	NA	NA	NA	X			
C1-Fluoranthenes/Pyrenes	PAH	5.29	1.94E+05	6.17E+03	4.803	2.96E+04	4.742	2.93E+04	X			1
C1-Fluorenes	PAH	4.72	5.25E+04	2.28E+03	2.175	4.95E+03	1.633	3.72E+03	X			1
C1-Naphthalenes	PAH	3.80	6.31E+03	4.55E+02	1.161	5.28E+02	1.042	4.74E+02	X			1
C1-Phenanthrenes/Anthracenes	PAH	5.04	1.10E+05	3.98E+03	3.181	1.27E+04	2.612	1.04E+04	X			1

Table 1. Summary of Compounds Routinely Analyzed for by NOAA and USEPA and Calculated Trophic Level BAFs (continued).

Analyte	Class	Log Kow	Kow	BCF*	Trohic Level 3 FCM	Trohic Level 3 BAF	Trohic Level 4 FCM	Trohic Level 4 BAF	Carcinogen	Mutagen	Teratogen	Reference
C2-Chrysenes	PAH	6.88	7.59E+06	9.97E+04	14.388	1.43E+06	26.669	2.66E+06	X			7
C2-Dibenzothiophenes	PAH	NA	NA	NA	NA	NA	NA	NA	X			
C2-Fluoranthenes/Pyrenes	PAH	5.29	1.94E+05	6.17E+03	4.803	2.96E+04	4.742	2.93E+04	X			
C2-Fluorenes	PAH	5.20	1.58E+05	5.27E+03	4.188	2.21E+04	3.873	2.04E+04	X			1
C2-Naphthalenes	PAH	4.30	2.00E+04	1.09E+03	1.491	1.63E+03	1.178	1.29E+03	X			1
C2-Phenanthrenes/Anthracenes	PAH	5.46	2.88E+05	8.31E+03	6.266	5.21E+04	7.079	5.88E+04	X			1
C3-Chrysenes	PAH	7.44	2.75E+07	2.66E+05	12.987	3.45E+06	21.038	5.59E+06	X			7
C3-Dibenzothiophenes	PAH	NA	NA	NA	NA	NA	NA	NA	X			
C3-Fluoranthenes/Pyrenes	PAH	5.29	1.94E+05	6.17E+03	4.803	2.96E+04	4.742	2.93E+04	X			
C3-Fluorenes	PAH	5.70	5.01E+05	1.26E+04	7.962	1.01E+05	10.209	1.29E+05	X			1
C3-Naphthalenes	PAH	4.80	6.31E+04	2.62E+03	2.452	6.42E+03	1.871	4.90E+03	X			1
C3-Phenanthrenes/Anthracenes	PAH	5.92	8.32E+05	1.86E+04	9.716	1.81E+05	13.964	2.60E+05	X			1
C4-Chrysenes	PAH	8.00	1.00E+08	7.08E+05	8.222	5.82E+06	7.798	5.52E+06	X			7
C4-Naphthalenes	PAH	5.30	2.00E+05	6.28E+03	4.803	3.02E+04	4.742	2.98E+04	X			1
C4-Phenanthrenes/Anthracenes	PAH	6.32	2.09E+06	3.74E+04	12.691	4.75E+05	21.677	8.11E+05	X			1
Cadmium	Metal	NA	NA	NA	NA	NA	NA	NA	X			2
Chlorpyrifos	Pesticide	5.26	1.82E+05	5.86E+03	4.803	2.81E+04	4.742	2.78E+04				5
Chromium	Metal	NA	NA	NA	NA	NA	NA	NA	X			2
Chrysene	PAH	5.71	5.16E+05	1.29E+04	7.962	1.02E+05	10.209	1.31E+05	X			1
Cis-Nonachlor	Pesticide	5.70	5.01E+05	1.26E+04	7.962	1.01E+05	10.209	1.29E+05				6
Copper	Metal	NA	NA	NA	NA	NA	NA	NA				2
Delta-Hexachlorocyclohexane	Pesticide	4.14	1.38E+04	8.25E+02	1.315	1.08E+03	1.096	9.04E+02	X			8
Dibenzo[a,h]anthracene	PAH	6.71	5.16E+06	7.41E+04	14.223	1.05E+06	26.363	1.95E+06	X			1
Dibenzofuran		4.12	1.32E+04	7.97E+02	1.315	1.05E+03	1.069	8.51E+02				5
Dibenzothiophene	PAH	4.49	3.09E+04	1.52E+03	1.766	2.69E+03	1.334	2.03E+03	X			1
Dibutyltin	Organotin	NA	NA	NA	NA	NA	NA	NA				2
Dieldrin	Pesticide	5.16	1.45E+05	4.92E+03	4.188	2.06E+04	3.873	1.90E+04		X		1
Endosulfan	Pesticide	2.23	4.10E+00	2.90E+01	1.005	2.91E+01	1.000	2.90E+01				2
Endrin	Pesticide	4.56	3.63E+04	1.72E+03	1.950	3.35E+03	1.459	2.51E+03				1
Fluoranthene	PAH	5.08	1.21E+05	4.27E+03	3.643	1.56E+04	3.162	1.35E+04	X			1
Fluorene	PAH	4.21	1.61E+04	9.32E+02	1.380	1.29E+03	1.130	1.05E+03	X			1
Gamma-Chlordane	PAH	6.00	1.00E+06	2.14E+04	10.556	2.26E+05	15.996	3.42E+05	X		X	1
Gamma-Hexachlorocyclohexane	Pesticide	3.61	4.07E+03	3.26E+02	1.103	3.60E+02	1.023	3.34E+02	X			8
Heptachlor	Pesticide	5.44	2.75E+05	8.02E+03	5.502	4.41E+04	5.821	4.67E+04	X			1
Heptachlor-Epoxide	Pesticide	5.40	2.51E+05	7.48E+03	5.502	4.12E+04	5.821	4.36E+04	X			1
Hexachlorobenzene	Pesticide	5.66	4.57E+05	1.18E+04	7.962	9.39E+04	10.209	1.20E+05	X	X		1
Indeno[1,2,3-c,d]pyrene	PAH	6.72	5.27E+06	7.54E+04	14.223	1.07E+06	26.363	1.99E+06	X			1
Iron	Metal	NA	NA	NA	NA	NA	NA	NA				2
Lead	Metal	NA	NA	NA	NA	NA	NA	NA	X			2
Manganese	Metal	NA	NA	NA	NA	NA	NA	NA				2
Mercury	Metal	NA	NA	NA	NA	NA	NA	NA				2
Mirex	PAH	6.89	7.76E+06	1.01E+05	14.388	1.46E+06	26.669	2.71E+06	X			1
Monobutyltin	Organotin	NA	NA	NA	NA	NA	NA	NA				2
Naphthalene	PAH	3.36	2.27E+03	2.09E+02	1.067	2.23E+02	1.014	2.12E+02	X			1
Nickel	Metal	NA	NA	NA	NA	NA	NA	NA	X			2

Table 1. Summary of Compounds Routinely Analyzed for by NOAA and USEPA and Calculated Trophic Level BAFs (continued).

Analyte	Class	Log Kow	Kow	BCF*	Trohic Level 3 FCM	Trohic Level 3 BAF	Trohic Level 4 FCM	Trohic Level 4 BAF	Carcinogen	Mutagen	Teratogen	Reference
Oxychlordane	Pesticide	2.60	3.98E+02	5.57E+01	1.028	5.73E+01	1.007	5.61E+01				6
PCB101/90	PCB	6.64	4.37E+06	6.55E+04	13.980	9.16E+05	25.645	1.68E+06	X			3
PCB105	PCB	6.91	8.13E+06	1.05E+05	14.388	1.51E+06	26.669	2.80E+06	X			3
PCB118	PCB	7.40	2.52E+07	2.48E+05	12.987	3.22E+06	21.038	5.21E+06	X			4
PCB128	PCB	7.02	1.05E+07	1.27E+05	14.305	1.82E+06	26.242	3.34E+06	X			3
PCB138	PCB	7.11	1.29E+07	1.49E+05	14.142	2.11E+06	25.468	3.80E+06	X			3
PCB153/132/168	PCB	6.86	7.24E+06	9.63E+04	14.388	1.39E+06	26.669	2.57E+06	X			3
PCB170/190	PCB	7.57	3.72E+07	3.34E+05	11.708	3.91E+06	16.749	5.59E+06	X			3
PCB18	PCB	5.60	3.98E+05	1.06E+04	7.096	7.53E+04	8.551	9.08E+04	X			4
PCB180	PCB	7.66	4.57E+07	3.90E+05	10.914	4.26E+06	14.388	5.62E+06	X			3
PCB187	PCB	7.47	2.95E+07	2.80E+05	21.517	6.03E+06	18.967	5.31E+06	X			3
PCB195/208	PCB	7.88	7.59E+07	5.74E+05	9.162	5.26E+06	9.840	5.65E+06	X			3
PCB206	PCB	7.88	7.59E+07	5.74E+05	9.162	5.26E+06	9.840	5.65E+06	X			3
PCB209	PCB	7.88	7.59E+07	5.74E+05	9.162	5.26E+06	9.840	5.65E+06	X			3
PCB28	PCB	5.89	7.76E+05	1.76E+04	9.716	1.71E+05	13.964	2.46E+05	X			3
PCB44	PCB	5.99	9.77E+05	2.10E+04	10.556	2.22E+05	15.996	3.36E+05	X			3
PCB52	PCB	6.08	1.20E+06	2.46E+04	11.337	2.79E+05	17.783	4.37E+05	X			3
PCB66	PCB	6.44	2.75E+06	4.62E+04	13.228	6.11E+05	23.281	1.07E+06	X			3
PCB8/5	PCB	5.27	1.86E+05	5.96E+03	4.803	2.86E+04	4.742	2.83E+04	X			3
Pentachloroanisole	Pesticide	NA	NA	NA	NA	NA	NA	NA	X			
Pentachlorobenzene	Pesticide	5.26	1.82E+05	5.86E+03	4.803	2.81E+04	4.742	2.78E+04	X			5
Perylene	PAH	6.14	1.36E+06	2.73E+04	11.337	3.10E+05	17.783	4.86E+05	X			1
Phenanthrene	PAH	4.57	3.72E+04	1.75E+03	1.950	3.41E+03	1.459	2.55E+03				1
Pyrene	PAH	4.92	8.36E+04	3.23E+03	2.780	8.98E+03	2.193	7.08E+03	X			1
Selenium	Metal	NA	NA	NA	NA	NA	NA	NA				2
Silicon	Metal	NA	NA	NA	NA	NA	NA	NA				2
Silver	Metal	NA	NA	NA	NA	NA	NA	NA				2
Tetrabutyltin	Organotin	NA	NA	NA	NA	NA	NA	NA				2
Tin	Metal	NA	NA	NA	NA	NA	NA	NA				2
Total butyltins	Organotin	NA	NA	NA	NA	NA	NA	NA				2
Total chlordanes	Pesticide	5.50	3.16E+05	8.91E+03	6.266	5.58E+04	7.079	6.31E+04	X		X	6
Total DDT	Pesticide	6.19	1.55E+06	2.98E+04	12.064	3.60E+05	19.907	5.93E+05	X	X		1
Total dieldrin	Pesticide	4.60	3.98E+04	1.85E+03	1.950	3.60E+03	1.459	2.69E+03		X		6,2
Total PAH	PAH	5.98	9.55E+05	2.06E+04	9.716	2.01E+05	13.964	2.88E+05	X			1
Total PAHhmw (4 or more rings)	PAH	5.98	9.55E+05	2.06E+04	9.716	2.01E+05	13.964	2.88E+05	X			1
Total PAHlmw (2-3 rings)	PAH	5.98	9.55E+05	2.06E+04	9.716	2.01E+05	13.964	2.88E+05	X			1
Trans-Nonachlor	Pesticide	5.70	5.01E+05	1.26E+04	7.962	1.01E+05	10.209	1.29E+05	X			6
Tributyltin	Organotin	NA	NA	NA	NA	NA	NA	NA				2
Zinc	Metal	NA	NA	NA	NA	NA	NA	NA				2

logBCF=(0.76)(logKow)-(0.23)
BAF = (BCF)(FCM) NA=not available

Table 1. Summary of Compounds Routinely Analyzed for by NOAA and EPA and Calculated Trophic Level BAFs (continued).

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Table 2. Multiplication Factors for Elements Present in Soil for Estimating Plant Concentrations in the Vegetative and Non-Vegetative Portions of the Plant[1].

Element	Vegetative	Non-Vegetative
Hafnium (Hf)	0.0035	0.0009
Tantalum (Ta)	0.0100	0.0025
Tungsten (W)	0.0450	0.0100
Rhenium (Re)	1.5000	0.3500
Osmium (Os)	0.0150	0.0035
Iridium (Ir)	0.0550	0.0150
Platinum (Pt)	0.0950	0.0250
Gold (Au)	0.4000	0.1000
Mercury (Hg)	0.9000	0.2000
Thallium (Tl)	0.0040	0.0004
Lead (Pb)	0.0450	0.0090
Bismuth (Bi)	0.0350	0.0050
Polonium (Po)	0.0025	0.0004
Astatine (At)	1.0000	0.1500
Francium (Fr)	0.0300	0.0300
Radium (Ra)	0.0150	0.1500
Lanthanum (La)	0.0100	0.0040
Cerium (Ce)	0.0100	0.0040
Prasiodimium (Pr)	0.0100	0.0040
Neodymium (Nd)	0.0100	0.0040
Promethium (Pm)	0.0100	0.0040
Samarium (Sm)	0.0100	0.0040
Europium (Eu)	0.0100	0.0040
Gadolinium (Gd)	0.0100	0.0040
Terbium (Tb)	0.0100	0.0040
Dysprosium (Dy)	0.0100	0.0040
Holmium (Ho)	0.0100	0.0040
Erbium (Er)	0.0100	0.0040
Thulium (TM)	0.0100	0.0040
Ytterbium (Yb)	0.0100	0.0040
Lutetion (Lu)	0.0100	0.0040
Actinium (Ac)	0.0035	0.0004
Thorium (Th)	0.0010	0.0001
Protactinium (Pa)	0.0025	0.0003
Uranium (U)	0.0085	0.0040
Neptunium (Np)	0.1000	0.0100
Plutonium (Pu)	0.0005	0.00005
Americium (Am)	0.0055	0.0003
Curium (Cu)	0.0009	0.00002

1. Source: Baes, C.F., Sharp, R.D., Sjoreen, A.L., and Shor, R.W. (1984). A Review and Analyses of Parameters for Assessing transport of Environmentally Released Radionuclide's through Agriculture. Oakridge National Laboratory. Managed by Martin Marietta Systems, INC. for the U.S. Department of Energy.

An alternative model has been proposed by Jager (1998), which is currently being recommended by USEPA for determining the BCF in earthworms (Connell and Markwell 1990; Sample et al. 1997). The model is based on the theory that bioconcentration in earthworms is governed by thermodynamic partitioning between surrounding water and the water and lipid phases inside the organism (Eq 15). For risk assessment the equations below can be used to predict BCFs for chemicals taken up by earthworms in the Log_{10} K_{ow} range of zero to eight. Tables 3-5 are based on the Jager (1998) model.

$$C_{worm}=K_{ww}\times C_w \qquad \textit{Eq. 3}$$

C_{worm}=concentration in worm (mg/kg dry weight)
K_{ww}=biota to soil water partitioning coefficient (L soil pore water/kg ww tissue)
C_w=concentration in soil pore water (mg/L)

Jager (1998) derived the following equations for determining K_{ww} and C_w.

$$Log_{10}(K_{ww})=0.87 \times Log_{10}(K_{ow}) - 2.0$$

$$C_w=C_s/K_d$$

C_s=concentration in soil (mg/kg soil)
K_d=soil to water partitioning coefficient (L soil pore water/kg dw soil)

For non-ionic organic compounds, K_d may be estimated using the following equation.

$$K_d=F_{oc} \times K_{oc}$$

F_{oc} = fraction of organic carbon in soil (kg organic carbon/kg soil)
K_{oc} = soil organic carbon to water partitioning coefficient
(volume soil pore water (L)/kg organic carbon)

We are recommending using Eq. 2 as the default if insufficient information is available. If the chemical is listed in Tables 1-3, utilize the equations to estimate tissue concentrations. Tables 1-3 were taken from the Ecological Soil Screening Levels Attachment 4-1 (2005), which is updated periodically as new information becomes available and is available through the ECOTOX database (http://cfpub.epa.gov/ecotox/). When sufficient data are available, and then utilize Eq. 3 to estimate the earthworm concentrations.

Table 3. Uptake Equations for Inorganic Compounds for Plants, Earthworms, and Small Mammals.

Analyte	Soil to Plants		Soil to Earthworms		Soil to Small Mammals	
	Equation	Source	Equation	Source	Equation	Source
Antimony	$\ln(C_p) = 0.938 * \ln(C_s) - 3.233$	a	$C_e = C_s$	g	$C_m = 0.001 * 50 * C_d$	f
Arsenic	$C_p = 0.03752 * C_s$	b	$\ln(C_e) = 0.706 * \ln(C_s) - 1.421$	e	$\ln(C_m) = 0.8188 * \ln(C_s) - 4.8471$	d
Barium	$C_p = 0.156 * C_s$	b	$C_e = 0.091 * C_s$	c	$C_m = 0.00015 * 50 * C_d$	f
Beryllium	$\ln(C_p) = 0.7345 * \ln(C_s) - 0.5361$	h	$C_e = 0.045 * C_s$	c	$C_m = 0.001 * 50 * C_d$	f
Cadmium	$\ln(C_p) = 0.546 * \ln(C_s) - 0.475$	b	$\ln(C_e) = 0.795 * \ln(C_s) + 2.114$	e	$\ln(C_m) = 0.4723 * \ln(C_s) - 1.2571$	d
Chromium	$C_p = 0.041 * C_s$	b	$C_e = 0.306 * C_s$	e	$\ln(C_m) = 0.7338 * \ln(C_s) - 1.4599$	d
Cobalt	$C_p = 0.0075 * C_s$	b	$C_e = 0.122 * C_s$	c	$\ln(C_m) = 1.307 * \ln(C_s) - 4.4669$	d
Copper	$\ln(C_p) = 0.394 * \ln(C_s) + 0.668$	b	$C_e = 0.515 * C_s$	e	$\ln(C_m) = 0.1444 * \ln(C_s) + 2.042$	d
Lead	$\ln(C_p) = 0.561 * \ln(C_s) - 1.328$	b	$\ln(C_e) = 0.807 * \ln(C_s) - 0.218$	e	$\ln(C_m) = 0.4422 * \ln(C_s) + 0.0761$	d
Manganese	$C_p = 0.079 * C_s$	b	$\ln(C_e) = 0.682 * \ln(C_s) - 0.809$	e	$C_m = 0.0205 * C_s$	d
Nickel	$\ln(C_p) = 0.748 * \ln(C_s) - 2.223$	b	$C_e = 1.059 * C_s$	e	$\ln(C_m) = 0.4658 * \ln(C_s) - 0.2462$	d
Selenium	$\ln(C_p) = 1.104 * \ln(C_s) - 0.677$	b	$\ln(C_e) = 0.733 * \ln(C_s) - 0.075$	e	$\ln(C_m) = 0.3764 * \ln(C_s) - 0.4158$	d
Silver	$C_p = 0.014 * C_s$	b	$C_e = 2.045 * C_s$	c	$C_m = 0.004 * C_s$	d
Vanadium	$C_p = 0.00485 * C_s$	b	$C_e = 0.042 * C_s$	c	$C_m = 0.0123 * C_s$	d
Zinc	$\ln(C_p) = 0.554 * \ln(C_s) + 1.575$	b	$\ln(C_e) = 0.328 * \ln(C_s) + 4.449$	e	$\ln(C_m) = 0.0706 * \ln(C_s) + 4.3632$	d

Source:

a. Regression derived from measured data [Appendix A]
b. Bechtel-Jacobs 1998
c. Sample et al. 1998b
d. Sample et al. 1998a
e. Sample et al. 1999
f. Baes et al. 1984
g. Assumed
h. Regression derived from measured data [Appendix A].

Abbreviations:

C_s = Concentration in soil (mg/kg)
C_p = Concentration in plant tissue (mg/kg dry weight)
C_e = Concentration in earthworm (mg/kg dry weight)
C_m = Concentration in small mammal tissue (mg/kg dry weight)
C_d = Concentration in diet (mg/kg dry weight)
where small mammal diet is assumed to be 100% earthworms

Table 4. Parameters Used in Calculating Earthworm BAFs for Selected Organic Compounds.

Chemical	K_{ow}: octanol to water partitioning coefficient			K_{ww}: worm to soil water partitioning coefficient			K_{oc}: water to soil organic carbon partitioning coefficient					K_d: soil to water partitioning coefficient	Soil to Earthworm BAF[5]
	log K_{ow}	K_{ow}	Source	log K_{ww}[1]	K_{ww} (L/kg worm ww)	K_{ww}[2] (L/kg worm dw)	slope	intercept	log K_{oc}	K_{oc}[3]	Source	K_d[4] (L/kg soil dw)	
Acenaphthene	3.92	8.32E+03	EPA 1996	1.41	2.57E+01	1.61E+02	0.762	1.051	4.04	1.09E+04	estimated (a)	1.09E+02	1.47
Acenaphthylene	4.07	1.17E+04	SRC, PP	1.54	3.47E+01	2.17E+02			2.98	9.47E+02	SRC, CF	9.47E+00	22.9
Anthracene	4.55	3.55E+04	EPA 1996	1.96	9.09E+01	5.68E+02			4.37	2.35E+04	EPA 1996	2.35E+02	2.42
Benzo(a)anthracene	5.7	5.01E+05	EPA 1996	2.96	9.10E+02	5.69E+03			5.55	3.58E+05	EPA 1996	3.58E+03	1.59
Benzo(a)pyrene	6.11	1.29E+06	EPA 1996	3.32	2.07E+03	1.29E+04			5.99	9.69E+05	EPA 1996	9.69E+03	1.33
Benzo(b)fluoranthene	6.2	1.58E+06	EPA 1996	3.39	2.48E+03	1.55E+04	0.762	1.051	5.78	5.96E+05	estimated (a)	5.96E+03	2.60
Benzo(e)pyrene	6.44	2.75E+06	SRC, PP	3.60	4.01E+03	2.50E+04	0.762	1.051	5.96	9.08E+05	estimated (a)	9.08E+03	2.76
Benzo(ghi)perylene	6.7	5.01E+06	EPA 1995	3.83	6.75E+03	4.22E+04	0.762	1.051	6.16	1.43E+06	estimated (a)	1.43E+04	2.94
Benzo(k)fluoranthene	6.2	1.58E+06	EPA 1996	3.39	2.48E+03	1.55E+04	0.762	1.051	5.78	5.96E+05	estimated (a)	5.96E+03	2.60
Chrysene	5.7	5.01E+05	EPA 1996	2.96	9.10E+02	5.69E+03	0.762	1.051	5.39	2.48E+05	estimated (a)	2.48E+03	2.29
Coronene	7.64	4.37E+07	SRC, PP	4.65	4.43E+04	2.77E+05	0.762	1.051	6.87	7.46E+06	estimated (a)	7.46E+04	3.72
Dibenzo(ah)anthracene	6.69	4.90E+06	EPA 1996	3.82	6.61E+03	4.13E+04			6.25	1.79E+06	EPA 1996	1.79E+04	2.31
Fluoranthene	4.95	8.91E+04	SRC, PP	2.31	2.03E+02	1.27E+03			4.62	4.17E+04	SRC, CF	4.17E+02	3.04
Fluorene	4.18	1.51E+04	SRC, PP	1.64	4.33E+01	2.71E+02			3.45	2.83E+03	SRC, CF	2.83E+01	9.57
Indeno(123 cd)pyrene	6.584	3.84E+06	SRC, PP	3.73	5.35E+03	3.34E+04	0.762	1.051	6.07	1.17E+06	estimated (a)	1.17E+04	2.86
Naphthalene	3.36	2.29E+03	EPA 1996	0.92	8.38E+00	5.24E+01			3.08	1.19E+03	EPA 1996	1.19E+01	4.40
Phenanthrene	4.55	3.55E+04	EPA 1995	1.96	9.09E+01	5.68E+02	0.762	1.051	4.52	3.30E+04	estimated (a)	3.30E+02	1.72
Pyrene	4.88	7.59E+04	SRC, PP	2.25	1.76E+02	1.10E+03			4.80	6.27E+04	SRC, CF	6.27E+02	1.75

Table 4. Parameters Used in Calculating Earthworm BAFs for Selected Organic Compounds (continued).

[1] $\log K_{ww} = 0.87 * \log K_{ow} - 2.0$ [model from Jager, 1998]

[2] Converted from wet weight to dry weight assuming 16% solids (Jager, 1998)

[3] Measured K_{oc} values from SRC Chem Fate Database or EPA, 1996 ($n > 2$).

If no measured K_{oc} values available, values modeled based on chemical class-specific models from Gerstl (1990).

where: $\log K_{oc} = \text{slope} * \log K_{ow} + \text{intercept}$

(a) slope and intercept for PAHs

[4] $K_d = f_{oc} * K_{oc}$ (assumes an f_{oc} of 1% [0.01])

[5] BAF = K_{ww} (L/kg worm dw) / K_d (L/kg soil dw)

Source Citations:

EPA (1995) = Internal report on summary of measured, calculated, and recommended Log Kow values. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. 38 pp.
EPA (1996) = Soil Screening Guidance: Technical Background Document. EPA/540/R-95/128
SRC, PP = Syracuse Research Corp. Physical Properties Database. http://esc.syrres.com/interkow/PhysProp.htm
SRC, CF = Syracuse Research Corp. Chem Fate Database. http://www.syrres.com/esc/chemfate.htm

Table 5. Equations for Calculating Uptake into Plants, Earthworms, and Small Mammals.

Chemical	Soil to Plants		Soil to Earthworms		Soil to Small Mammals	
	Equation	Source	Equation	Source	Equation	Source
Non-PAHs						
Dieldrin	$C_p = 0.41 * C_s$	a	$\ln(C_e) = 0.8756 * \ln(C_s) + 2.2757$	a	$\ln(C_m) = 0.6076 * \ln(C_d) + 1.9582$	a
DDT, DDD and DDE Combined	$\ln(C_p) = 0.7524 * \ln(C_s) - 2.5119$	b	$\ln(C_e) = 0.8561 * \ln(C_s) + 2.1287$	b	$\ln(C_m) = 0.663 * \ln(C_d) + 2.3833$	b
DDT	*Not Available*		$\ln(C_e) = 0.8689 * \ln(C_s) + 2.1247$	b	$\ln(C_m) = 0.7254 * \ln(C_d) + 1.1788$	b
DDD	*Not Available*		$\ln(C_e) = 0.6975 * \ln(C_s) + 1.1613$	b	*Not Available*	
DDE	*Not Available*		$\ln(C_e) = 0.8804 * \ln(C_s) + 2.4771$	b	$\ln(C_m) = 0.641 * \ln(C_d) + 3.6401$	b
TNT	$C_p = 4.23 * C_s$	c	*Not Available*		$C_m = 0$	f
RDX	$C_p = 0.43 * C_s$	c	*Not Available*		$C_m = 0$	f
PAHs						
Acenaphthene	$\ln(C_p) = -0.8556 * \ln(C_s) - 5.562$	d	$C_e = 1.47 * C_s$	e	$C_m = 0$	f
Acenaphthylene	$\ln(C_p) = 0.791 * \ln(C_s) - 1.144$	g	$C_e = 22.9 * C_s$	e	$C_m = 0$	f
Anthracene	$\ln(C_p) = 0.7784 * \ln(C_s) - 0.9887$	d	$C_e = 2.42 * C_s$	e	$C_m = 0$	f
Benzo(a)anthracene	$\ln(C_p) = 0.5944 * \ln(C_s) - 2.7078$	d	$C_e = 1.59 * C_s$	e	$C_m = 0$	f
Benzo(a)pyrene	$\ln(C_p) = 0.9750 * \ln(C_s) - 2.0615$	d	$C_e = 1.33 * C_s$	e	$C_m = 0$	f
Benzo(b)fluoranthene	$C_p = 0.310 * C_s$	c	$C_e = 2.60 * C_s$	e	$C_m = 0$	f
Benzo(e)pyrene	$C_p = 0.19 * C_s$	c	$C_e = 2.76 * C_s$	e	$C_m = 0$	f
Benzo(ghi)perylene	$\ln(C_p) = 1.1829 * \ln(C_s) - 0.9313$	d	$C_e = 2.94 * C_s$	e	$C_m = 0$	f
Benzo(k)fluoranthene	$\ln(C_p) = 0.8595 * \ln(C_s) - 2.1579$	d	$C_e = 2.60 * C_s$	e	$C_m = 0$	f
Chrysene	$\ln(C_p) = 0.5944 * \ln(C_s) - 2.7078$	d	$C_e = 2.29 * C_s$	e	$C_m = 0$	f
Coronene	$C_p = 0.68 * C_s$	c	$C_e = 3.72 * C_s$	e	$C_m = 0$	f
Dibenz(ah)anthracene	$C_p = 0.13 * C_s$	c	$C_e = 2.31 * C_s$	e	$C_m = 0$	f
Fluoranthene	$C_p = 0.50 * C_s$	c	$C_e = 3.04 * C_s$	e	$C_m = 0$	f
Fluorene	$\ln(C_p) = -0.8556 * \ln(C_s) - 5.562$	d	$C_e = 9.57 * C_s$	e	$C_m = 0$	f
Indeno(123 cd)pyrene	$C_p = 0.11 * C_s$	c	$C_e = 2.86 * C_s$	e	$C_m = 0$	f
Naphthalene	$C_p = 12.2 * C_s$	c	$C_e = 4.40 * C_s$	e	$C_m = 0$	f
Phenanthrene	$\ln(C_p) = 0.6203 * \ln(C_s) - 0.1665$	d	$C_e = 1.72 * C_s$	e	$C_m = 0$	f
Pyrene	$C_p = 0.72 * C_s$	c	$C_e = 1.75 * C_s$	e	$C_m = 0$	f

Table 5. Equations for Calculating Uptake into Plants, Earthworms, and Small Mammals (continued).

Source:

a. Regression derived from measured data [Appendix E].
b. Regression derived from measured data [Appendix D].
c. Median BAF calculated from measured data [Appendix C].
d. Regression derived from measured data [Appendix C].
e. Modeled from K_{ow} based on Jager (1998) [Table 5].
f. Assumed to be negligible
g. Modeled using the rinsed PAH-specific equation [Figure 3]

Abbreviations:

C_s = Concentration in soil (mg/kg)
C_p = Concentration in plant tissue (mg/kg dry weight)
C_e = Concentration in earthworm (mg/kg dry weight)
C_m = Concentration in small mammal or bird tissue (mg/kg dry weight)
C_d = Concentration in diet (mg/kg dw) where diet is assumed to be 100% earthworms.

Chemical	Soil to Plants		Soil to Earthworms		Soil to Small Mammals	
	Equation	Source	Equation	Source	Equation	Source
Pentachlorophenol	$C_p = 5.93 * C_s$	a	$\ln(C_e) = 0.3308 * \ln(C_s) + 5.5463$	b	$C_m = 0.00452 * C_d + 0.198$	c

1.3 USEPA Environmental Response Team SOPs

1.3.1 General Field Sampling Guidelines (USEPA-Environmental Response Team)

SOP#: 2001
DATE: 08/11/94
REV. #: 0.0

Scope and Application: The purpose of this SOP is to provide general field sampling guidelines that will assist personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling. These are standard (i.e., typically applicable) operating procedures that may be varied or changed as required depending on site conditions, equipment limitations, and limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and reported. Mention of trade names or commercial products does not constitute USEPA endorsement or recommendation for use.

Method Summary: Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment. The primary objective of all sampling activities is to characterize a hazardous waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is assured, quality assurance standards are maintained, and the sample can accurately represent the larger body of material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

Sample Preservation, Containers, Handling, and Storage: The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

Interferences and Potential Problems: The nature of the object or materials being sampled may be a potential problem to the sampler. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of changes in the material over distance, both laterally and vertically. Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample.
Environmental conditions, weather conditions, or non-target chemicals may cause problems and interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

Equipment/Apparatus: The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques, which include lists of the equipment/apparatus required for sampling.

Reagents: Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

Procedure: *Types of Samples*: In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample. Environmental samples are those collected from streams, ponds, lakes, and wells; there are offsite samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples. Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

The importance of making the distinction between environmental and hazardous samples is two-fold:

(1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.

(2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association Dangerous Goods Regulations or Department of Transportation (DOT) regulations and USEPA guidelines.

Sample Collection Techniques: In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab Samples: A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples: Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits. Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations. For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

Types of Sampling Strategies: The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling. Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern that has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

Quality Analysis Work Plans (QAWP): A QAWP is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

1. Objective and purpose of the investigation.
2. Basis upon which data will be evaluated.
3. Information known about the site including location, type and size of the facility, and length of operations/abandonment.
4. Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data.
5. Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented.
6. Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
7. QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

Legal Implications: The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities. Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and indefensible in court, and the consequent loss of enforcement proceedings.

Calculations: Refer to the specific SOPs for any calculations which are associated with sampling techniques.

QA/QC: Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

Data Validation: Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

Health and Safety: When working with potentially hazardous materials follow USEPA, OSHA, and corporate health and safety procedures.

1.3.2 Sampling Equipment Decontamination (USEPA - Environmental Response Team)

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

Scope and Application: The purpose of this SOP is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e., typically applicable) operating procedures that may be varied or changed as required depending on site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and reported.

Mention of trade names or commercial products does not constitute USEPA endorsement or recommendation for use.

Method Summary: Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter, residual oils, and grease. This may be preceded by a steam or high-pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the priority pollutant list. If acetone is known to be a contaminant of concern at a given site or if target compound list analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry

9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

Sample Preservation, Containers, Handling, and Storage: The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

Interferences and Potential Problems: The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.

If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.

Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

Equipment/Apparatus: Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, softwash bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold softwash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.
The following standard materials and equipment are recommended for decontamination activities:

Decontamination Solutions: Non-phosphate detergent, selected solvents (acetone, hexane, nitric acid, etc.), tap water, distilled or deionized water.

Decontamination Tools/Supplies: Long and short handled brushes, bottle brushes, drop cloth/plastic sheeting, paper towels, plastic or galvanized tubs or buckets, pressurized sprayers, solvent sprayers, and aluminum foil.

Health and Safety Equipment: Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, and emergency eye wash).

Waste Disposal: Trash bags, trash containers, 55-gallon drums, and metal/plastic buckets/containers for storage and disposal of decontamination solutions.

Reagents: There are no reagents used in this procedure aside from the actual decontamination solutions. Table 6 lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes: 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.

Acetone (pesticide grade)(1)
Hexane (pesticide grade)(1)
Methanol(1)

(1)- Only if sample is to be analyzed for organics.

Procedures: As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- The number, location, and layout of decontamination stations.
- Decontamination equipment needed.
- Appropriate decontamination methods.
- Methods for disposal of contaminated clothing, equipment, and solutions.

Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

Table 6. Soluble Contaminants and Recommended Solvent Rinse.

Solvent[1]	Examples of Solvents	Soluble Contaminants
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic solvents[2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene	Nonpolar compounds (e.g., some organic compounds
Organic solvent[2]	Hexane	PCBs

- Material safety data sheets are required for all decontamination solvents or solutions as required by the hazard communication standard
- WARNING: Some organic solvents can permeate and/or degrade the protective clothing

Decontamination Methods: All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization. Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

Abrasive Cleaning Methods: Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

> *Mechanical*: Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.
>
> *Air Blasting*: Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.
>
> *Wet Blasting*: Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

Non-Abrasive Cleaning Methods: Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

> *Low-Pressure Water*: This method consists of a container that is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.
>
> *High-Pressure Water*: This method consists of a high-pressure pump, an operator controlled directional nozzle, and a highpressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.
>
> *Ultra-High-Pressure Water*: This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.
>
> *Rinsing*: Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.
>
> *Damp Cloth Removal*: In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants that may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization: Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed offsite.

Field Sampling Equipment Decontamination Procedures: The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of one meter. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: hot zone or exclusion zone, the contamination reduction zone (CRZ), and the support or safe zone. The decontamination line should be setup in the contamination reduction corridor (CRC) which is in the CRZ. Figure 1 shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

Decontamination Setup: Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop
Place plastic sheeting on the ground (Figure 2). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment that is likely to be heavily contaminated.

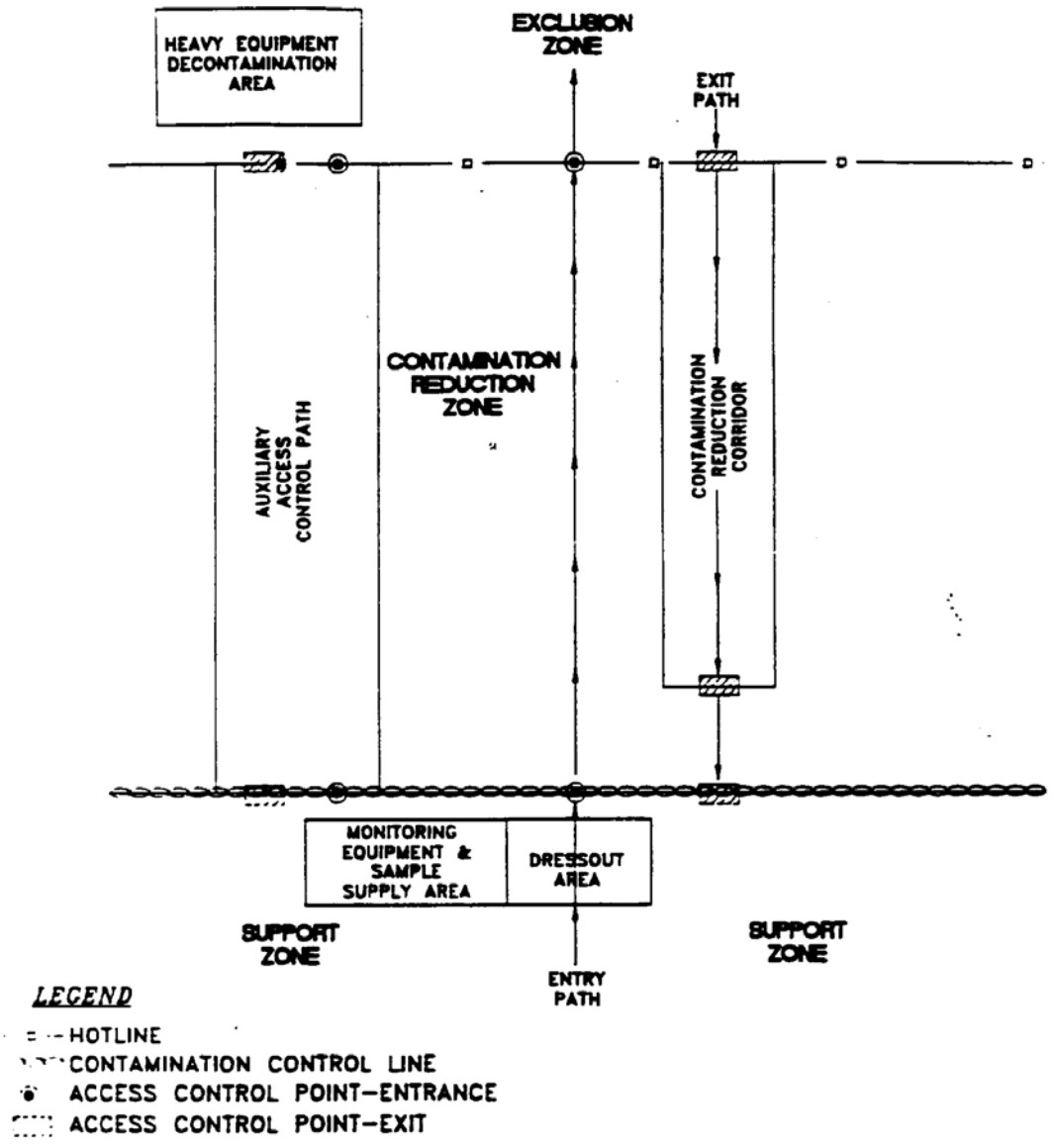


Figure 1. Contamination Reduction Zone Layout.

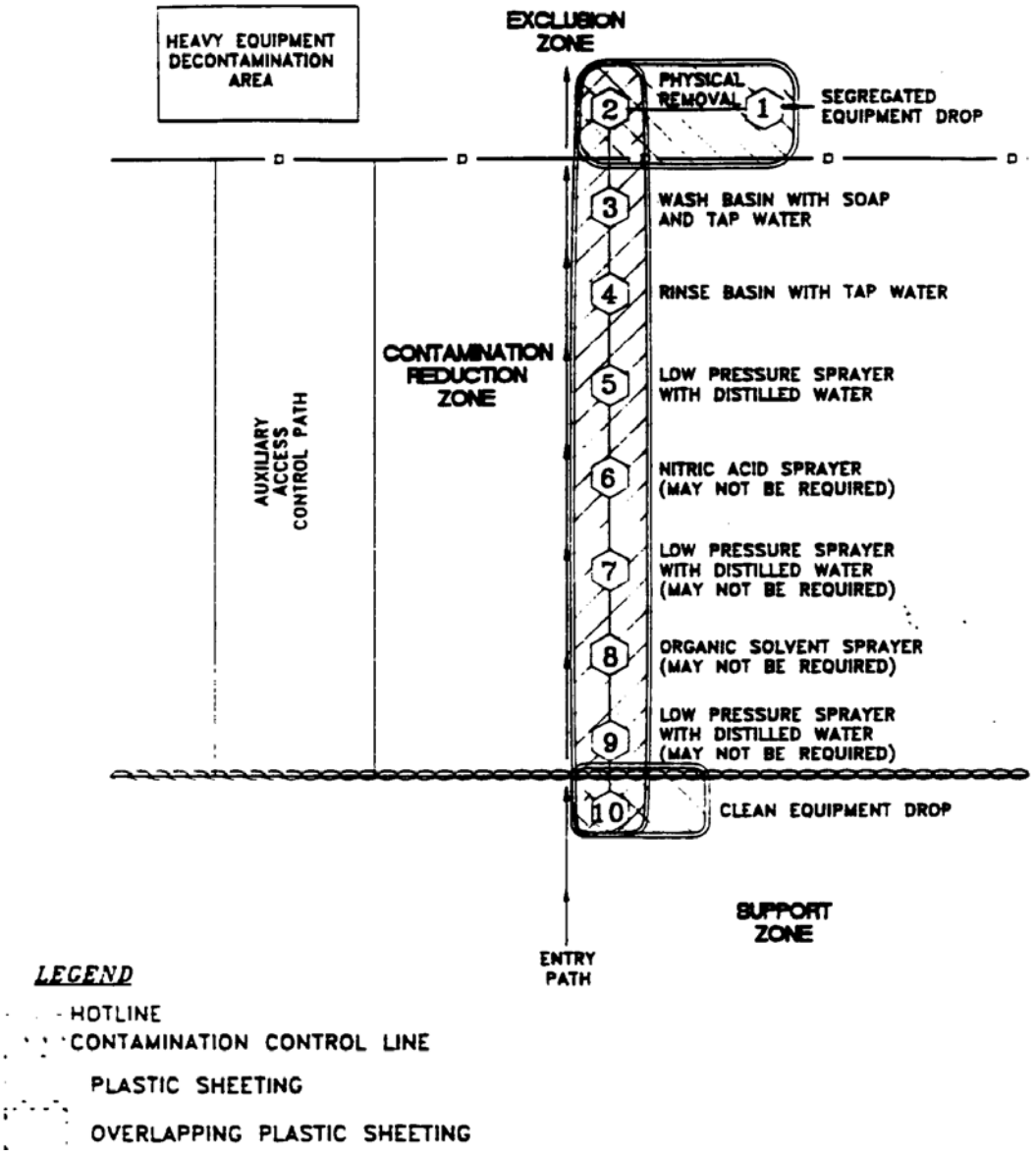


Figure 2. Decontamination Layout.

Station 2: Physical Removal with a High-Pressure Washer (Optional)
A high-pressure wash may be required for compounds that are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high- pressure wash area. An example of a wash pad may consist of an approximately a half meter deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes and a Wash Basin
Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.

Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station. Approximately 38 – 189 liters of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin
Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 38 – 189 liters of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers
Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 38 – 76 liters of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers
Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers
Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers
Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount

of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers
Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop
Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

Decontamination Procedures:

Station 1: Segregate Equipment Drop
Deposit equipment used on-site (e.g., tools, sampling devices and containers, monitoring instruments radios, and clipboards) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic Ziploc bags if contamination is evident.

Station 2: Physical Removal With a High-Pressure Washer (Optional)
Use high pressure wash on grossly contaminated equipment. Do not use high-pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes and a Wash Basin
Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) that is waterproof should be washed. Equipment that is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse
Wash soap from equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse
Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)
Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station.

Station 7: Low-Pressure Sprayers
Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers
Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10: Clean Equipment Drop
Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

Post Decontamination Procedures:

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
3. Empty soap and water liquid wastes from basins and buckets and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.
5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.
6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.
7. Empty low-pressure sprayer water onto the ground.
8. Place all solid waste materials generated from the decontamination area (e.g., gloves and plastic sheeting) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

Calculations: This section is not applicable to this SOP.

QA/QC: A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field. Rinsate blanks are samples obtained by running analyte-free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day.

A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet quality assurance objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

Data Validation: Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

Health and Safety: When working with potentially hazardous materials, follow OSHA, USEPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal protective equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).
In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

1.3.3 General Air Sampling Guidelines (USEPA - Environmental Response Team SOPs)

GENERAL AIR SAMPLING GUIDELINES

SOP#: 2008
DATE: 11/16/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) provides guidance in developing and implementing sampling plans to assess the impact of hazardous waste sites on ambient air. It presents the United States Environmental Protection Agency/Environmental Response Team's (U.S. EPA/ERT's) approach to air sampling and monitoring and identifies equipment requirements. It is not within the scope of this SOP to provide a generic air sampling plan. Experience, objectives, site characteristics, and chemical characteristics will dictate sampling strategy. This SOP does not address indoor air sampling.

Two basic approaches can be used to assess ambient air (also referred to as air pathway assessments): modeling and measurements. The modeling approach initially estimates or measures the overall site emission rate(s) and pattern(s). These data are input into an appropriate air dispersion model, which predicts either the maximum or average air concentrations at selected locations or distances during the time period of concern. This overall modeling strategy is presented in the first three volumes of the Air Superfund National Technical Guidance Series on Air Pathway Assessments[1,2,3]. Specific applications of this strategy are presented in several additional Air Superfund Technical Guidance documents[4].

The measurement approach involves actually measuring the air impact at selected locations during specific time periods. These measurements can be used to document actual air impacts during specific time intervals (i.e., during cleanup operations) or to extrapolate the probable "worst case" concentrations at that and similar locations over a longer time period than was sampled.

This SOP addresses issues associated with this second assessment strategy. This SOP also discusses the U.S. EPA/ERT's monitoring instruments, air sampling kits, and approach to air sampling and monitoring at hazardous waste sites.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, depending on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Air monitoring is defined as the use of direct-reading instruments and other screening or monitoring equipment and techniques that provide instantaneous (real-time) data on the levels of airborne contaminants. The U.S. EPA/ERT maintains numerous monitors for real-time measurements. Examples of air monitoring equipment are hand-held photoionization detectors (PID), flame ionization detectors (FID), oxygen/combustible gas detectors, and remote optical sensors.

Air sampling is defined as those sampling and analytical techniques that require either off- or on-site laboratory analysis and therefore do not provide immediate results. Typically, air sampling occurs after use of real-time air monitoring equipment has narrowed the number of possible contaminants and has provided some qualitative measurement of contaminant concentration. Air sampling techniques are used to more accurately detect, identify and quantify specific chemical compounds relative to the majority of air monitoring technologies.

In the Superfund Removal Program, On-Scene Coordinators (OSCs) may request the U.S. EPA/ERT to conduct air monitoring and sampling during the

following situations: emergency responses, site assessments, and removal activities. Each of these activities has a related air monitoring/sampling objective that is used to determine the potential hazards to workers and/or the community.

C Emergency Response

Emergency responses are immediate responses to a release or threatened release of hazardous substances presenting an imminent danger to public health, welfare, or the environment (i.e., chemical spills, fires, or chemical process failures resulting in a controlled release of hazardous substances). Generally these situations require rapid on-site investigation and response. A major part of this investigation consists of assessing the air impact of these releases.

C Removal Site Assessment

Removal site assessments (referred to as site assessments) are defined as any of several activities undertaken to determine the extent of contamination at a site and which help to formulate the appropriate response to a release or threatened release of hazardous substances. These activities may include a site inspection, multimedia sampling, and other data collection.

C Removal Actions

Removal actions clean up or remove hazardous substances released into the environment. Removal actions include any activity conducted to abate, prevent, minimize, stabilize, or eliminate a threat to public health or welfare, or to the environment.

Personal risk from airborne contaminants can be determined by comparing the results of on-site monitoring and sampling to health-based action levels such as the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) and the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). Residential risk can be determined by comparing the results of off-site monitoring or sampling to health-based action levels such as those developed by the Agency for Toxic Substance and Disease Registry (ATSDR).

The extent to which valid inferences can be drawn from air monitoring/sampling depends on the degree to which the monitoring/sampling effort conforms to the objectives of the event. Meeting the project's objectives requires thorough planning of the monitoring/sampling activities, and implementation of the most appropriate monitoring/sampling and analytical procedures. These issues will be discussed in this SOP.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Preservation, containers, handling and storage for air samples are discussed in the specific SOPs for the technique selected. In addition, the analytical method (i.e., U.S. EPA, National Institute for Occupational Safety and Health [NIOSH], and OSHA Methods) may be consulted for storage temperature, holding times and packaging requirements. After sample collection, the sampling media (i.e., cassettes or tubes) are immediately sealed. The samples are then placed into suitable containers (i.e., whirl bags, resealable bagsor culture tubes) which are then placed into a shipping container.

Use bubble wrap or styrofoam peanuts when packing air samples for shipment. DO NOT USE VERMICULITE.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Upwind sources can contribute to sample concentration. Natural sources, such as biological waste, can produce hydrogen sulfide and methane which may contribute to the overall contaminant level. Extraneous anthropogenic contaminants (i.e., burning of fossil fuels; emissions from vehicular traffic, especially diesel; volatile compounds from petrochemical facilities; and effluvium from smoke stacks) may also contribute. Air sampling stations should be strategically placed to identify contributing sources.

Photoreactivity or reaction of the parameters of concern may occur with nonrelated compounds [i.e., nitrogen compounds and polyaromatic hydrocarbons

(PAHs)]. Some sorbent media/samples should not be exposed to light during or after sampling due to photochemical effects (i.e., PAHs).

Various environmental factors, including humidity, temperature and pressure, also impact the air sampling methodology, collection efficiency and detection limit. Since the determination of air contaminants is specifically dependent on the collection parameters and efficiencies, the collection procedure is an integral part of the analytical method.

Detection limits depend on the contaminants being investigated and the particular site situation. It is important to know why the data are needed and how the data will be used. Care should be taken to ensure the detection limits are adequate for the intended use of the final results.

Some equipment may be sensitive to humidity and temperature extremes.

5.0 EQUIPMENT/APPARATUS

5.1 Direct Reading Instruments (Air Monitoring Instruments)

There are two general types of direct reading instruments: portable screening devices and specialized analytical instruments. Generally all these techniques involve acquiring, for a specific location or area, continuous or sequential direct air concentrations in either a real-time or semi-real-time mode. None of these instruments acquires true time-weighted average concentrations. In addition, these instruments are not capable of acquiring simultaneous concentration readings at multiple locations, although several are able to sequentially analyze samples taken remotely from different locations. The document, "Guide to Portable Instruments for Assessing Airborne Pollutants Arising from Hazardous Waste Sites[5]," provides additional information about air sampling and monitoring. The hazard levels for airborne contaminants vary. See the ACGIH TLVs and the OSHA PELs for safe working levels. Common screening devices and analytical instruments are described in Appendix A.

5.2 Air Sampling Equipment and Media/Devices

The U.S. EPA/ERT uses the following analytical methods for sampling: *NIOSH Manual of Analytical Methods*[6], *American Society for Testing and Materials (ASTM) Methods*[7], *U.S. EPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*[8,9], and *OSHA Methods*[10]. Additional air sampling references include *Industrial Hygiene and Toxicology* (3rd Ed.)[11] and *Air Sampling Instruments for Evaluation of Atmospheric Contaminants*[12]. These methods typically specify equipment requirements for sampling. Since air sampling is such a diverse technology, no single method or reference is best for all applications. Common sampling equipment and media/devices are described in Appendix B.

5.3 Tools/Material and Equipment List

In addition to equipment and materials identified in Appendices A and B, the following equipment and materials may be required to conduct air sampling and monitoring at hazardous waste sites:

- Camera
- Site logbook
- Clipboard
- Chain of custody records
- Custody seals
- Air sampling worksheets
- Sample labels
- Small screwdriver set
- Aluminum foil
- Extension cords
- Glass cracker
- Multiple plug outlet
- Whirl bags or culture tubes
- Teflon tape
- Calibration devices
- Tygon and/or Teflon® tubing
- Surgical gloves
- Lint-free gloves
- Ice
- Sample container

Use the following additional equipment when decontaminating glassware on site:

- Protective equipment (i.e., gloves, splash goggles, etc.)
- Appropriate solvent(s)
- Spray bottles
- Liquinox (soap)
- Paper towels

- Distilled/deionized water
- Five-gallon buckets
- Scrub brushes and bottle brushes

6.0 REAGENTS

Impinger sampling involves using reagents contained in a glass vial to absorb contaminants of concern (for example, NIOSH Method 3500 for formaldehyde uses 1% sodium bisulfite solution). Impinger solutions vary and are method-dependent.

Reagents such as acetone and hexane are required to decontaminate glassware and some air sampling equipment. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP.

7.0 PROCEDURES

7.1 Air Monitoring Design

7.1.1 Initial Surveys

In general, the initial survey is considered to be a relatively rapid screening process for collecting preliminary data at hazardous waste sites. However, initial surveys may require many hours to complete and may consist of more than one entry.

Some information is generally known about the site; therefore, real-time instrumentation for specific compounds (i.e., detector tubes and electrochemical sensors) can be used to identify hot spots. Sufficient data should be obtained with real-time instruments during the initial entry to screen the site for various contaminants. When warranted, intrinsically safe or explosion-proof instruments should be used. An organic vapor analyzer (OVA) is typically used during this survey. These gross measurements may be used on a preliminary basis to (1) determine levels of personal protection, (2) establish site work zones, and (3) map candidate areas for more thorough qualitative and quantitative studies involving air sampling.

In some situations, the information obtained may be sufficient to preclude additional monitoring. Materials detected during the initial survey may call for a more comprehensive evaluation of hazards and analyses for specific compounds. Since site activities and weather conditions change, a continuous program to monitor the ambient atmosphere must be established.

7.1.2 Off-Site Monitoring

Typically, perimeter monitoring with the same instruments employed for on-site monitoring is utilized to determine site boundaries. Because air is a dynamic matrix, physical boundaries like property lines and fences do not necessarily delineate the site boundary or area influenced by a release. Whenever possible, atmospheric hazards in the areas adjacent to the on-site zone should be monitored with direct-reading instruments. Monitoring at the fenceline or at varying locations off site provides useful information regarding pollutant migration. Three to four locations downwind of the source (i.e., plume) at breathing-zone height, provide a basic fingerprint of the plume. Negative instrument readings off site should not be interpreted as the complete absence of airborne toxic substances; rather, they should be considered another piece of information to assist in the preliminary evaluation. The interpretation of negative readings is instrument-dependent. The lack of instrument readings off site should not be interpreted as the complete absence of all airborne toxic substances; rather, it is possible that the particular compound or class of compounds to which the monitoring instrument responds is not present or that the concentration of the compound(s) is below the instrument's detection limit.

7.2 Air Sampling Design

7.2.1 Sampling Plan Design

The goal of air sampling is to accurately assess the impact of a contaminant source(s) on ambient air quality. This impact is expressed in terms of overall average and/or maximum air concentrations for the time period of concern and may be affected by the transport and release of pollutants from both on- and off-site sources. The location of these sources must be taken into account as they impact the selection of sampling locations. Unlike soil and groundwater concentrations, air concentrations at points of interest can easily vary by orders of magnitude over the period of concern. This variability plays a major role in designing an air sampling plan.

Downwind air concentration is determined by the amount of material being released from the site into the air (the emission rate) and by the degree that the contamination is diluted as it is transported. Local

meteorology and topography govern downwind dilution. Contaminant emission rates can also be heavily influenced by on-site meteorology and on-site activities. All of these concerns must be incorporated into an air sampling plan.

A sampling strategy can be simple or complex, depending on the sampling program objectives. Programs involving characterization of the pollutant contribution from a single point source tend to be simple, whereas sampling programs investigating fate and transport characteristics of components from diverse sources require a more complex sampling strategy. In addition, resource constraints may affect the complexity of the sampling design.

An optimal sampling strategy accounts for the following site parameters:

- Location of stationary as well as mobile sources
- Analytes of concern
- Analytical detection limit to be achieved
- Rate of release and transport of pollutants from sources
- Availability of space and utilities for operating sampling equipment
- Meteorological monitoring data
- Meteorological conditions in which sampling is to be conducted

The sampling strategy typically requires that the concentration of contaminants at the source or area of concern as well as background contributions be quantified. It is important to establish background levels of contaminants in order to develop a reference point from which to evaluate the source data. Field blanks and lot blanks, as well as various other types of QA/QC samples, can be utilized to determine other sources. The impact of extraneous sources on sampling results can frequently be accounted for by placing samplers upwind, downwind and crosswind from the subject source. The analytical data from these different sampling locations may be compared to determine statistical differences.

7.2.2 Sampling Objectives

The objectives of the sampling must be determined prior to developing the sampling plan. Does the sampling plan verify adequate levels of protection for on-site personnel, or address potential off-site impacts associated with the site or with site activities? In addition, the assumptions associated with the sampling program must be defined. These assumptions include whether the sampling is to take place under "typical," "worst case," or "one-time" conditions. If the conditions present at the time of sampling are different from those assumed during the development of the sampling plan, then quality of the data collected may be affected. The following definitions have been established:

- Typical: routine daily sampling or routine scheduled sampling at pre-established locations.
- Worst case: sampling conducted under the worst meteorological and/or site conditions which would result in elevated ambient concentrations.
- One-time: only one chance is given to collect a sample without regard to time or conditions.

Qualitative data acquired under these conditions are usually applicable only to the time period during which the data were collected and may not provide accurate information to be used in estimating the magnitude of an air impact during other periods or over a long time interval.

The sampling objectives also dictate the detection limits. Sampling methods for airborne contaminants will depend upon the nature and state (solid, liquid or gas) of the contaminant. Gases and vapors may be collected in aqueous media or adsorbents, in molecular sieves, or in suitable containers. Particulates are collected by filters or impactors. The volume of sample to be collected is dependent upon an estimate of the contaminant concentration in the air, the sensitivity of the analytical method, and the standard or desired detection limit. A sufficient amount of sample must be collected to achieve the desired detection limit without interference from other contaminants. In addition, the selected method must be able to detect the target compound(s).

7.2.3 Location and Number of Individual Sampling Points

Choose the number and location of sampling points according to the variability, or sensitivity, of the

sampling and analytical methods being utilized, the variability of contaminant concentration over time at the site, the level of precision required and costlimitations. In addition, determine the number of locations and placement of samplers by considering the nature of the response, local terrain, meteorological conditions, location of the site (with respect to other conflicting background sources), size of the site, and the number, size, and relative proximity of separate on-site emission sources and upwind sources. The following are several considerations for sampler placement:

- C Location of potential on-site emission sources, as identified from the review of site background information or from preliminary on-site inspections.

- C Location of potential off-site emission sources upwind of the sampling location(s). Review local wind patterns to determine the location of off-site sources relative to wind direction.

- C Topographic features that affect the dispersion and transport of airborne toxic constituents.

Avoid natural obstructions when choosing air sampling station locations, and account for channelization around those obstructions.

- C Large water bodies, which affect atmospheric stability and the dispersion of air contaminants.

- C Roadways (dirt or paved), which may generate dust that could mask site contaminants.

- C Vegetation, such as trees and shrubs, which stabilizes soil and retards subsurface contaminants from becoming airborne. It also affects air flow and scrubs some contaminants from the air. Sometimes thick vegetation can make an otherwise ideal air monitoring location inaccessible.

Consider the duration of sampling activities when choosing the location and number of samples to be collected. For example, if the sampling period is limited to a few hours, one or two upwind and several downwind samples would typically be adequate, especially around major emission sources.

A short-term monitoring program ranges from sev days to a few weeks and generally includes gathe data for site assessments, removal actions, and so determination data (for further modeling). Activ involved in a short-term sampling strategy must n the most of the limited possibilities for data collect Consider moving upwind/downwind locations d based on National Oceanic and Atmosph Administration (NOAA) weather forecasts. Wea monitoring becomes critical where complex ter and local meteorological effects frequently cha wind direction. Often, a number of alternatives fulfill the same objective.

Prevailing winds running the length of a valley usu require a minimum number of sampler locati however, a complex valley may require more sam locations to account for the wide variety of wi Ocean/lake effects may require a radical plan collect enough samples to reach a low detection li Two sets of samplers may be placed next to e other: one set would be activated during the sea br while the other set is turned off, and vice versa w there is no sea breeze. After the sampling event respective upwind and downwind samples woul combined. Another alternative for sampling ne large body of water may be to use automatic, w vector-operated samplers, which turn the sample only when the wind comes from a specified ve At sites located on hillsides, wind will move dow valley and produce an upward fetch at the same ti Sampling locations may have to ring the site measure the wind's impact.

Off-site sources may affect on-site monitoring. In case, on-site meteorological data, concurrent sampling data, is essential to interpreting the acqu data. Also, additional upwind sampling sites may needed to fully characterize ambient backgrc contaminant levels. Multiple off-site sources require several monitoring locations, but if the sou are at a sufficient distance, only one monito location is needed.

Topography and weather are not the only factor sampler location; the sampling sites must be se from vandals and mishap. Secure all samp locations to maintain chain of custody, and to pre tampering with samples or loss of sampling u High-volume sampling methods often require the of 110 VAC electric power. When port

generators are used, the power quality may affect sampler operation. Also, be aware that the generators themselves could be a potential pollution source if their placement is not carefully considered.

Air quality dispersion models can be used to place samplers. The models incorporate source information, surrounding topography, and meteorological data to predict the general distance and directions of maximum ambient concentrations. Modeling results should be used to select sampling locations in areas of maximum pollutant concentrations.

7.2.4 Time, Duration and Frequency of Sampling Events

After choosing appropriate sampling or monitoring locations, determine the sampling frequency and the number of samples to be collected. The time of day, duration and frequency of sampling events is governed by:

- The effects of site activities and meteorology on emission rates
- The diurnal effect of the meteorology on downwind dispersion
- The time period(s) of concern as defined by the objective
- The variability in the impact from other non-site-related sources
- If defined, the degree of confidence needed for either the mean or maximum downwind concentrations observed
- The precision requirements for single measurements
- Cost and other logistical considerations

The duration of the removal action and the number of hours per day that site work is conducted determine the time, duration, and frequency of samples. Short-term sampling programs may require daily sampling, while long-term programs may require 24-hour sampling every sixth or twelfth day. If the site will be undergoing removal activities 24 hours a day, continuous air sampling may be warranted. However, if the site activities will be conducted for only eight hours a day, and there are no emissions likely to occur during the remaining 16 hours, then sampling would be appropriate prior to the start of daily activities, would continue during operations, and end at the conclusion of the daily activities. An off-peak sample collection can ensure that emissions are not persisting after the conclusion of daily cleanup activities. For some sites, emissions are still a factor several hours after daily site activities have been completed. Because of the typically decreased downwind dispersion in the evening, higher downwind concentrations than were present during daytime site activities may be detected. For sites where this is possible, the sampling duration needs to be lengthened accordingly.

Sampling duration and flow rate dictate the volume of air collected, and to a major degree, the detection limit. The analytical method selected will provide a reference to flow rate and volume. Flow rates are limited to the capacity of the pumps being employed and the contact time required by the collection media.

The duration or period of air sampling is commonly divided into two categories (1) samples collected over a brief time period are referred to as "instantaneous" or "grab" samples and are usually collected in less than five minutes and (2) average or integrated samples are collected over a significantly longer period of time. Integrated samples provide an average concentration over the entire sampling period. Integrated samples are not suited to determining cyclical releases of contaminants because periodic or cyclical events are averaged out by the proportionally long sampling duration.

Air quality dispersion models can predict the maximum air contaminant concentration expected from a source. The meteorological and site conditions expected to cause the highest concentration are known as worst-case conditions and can be identified by analyzing the modeling results. Depending upon the objective, one may sample when the model predicts worst-case conditions will exist.

7.2.5 Meteorological and Physical/Chemical Considerations

A meteorological monitoring program is an integral part of site monitoring activities. Meteorological data, which define local terrain impacts on air flow paths, are needed to interpret air concentration data. Meteorological data may be available from an existing station located near the site (i.e., at a local airport), otherwise a station should be set up at the site. This data will document the degree that samples actually were downwind and verify whether other worst-case assumptions were met. Meteorological parameters to

be monitored are, at a minimum, wind speed, wind direction, and sigma theta (which is the horizontal wind direction standard deviation and an indicator of atmospheric stability). The remaining parameters primarily affect the amount of a contaminant available in the air.

C Wind Speed

When the contaminant of concern is a particulate, wind speed is critical in determining whether the particulate will become airborne, the quantity of the particulate that becomes airborne, and the distance the particulate will travel from the source. Wind speed also contributes to the volatilization of contaminants from liquid sources.

C Wind Direction

Wind direction highly influences the path of airborne contaminants. In addition, variations in wind direction increase the dispersion of pollutants from a given source.

C Atmospheric Stability

Atmospheric stability refers to the degree to which the atmosphere tends to dampen vertical and horizontal motion. Stable atmospheric conditions (i.e., evenings) result in low dispersion, and unstable atmospheric conditions (i.e., hot sunny days) result in higher dispersion.

C Temperature

Higher temperatures increase the rate of volatilization of organic and some inorganic compounds and affect the initial rise of gaseous or vapor contaminants. Therefore, worst-case emission of volatiles and semivolatiles occurs at the hottest time of day, or on the hottest day.

C Humidity

High humidity affects water-soluble chemicals and particulates. Humid conditions may dictate the sampling media used to collect the air sample, or limit the volume of air sampled and thereby increase the detection limit.

C Atmospheric Pressure

Migration of landfill gases through the landfill surface and through surrounding soils are governed by changes in atmospheric pressure. Atmospheric pressure will influence upward migration of gaseous contaminants from shallow aquifers into the basements of overlying structures.

In many cases, the transport and dispersion of air pollutants is complicated by local meteorology. Normal diurnal variations (i.e., temperature inversions) affect dispersion of airborne contaminants. Terrain features can enhance or create air inversions and can also influence the path and speed of air flow, complicating transport and dispersion patterns.

The chemical characteristics of a contaminant (i.e., molecular weight, physical state, vapor pressure, aerodynamic size, temperature, reactive compounds, and photodegradation) affects its behavior and can influence the method used to sample and analyze it.

8.0 CALCULATIONS

Volume is obtained by multiplying the sample time in minutes by the flow rate. Sample volume should be indicated on the chain of custody record. Adjustments for temperature and pressure differences may be required.

Results are usually provided in parts per million (ppm), parts per billion (ppb), milligrams per cubic meter (mg/m^3) or micrograms per cubic meter ($\mu g/m^3$).

Refer to the analytical method or regulatory guidelines for other applicable calculations.

9.0 QUALITYASSURANCE/ QUALITY CONTROL

The manufacturer's instructions should be reviewed prior to instrument use. Instruments must be utilized in accordance with manufacturer's instructions. Equipment checkout and calibration activities must

occur prior to and after monitoring and sampling and must be documented.

9.1 QA/QC Samples

QA/QC samples provide information on the variability and usability of environmental sample results. Various QA/QC samples may be collected to detect error. QA/QC samples are submitted with the field samples for analysis to aid in identifying the origin of analytical discrepancies; then a determination can be made as to how the analytical results should be used. Collocated samples, background samples, field blanks, and lot blanks are the most commonly collected QA/QC field samples. Performance evaluation (PE) samples and matrix spikes provide additional measures of data QA/QC control. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet site-specific QA or data quality objectives.

9.2 Sample Documentation

All sample and monitoring activities should be documented legibly, in ink. Any corrections or revisions should be made by lining through the incorrect entry and by initialing the error. All samples must be recorded on an Air Sampling Worksheet. A chain of custody record must be maintained from the time a sample is taken to the final deposition of the sample. Custody seals demonstrate that a sample container has not been opened or tampered with during transport or storage of samples.

10.0 DATA VALIDATION

Results for QA/QC samples should be evaluated for contamination. This information should be utilized to qualify the environmental sample results accordingly with data quality objectives.

11.0 HEALTH AND SAFETY

Personal protection equipment (PPE) requirements identified in federal and/or state regulations and 29 Code of Federal Regulations (CFR) 1910.120 for hazardous waste site work must be followed.

The majority of physical precautions involved in air sampling are related to the contaminant sampled. Attention should be given when sampling in potentially explosive, flammable or acidic atmospheres. On rare occasions, the collection media may be hazardous; for example, in the instance where an acidic or basic solution is utilized in an impinger.

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

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APPENDIX A

Portable Screening Devices and Specialized Analytical Instruments

PORTABLE SCREENING DEVICES

Where possible, a datalogger should be used to minimize the length of time required for site personnel to be in a potentially contaminated area. Datalogger cable is available from manufacturers for linear output instruments and some nonlinear output instruments. U.S. EPA ERT/REAC has output cables for organic vapor analyzers (i.e., HNU and OVA), toxic gas analyzers (i.e., monitox) and real-time aerosol monitors (i.e., RAM and miniram).

C Total Hydrocarbon Analyzers

Total hydrocarbon analyzers used to detect a variety of volatile organic compounds (VOCs) at hazardous waste sites principally employ either a photoionization detector (PID) or a flame ionization detector (FID). Compounds are ionized by a flame or an ultraviolet lamp. PIDs depend on the ionization potential of the compounds. PIDs are sensitive to aromatic and olefinic (unsaturated) compounds such as benzene, toluene, styrene, xylenes, and acetylene. Greater selectivity is possible by using low-voltage lamps. The ionization potential of individual compounds can be found in the NIOSH Pocket Guide to Chemical Hazards. These instruments are not compound-specific and are typically used as screening instruments. FIDs are sensitive to volatile organic vapor compounds such as methane, propanol, benzene and toluene. They respond poorly to organic compounds lacking hydrocarbon characteristics.

C Oxygen and Combustible Gas Indicators

Combustible Gas Indicators (CGIs) provide efficient and reliable methods to test for potentially explosive atmospheres. CGI meters measure the concentration of a flammable vapor or gas in air and present these measurements as a percentage of the lower explosive limit (LEL).

The measurements are temperature-dependent. The property of the calibration gas determines sensitivity. LELs for individual compounds can be found in the NIOSH Pocket Guide to Chemical Hazards. If readings approach or exceed 10% of the LEL, extreme caution should be exercised in continuing the investigation. If readings approach or exceed 25% LEL, personnel should be withdrawn immediately.

CGIs typically house an electrochemical sensor to determine the oxygen concentration in ambient air. Normally, air contains approximately 20.9% oxygen by volume. Oxygen measurements are of particular importance for work in enclosed spaces, low-lying areas, or in the vicinity of accidents that have produced heavier-than-air vapors which could displace ambient air. The meters are calibrated for sea level and may indicate a false negative (i.e, O_2 content) at higher altitudes. Since the air has been displaced by other substances, these oxygen-deficient areas are also prime locations for taking additional organic vapor and combustible gas measurements. Oxygen-enriched atmospheres increase the potential for fires by their ability to contribute to combustion or to chemically react with flammable compounds and promote auto-ignition.

C Toxic Atmosphere Analyzers

The toxic atmosphere analyzer is a compound-specific instrument, designed and calibrated to identify and quantify a specific compound or class of compounds in either gaseous or vapor form. Cross-sensitivity to air pollutants not of interest may be lead to erroneous results.

U.S. EPA/ERT has the following toxic atmosphere analyzers: carbon monoxide, phosgene, nitrous oxide, hydrogen cyanide, sulfur dioxide, hydrogen sulfide, and chlorine gas.

- Aerosol/Particulate Monitors

  A Real-Time Aerosol/Particulate Monitor (RAM) displays readings for total particulates. The instrument employs a pulse light emitting diode which generates a narrow band emission in conjunction with a photovoltaic cell to detect light scattered from particulates.

  The U.S. EPA/ERT uses the RAM when the contaminant of concern is associated with particulates, and when responding to fires involving hazardous materials, to identify plume levels. The instrument is very useful in determining the presence of a plume when it is not visible. The U.S. EPA/ERT typically uses RAMs on tripods to obtain particulate concentrations at the breathing zone level. Personal dataloggers are used with the RAMs to document minimum, average and maximum concentrations. This provides real-time data without requiring those in personal protective equipment to be constantly present in the plume.

- Chemical Detector Tubes (Colorimetric Tubes)

  A chemical detector tube is a hollow, tube-shaped, glass body containing one or more layers of chemically impregnated inert material. To use, the fused ends are broken off and a manufacturer-specified volume of air is drawn through the tube with a pump to achieve a given detection limit. The chemicals contained within the packing material undergo a chemical reaction with the airborne pollutant present, producing a color change during the intake of each pump stroke. The concentration of a pollutant is indicated by the length of discoloration on a calibrated scale printed on the detector tube.

- Radiation Meters

  Radiation meters determine the presence and level of radiation. The meters use a gas or solid ion detection media which becomes ionized when radiation is present. The meters are normally calibrated to one probe. Meters that detect alpha, beta, and gamma radiation are available.

- Gold Film (Hydrogen Sulfide and Mercury Vapor) Monitors

  Hydrogen sulfide (H_2S) and Mercury (Hg) monitors operate on the principle that electric resistivity increases across a gold film as a function of H_2S and Hg concentration. The monitors provide rapid and relatively low detection limits for H_2S and Hg in air. After extensive sampling periods or high concentrations of H_2S and Hg, the gold film must be heated to remove contamination and return the monitor to its original sensitivity.

- Infrared Detectors

  Infrared detectors such as the Miniature Infrared Analyzer (MIRAN) use infrared (IR) absorption as a function of specific compounds. MIRAN instruments apply to situations where the contaminants are identified but concentrations are not. MIRAN instruments generally require AC power.

SPECIALIZED ANALYTICAL INSTRUMENTS

The continuous monitors described above provide qualitative measurement of air contaminants. Quantitative measurements in the field can be obtained using more sophisticated instruments, such as portable Gas Chromatographs, to analyze grab samples.

- Direct Air Sampling Portable Gas Chromatographs (GCs)

  Portable GCs use gas chromatography to identify and quantify compounds. The time it takes for a compound to move through a chromatographic column is a function of that specific compound or group of compounds. A trained technician with knowledge of the range of expected concentrations of compounds can utilize a portable GC in the field to analyze grab samples. GCs generally require AC power and shelter to operate. This method is limited by its reliance on a short-term grab sample to be representative of the air quality at a site.

- Remote Optical Sensing

  This technique, also referred to as long-path or open-path monitoring, involves transmitting either an infrared or ultraviolet light beam across a long open path and measuring the absorbance at specific wavelengths. The technique is capable of analyzing any preselected organic or inorganic volatile compound that can be resolved from compounds naturally occurring in ambient air. Current projected removal applications include perimeter monitoring during site cleanups and measurement of emission source strengths during site assessments.

- TAGA Direct Air Sampling Mass Spectrometer/Mass Spectrometer

  The Trace Atmospheric Gas Analyzer (TAGA), which is operated by the U.S. EPA/ERT, is capable of real-time detection of preselected organic compounds at low parts-per-billion concentrations. The instrument has been successfully used by the U.S. EPA/ERT for isolating individual emission plumes and tracking those plumes back to their sources.

APPENDIX B

Air Sampling Equipment and Media/Devices

AIR SAMPLING EQUIPMENT

C High-Volume, Total Suspended Particulate (TSP) Samplers

High-volume TSP samplers collect all suspended particles by drawing air across an 8- by 10-inch glass-quartz filter. The sample rate is adjusted to 40 cubic feet per minute (CFM), or 1134 liters per minute (L/min), and it is held constant by a flow controller over the sample period. The mass of TSPs can be determined by weighing the filter before and after sampling. The composition of the filter varies according to the analytical method and the detection limit required.

C PM-10 Samplers

PM-10 samplers collect particulates with a diameter of 10 microns or less from ambient air. Particulates of this size represent the respirable fraction, and thus are of special significance. PM-10 samplers can be high-volume or low-volume. The high-volume sampler operates in the same manner as the TSP sampler at a constant flow rate of 40 CFM; it draws the sample through a special impactor head which collects particulates of 10 microns or less. The particulate is collected on an 8- by 10-inch filter. The low-volume sampler operates at a rate of approximately 17 L/min. The flow must remain constant through the impactor head to maintain the 10-micron cut-off point. The low-volume PM-10 collects the sample on 37-mm Teflon filters.

C High-Volume PS-1 Samplers

High-volume PS-1 samplers draw a sample through polyurethane foam (PUF) or a combination foam and XAD-2 resin plug, and a glass quartz filter at a rate of 5-10 CFM (144 to 282 L/min). This system is excellent for measuring low concentrations of semivolatiles, PCBs, pesticides, or chlorinated dioxins in ambient air.

C Area Sampling Pumps

These pumps provide flow-rate ranges of 2-20 L/min and have a telescopic sampling mast with the sampling train. Because of the higher volume, this pump is suitable for sampling low concentrations of airborne contaminants (i.e., asbestos sampling). These pumps are also used for metals, pesticides and PAH sampling which require large sample volumes.

C Personal Sampling Pumps

Personal sampling pumps are reliable portable sampling devices that draw air samples through a number of sampling media including resin tubes, impingers, and filters. Flow rates are usually adjustable from 0.1 to 4 L/min (or 0.01 to .75 L/min with a restrictive orifice) and can remain constant for up to 8 hours on one battery charge or continuously with an AC charger/converter.

C Canister Samplers

Evacuated canister sampling systems use the pressure differential between the evacuated canister and ambient pressure to bleed air into the canister. The sample is bled into the canister at a constant rate over the sampling period using a critical orifice, a mechanically compensated regulator, or a mass flow control
device until the canister is near atmospheric pressure.

Pressure canister sampling systems use a pump to push air into the canister. To maintain a higher, more controlled flow, the pump typically controls the pressure differential across a critical orifice at the

inlet of the canister, resulting in a pressurized canister at the completion of sampling.

AIR SAMPLING MEDIA/DEVICES

If possible, before employing a specific sampling method, consult the laboratory that will conduct the analyses. Many of the methods can be modified to provide better results or a wider range of results.

C Summa® Canisters

Summa canisters are highly polished passivated stainless steel cylinders. The Summa polishing process brings chrome and nickel to the surface of the canisters, which results in an inert surface. This surface restricts adsorption or reactions that occur on the canister's inner surface after collection. At the site, the canister is either placed in a sampler to control sample collection rate, or opened to collect a grab sample. Samples can be collected by allowing air to bleed into or be pumped into the canister. U.S. EPA/ERT uses 6-liter Summa canisters for VOC and permanent gas analysis.

C Passive Dosimeters

Passive dosimeters are clip-on vapor monitors (samplers) in which the diffused contaminants are absorbed on specially prepared active surfaces. Industrial hygienists commonly use dosimeters to obtain time-weighted averages or concentrations of chemical vapors, as they can trap over 130 organic compounds. Selective dosimeters have also been developed for a number of chemicals including formaldehyde, ethylene oxide, hydrogen sulfide, mercury vapor, nitrogen dioxide, sulfur dioxide, and ozone. Dosimeters must be sent to a laboratory for analysis.

C Polyurethane Foam (PUF)

PUF is a sorbent used with a glass filter for the collection of semivolatile organic compounds such as pesticides, PCBs, chlorinated dioxins and furans, and PAHs. Fewer artifacts (chemical changes that occur to collected compounds) are produced than with some other solid sorbents. PUF is used with the PS-1 sampler and U.S. EPA Method TO13. PUF can also be used with personal sampling pumps when sampling for PAHs using the Lewis/McCloud method. Breakthrough of the more volatile PCBs and PAHs may occur when using PUF.

C Sampling Bags (Tedlar®)

Sampling bags, like canisters, transport air samples to the laboratory for analysis. Samples are generally pumped into the bags, but sometimes a lung system is used, in which a pump creates a vacuum around the bag in a vacuum box. Then the sample flows from a source into the bag. This method is used for VOCs, fixed gases (CO_2, O_2, and N_2) and methane.

C Impingers

An impinger allows an air sample to be bubbled through a solution, which collects a specific contaminant by either chemical reaction or absorption. For long sampling periods, the impinger may need to be kept in an ice bath to prevent the solution from evaporating during sampling. The sample is drawn through the impinger by using a sampling pump or more elaborate sampling trains with multiple impingers.

C Sorbent Tubes/Cartridges

A variety of sampling media are available in sorbent tubes, which are used primarily for industrial hygiene. A few examples are carbon cartridges, carbon molecular sieves, Tenax tubes and tube containing the XAD-2 polymer. Depending upon the sorbent material, tubes can be analyzed using either a solvent extraction or thermal desorption. The former technique uses standard laboratory equipment and allows for multiple analyses of the same sample. The latter technique requires special, but readily available, laboratory equipment and allows only one analysis per sample. In addition, thermal desorption typically allows for lower detection limits by two or more orders of magnitude. Whenever sorbent tubes are

being used for thermal desorption, they should be certified as "clean" by the laboratory doing the analysis.

Thermally Desorbed Media

During thermal desorption, high-temperature gas streams are used to remove the compounds collected on a sorbent medium. The gas stream is injected and often cryofocused into an analytical instrument, such as a GC, for compound analysis:

C Tenax Tubes

Tenax tubes are made from commercially available polymer (p-phenylene oxide) packed in glass or stainless steel tubes through which air samples are drawn or sometimes pumped. These tubes are used in U.S. EPA Method TO1 and VOST for volatile nonpolar organic, some polar organic, and some of the more volatile semivolatile organics. Tenax is not appropriate for many of the highly volatile organics (with vapor pressure greater than approximately 200 mm Hg).

C Carbonized Polymers

The carbonized molecular sieve (CMS), a carbonized polymer, is a commercially available, carbon sorbent packed in stainless-steel sampling tubes through which air samples are drawn or sometimes pumped. These are used in U.S. EPA Method TO2 for highly volatile nonpolar compounds which have low-breakthrough volumes on other sorbents. When high-thermal desorption temperatures are used with CMS, more variability in analysis may occur than with other sorbents.

C Mixed Sorbent Tubes

Sorbent tubes can contain two type of sorbents. Combining the advantages of each sorbent into one tube increases the possible types of compounds to be sampled. The combination of two sorbents can also reduce the chance that highly volatile compounds will break through the sorbent media. An example of a mixed sorbent tube is the combination of Tenax and charcoal with a carbonized molecular sieve. A potential problem with mixed sorbent tubes is the breakthrough of a compound from an earlier sorbent to a later sorbent from which it cannot be desorbed.

Solvent-Extracted Media

Solvent-extracted media use the principle of chemical extraction to remove compounds collected on a sorbent media. The chemical solvent is injected into an instrument, such as a GC, for analysis of compounds. Examples of solvent-extracted media follow:

C Chemically Treated Silica Gel

Silica gel is a sorbent which can be treated with various chemicals. The chemically treated silica gel can then be used to sample for specific compounds in air. Examples include the DNPH-coated silica gel cartridge used with U.S. EPA Method TO11.

C XAD-2 Polymers

XAD-2 polymers usually are placed in tubes, custom-packed sandwich-style with polyurethane foam, and prepared for use with U.S. EPA Method TO13 or the semi-VOST method. The polymers are used for the collection of semivolatile polar and nonpolar organic compounds. The compounds collected on the XAD-2 polymer are chemically extracted for analysis.

C Charcoal Cartridges

Charcoal cartridges, consisting of primary and backup sections, trap compounds by adsorption. Ambient air is drawn through them so that the backup section verifies that breakthrough of the analytes on the first section did not occur, and the sample collection was therefore quantitative. Quantitative sample collection is evident by the presence of target chemicals on the first charcoal section and the absence on the second section. Next, the adsorbed compounds must be eluted, usually with a solvent extraction, and analyzed by GC with a detector, such as a Mass Spectrometer (MS).

- Tenax Tubes

  Cartridges are used in OSHA and NIOSH methods in a manner similar to charcoal cartridges but typically for less volatile compounds.

Particulate Filters

Particulate filters are used by having a sampling pump pass air through them. The filter collects the particulates present in the air and is then analyzed for particulate mass or chemical or radiological composition. Particulate filters are made from different materials which are described below.

- Mixed Cellulose Ester (MCE)

  MCE is manufactured from mixed esters of cellulose which are a blend of nitro-cellulose and cellulose acetate. MCE filters are used often for particulate sampling.

- Glass Fiber

  Glass fiber is manufactured from glass fibers without a binder. Particulate filters with glass fiber provide high flow rates, wet strength, and high, solid holding capacity. Generally, the filters are used for gravimetric analysis of particulates.

- Polyvinyl Chloride

  Particulate filters with polyvinyl chloride are resistant to concentrated acids and alkalis. Their low moisture pickup and light tare weight make them ideal for gravimetric analysis.

- Teflon

  Teflon is manufactured from polytetrafluorethylene (PTFE). Particulate filters with Teflon are easy to handle and exceptionally durable. Teflon filters are used for metal collection.

- Silver

  Particulate filters manufactured from pure silver have high collection efficiency and uniform pore size. These filters are used for mercury collection and analysis.

- Cellulose

  Particulate filters with cellulose contain less than 0.01% ash. These filters are used to collect particulates.

1.3.4 Surface Water Sampling (USEPA - Environmental Response Team SOPs)

SOP#: 2013
DATE: 11/17/94
REV. #: 0.0

Scope and Application: This SOP is applicable to the collection of representative liquid samples, both aqueous and non-aqueous from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface. These are standard (i.e., typically applicable) operating procedures that may be varied or changed as required, depending on site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report. Mention of trade names or commercial products does not constitute USEPA endorsement or recommendation for use.

Method Summary: Sampling situations vary widely, therefore, no universal sampling procedure can be recommended. However, sampling of both aqueous and non-aqueous liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

- Kemmerer bottle
- Bacon bomb sampler
- Dip sampler
- Direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

Sample Preservation Containers, Handling, and Storage: Once samples have been collected, the following procedure should be followed:

1. Transfer the sample(s) into suitable, labeled sample containers.
2. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
3. Cap the container, place in a Ziploc plastic bag and cool to 4°C.
4. Record all pertinent data in the site logbook and on field data sheets.
5. Complete the chain of custody record.
6. Attach custody seals to cooler prior to shipment.
7. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device.

Interferences and Potential Problems: There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP.
2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area. Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

Equipment/Apparatus: Equipment needed for collection of surface water samples may include (depending on technique chosen):

- Kemmerer bottles
- Bacon bomb sampler
- Dip sampler
- Line and messengers
- Sample bottles/preservatives
- Ziploc bags
- Ice
- Coolers
- Chain of Custody records, custody seals
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Logbook/waterproof pen
- Sample bottle labels

Reagents: Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be preserved.

Procedures: *Preparation*:

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry, in accordance with the site specific health and safety plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

Representative Sampling Considerations: In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths. Water quality data should be collected in impoundments, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist that would affect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

Water quality measurements such as dissolved oxygen, pH temperature, conductivity, and oxidation-reduction potential can assist in the interpretation of analytical data and the selection of sampling sites and depths when surface water samples are collected. Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

Sampler Composition: The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

Sample Collection: *Kemmerer Bottle*: A Kemmerer bottle (Figure 3) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows:

1. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the sampling end pieces (upper and lower stoppers) are pulled away from the sampling tube (body), allowing the substance to be sampled to pass through this tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.
3. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.

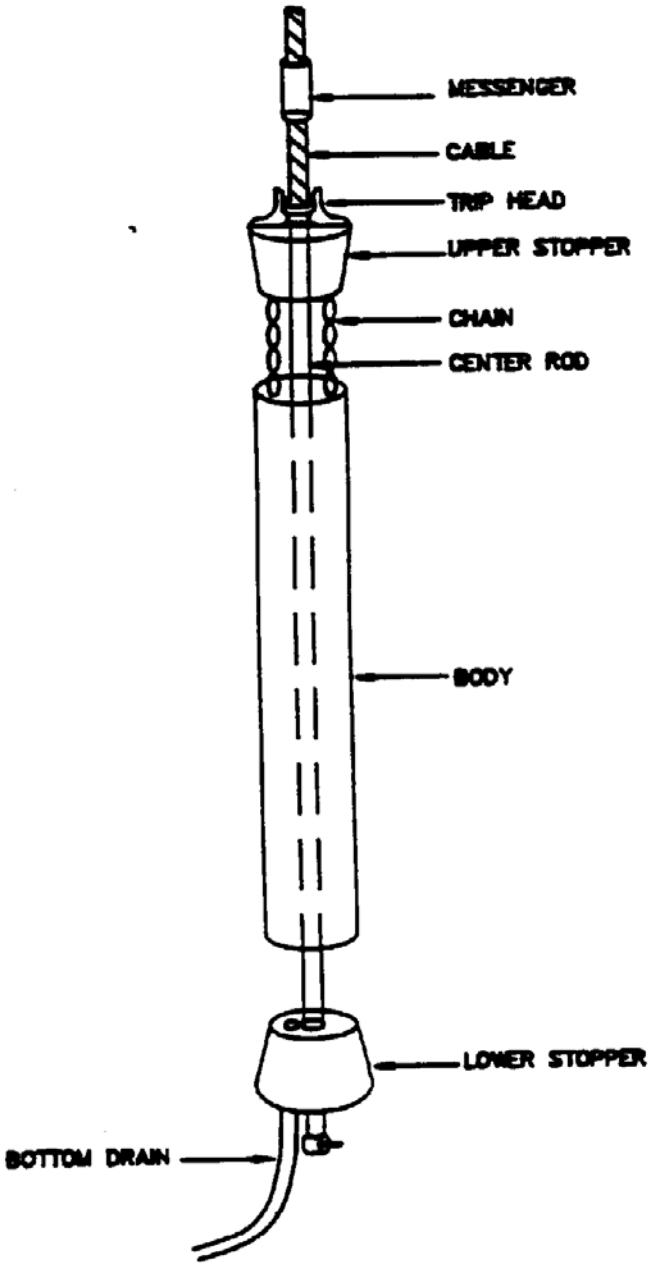


Figure 3. Kemmerer Bottle.

4. Retrieve the sampler and discharge from the bottom drain from the first 10-20 mL to clear any potential contamination of the valve. Transfer the sample to the appropriate sample container.

Bacon Bomb Sampler: A bacon bomb sampler (Figure 4) may be used in situations similar to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut. This will allow the sampler to fill.
2. Release the trigger line and retrieve the sampler.
3. Transfer the sample to the appropriate sample container by pulling up on the trigger.

Dip Sampler: A dip sampler (Figure 5) is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample by dipping the sampler into the substance.
3. Retrieve the sampler and transfer the sample to the appropriate sample container.

Direct Method: For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples from the surface directly into the sample bottle. This method is not to be used for sampling lagoons or other impoundments where contact with contaminants is a concern. Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake. When using the direct method, do not use prepreserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

Calculations: This section is not applicable to this SOP.

QA/QC: There are no specific QA activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

Data Validation: This section is not applicable to this SOP.

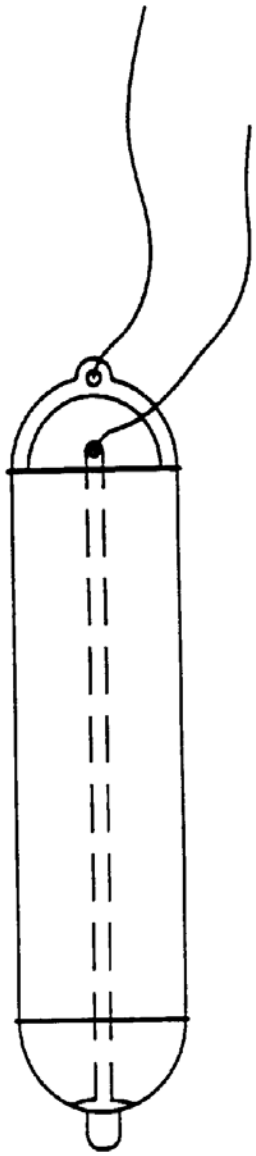


Figure 4. Bacon Bomb Sampler.

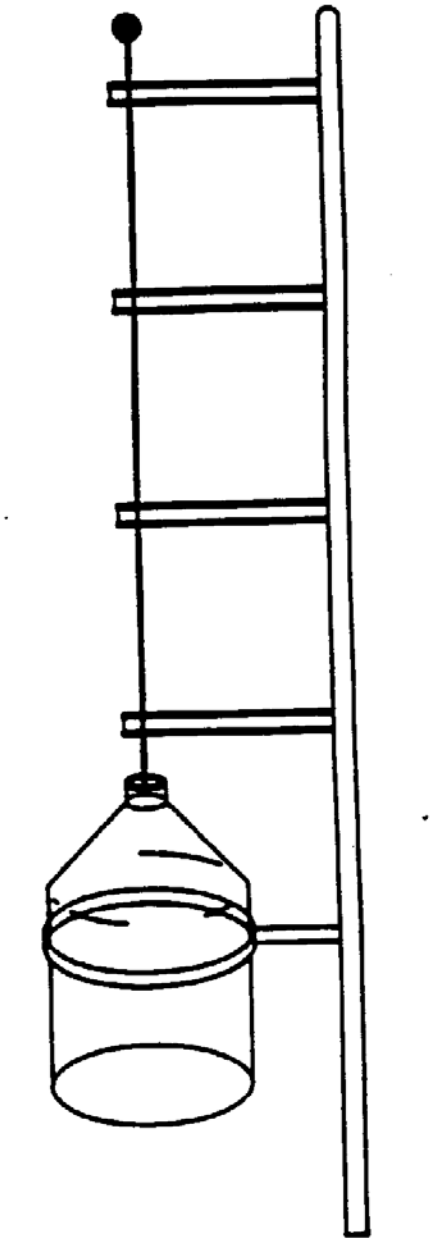


Figure 5. Dip Sampler

Health and Safety: When working with potentially hazardous materials, follow USEPA, OSHA, and corporate health and safety procedures. More specifically, when sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate precautions must be taken to ensure the safety of sampling personnel. The sampling team members collecting the samples should not get too close to the edge of the impoundment, where bank failure may cause them to lose their balance. The persons performing the samplings should be on a lifeline and be wearing adequate protective equipment. When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures should be followed.

1.3.5 Groundwater Well Sampling (USEPA - Environmental Response Team)
SOP#: 2007
DATE: 01/26/95
REV. #: 0.0

Scope and Application: The objective of this SOP is to provide general reference information on sampling of groundwater wells. This guideline is primarily concerned with the collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. These procedures are designed to be used in conjunction with analyses for the most common types of groundwater contaminants (e.g., volatile and semivolatile organic compounds, pesticides, metals, biological parameters). These are standard (i.e., typically applicable) operating procedures that may be varied or changed as required, depending on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and reported. Mention of trade names or commercial products does not constitute USEPA endorsement or recommendation for use.

Method Summary: In order to obtain a representative groundwater sample for chemical analysis it is important to remove stagnant water in the well casing and the water immediately adjacent to the well before collection of the sample. This may be achieved with one of a number of instruments. The most common of these are the bailer, submersible pump, non-contact gas bladder pump, inertia pump and suction pump. At a minimum, three well volumes should be purged, if possible. Equipment must be decontaminated prior to use and between wells. Once purging is completed and the correct laboratory-cleaned sample containers have been prepared, sampling may proceed. Sampling may be conducted with any of the above instruments and need not be the same as the device used for purging. Care should be taken when choosing the sampling device as some will affect the integrity of the sample. Sampling should occur in a progression from the least to most contaminated well, if this information is known. The growing concern over the past several years over low levels of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at part per trillion levels. While the laboratory methods are extremely sensitive, well controlled and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed, and quality assured as the analytical procedures.

Sample Preservation, Containers, Handling, and Storage: The type of analysis for which a sample is being collected determines the type of bottle, preservative, holding time, and filtering requirements. Samples should be collected directly from the sampling device into appropriate laboratory cleaned containers. Check that a Teflon liner is present in the cap, if required. Attach a sample identification label. Complete a field data sheet, a chain of custody form, and record all pertinent data in the site logbook. Samples shall be appropriately preserved, labeled, logged, and placed in a cooler to be maintained at 4°C. Samples must be shipped well before the holding time is up and ideally should be shipped within 24 hours of collection. It is imperative that samples be shipped or delivered daily to the analytical laboratory in order to maximize the time available for the laboratory to perform the analyses. The bottles should be shipped with adequate packing and cooling to ensure that they arrive intact.

Sample retrieval systems suitable for the valid collection of volatile organic samples include positive displacement bladder pumps, gear driven submersible pumps, syringe samplers and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must remain to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible. Treatment of the sample with sodium thiosulfate preservative is required only if there is residual chlorine in the water that could cause free radical chlorination and change the identity of the original contaminants. It should not be used if there is no chlorine in the water. Holding time for volatiles analysis is seven days. It is imperative that the sample be shipped or delivered daily to the analytical laboratory. The bottles must be shipped on their sides to aid in maintaining the airtight seal during shipment; with adequate packing and cooling to ensure that they arrive intact. For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies: field kit for chlorine, preservatives, parafilm, foam sleeves and coolers. Due to the extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross contamination.

Interferences and Potential Problems: *General*: The primary goal in performing groundwater sampling is to obtain a representative sample of the groundwater body. Analysis can be compromised by field personnel in two primary ways: (1) taking an unrepresentative sample, or (2) by incorrect handling of the sample. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilizing trained field personnel.

Purging: In a nonpumping well, there will be little or no vertical mixing of the water, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated, become stagnant, and may lack the contaminants representative of the groundwater. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in an unrepresentative sample. To safeguard against collecting nonrepresentative stagnant water, the following guidelines and techniques should be adhered to during sampling:

1. As a general rule, all monitor wells should be pumped or bailed prior to sampling. Purged water should be containerized onsite or handled as specified in the site specific project plan. Evacuation of a minimum of one volume of water in the well casing, and preferably three to five volumes, is recommended for a representative sample. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical. However, in all cases where the monitoring data are to be used for enforcement actions, evacuation is recommended.
2. When purging with a pump (not a bailer), the pump should be set at the screened interval, or if the well is an open-rock well, it should be set at the same depth the sample will be collected. When sampling a screened well, the sample should also be collected from the same depth the pump was set at.
3. The well should be sampled as soon as possible after purging.
4. Analytical parameters typically dictate whether the sample should be collected through the purging device, or through a separate sampling instrument.
5. For wells that can be pumped or bailed to dryness with the equipment being used, the well should be evacuated and allowed to recover prior to collecting a sample. If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred. If recovery is slow, sample the well upon recovery after one evacuation.
6. A non-representative sample can also result from excessive pre-pumping of the monitoring well. Stratification of the leachate concentration in the groundwater formation may occur, or heavier-

than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point of interest.

Materials: Materials of construction for samplers and evacuation equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon, and glass in areas where concentrations are expected to be at or near the detection limit. The tendency of organics to leach into and out of many materials make the selection of materials critical for trace analyses. The use of plastics, such as PVC or polyethylene, should be avoided when analyzing for organics. However, PVC may be used for evacuation equipment as it will not come in contact with the sample, and in highly contaminated wells, disposable equipment (i.e., polypropylene bailers) may be appropriate to avoid cross-contamination.

Materials of construction (bladders/ pumps, bailers, tubing, etc.) suitable for collecting and handling volatile organic samples should be limited to stainless steel, Teflon, and glass in areas in which detection limit range concentrations are expected. The tendency of organics to leach into and out of many materials, make the selection of materials critical for these trace analyses. The use of plastics should be avoided. There are numerous ways of introducing foreign contaminants into a sample, and these must be avoided by following strict sampling procedures and utilization of trained personnel.

Advantages/Disadvantages of Certain Equipment:

Bailers:

Advantages	Disadvantages
Only practical limitations on size and materials	Time-consuming to flush a large well of stagnant water
Portable	Transfer of sample may cause aeration
Inexpensive, so it can be dedicated and hung in a well, thereby reducing the chances of cross contamination	Stoppers at the bottom of the bailer usually leak thus the bailer must be brought to the surface rapidly
Minimal outgassing of volatile organics while sample is in bailer	If the bailer is allowed to hit the bottom of the well boring, gravel can displace the ball valve not allowing the bailer to hold water
No power source needed	
Readily available	
Removes stagnant water first	
Rapid, simple method for removing small volumes of purge water	

Submersible Pumps:

Advantages	Disadvantages
Portable and can be transported to several wells	Potential for effects on analysis of trace organics
Depending upon the size of the pump and the pumping depths, relatively high pumping rates are possible	Heavy and cumbersome to deal with, particularly in deeper wells

Generally very reliable and does not require priming	Expensive
	Power source needed
	Sediment in water may cause problems with the pumps
	Impractical in low yielding or shallow wells

Non-Contact Gas Bladder Pumps:

Advantages	Disadvantages
Maintains integrity of sample	Difficulty in cleaning, though dedicated tubing and bladder may be used
Easy to use	Only useful to about 30.5 meters
Can sample from discrete locations within the monitor well	Supply of gas for operation, gas bottles and compressors are often difficult to obtain and are cumbersome
	Relatively low pumping rates
	Requires air compressor or pressurized gas source and control box

Suction Pumps:

Advantages	Disadvantages
Portable, inexpensive, and readily available	Restricted to areas with water levels within
	Vacuum can cause loss of dissolved gasses
	Pump must be primed and vacuum is often pumping approximately 6 to 8 meters of the ground surface and volatile organics difficult to maintain during initial stages of pumping

Inertia Pumps

Advantages	Disadvantages
Portable, inexpensive, and readily available	Restricted to areas with water levels within these manual pumps diameter wells approximately 21 meters of the ground surface
Offers a rapid method for purging relatively shallow wells	May be time consuming to purge wells
	Labor intensive

WaTerra pumps are only effective in 51 millimeters

Equipment Apparatus: *Equipment Checklist*:

General

- Water level indicator
- Electric sounder
- Steel tape
- Transducer
- Reflection sounder
- Airline
- Depth sounder
- Appropriate keys for well cap locks
- Steel brush
- Hnu or ova (whichever is most appropriate)
- Logbook
- Calculator
- Field data sheets and samples labels
- Chain of custody records and seals
- Sample containers
- Engineer's rule
- Sharp knife (locking blade)
- Tool box (to include at least: screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
- Leather work gloves
- Appropriate health and safety gear
- Plastic sheeting
- Shipping containers
- Packing materials
- Bolt cutters
- Ziploc plastic bags
- Containers for evacuation liquids
- Decontamination solutions
- Tap water
- Non phosphate soap
- Several brushes
- Pails or tubs
- Aluminum foil
- Garden sprayer
- Preservatives
- Distilled or deionized water
- Fire extinguisher (if using a generator for your power source)

Bailers

- Clean, decontaminated bailers of appropriate size and construction material
- Nylon line, enough to dedicate to each well
- Teflon-coated bailer wire
- Sharp knife

- Aluminum foil (to wrap clean bailers)
- Five gallon bucket

Submersible Pump

- Pump(s)
- Generator (110, 120, or 240 volt) or 12 volt battery if inaccessible to field vehicle – amp meter is useful
- 25.5 mm black PVC coil tubing - enough to dedicate to each well
- Hose clamps
- Safety cable
- Tool box supplement
- Pipe wrenches
- Wire strippers
- Electrical tape
- Heat shrink
- Hose connectors
- Teflon tape
- Winch, pulley or hoist
- Gasoline for generator/gas can
- Flow meter with gate valve
- 25.5 mm nipples and various plumbing (i.e., pipe connectors)
- Control box (if necessary)

Non-Gas Contact Bladder Pump

- Non-gas contact bladder pump
- Compressor or nitrogen gas tank
- Batteries and charger
- Teflon tubing - enough to dedicate to each well
- Swagelock fitting
- Toolbox supplements - same as submersible pump
- Control box (if necessary)

Suction Pump

- Pump
- 25.5 mm black PVC coil tubing - enough to dedicate to each well
- Gasoline - if required
- Toolbox
- Plumbing fittings
- Flow meter with gate valve

Inertia Pump

- Pump assembly (WaTerra pump, piston pump)
- Five gallon bucket

Reagents: Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

Procedure: *Preparation*:

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed (i.e, diameter and depth of wells to be sampled).
2. Obtain necessary sampling and monitoring equipment, appropriate to type of contaminant being investigated. For collection of volatile organic samples, refer to the work plan to ensure that 40 mL glass sample vials with Teflon lined septa are ordered and in sufficient numbers. Check sampling supplies: field kit for chlorine, preservatives, parafilm, foam sleeves, and coolers. Due to extreme trace levels at which volatile organics are detectable, cross contamination and introduction of contaminants must be avoided. Trip blanks are incorporated into the shipment package to provide a check against cross-contamination.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific health and safety plan.
6. Identify and mark all sampling locations.

Field Preparation:

1. Start at the least contaminated well, if known.
2. Lay plastic sheeting around the well to minimize likelihood of contamination of equipment from soil adjacent to the well.
3. Remove locking well cap, note location, time of day, and date in field notebook or appropriate log form.
4. Remove well casing cap.
5. Screen headspace of well with an appropriate monitoring instrument to determine the presence of volatile organic compounds and record in site logbook.
6. Lower water level measuring device or equivalent (i.e., permanently installed transducers or airline) into well until water surface is encountered.
7. Measure distance from water surface to reference measuring point on well casing or protective barrier post and record in site logbook. Alternatively, if no reference point, note that water level measurement is from top of steel casing, top of PVC riser pipe, from ground surface, or some other position on the well head. If floating organics are of concern, this can be determined by measuring the water level with an oil/water interface probe that measures floating organics.
8. Measure total depth of well (at least twice to confirm measurement) and record in site logbook or on field data sheet.
9. Calculate the volume of water in the well and the volume to be purged using the calculations near the end of this SOP.
10. Select the appropriate purging and sampling equipment.
11. If residual chlorine is suspected, use the Hach Field Test Kit for chlorine to determine if there is residual chlorine in the water to be sampled. If there is, treat the sample vial with a crystal of sodium thiosulfate prior to sample collection.

Purging: The amount of flushing a well receives prior to sample collection depends on the intent of the monitoring program and the hydrogeologic conditions. Programs where overall quality determination of water resources are involved may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume can be determined prior to sampling so that the sample is collected after a known volume of the water is evacuated from the aquifer, or the well can be pumped until the stabilization of parameters such as temperature, electrical conductance, pH, or turbidity has occurred.

However, monitoring to define a contaminant plume requires a representative sample of a small volume of the aquifer. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce flow from surrounding areas. Generally, three well volumes are considered effective, or calculations can be made to determine, on the basis of the aquifer parameters and well dimensions, the appropriate volume to remove prior to sampling.

During purging, water level measurements may be taken regularly at 15-30 second intervals. These data may be used to compute aquifer transmissivity and other hydraulic characteristics. The following well evacuation devices are most commonly used. Other evacuation devices are available, but have been omitted in this discussion due to their limited use.

Bailers: Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. The three most common types of bailer are PVC, Teflon, and stainless steel.

This manual method of purging is best suited to shallow or narrow diameter wells. For deep, larger diameter wells which require evacuation of large volumes of water, other mechanical devices may be more appropriate.

Operation: Equipment needed will include a clean decontaminated bailer, Teflon or nylon line, a sharp knife, and plastic sheeting.

1. Determine the volume of water to be purged as described in the calculations near the end of this SOP.
2. Lay plastic sheeting around the well to prevent contamination of the bailer line with. foreign materials.
3. Attach the line to the bailer and slowly lower until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile organic contaminants.
4. Pull bailer out ensuring that the line either falls onto a clean area of plastic sheeting or never touches the ground.
5. Empty the bailer into a pail until full to determine the number of bails necessary to achieve the required purge volume.
6. Thereafter, pour the water into a container and dispose of purge waters as specified in the site-specific sampling plan.

Submersible Pumps: The use of submersible pumps for sample collection is permissible provided they are constructed of suitable non-contaminating materials. The chief drawback, however, is the difficulty avoiding cross-contamination between wells. Although some units can be disassembled easily to allow surfaces contacted by contaminants to be cleaned, field decontamination may be difficult and require solvents that can affect sample analysis. The use of submersible pumps in multiple well-sampling programs, therefore, should be carefully considered against other sampling mechanisms (bailers, bladder pumps). In most cases, a submersible pump, however, may be the only practical sampling device for extremely deep wells (greater than 91 meters of water). Under those conditions, dedicated pump systems should be installed to eliminate the potential for cross-contamination. A sample can be collected by bailer after purging.

Submersible pumps generally use one of two types of power supplies, either electric or compressed gas or air. Electric powered pumps can run off a 12 volt DC rechargeable battery, or a 110 or 220 volt AC power supply. Those units powered by compressed air normally use a small electric or gas-powered air

compressor. They may also utilize compressed gas (i.e., nitrogen) from bottles. Different size pumps are available for different depth or diameter monitoring wells.

Operation:

1. Determine the volume of water to be purged as described in near the end of this SOP.
2. Lay plastic sheeting around the well to prevent contamination of pumps, hoses or lines with foreign materials.
3. Assemble pump, hoses and safety cable, and lower the pump into the well. Make sure the pump is deep enough so all the water is not evacuated. (Running the pump without water may cause damage.)
4. Attach flow meter to the outlet hose to measure the volume of water purged.
5. Use a ground fault circuit interrupter (GFCI) or ground the generator to avoid possible electric shock.
6. Attach power supply, and purge the well until the specified volume of water has been evacuated (or until field parameters, such as temperature, pH, conductivity, etc., have stabilized). Do not allow the pump to run dry. If the pumping rate exceeds the well recharge rate, lower the pump further into the well, and continue pumping.
7. Collect and dispose of purge waters as specified in the site-specific sampling plan.

Non-Contact Gas Bladder Pumps: For this procedure, an all stainless-steel and Teflon Middleburg-squeeze bladder pump (e.g., IEA, TIMCO, Well Wizard, Geoguard, and others) is used to provide the least amount of material interference to the sample (Barcelona, 1985). Water comes into contact with the inside of the bladder (Teflon) and the sample tubing (also Teflon) which may be dedicated to each well. Some wells may have permanently installed bladder pumps, (i.e., Well Wizard, Geoguard), that will be used to sample for all parameters.

Operation:

1. Assemble Teflon tubing, pump, and charged control box.
2. Procedure for purging with a bladder pump is the same as for a submersible pump.
3. Be sure to adjust flow rate to prevent violent jolting of the hose as sample is drawn in.

Suction Pumps: There are many different types of suction pumps. They include: centrifugal, peristaltic, and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze the flexible tubing thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. Peristaltic pumps, however, require a power source.

Operation:

1. Assembly of the pump, tubing, and power source if necessary.
2. Procedure for purging with a suction pump is exactly the same as for a submersible pump.

Inertia Pumps: Inertia pumps such as the WaTerra pump and piston pump, are manually operated. They are most appropriate to use when wells are too deep to bail by hand, or too shallow or narrow (or inaccessible) to warrant an automatic (submersible, etc.) pump. These pumps are made of plastic and may be either decontaminated or discarded.

Operation:

1. Determine the volume of water to be purged as described near the end of this SOP.

2. Lay plastic sheeting around the well to prevent contamination of pumps or hoses with foreign materials.
3. Assemble pump and lower to the appropriate depth in the well.
4. Begin pumping manually, discharging water into a 5 gallon bucket (or other graduated vessel). Purge until specified volume of water has been evacuated (or until field parameters such as temperature, pH, conductivity, etc. have stabilized).
5. Collect and dispose of purge waters as specified in the site specific project plan.

Sampling: Sample withdrawal methods require the use of pumps, compressed air, bailers, and samplers. Ideally, purging and sample withdrawal equipment should be completely inert, economical to manufacture, easily cleaned, sterilized, reusable, able to operate at remote sites in the absence of power resources, and capable of delivering variable rates for sample collection. There are several factors to take into consideration when choosing a sampling device. Care should be taken when reviewing the advantages or disadvantages of any one device. It may be appropriate to use a different device to sample than that which was used to purge. The most common example of this is the use of a submersible pump to purge and a bailer to sample.

Bailers: The positive-displacement volatile sampling bailer is perhaps the most appropriate for collection of water samples for volatile analysis. Other bailer types (messenger, bottom fill, etc.) are less desirable, but may be mandated by cost and site conditions.

Operation:

1. Surround the monitor well with clean plastic sheeting. If using the GPI bailer, insert a vial into the claim and assemble the unit.
2. Attach a line to a clean decontaminated bailer.
3. Lower the bailer slowly and gently into the well, taking care not to shake the casing sides or to splash the bailer into the water. Stop lowering at a point adjacent to the screen.
4. Allow bailer to fill and then slowly and gently retrieve the bailer from the well avoiding contact with the casing, so as not to knock flakes of rust or other foreign materials into the bailer. If using the GPI bailer for collecting volatile organic samples, once at the surface, remove the bailer from and remove the vial. Begin slowly pouring from the bailer, and collect the duplicate the cable. Carefully open the GPI bailer unit samples from the midstream sample.
5. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated.
6. Begin slowly pouring from the bailer.
7. Filter and preserve samples as required by sampling plan.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the well cap.
10. Log all samples in the site logbook and on field data sheets and label all samples.
11. Package samples and complete necessary paperwork.
12. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

Submersible Pumps: Although it is recommended that samples not be collected with a submersible pump for the reasons stated earlier, there are some situations where they may be used.

Operation:

1. Allow the monitor well to recharge after purging, keeping the pump just above screened section.

2. Attach gate valve to hose (if not already fitted), and reduce flow of water to a manageable sampling rate.
3. Assemble the appropriate bottles.
4. If no gate valve is available, run the water down the side of a clean jar and fill the sample bottles from the jar.
5. Cap the sample container tightly and place prelabeled sample container in a carrier.
6. Replace the well cap.
7. Log all samples in the site logbook and on the field data sheets and label all samples.
8. Package samples and complete necessary paperwork.
9. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
10. Upon completion, remove pump and assembly and fully decontaminate prior to setting into the next sample well. Dedicate the tubing to the hole.

Non-Contact Gas Bladder Pumps: The use of a non-contact gas positive displacement bladder pump is often mandated by the use of dedicated pumps installed in wells. These pumps are also suitable for shallow (less than 30.5 meters) wells. They are somewhat difficult to clean, but may be used with dedicated sample tubing to avoid cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates making them ideal for both purging and sampling.

Barcelona (1984) and Nielsen (1985) report that the non-contact gas positive displacement pumps cause the least amount of alteration in sample integrity as compared to other sample retrieval methods.

Operation:

1. Allow well to recharge after purging.
2. Assemble the appropriate bottles.
3. Turn pump on, increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.
4. Cap the sample container tightly and place prelabeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to analytical laboratory.
9. On completion, remove the tubing from the well and either replace the Teflon tubing and bladder with new dedicated tubing and bladder or rigorously decontaminate the existing materials.
10. Nonfiltered samples shall be collected directly from the outlet tubing into the sample bottle.
11. For filtered samples, connect the pump outlet tubing directly to the filter unit. The pump pressure should remain decreased so that the pressure build up on the filter does not blow out the pump bladder or displace the filter. For the Geotech barrel filter, no actual connections are necessary so this is not a concern.

Suction Pumps: In view of the limitations of these type pumps, they are not recommended for sampling purposes.

Inertia Pumps: Inertia pumps may be used to collect samples. It is more common, however, to purge with these pumps and sample with a bailer.

Operation:

1. Following well evacuation, allow the well to recharge.
2. Assemble the appropriate bottles.
3. Since these pumps are manually operated, the flow rate may be regulated by the sampler. The sample may be discharged from the pump outlet directly into the appropriate sample container.
4. Cap the sample container tightly and place prelabeled sample container in a carrier.
5. Replace the well cap.
6. Log all samples in the site logbook and on field data sheets and label all samples.
7. Package samples and complete necessary paperwork.
8. Transport sample to decontamination zone for preparation for transport to the analytical laboratory.
9. Upon completion, remove pump and decontaminate or discard, as appropriate.

Sample Retrieval – Syringe: A limited number of commercial syringe type samplers are available (IEA, TIMCO, etc.) and some are homemade devices. These devices are claimed to provide good quality samples for volatile analysis, but are severely limited in sample volume and are specific to sampling for volatiles. Essentially, they are operated with an evacuated chamber that is lowered down the well, and allowed to fill with the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample may then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. Evacuate the syringe if necessary, and lower the sampling device to just below the well screen.
2. Remove the constriction from the device and allow the sample to fill the syringe, apply slight suction as necessary.
3. Bring unit to the surface. If necessary, transfer the sample to vials, as outlined in steps 2 through 7 above.

Filtering: For samples requiring filtering, such as total metals analysis, the filter must be decontaminated prior to and between uses. Filters work by two methods. A barrel filter such as the "Geotech" filter works with a bicycle pump, used to build up positive pressure in the chamber containing the sample which is then forced through the filter paper (minimum size 0.45 μm) into a jar placed underneath. The barrel itself is filled manually from the bailer or directly via the hose of the sampling pump. The pressure must be maintained up 0.0202 kg/mm^2 by periodic pumping.

A vacuum type filter involves two chambers; the upper chamber contains the sample and a filter (minimum size 0.45 μm) divides the chambers. Using a hand pump or a Gilian type pump, air is withdrawn from the lower chamber, creating a vacuum and thus causing the sample to move through the filter into the lower chamber where it is drained into a sample jar. Repeated pumping may be required to drain all the sample into the lower chamber. If preservation of the sample is necessary, this should be done after filtering.

Post Operation: After all samples are collected and preserved, the sampling equipment should be decontaminated prior to sampling another well to prevent cross-contamination of equipment and monitor wells between locations.

1. Decontaminate all equipment.
2. Replace sampling equipment in storage containers.
3. Prepare and transport groundwater samples to the laboratory. Check sample documentation and make sure samples are properly packed for shipment.

Special Considerations for Volatile Organic Analysis (VOA) Sampling: The proper collection of a sample for volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are: positive displacement bladder pumps, gear driven submersible pumps, syringe samplers, and bailers (Barcelona, 1984; Nielsen, 1985). Field conditions and other constraints will limit the choice of appropriate systems. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible.

The following procedures should be followed:

1. Open the vial, set cap in a clean place, and collect the sample during the middle of the cycle. When collecting duplicates, collect both samples at the same time.
2. Fill the vial to just overflowing. Do not rinse the vial, nor excessively overflow it. There should be a convex meniscus on the top of the vial.
3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw down firmly. Do not overtighten and break the cap.
4. Invert the vial and tap gently. Observe vial for at least ten seconds. If an air bubble appears, discard the sample and begin again. It is imperative that no entrapped air is in the sample vial.
5. Immediately place the vial in the protective foam sleeve and place into the cooler, oriented so that it is lying on its side, not straight up.
6. The holding time for VOAs is seven days. Samples should be shipped or delivered to the laboratory daily so as not to exceed the holding time. Ensure that the samples remain at 4°C, but do not allow them to freeze.

Calculations: If it is necessary to calculate the volume of the well, utilize the following equation:

Well volume $nr^2h(cf)$ [Equation 1]:

n = pi
r = radius of monitoring well (meters)
h = height of the water column (meters) [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor (L/m^3) = 1,000 L/m^3
[In this equation, 1,000 L/m^3 is the necessary conversion factor.]

v(L/m) $nr^2(cf)$ [Equation 2]

Monitor well diameters are typically 50.8mm, 76.2mm, 101.6mm, or 152.4mm. Knowing the diameter of the monitor well, there are a number of standard conversion factors which can be used to simplify the equation above.
The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:
n = pi
r = radius of monitoring well (m)
cf = conversion factor (1,000 L/m^3)

For a 50.8mm diameter well, the volume per linear foot can be calculated as follows:
vol/linear meter $nr^2(cf)$ [Equation 3]

3.14 $(0.0254m)^2$ 1,000 L/m^3
2.03 L/m

Remember that if you have a 50.8mm diameter well, you must convert this to the radius in feet to be able to use the equation.

The conversion factors for the common size monitor wells are as follows:

Well diameter (mm)	50.8	76.2	101.6	152.4
Volume (L/m.)	2.027	4.560	8.107	18.24

If you utilize the conversion factors above, the equation should be modified as follows:
Well volume (h)(cf) [Equation 4]

h = height of water column (meters)

cf = the conversion factor calculated from Equation 2

The well volume is typically tripled to determine the volume to be purged.

QA/QC: There are no specific QA activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.
3. The collection of rinsate blanks is recommended to evaluate potential for cross contamination from the purging and/or sampling equipment.
4. Trip blanks are required if analytical parameters include VOAs.

Data Validation: This section is not applicable to this SOP.

Health and Safety: When working with potentially hazardous materials, follow U.S. EPA, OSHA or REAC health and safety guidelines. More specifically, depending upon the site specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the well sampling tasks. Standard safe operating practices should be followed such as minimizing contact with potential contaminants in both the vapor phase and liquid matrix through the use of respirators and disposable clothing.

When working around volatile organic contaminants:

1. Avoid breathing constituents venting from the well.
2. Pre-survey the well head-space with flame ionization/photoionization prior to sampling.
3. If monitoring results indicate organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing.

Physical hazards associated with well sampling:

1. Lifting injuries associated with pump and bailers retrieval; moving equipment.
2. Use of pocket knives for cutting discharge hose.
3. Heat/cold stress as a result of exposure to extreme temperatures and protective clothing.
4. Slip, trip, and fall conditions as a result of pump discharge.
5. Restricted mobility due to the wearing of protective clothing.
6. Electrical shock associated with use of submersible pumps is possible. Use a GFCI or a copper grounding stake to avoid this problem.

1.3.6 Sediment Sampling (USEPA- Environmental Response Team)
SOP#: 2016
DATE: 11/17/94
REV. #: 0.0

Scope and Application: This SOP is applicable to the collection of representative sediment samples. Sediments may be analyzed for biological, chemical, or physical characteristics to determine the following:

- Toxicity
- Biological availability and effects of contaminants
- Benthic biota
- Extent and magnitude of contamination
- Contaminant migration pathways and source
- Fate of contaminants
- Grain size distribution

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. However, if modifications occur, they should be documented in a site or personal logbook and discussed in reports summarizing field activities and analytical results.

For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The aqueous layer may be either static (lakes, ponds, and impoundments) or flowing (rivers and streams).

Mention of trade names or commercial products does not constitute USEPA endorsement or recommendation for use.

Method Summary: Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, and sediment type.

Sediment is collected from beneath an aqueous layer either directly (using a hand held device such as a shovel, trowel, or auger) or indirectly (using a remotely activated device such as an Ekman or Ponar dredge). Following collection, sediment is transferred from the sampling device to a sample container of appropriate size and construction for the analyses requested. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of inert material, homogenized, and transferred to sample containers appropriate for the analyses requested. The homogenization procedure should not be used if sample analysis includes volatile organics; in this case, sediment, or multiple grabs of sediment, should be transferred directly from the sample collection device or homogenization container to the sample container.

Sample Preservation, Containers, Handling, and Storage:

1. Chemical preservation of solids is generally not recommended. Cooling to 4°C is usually the best approach, supplemented by the appropriate holding time for the analyses requested.
2. Wide mouth glass containers with Teflon-lined caps are utilized for sediment samples. The sample volume is a function of the analytical requirements and will be specified in the work plan.

3. If analysis of sediment from a discrete depth or location is desired, sediment is transferred directly from the sampling device to a labeled sample container(s) of appropriate size and construction for the analyses requested. Transfer is accomplished with a stainless steel or plastic lab spoon or equivalent.
4. If composite sampling techniques or multiple grabs are employed, equal portions of sediment from each location are deposited into a stainless steel, plastic, or other appropriate composition (e.g., Teflon) containers. The sediment is homogenized thoroughly to obtain a composite representative of the area sampled. The composite sediment sample is transferred to a labeled container(s) of appropriate size and construction for the analyses requested. Transfer of sediment is accomplished with a stainless steel or plastic lab spoon or equivalent. Samples for volatile organic analysis must be transferred directly from the sample collection device or pooled from multiple areas in the homogenization container prior to mixing. This is done to minimize loss of contaminant due to volatilization during homogenization.
5. All sampling devices should be decontaminated, then wrapped in aluminum foil. The sampling device should remain in this wrapping until it is needed. Each sampling device should be used for only one sample. Disposable sampling devices for sediment are generally impractical due to cost and the large number of sediment samples that may be required. Sampling devices should be cleaned in the field using the decontamination procedure described in the Sampling Equipment Decontamination SOP.

Interferences and Potential Problems: Substrate particle size and organic matter content are a direct consequence of the flow characteristics of a waterbody. Contaminants are more likely to be concentrated in sediments typified by fine particle size and a high organic matter content. This type of sediment is most likely to be collected from depositional zones. In contrast, coarse sediments with low organic matter content do not typically concentrate pollutants and are generally found in erosional zones. The selection of a sampling location can, therefore, greatly influence the analytical results and should be justified and specified in the Work Plan.

Equipment/Apparatus: Equipment needed for collection of sediment samples may include:

- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Stainless steel, plastic, or other appropriate composition bucket
- 4-oz., 8-oz., and 1 liter, wide mouth jars with Teflon-lined lids
- Ziploc plastic bags
- Logbook
- Sample jar labels
- Chain of custody records, field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Spade or shovel
- Spatula
- Scoop
- Trowel

- Bucket auger
- Tube auger
- Extension rods
- "T" handle
- Sediment coring device (tube, drive head, eggshell check value, nosecone, acetate tube, extension rods, "T" handle)
- Ponar dredge
- Ekman dredge
- Nylon rope or steel cable
- Messenger device

Reagents: Reagents are not used for preservation of sediment samples. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP.

Procedures: *Preparation*:

1. Determine the objective(s) and extent of the sampling effort. The sampling methods to be employed, and the types and amounts of equipment and supplies required will be a function of site characteristics and objectives of the study.
2. Obtain the necessary sampling and monitoring equipment.
3. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
4. Decontaminate or pre-clean equipment, and ensure that it is in working order.
5. Perform a general site survey prior to site entry in accordance with the site specific health and safety plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors including flow regime, basin morphometry, sediment characteristics, depth of overlying aqueous layer, contaminant source, and extent and nature of contamination should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

Sample Collection: Selection of a sampling device is most often contingent upon: (1) the depth of water at the sampling location, and (2) the physical characteristics of the sediment to be sampled. The following procedures may be utilized:

Sampling Surface Sediment with a Trowel or Scoop from Beneath a Shallow Aqueous Layer: For the purpose of this method, surface sediment is considered to range from zero to 152.5 millimeters in depth and a shallow aqueous layer is considered to range from zero to 305 millimeters in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, trowels, and scoops. Although this method can be used to collect both unconsolidated/consolidated sediment, it is limited somewhat by the depth and movement of the aqueous layer. Deep and rapidly flowing water render this method less accurate than others discussed below. However, representative samples can be collected with this procedure in shallow sluggish water provided care is demonstrated by the sample team member. A stainless steel or plastic sampling implement will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials; plating is particularly common with garden trowels.

The following procedure will be used to collect sediment with a scoop, shovel, or trowel:

1. Using a decontaminated sampling implement, remove the desired thickness and volume of sediment from the sampling area.

2. Transfer the sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.
3. Surface water should be decanted from the sample or homogenization container prior to sealing or transfer; care should be taken to retain the fine sediment fraction during this procedure.

Sampling Surface Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer: For the purpose of this method, surface sediment is considered to range from zero to 152.5 in depth and a shallow aqueous layer is considered to range from zero to 610 millimeters in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of bucket auger or tube auger, a series of extensions, and a "T" handle (Figure 6). The use of additional extensions in conjunction with a bucket auger can increase the depth of water from which sediment can be collected from 610 millimeters to three meters or more. However, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger or tube auger is driven into the sediment and used to extract a core. The various depths represented by the core are homogenized or a subsample of the core is taken from the appropriate depth.

The following procedure will be used to collect sediment samples with a bucket auger or tube auger:

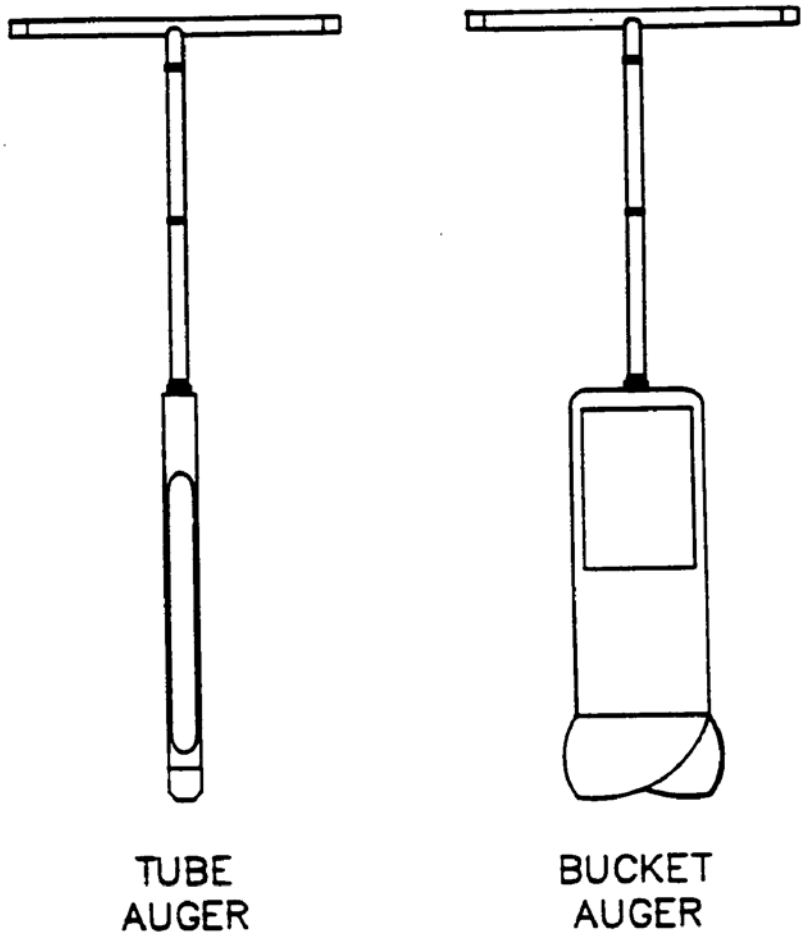


Figure 6. Sampling Augers.

1. An acetate core may be inserted into the bucket auger or tube auger prior to sampling if characteristics of the sediments or waterbody warrant. By using this technique, an intact core can be extracted.
2. Attach the auger head to the required length of extensions, then attach the “T” handle to the upper extension.
3. Clear the area to be sampled of any surface debris.
4. Insert the bucket auger or tube auger into the sediment at a 0 to 20° angle from vertical. This orientation minimizes spillage of the sample from the sampler upon extraction from the sediment and water.
5. Rotate the auger to cut a core of sediment.
6. Slowly withdraw the auger; if using a tube auger, make sure that the slot is facing upward.
7. Transfer the sample or a specified aliquot of sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

Sampling Deep Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer: For the purpose of this method, deep sediment is considered to range from 152.5 to greater than 457 millimeters in depth and a shallow aqueous layer is considered to range from zero to 610 millimeters. Collection of deep sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a bucket auger, a tube auger, a series of extensions and a “T” handle. The use of additional extensions can increase the depth of water from which sediment can be collected from 610 millimeters to 1.5 meters or more. However, water clarity must be high enough to permit the sampler to directly observe the sampling operation. In addition, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger is used to bore a hole to the upper range of the desired sampling depth and then withdrawn. The tube auger is then lowered down the borehole, and driven into the sediment to the lower range of the desired sampling depth. The tube is then withdrawn and the sample recovered from the tube. This method can be used to collect firmly consolidated sediments, but is somewhat limited by the depth of the aqueous layer, and the integrity of the initial borehole.

The following procedure will be used to collect deep sediment samples with a bucket auger and a tube auger:

1. Attach the bucket auger bit to the required lengths of extensions, then attach the “T” handle to the upper extension.
2. Clear the area to be sampled of any surface debris.
3. Begin augering, periodically removing any the auger bucket. Cuttings should be disposed far enough from the sampling area to minimize cross contamination of accumulated sediment (i.e., cuttings) from various depths.
4. After reaching the upper range of the desired depth, slowly and carefully remove bucket auger from the boring.
5. Attach the tube auger bit to the required lengths of extensions, then attach the “T” handle to the upper extension.
6. Carefully lower the tube auger down borehole using care to avoid making contact with the borehole sides and, thus, cross-contaminating the sample. Gradually force the tube auger into sediment to the lower range of the desired sampling depth. Hammering of the tube auger to facilitate coring should be avoided as the vibrations may cause the boring walls to collapse.
7. Remove the tube auger from the borehole, again taking care to avoid contact with the borehole sides and, thus, cross-contaminating the sample.
8. Discard the top of core (approximately 25.5 mm); as this represents material collected by the tube auger before penetration to the layer of concern.

9. Transfer sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

Sampling Surface Sediment with an Ekman or Ponar Dredge from Beneath a Shallow or Deep Aqueous Layer: For the purpose of this method, surface sediment is considered to range from zero to 152.5 millimeters in depth. Collection of surface sediment can be accomplished with a system consisting of a remotely activated device (dredge) and a deployment system. This technique consists of lowering a sampling device (dredge) to the surface of the sediment by use of a rope, cable, or extended handle. The mechanism is activated, and the device entraps sediment in spring loaded or lever operated jaws. An Ekman dredge is a lightweight sediment sampling device with spring activated jaws. It is used to collect moderately consolidated, fine textured sediment. The following procedure will be used for collecting sediment with an Ekman dredge (Figure 7):

1. Attach a sturdy nylon rope or stainless steel cable through the hole on the top of the bracket, or secure the extension handle to the bracket with machine bolts.
2. Attach springs to both sides of the jaws. Fix the jaws so that they are in open position by placing trip cables over the release studs. Ensure that the hinged doors on the dredge top are free to open.
3. Lower the sampler to a point 102 to 152.5 millimeters above the sediment surface.
4. Drop the sampler to the sediment.
5. Trigger the jaw release mechanism by lowering a messenger down the line, or by depressing the button on the upper end of the extension handle.
6. Raise the sampler and slowly decant any free liquid through the top of the sampler. Care should be taken to retain the fine sediment fraction during this procedure.
7. Open the dredge jaws and transfer the sample into a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment grabs until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

A Ponar dredge is a heavyweight sediment sampling device with weighted jaws that are lever or spring activated. It is used to collect consolidated fine to coarse textured sediment. The following procedure will be used for collecting sediment with a Ponar dredge (Figure 8):

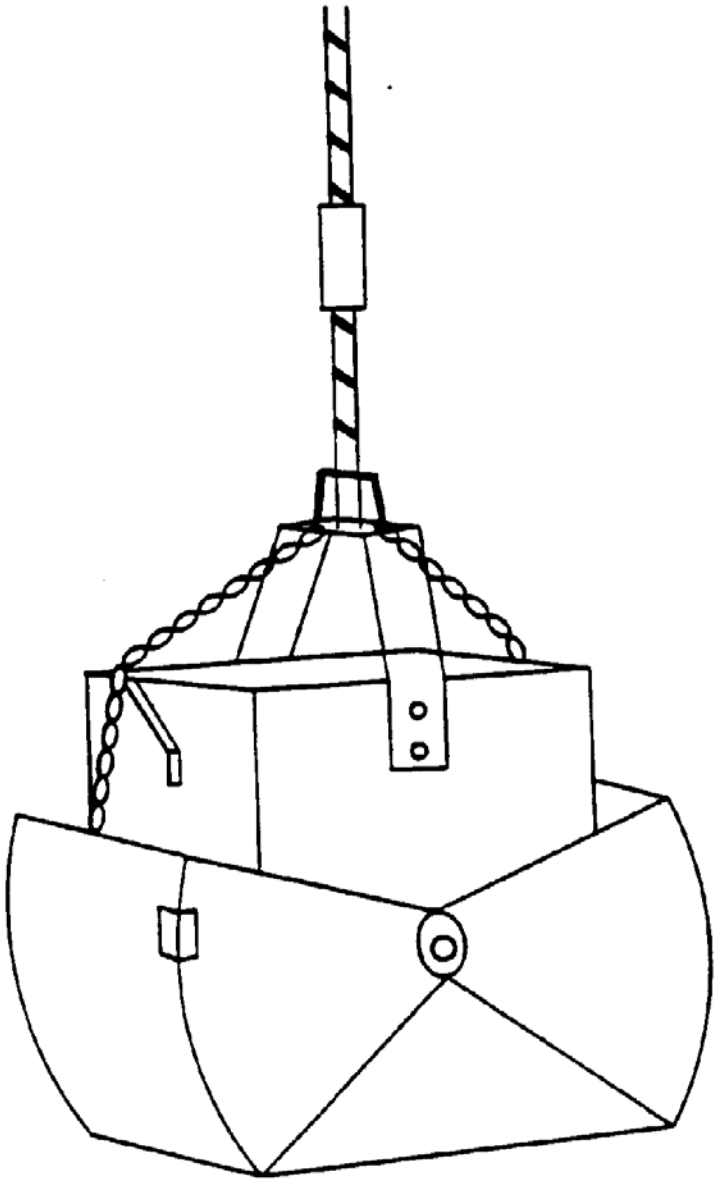


Figure 7. Ekman Dredge.

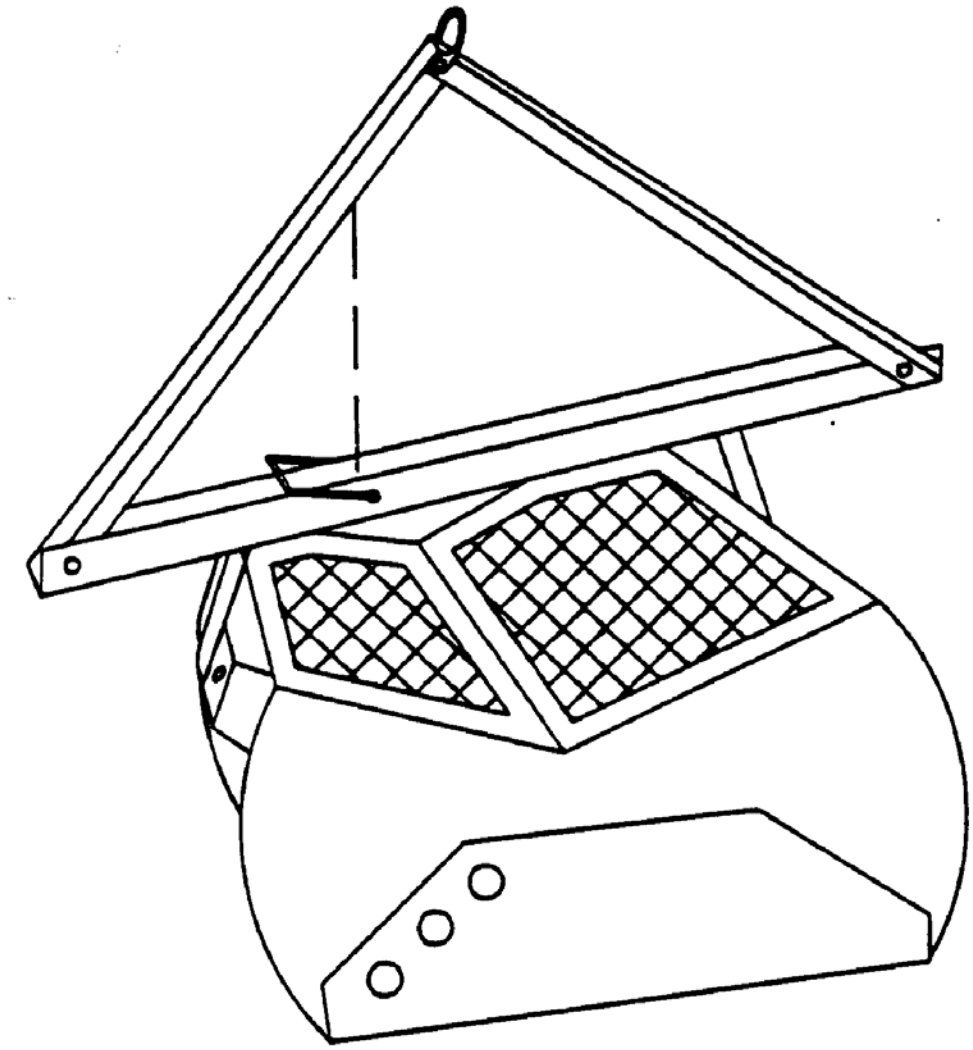


Figure 8. Ponar Dredge.

1. Attach a sturdy nylon rope or steel cable to the ring provided on top of the dredge.
2. Arrange the Ponar dredge with the jaws in the open position, setting the trip bar so the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring loaded pin into the aligned holes in the trip bar.
3. Slowly lower the sampler to a point approximately 51 millimeters above the sediment.
4. Drop the sampler to the sediment. Slack on the line will release the trip bar or spring loaded pin; pull up sharply on the line closing the dredge.
5. Raise the dredge to the surface and slowly decant any free liquid through the screens on top of the dredge. Care should be taken to retain the fine sediment fraction during this operation.
6. Open the dredge and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenized and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

Sampling Subsurface Sediment with a Coring Device from Beneath a Shallow Aqueous Layer: For purposes of this method, subsurface sediment is considered to range from 152.5 to 610 millimeters in depth and a shallow aqueous layer is considered to range from zero to 610 millimeters in depth. Collection of subsurface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a tube sampler, acetate tube, eggshell check valve, nosecone, extensions, and "T" handle, or drivehead. The use of additional extensions can increase the depth of water from which sediment can be collected from 610 millimeters to three meters or more. This sampler may be used with either a drive hammer for firm sediment, or a "T" handle for soft sediment. However, sample handling and manipulation increases in difficulty with increasing depth of water.

The following procedure describes the use of a sample coring device (Figure 9) used to collect subsurface sediments.

1. Assemble the coring device by inserting the acetate core into the sampling tube.
2. Insert the "egg shell" check valve into the lower end of the sampling tube with the convex surface positioned inside the acetate core.
3. Screw the nosecone onto the lower end of the sampling tube, securing the acetate tube and eggshell check valve.
4. Screw the handle onto the upper end of the sampling tube and add extension rods as needed.
5. Place the sampler in a perpendicular position on the sediment to be sampled.
6. If the "T" handle is used, place downward pressure on the device until the desired depth is reached. After the desired depth is reached, rotate the sampler to shear off the core at the bottom. Slowly withdraw the sampler from the sediment and proceed to Step 15.

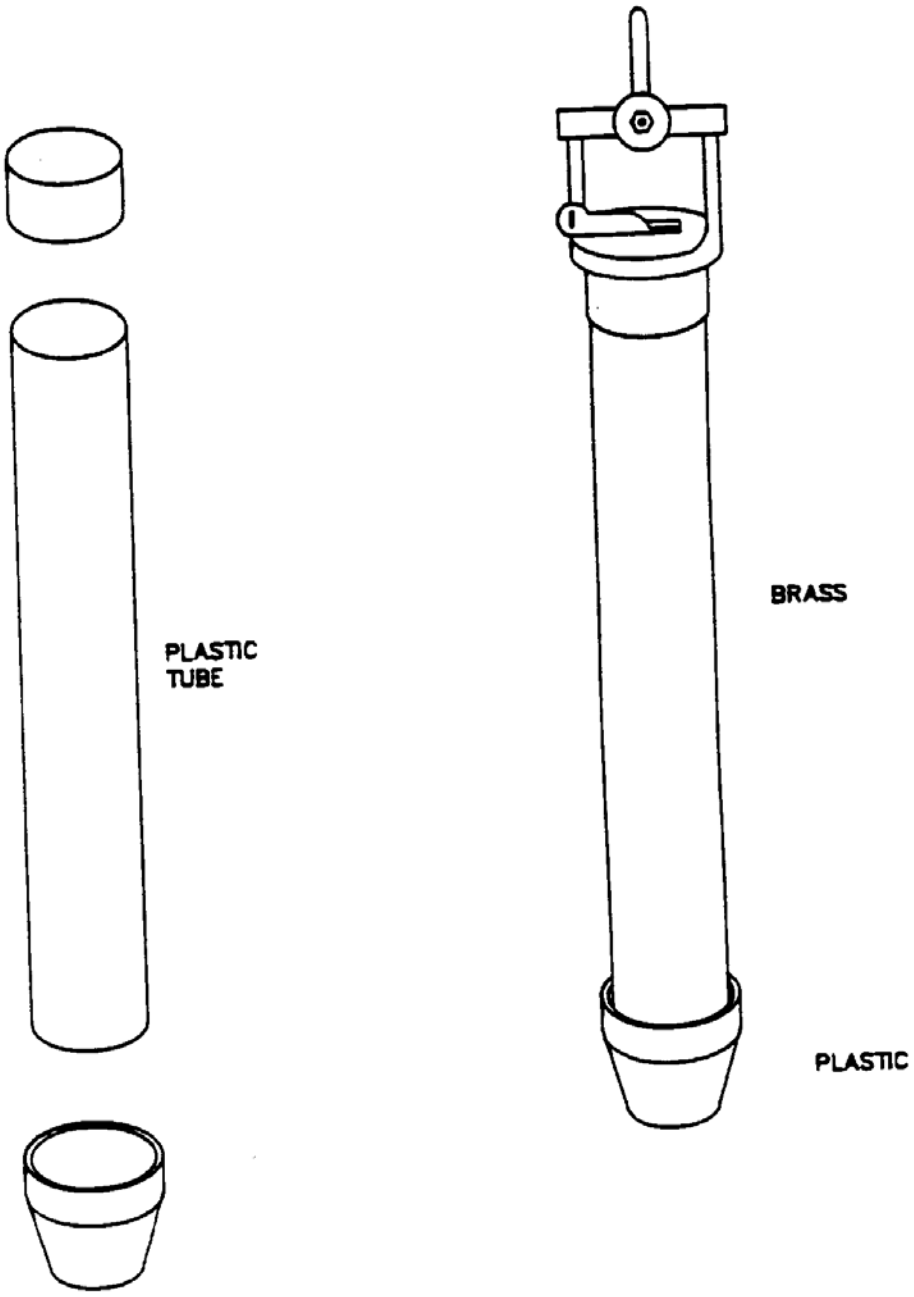


Figure 9. Sample Coring Device.

7. If the drive hammer is selected, insert the tapered handle (drive head) of the drive hammer through the drive head.
8. Drive the sampler into the sediment to the desired depth.
9. Record the length of the tube that penetrated the sample material, and the number of blows required to obtain this depth.
10. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position, the hammer serves as a handle for the sampler.
11. Rotate the sampler to shear off the core at the bottom.
12. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate about 90°.
13. Slowly withdraw the sampler from the sediment. If the drivehead was used, pull the hammer upwards and dislodge the sampler from the sediment.
14. Carefully remove the coring device from the water.
15. Unscrew the nosecone and remove the eggshell check valve.
16. Slide the acetate core out of the sampler tube. Decant surface water, using care to retain the fine sediment fraction. If head space is present in the upper end, a hacksaw may be used to shear the acetate tube off at the sediment surface. The acetate core may then be capped at both ends. Indicate on the acetate tube the appropriate orientation of the sediment core using a waterproof marker. The sample may be used in this fashion, or the contents transferred to a sample or homogenization container.
17. Open the acetate tube and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

Calculations: This section is not applicable to this SOP.

QA/QC: There are no specific QA activities that apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

Data Validation: This section is not applicable to this SOP.

Health and Safety: When working with potentially hazardous materials, follow USEPA/OSHA and corporate health and safety procedures.

More specifically, when sampling sediment from waterbodies, physical hazards must be identified and adequate precautions must be taken to ensure the safety of the sampling team. The team member collecting the sample should not get too close to the edge of the waterbody, where bank failure may cause loss of balance. To prevent this, the person performing the sampling should be on a lifeline, and be wearing adequate protective equipment. If sampling from a vessel is determined to be necessary, appropriate protective measures must be implemented.

1.3.7 Soil Sampling (USEPA- Environmental Response Team)

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Scope and Application: The purpose of this SOP is to describe the procedures for the collection of representative soil samples. Sampling depths are assumed to be those that can be reached without the use of a drill rig, direct-push, or other mechanized equipment (except for a backhoe). Analysis of soil samples may determine whether concentrations of specific pollutants exceed established action levels, or if the concentrations of pollutants present a risk to public health, welfare, or the environment. These are standard (i.e., typically applicable) operating procedures that may be varied or changed as required, depending on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the actual procedures used should be documented and described in an appropriate site report. Mention of trade names or commercial products does not constitute USEPA endorsement or recommendation for use.

Method Summary: Soil samples may be collected using a variety of methods and equipment depending on the depth of the desired sample, the type of sample required (disturbed vs. undisturbed), and the soil type. Near-surface soils may be easily sampled using a spade, trowel, and scoop. Sampling at greater depths may be performed using a hand auger, continuous flight auger, a trier, a split-spoon, or, if required, a backhoe.

Sample Preservation, Containers, Handling, and Storage: Chemical preservation of solids is not generally recommended. Samples should, however, be cooled and protected from sunlight to minimize any potential reaction. The amount of sample to be collected and proper sample container type are discussed in ERT/REAC SOP #2003 Rev. 0.0 08/11/94, Sample Storage, Preservation and Handling.

Interferences and Potential Problems: There are two primary potential problems associated with soil sampling - cross contamination of samples and improper sample collection. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection can involve using contaminated equipment, disturbance of the matrix resulting in compaction of the sample, or inadequate homogenization of the samples where required, resulting in variable, non-representative results.

Equipment: Soil sampling equipment includes the following:

- Maps/plot plan
- Safety equipment, as specified in the site-specific health and safety plan
- Survey equipment or global positioning system (GPS) to locate sampling points
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan
- Appropriate size sample containers
- Ziploc plastic bags
- Logbook
- Labels
- Chain of custody records and custody seals

- Field data sheets and sample labels
- Cooler(s)
- Ice
- Vermiculite
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel(s)
- Continuous flight (screw) auger
- Bucket auger
- Post hole auger
- Extension rods
- T-handle
- Sampling trier
- Thin wall tube sampler
- Split spoons
- Vehimeyer soil sampler outfit
- Tubes
- Points
- Drive head
- Drop hammer
- Puller jack and grip
- Backhoe

Reagents: Reagents are not used for the preservation of soil samples. Decontamination solutions are specified in ERT/REAC SOP #2006 Rev. 0.0 08/11/94, Sampling Equipment Decontamination, and the site specific work plan.

Procedures: *Preparation*:

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site specific health and safety plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors, including extent and nature of contaminant, should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations should be utility-cleared by the property owner or the on-scene-coordinator prior to soil sampling; and utility clearance should always be confirmed before beginning work.

Sample Collection:

Surface Soil Samples: Collection of samples from near-surface soil can be accomplished with tools such as spades, shovels, trowels, and scoops. Surface material is removed to the required depth and a stainless steel or plastic scoop is then used to collect the sample.

This method can be used in most soil types but is limited to sampling at or near the ground surface. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A flat, pointed mason trowel to cut a block of the desired soil is helpful when undisturbed profiles are required. Tools plated with chrome or other materials should not be used. Plating is particularly common with garden implements such as potting trowels. The following procedure is used to collect surface soil samples:

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.
2. Using a pre-cleaned, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area that came in contact with the spade.
3. If volatile organic analysis is to be performed, transfer the sample directly into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval or location into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

Sampling at Depth with Augers and Thin Wall Tube Samplers: This system consists of an auger, or a thin-wall tube sampler, a series of extensions, and a "T" handle (Figure 6). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the auger. If a core sample is to be collected, the auger tip is then replaced with a thin wall tube sampler. The system is then lowered down the borehole, and driven into the soil to the completion depth. The system is withdrawn and the core is collected from the thin wall tube sampler.

Several types of augers are available; these include: bucket type, continuous flight (screw), and post-hole augers. Bucket type augers are better for direct sample recovery because they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights. The continuous flight augers are satisfactory when a composite of the complete soil column is desired. Post-hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy soil and cannot be used below a depth of approximately one meter.

The following procedure is used for collecting soil samples with the auger:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.
2. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). It may be advisable to remove the first 76 to 152.5 millimeters of surface soil for an area approximately 152.5 in radius around the drilling location.
3. Begin augering, periodically removing and depositing accumulated soils onto a plastic sheet spread near the hole. This prevents accidental brushing of loose material back down the borehole when removing the auger or adding drill rods. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the hole. When sampling directly from the auger, collect the sample after the auger is removed from the hole and proceed to Step 10.
5. Remove auger tip from the extension rods and replace with a pre-cleaned thin wall tube sampler. Install the proper cutting tip.
6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the soil. Do not scrape the borehole sides. Avoid hammering the rods as the vibrations may cause the boring walls to collapse.
7. Remove the tube sampler, and unscrew the drill rods.
8. Remove the cutting tip and the core from the device.
9. Discard the top of the core (approximately 25.5mm), as this possibly represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.
10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly, or if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.
11. If another sample is to be collected in the same hole, but at a greater depth, reattach the auger bit to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the auger and tube sampler between samples.
12. Abandon the hole according to applicable state regulations. Generally, shallow holes can simply be backfilled with the removed soil material.

Sampling with a Trier: The system consists of a trier and a "T" handle. The auger is driven into the soil to be sampled and used to extract a core sample from the appropriate depth.

The following procedure is used to collect soil samples with a sampling trier:

1. Insert the trier (Figure 10) into the material to be sampled at a 0° to 45° angle from horizontal. This orientation minimizes the spillage of sample.
2. Rotate the trier once or twice to cut a core of material.
3. Slowly withdraw the trier, making sure that the slot is facing upward.
4. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly, or if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

Sampling at Depth with a Split Spoon (Barrel) Sampler: Split spoon sampling is generally used to collect undisturbed soil cores of 457 or 610 millimeters in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted.

When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D1586-98, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

The following procedures are used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.
2. Place the sampler in a perpendicular position on the sample material.
3. Using a well ring, drive the tube. Do not drive past the bottom of the head piece or compression of the sample will result.

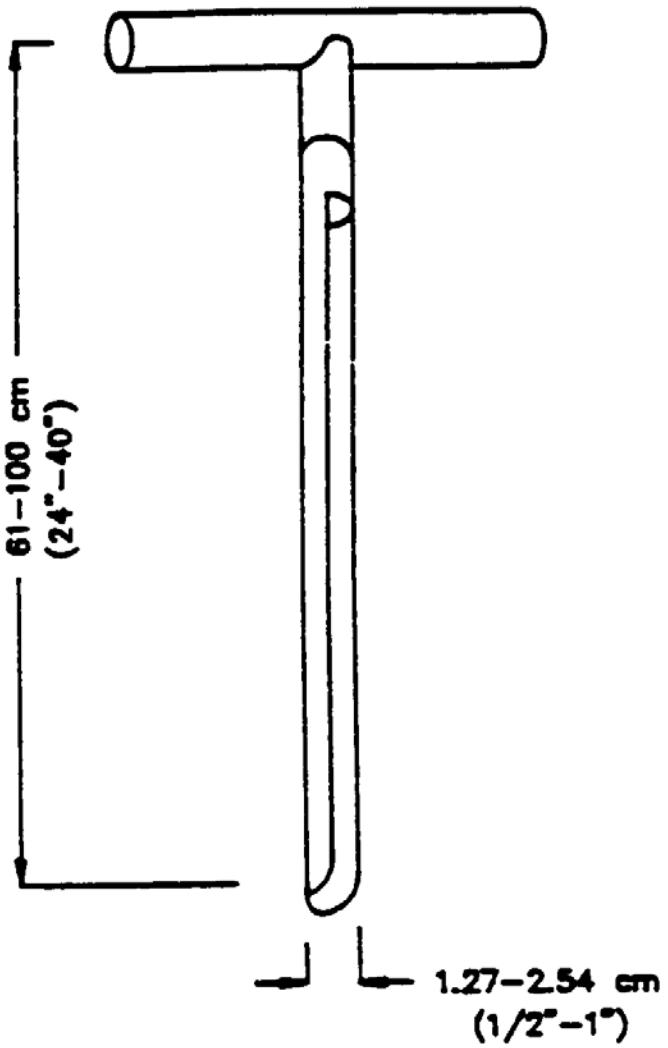


Figure 10. Sampling Trier.

4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.
5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 51 and 89 millimeter diameters. A larger barrel may be necessary to obtain the required sample volume.
6. Without disturbing the core, transfer it to appropriate labeled sample container(s) and seal tightly.

Test Pit/Trench Excavation: A backhoe can be used to remove sections of soil, when detailed examination of soil characteristics are required. This is probably the most expensive sampling method because of the relatively high cost of backhoe operation.

The following procedures are used for collecting soil samples from test pits or trenches:

1. Prior to any excavation with a backhoe, it is important to ensure that all sampling locations are clear of overhead and buried utilities.
2. Review the site specific health and safety plan and ensure that all safety precautions including appropriate monitoring equipment are installed as required.
3. Using the backhoe, excavate a trench approximately one meter wide and approximately 305 millimeters deep below the cleared sampling location. Place excavated soils on plastic sheets. Trenches greater than 1.5 meters deep must be sloped or protected by a shoring system, as required by OSHA regulations.
4. A shovel is used to remove a 25.5 to 51 millimeter layer of soil from the vertical face of the pit where sampling is to be done.
5. Samples are taken using a trowel, scoop, or coring device at the desired intervals. Be sure to scrape the vertical face at the point of sampling to remove any soil that may have fallen from above, and to expose fresh soil for sampling. In many instances, samples can be collected directly from the backhoe bucket.
6. If volatile organic analyses are required, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly, or if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.
7. Abandon the pit or excavation according to applicable state regulations. Generally, shallow excavations can simply be backfilled with the removed soil material.

Calculations: This section is not applicable to this SOP.

QA/QC: There are no specific QA activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

Data Validation: This section is not applicable to this SOP.

Health and Safety: When working with potentially hazardous materials, follow USEPA, OHSA, and corporate health and safety procedures, in addition to the procedures specified in the site specific health and safety plan.

1.3.8 Survey of Environmental Contaminants National Park Service

- Dedicated to improving the health of diverse populations -

1	What park are you reporting on? What is your position at the park? Do you have a WWTP or WTP operation within your park?	 Neither
2	Does your waste go to a municipal waste facility or do you have septic systems or both?	Waste
3	How large a janitorial staff do you have?	
4	Have you converted to “green” products? What products are used?	No
5	Do you have a paint shop? What type of products are used?	No
6	Do you have an autoshop?	No
7	Do you recycle oil or antifreeze?	Neither
8	What is your vehicle fleet size?	
9	Do you use diesel or gas or both? Underground storage tanks? Have the tanks been recently replaced?	Neither No No
10	Do you have a hazardous waste storage area? What types of wastes are stored?	No

11	Have you had a spill, if so what/when/where?	No
12	Do you have a lab? If so what is its primary use? What chemicals do you routinely use. How much waste is generated per year roughly from lab activities?	No
13	Do you have a landfill in close proximity (either historic or currently used)? If so, name the facility.	No
14	Do you have boat operations? If so, estimate the fleet size.	No
15	Do you have marina?	No
16	Does illegal dumping occur within your park? Is one particular area targeted?	No
17	Is there a hazardous waste site within or near your boundaries? If so where and name the site.	No
18	What contaminant threats pose the greatest concern to you from outside the boundaries?	
19	What contaminant threats pose the greatest concern to you from inside the boundaries?	

20	Do you salt your roads, if so what is sand/salt ratio? Is it under cover?	No
21	Are there any historic practices that existed in the park that you would now consider a contaminant problem (i.e., oiling sand roads with used motor oil)?	No
22	Do you fertilize lawns? Do you use pesticides? What types? With what frequency does your use of pesticides need to be supplemented?	No No Infrequently
23	Do you flush wells? If so what is technique?	No
24	Do you use pressure treated wood? Creosote or CCA treated?	No Both
25	Do you do prescribed fires? How many acres per year?	No
26	Have you burned buildings for demolition or training historically? Currently?	No No
27	Do you store batteries for recycling?	No
28	Do you have a photo lab?	No

29	Do you own buildings which are being renovated? (concern associated with Hg, PCB)?	No No
30	Do you have a waste oil furnace?	No
31	Do you ave buildings with asbestos tiles or lead paint?	No
32	Are your pipes covered in asbestos wraps?	No
33	Do you have termites? If so how are they treated?	No
34	Are any of your facilities formerly used Defense Sites?	No
35	Do you know of any unexploded ordnance issues?	No
36	Do you have old transformers?	No
37	How do you deal with refrigerant coolants?	
38	Do you have any incinerators?	No
39	How do you store and dispose of tires?	

Natural Resource Assessment Questions (to establish setting and exposure pathways)		
40	Do you have any T&E species present in your boundaries?	No
41	What do you consider as your most sensitive habitats?	
42	What type of water resources do you have?	
43	What other threats (other than contaminants) exist within your park?	

Please provide a recent copy of your General Management Plan and an old Resource Management Plan (if available).

Submit

Appendix 3: USEPA REMAP Data for Specific Stations in GATE and NOAA Mussel Watch Data for GATE

Note: Some of the data described in this article were produced by the U. S. Environmental Protection Agency through its Environmental Monitoring and Assessment Program (EMAP). Data within this report has also been taken directly from NOAA Status and Trends and has been summarized within tables within this report.

General Notes:

Red highlighted numbers: Concentration above the ERL- Expected Response Low (NOAA SQuiRT)

Blue highlighted numbers: Concentration above the TEL- Threshold Effects Level (NOAA SQuiRT)

Pink highlighted numbers: Concentrations above both the ERL and TEL (NOAA SQuiRT)

Green highlighted numbers: Concentrations above ERL, TEL, and ERM (NOAA SQuiRT)

HRUB SBAF values were not calculated. Sampling years between sediment and tissue were not consistent enough to make calculations.

Conversions:

NOAA SQuiRT table value units: ppb

1ng/g = 1ppb
1µg/g = 1ppm
1,000ppb = 1ppm

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Table 1. USEPA REMAP 1993-1994 NY/NJ Harbor Sediment Data Sets.

Sampling Year		1993										1994			
Station		JB002	JB008	JB012	JB015	JB033	JB039	JB041	JB042	JB043	JB106	JB101	JB103	JB114	JB115
Analyte	UNIT														
Acenaphthene	ppb	0	18	830	36	0	12	22	0	44	31	36	38	4	0
Acenaphthylene	ppb	0	55	590	0	31	35	48	58	30	59	96	57	5.2	0
Silver	ppm	0.2	*2.24*	*4.32*	*2.45*	*1.21*	***0.83***	*1.74*	0.12	***0.76***	*2.73*	*4.67*	*2.31*	0.24	0.03
Silver partial	ppm	1.4	3.6	4.3	8.4	0	2.3	3.1	0	2.4	0	0	0	0	0
Aluminum	ppm	30956	44804	35615	45741	42471	33386	48444	13215	31849	41965	48004	40385	18923	19850
Aldrin	ppb	0	0	5.73	0	0	0	0	0	0	0	0	0	0	0
Alpha-chlordane	ppb	0.17	4.38	13.42	3.49	0.39	0.81	1.06	0.06	0.64	4.68	5.6	6.73	0.2	0.02
Aluminum partial	ppm	1480	8750	1900	10400	5400	3460	7160	404	3420	11600	20600	5560	2240	1870
Anthracene	ppb	0	150	2500	110	57	56	92	44	200	87	200	160	12	0
Arsenic	ppm	2.7	5.85	6.08	*10.28*	5	4.2	*9.72*	0.73	4.64	*12.1*	*14.8*	*9.44*	2.63	2.88
Arsenic partial	ppm	1.4	9.3	1.1	8.9	5.9	6.2	8.6	0.6	3.8	7.2	9.6	0	1.9	0.9
AVS	mmol	0.39	47.79	389.86	243.3	48.13	47.38	0	1.18	0.93	43.98	116.95	237.7	3.06	0.69
Benzo[a]anthracene	ppb	36	260	3200	210	97	100	140	130	220	190	410	380	27	6.8
Benzo[a]pyrene	ppb	31	240	3000	270	120	110	160	110	140	190	370	470	24	5.6
Benzo[e]pyrene	ppb	28	200	3000	270	99	88	140	66	110	110	190	210	19	8.3
Benzo[b,k]fluoranthene	ppb	79	540	7112	640	226	200	328	133	301	520	1100	1290	56	12.3
Benzo[g,h,i]perylene	ppb	21	0	1900	0	69	93	130	62	53	130	290	400	29	0
Biphenyl	ppb	0	17	740	0	15	13	25	0	14	28	31	21	3.2	0
Cadmium	ppm	0.28	*1.63*	*8.79*	*2.36*	0.67	0.42	*0.71*	0.04	0.37	*0.69*	*2.93*	*1.56*	0.13	0
Cadmium partial	ppm	0.16	1.34	1.52	1.38	0.45	0.39	0	0.03	0	1.26	4.32	2.25	0.23	0.45
Total Chlordane	ppb	0.5	11.52	31.58	11.38	1.29	3.06	3.95	0.2	2.06	10.56	17.65	21.55	0.67	0.06
Chrysene	ppb	78	310	4700	320	120	130	180	130	230	230	480	530	31	7.2
Clostridium	#/gm	3200	1500	89000	490	2000	4900	4200	110	1200	2100	35	3900	77	35
Chromium	ppm	30.2	***66.8***	*109.4*	***69.4***	***62.1***	40.3	***76.9***	11.7	39.6	*102*	*114*	***72.7***	34.3	48
Chromium partial	ppm	9	52	15	51	31	22	46	3	21	52	104	20	9	5
Copper	ppm	9.8	*79.69*	*589.2*	*88.66*	*36.96*	***25.01***	*49.24*	3.33	23.48	*81.5*	*175*	*84.8*	6.6	3.7
Copper partial	ppm	7	93	107	84	32	25	50	0	25	59	186	37	7	0
Dibutyltin	ppb	2	8	90	7	3	2	4	1	2	25.5	67	10.9	1.8	1.3
Total DDT	ppb	0.42	9.55	39.69	8.32	1.91	3.32	5.17	0.57	4.44	11.27	20.38	25.32	1.25	0.35
Dibenz[a,h]anthracene	ppb	0	0	0	0	16	20	29	14	14	45	100	0	16	0
Dieldrin	ppb	0.06	*1.2*	*3.47*	0	***0.17***	***0.16***	0	***0.07***	***0.1***	*1.44*	*2.24*	*4.48*	***0.24***	***0.26***
2,6-Dimethylnaphthalene	ppb	13	590	6200	1900	240	230	380	0	200	730	1500	1800	58	0
Endrin	ppb	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Iron	ppm	8028	20137	25686	29076	16450	10805	22346	3532	10414	34800	38240	33940	9120	17680
Iron partial	ppm	3330	20400	5090	26900	12000	8880	17700	1110	8220	19900	35300	10600	3370	3670
Fluoranthene	ppb	46	650	8300	640	190	190	370	140	750	300	870	1100	51	11
Fluorene	ppb	0	38	1500	72	22	23	39	0	93	26	55	66	5.2	0
Heptachlor	ppb	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heptachlor Epoxide	ppb	0	0.21	0	0.19	0	0.07	0.11	0	0.12	0.16	0.26	0.23	0	0.01
Hexachlorobenzene	ppb	0.01	0.1	24.59	0.37	0.1	0.14	0.35	0.01	0.19	0.17	0.1	0.04	0.06	0.02
Mercury	ppm	0.05	*0.35*	*2.15*	*0.38*	*0.34*	*0.41*	*0.48*	0.04	*0.24*	*0.55*	*0.65*	*0.26*	0.08	0.04
Mercury partial	ppm	0.05	0.36	1.54	0.56	0.5	0.29	0.48	0.03	0.26	0.48	0.66	0.34	0.05	0.02

(USEPA 1998)

Table 1. USEPA REMAP 1993-1994 NY/NJ Harbor Sediment Data Sets. (Continued)

Sampling Year		1993										1994			
Station		JB002	JB008	JB012	JB015	JB033	JB039	JB041	JB042	JB043	JB106	JB101	JB103	JB114	JB115
Analyte	UNIT														
Naphthalene	ppb	28	64	1600	84	62	52	71	24	50	95	110	89	0	0
Nickel	ppm	8.17	17.92	180.8	21.27	12.12	11.25	15.92	2.15	11.1	27.7	33.3	25.1	4.3	5.2
Nickel partial	ppm	0	20	10	0	11	0	16	0	8	17	39	0	0	0
o,p, DDD	ppb	0.02	0.58	16.52	0.54	0.11	0.19	0.3	0.05	0.24	0.75	1.11	2.02	0.08	0.02
o,p, DDE	ppb	0.01	0.09	23.17	0.13	0.05	0.09	0.21	0.01	0.14	0.34	0.18	0	0.07	0.02
o,p, DDT	ppb	0.01	0.06	0	0.06	0	0	0.09	0	0.07	0	0	0	0	0
Lead	ppm	17.1	62.7	650.7	77.9	51.6	39.2	74.1	10.2	35.2	97.7	127	76.5	16	7.49
Lead partial	ppm	4.3	69	121	51.9	40	37	73	2.9	35	67	124	91.5	16.6	6
PCB Congener 101	ppb	0.52	4	3.76	4.08	0.89	1.48	2.68	0.16	1.84	2.99	9.25	12.75	0.24	0.01
PCB Congener 105	ppb	0.08	1	0	0.75	0.28	0.35	0.72	0.03	0.38	2.09	3.14	4.76	0.24	0.03
PCB Congener 110/77	ppb	1.02	10.55	0	9.24	1.89	3.39	5.41	0.43	4.53	9.75	34.49	47.47	0.99	0.15
PCB Congener 118	ppb	0.35	4.6	6.83	3.27	0.83	1.59	2.55	0.19	1.87	5.43	12.42	14.12	0.43	0.03
PCB Congener 126	ppb	0	0	0	0	0	0	0	0	0	2.92	5.51	6.48	0	0
PCB Congener 128	ppb	0.06	1.28	0	0.73	0.17	0.44	0.49	0.24	0.7	1.08	2.71	2.2	0	0
PCB Congener 138	ppb	0.7	5.56	0	4.5	0.91	1.45	2.37	0.11	1.81	5.72	14.88	21.74	0.66	0.1
PCB Congener 153	ppb	0.87	8.3	0	5.97	1.21	2.28	3.49	0.18	2.76	14.97	18.23	26.35	0.58	0.1
PCB Congener 179	ppb	0.19	2.07	0	1.4	.	0.36	0.45	.	0.49	38.93	163.51	281.1	0.23	0.12
PCB Congener 18	ppb	0.03	1.29	0	0.86	0.36	0.68	0.83	0	0.39	2.04	5.97	2.8	0.07	0
PCB Congener 180	ppb	0.39	4.59	0	3.78	0.52	0.94	1.63	0.1	1.45	3.03	7.93	18.21	0.27	0.07
PCB Congener 187	ppb	0.14	1.84	0	1.39	0.27	0.48	0.85	0.03	0.65	1.92	4.9	8.74	0.12	0
PCB Congener 195	ppb	0.02	0.4	0	0.32	0.07	0.09	0.22	0.02	0.13	0.44	1.39	0	0.04	0
PCB Congener 206	ppb	0.02	0.48	0	0.29	0.09	0.11	0.21	0	0.21	1.33	0.95	1.81	0.09	0
PCB Congener 209	ppb	0	0.58	0	0.42	0.13	0.19	0.32	0	0.28	0.67	2.46	9.58	0.07	0
PCB Congener 28	ppb	0.17	7.64	26.63	2.4	1.8	3.13	6.35	0.05	3.75	8.09	9.47	11.98	0.63	0.03
PCB Congener 44	ppb	0.1	1.19	0	2.78	0.32	0.94	1.81	0.04	1.05	2.05	2.47	3.05	0.17	0.03
PCB Congener 52	ppb	0.97	5.88	0	9.73	1.62	2.75	5.58	0.15	2.23	5.01	6.99	17.95	0.42	0.03
PCB Congener 66	ppb	0.06	2.47	0	0.99	0.84	1.38	2.68	0.09	1.54	5.98	5.37	15.5	0.4	0.05
PCB Congener 8	ppb	0	0.04	0	0	0.15	0.29	0.75	0	0.32	1.06	0.54	0.09	0.05	0.04
Perylene	ppb	0	85	660	92	46	44	75	20	46	240	470	560	36	6
Phenanthrene	ppb	18	170	7100	320	100	100	200	66	490	140	230	310	37	0
p,p, DDD	ppb	0.13	3.59	0	3.72	0.79	1.39	2.14	0.35	1.61	4.64	8.01	10.51	0.48	0.11
p,p, DDE	ppb	0.22	5.1	0	3.74	0.86	1.46	2.18	0.17	1.62	4.75	10.19	11.65	0.54	0.19
p,p, DDT	ppb	0.01	0.12	0	0.13	0.1	0.19	0.26	0	0.76	0.79	0.9	1.14	0.08	0
Pyrene	ppb	63	520	7600	550	180	190	330	250	490	280	750	930	47	9.9
Antimony	ppm	0.04	0.58	9.03	0.74	0.23	0.15	0.29	0.12	0.34	1.21	1.58	1.28	0.21	1.15
Antimony partial	ppm	0	0	0	0	0	0	0	0	0	1	2	0	0	0
Selinium	ppm	0.21	0.82	1.78	1.31	0.56	0.34	0.79	0.04	0.29	6.89	5.92	2.21	0	0
SEM Cd	ppm	0.1	1.2	4.8	2	0.6	1	0.7	0	0.4	0.73	2.42	1.8	0	0
SEM Cd	mmol	0	0.01	0.04	0.02	0.01	0.01	0.01	0	0	0.01	0.02	0.02	0	0
SEM Cu	ppm	4.3	0.6	0.7	0.2	2.1	9.7	1.5	1.3	8.3	45	0.88	6.29	3.67	0
SEM Cu	mmol	0.07	0.01	0.01	0	0.03	0.15	0.02	0.02	0.13	0.71	0.01	0.1	0.06	0
SEM Hg	ppm	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEM Hg	mmol	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEM Ni	ppm	0.5	3.9	21.7	6.4	3.9	7.2	5.5	0.1	2.6	4.83	3.14	7.83	0.55	0
SEM Ni	mmol	0.01	0.07	0.37	0.11	0.07	0.12	0.09	0	0.05	0.08	0.05	0.13	0.01	0
SEM Pb	ppm	5.1	51	233.6	81.9	45	93.2	70.9	2.6	26.2	82	88	75	10	1
SEM Pb	mmol	0.03	0.25	1.13	0.4	0.22	0.45	0.34	0.01	0.13	0.4	0.43	0.36	0.05	0.01
SEM Zn	ppm	14.7	110.7	849.9	183.5	60.5	114	83.6	6.2	35.4	128	254	214	17	0
SEM Zn	mmol	0.23	1.69	13	2.81	0.93	1.74	1.28	0.1	0.54	1.96	3.89	3.27	0.26	0
Selinium partial	ppm	0	0	0	0	0	0.7	0	0	0	0	0	0	0	0
Silicon	ppm	4E+05	311770	168410	2E+05	3E+05	3E+05	3E+05	4E+05	351751	265748	246870	2E+05	419341	4E+05
Tin	ppm	2.2	5.88	23.46	4.78	5.95	4.06	6.78	0.86	3.35	0.51	1.31	0.91	0.1	0.1
Tributyltin	ppb	9	37	159	12	6	4	6	1	13	110.9	208.8	22.8	6.2	0.8
Tetrabutyltin	ppb	0	0	1	1	0	0	0	0	0	17	35.2	3.7	0.8	1
Trans-Nonachlor	ppb	0.11	2.33	1.18	2.36	0.32	0.73	1.12	0.05	0.59	1.24	3.21	3.6	0.12	0.01
Total Organic Carbon	ppm	2920	7680	15200	8300	5390	11200	11400	2080	15800	54700	65500	84500	13000	7450
2,3,5 Trimethylnaphthalene	ppb	0	0	4900	0	0	0	17	13	0	0	0	0	0	0
Zinc	ppm	30	148	1278	212	98	67	124	11	65	180	344	225	30	15
Zinc partial	ppm	18	159	206	191	68	61	109	7	57	98	256	51	20	3

Table 2. USEPA REMAP 1998 NY/NJ Harbor Sediment Data Sets, Organics Only.

Analyte		JB008	JB033	JB039	JB041	JB042	JB043	JB203	JB212	JB214	JB216	JB217	RB002	RB007	RB012	RB024	RB027	RB032	RB033	RB203	RB210	RB214
HEXACHLOROBENZENE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
ACENAPHTHENE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U
ACENAPHTHYLENE	Concen.	0	0	*50*	0	0	0	0	0	0	0	0	0	*22*	0	*75*	*91*	*140*	0	*39*	*130*	0
	QA	U	U		U	U	U	U	U	U	U	U	U		U				U			U
ALDRIN	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
ALPHA-BHC	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
ALPHA CHLORDANE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	1.3	1.2	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U				U	U
ANTHRACENE	Concen.	0	*75*	*90*	*52*	0	0	0	0	0	0	0	18	24	0	*110*	*130*	*85*	0	*51*	*180*	0
	QA	U				U	U	U	U	U	U	U			U				U			U
BENZ(A)ANTHRACENE	Concen.	260	0	150	110	77	29	250	0	0	0	0	39	76	0	180	200	0	92	110	*270*	0
	QA		U						U	U	U	U			U			U				U
BENZO(A)PYRENE	Concen.	0	0	*190*	*130*	69	0	0	0	*130*	0	0	42	95	0	*250*	*320*	*260*	*110*	*130*	*470*	0
	QA	U	U				U	U	U		U	U			U							U
BENZO(E)PYRENE	Concen.	140	100	75	69	14	0	150	0	60	0	0	24	30	0	120	160	50	35	48	220	0
	QA						U		U		U	U			U							U
BENZO(B)FLUORANTHENE	Concen.	470	230	210	180	60	0	470	0	160	0	0	47	92	0	270	340	240	110	0	500	0
	QA						U		U		U	U			U					U		U
BENZO(K)FLUORANTHENE	Concen.	0	0	78	0	0	0	170	0	64	0	0	18	34	0	95	130	100	0	0	140	0
	QA	U	U		U	U	U		U		U	U			U				U	U		U
BENZO(G,H,I)PERYLENE	Concen.	0	0	91	0	43	0	0	0	0	0	0	25	0	0	140	190	140	67	67	0	0
	QA	U	U		U		U	U	U	U	U	U		U	U						U	U
BETA-BHC	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
BIPHENYL	Concen.	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	34	0
	QA	U		U	U	U	U	U	U	U	U	U	U	U	U	U		U	U	U		U
CHRYSENE	Concen.	*330*	*160*	*180*	*120*	72	16	*330*	0	*110*	0	0	37	73	0	*180*	*210*	*290*	93	*120*	*300*	0
	QA								U		U	U			U							U
CIS-NONACHLOR	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
DELTA-BHC	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
DIBENZO(A,H)ANTHRACENE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
DIELDRIN	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
2,6-DIMETHYLNAPHTHALENE	Concen.	720	360	280	210	0	0	1200	0	140	0	0	7.5	0	0	180	170	0	0	90	270	0
	QA					U	U		U		U	U		U	U			U	U			U
ENDOSULFAN I	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
ENDRIN	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
FLUORANTHENE	Concen.	*660*	*270*	*310*	*250*	68	29	0	0	*200*	0	0	63	100	0	*270*	*370*	*470*	*150*	*230*	*460*	0
	QA	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*If QA = "U" then the concentration was below the detection limit a '0' is entered for the concentration.
*All analyte concentrations are in ug/kg.

Table 2. USEPA REMAP 1998 NY/NJ Harbor Sediment Data Sets, Organics Only. (Continued)

Analyte		JB008	JB033	JB039	JB041	JB042	JB043	JB203	JB212	JB214	JB216	JB217	RB002	RB007	RB012	RB024	RB027	RB032	RB033	RB203	RB210	RB214
FLUORENE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
GAMMA CHLORDANE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
HEPTACHLOR	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
HEPTACHLOR EPOXIDE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
INDENO(1,2,3-C,D)PYRENE	Concen.	0	0	0	0	0	0	0	0	85	0	0	28	0	0	0	0	0	0	81	0	0
	QA	U	U	U	U	U	U	U	U		U	U		U	U	U	U	U	U		U	U
GAMMA-BHC	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
1-METHYLNAPTHALENE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U
2-METHYLNAPHTHALENE	Concen.	44	0	31	0	8	0	0	0	0	0	0	0	7.2	0	48	63	0	0	0	85	0
	QA		U		U		U	U	U	U	U	U	U		U			U	U	U		U
1-METHYLPHENANTHRENE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
MIREX	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U		U	U	U	U	U	U
METHOXYCHLOR	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
NAPHTHALENE	Concen.	70	67	54	43	0	0	80	0	0	0	0	0	0	0	92	100	0	47	0	130	0
	QA					U	U		U	U	U	U	U	U	U			U		U		U
O,P'-DDD	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
O,P'-DDE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
O,P'-DDT	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
OXYCHLORDANE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
PERYLENE	Concen.	220	130	110	76	36	6.4	240	0	86	0	0	25	51	0	140	190	130	58	86	270	0
	QA								U		U	U			U							U
PHENANTHRENE	Concen.	280	150	150	120	0	0	250	0	110	0	0	41	47	0	190	220	110	72	110	240	0
	QA					U	U		U		U	U			U							U
P,P'-DDD	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.6	6.9	0	0	3.4	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U			U	U		U	U
P,P'-DDE	Concen.	6.5	6.1	3.7	0	0	1.3	0	0	0	1.8	1.5	1.1	2.2	1	7.4	7.4	0	0	4.5	7.9	0
	QA				U	U		U	U	U								U	U			U
P,P'-DDT	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
PYRENE	Concen.	540	240	290	200	130	36	290	0	190	0	0	68	110	0	290	340	620	150	210	480	0
	QA								U		U	U			U							U
TRANS-NONACHLOR	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
2,3,5-TRIMETHYLNAPHTHALENE	Concen.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	QA	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U

(USEPA 2003)

Table 3. Dioxins and Furans Sediment Chemistry Data for Summer 1998.

*If the concentration = 0 then a QA code of "U" is applicable and means the analyte was below the detection limit; a '0' is entered for the concentration.
* If the concentration = 0 then units = ug/kg; otherwise units = pg/g.

Analyte	JB008	JB033	JB039	JB041	JB042	JB043	JB203	JB212	JB214	JB216	JB217	RB002	RB007	RB012	RB024	RB027	RB032	RB033	RB203	RB210	RB214
1,2,3,4,7,8-HXCDD	0	0	0	0	0	0	0	0	0	0	0	0.31	0.35	0	5.35	5.23	0	0	0	0	0
1,2,3,4,7,8-HXCDF	0	0	0	5.05	0	0	0	0	0	1.09	0	0.88	1.37	0	16.67	15.88	0	7.07	0	1.06	0
1,2,3,6,7,8-HXCDD	0	0	0	0	0	0	0	0	0	2.1	0	1.62	1.75	0	26.37	30.16	0	13.36	15.07	1.85	0
1,2,3,6,7,8-HXCDF	0	0	0	3.54	0	0	0	0	0	0.72	0	0.57	0.72	0	9.47	10.78	0	4.22	0	0.51	0
1,2,3,7,8,9-HXCDD	0	0	0	0	0	0	0	0	0	1.51	0	1.3	1.37	0	18.37	20.02	0	8.97	0	1.32	0
1,2,3,7,8,9-HXCDF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.04	0	0	0	0	0
1,2,3,4,6,7,8-HPCDD	66.53	27.78	33.62	93.57	4.43	9.31	39.45	2.79	40.44	26.83	7.74	23.6	28.55	6.1	338.29	343.34	16.51	134.62	177.15	19.6	7.23
1,2,3,4,6,7,8-HPCDF	20.12	8.99	9.49	30.79	1.56	0	11.02	0	9.84	7.95	2.74	9.89	9.53	0.78	115.05	135.5	6.33	47.11	49.86	6.78	0.74
1,2,3,7,8-PECDD	0	0	0	0	0	0	0	0	0	0	0	0.32	0.28	0	7.46	7.24	0	2.58	0	0	0
1,2,3,7,8-PECDF	0	0	0	0	0.39	0	0	0	0	1.13	0	0.57	0.82	0	11.41	12.63	0	5.03	0	0.99	0
1,2,3,4,7,8,9-HPCDF	0	0	0	0	0	0	0	0	0	0	0	0.4	0.48	0	6.22	8.66	0	2.79	0	0	0
2,3,4,6,7,8-HXCDF	0	0	0	0	0	0	0	0	0	0	0	0.71	0.88	0	11.87	14.09	0	5.47	0	0.79	0
2,3,4,7,8-PECDF	0	0	0	0	0	0	0	0	0	0	0	0.94	1.14	0	12.44	16.32	0	6.92	0	1.12	0
OCDD	662.37	246.71	308.18	874.05	43.73	94.79	351.42	27.93	339.49	262.32	76.1	267.28	318.51	135.47	4246.5	4232.5	218.36	1818.89	2912.6	209.75	155.17
OCDF	42.35	19.46	20.6	56.35	3.09	5.43	20.29	0	21.37	12.91	4.15	15.06	17.97	1.8	176	180.55	13.94	68.74	79.02	9.76	0
2,3,7,8-TCDD	0	0	0	6.39	0.26	0	0	0	0.84	0.61	0	0.77	0	0	17.34	17.15	0.94	6.97	0	2.55	0.2
2,3,7,8-TCDF	6.65	3.74	4.62	12.89	1.15	0	2.55	1.48	2.86	3.37	2.09	2.2	2.73	0.34	32.36	32.91	1.86	14.88	20.62	1.63	0.45

(USEPA 2003)

TES for the following Tables for NOAA Mussel Watch data:

PERCENTILE 85th: 85 percentile based on all sites and all years in the Mussel Watch database by matrix (sediment or tissue).

Mussels and oysters accumulate copper (Cu), zinc (Zn) and lead (Pb) differently. For example in the early 1990s, oysters collected from Long Island Sound, NY had Cu and Zn concentrations ten-times higher than mussels, while lead levels were three-times higher in mussels relative to oysters.

Reference : O'Connor, T. P. and Beliaeff, B. 1995. Recent trends in coastal environmental quality: Results from the Mussel Watch Project. NOAA, National Status and Trends Program, Silver Spring, MD. 40pp.

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) \

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
1,2,3,4-Tetrachlorobenzene	1995	0.353		ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2001	3.78	0.29	ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2004	0	0.293	ng/dry g	1.33
1,2,4,5-Tetrachlorobenzene	1995	0		ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2001	37.513	0.27	ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2004	22.222	0.3	ng/dry g	3.33
1,6,7-Trimethylnaphthalene	1990	5.226	9.7	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1994	10.53	1.8	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1995	6.47	8.4	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2001	6.2	1	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2004	0.7	0.805	ng/dry g	10.34
1-Methylnaphthalene	1990	7.637	22	ng/dry g	16.6
1-Methylnaphthalene	1994	5.3	2.6	ng/dry g	16.6
1-Methylnaphthalene	1995	6.82	6.4	ng/dry g	16.6
1-Methylnaphthalene	2001	325	0.3	ng/dry g	16.6
1-Methylnaphthalene	2004	7.7	4.465	ng/dry g	16.6
1-Methylphenanthrene	1990	10.446	22	ng/dry g	16.9
1-Methylphenanthrene	1994	16.9	3	ng/dry g	16.9
1-Methylphenanthrene	1995	13.29		ng/dry g	16.9
1-Methylphenanthrene	2001	16.9	1.3	ng/dry g	16.9
1-Methylphenanthrene	2004	1.5	1.014	ng/dry g	16.9
2,4'-DDD	1990	12.747	0.69	ng/dry g	6.33
2,4'-DDD	1994	28.26	0.89	ng/dry g	6.33
2,4'-DDD	1995	15.315	0.17	ng/dry g	6.33
2,4'-DDD	2001	21.81	0.29	ng/dry g	6.33
2,4'-DDD	2004	12.344	0.198	ng/dry g	6.33
2,4'-DDE	1990	14.611	1.1	ng/dry g	3.22
2,4'-DDE	1994	5.13	0.94	ng/dry g	3.22
2,4'-DDE	1995	5.496	0.44	ng/dry g	3.22
2,4'-DDE	2001	7.706	0.25	ng/dry g	3.22
2,4'-DDE	2004	3.918	0.184	ng/dry g	3.22
2,4'-DDT	1990	11.097	1.1	ng/dry g	3.3
2,4'-DDT	1994	0	0.97	ng/dry g	3.3
2,4'-DDT	1995	2.148	0.31	ng/dry g	3.3
2,4'-DDT	2001	3.199	0.25	ng/dry g	3.3
2,4'-DDT	2004	2.299	0.216	ng/dry g	3.3
2,6-Dimethylnaphthalene	1990	1.746	38	ng/dry g	13.77
2,6-Dimethylnaphthalene	1994	6.44	3.6	ng/dry g	13.77
2,6-Dimethylnaphthalene	1995	7.51	10	ng/dry g	13.77
2,6-Dimethylnaphthalene	2001	9.4	0.5	ng/dry g	13.77
2,6-Dimethylnaphthalene	2004	3.6	2.975	ng/dry g	13.77
2-Methylnaphthalene	1990	10.94	20	ng/dry g	29.97
2-Methylnaphthalene	1994	10.22	2.3	ng/dry g	29.97
2-Methylnaphthalene	1995	12.74		ng/dry g	29.97
2-Methylnaphthalene	2001	197	0.6	ng/dry g	29.97
2-Methylnaphthalene	2004	15.1	7.349	ng/dry g	29.97
4,4'-DDD	1990	80.49	7.1	ng/dry g	19
4,4'-DDD	1994	52.55	0.69	ng/dry g	19
4,4'-DDD	1995	32.104	0.28	ng/dry g	19
4,4'-DDD	2001	44.928	0.34	ng/dry g	19
4,4'-DDD	2004	25.021	0.176	ng/dry g	19

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
4,4'-DDE	1990	73.317	6.4	ng/dry g	48
4,4'-DDE	1994	41.4	2.5	ng/dry g	48
4,4'-DDE	1995	32.084	0.92	ng/dry g	48
4,4'-DDE	2001	25.59	0.24	ng/dry g	48
4,4'-DDE	2004	21.496	0.192	ng/dry g	48
4,4'-DDT	1990	9.037	1.7	ng/dry g	4.39
4,4'-DDT	1994	7.55	1.3	ng/dry g	4.39
4,4'-DDT	1995	4.153	0.83	ng/dry g	4.39
4,4'-DDT	2001	2.617	0.25	ng/dry g	4.39
4,4'-DDT	2004	1.346	0.182	ng/dry g	4.39
Acenaphthene	1990	0	8.5	ng/dry g	9.7
Acenaphthene	1994	4.34	2.7	ng/dry g	9.7
Acenaphthene	1995	6.48	12	ng/dry g	9.7
Acenaphthene	2001	94.1	0.4	ng/dry g	9.7
Acenaphthene	2004	2.5	1.79	ng/dry g	9.7
Acenaphthylene	1990	7.726	36	ng/dry g	7.55
Acenaphthylene	1994	8.38	2.1	ng/dry g	7.55
Acenaphthylene	1995	7.68	4.8	ng/dry g	7.55
Acenaphthylene	2001	28.6	0.5	ng/dry g	7.55
Acenaphthylene	2004	10.2	1.872	ng/dry g	7.55
Aldrin	1990	0	0.39	ng/dry g	0.69
Aldrin	1994	0	1.3	ng/dry g	0.69
Aldrin	1995	0	0.41	ng/dry g	0.69
Aldrin	2001	0	0.25	ng/dry g	0.69
Aldrin	2004	0	0.215	ng/dry g	0.69
Alpha-Chlordane	1990	27.55	1.3	ng/dry g	10.89
Alpha-Chlordane	1994	14.89	1.8	ng/dry g	10.89
Alpha-Chlordane	1995	12.171		ng/dry g	10.89
Alpha-Chlordane	2001	4.217	0.29	ng/dry g	10.89
Alpha-Chlordane	2004	6.172	0.207	ng/dry g	10.89
Alpha-Hexachlorocyclohexane	1995	3.32		ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2001	0	0.25	ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2004	0	0.203	ng/dry g	1.42
Aluminum	1990	488.333	160	µg/dry g	732
Aluminum	1995	2336.371	120	µg/dry g	732
Aluminum	2001	48.2	5	µg/dry g	732
Aluminum	2004	1900	4.882	µg/dry g	732
Anthracene	1990	13.189	23	ng/dry g	18.2
Anthracene	1994	14.19	2.4	ng/dry g	18.2
Anthracene	1995	19.83	4.5	ng/dry g	18.2
Anthracene	2001	23	1.7	ng/dry g	18.2
Anthracene	2004	18.6	0.992	ng/dry g	18.2

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Antimony	1990	0.057	0.01	µg/dry g	0.05
Arsenic	1990	7.287	5	µg/dry g	15.67
Arsenic	1995	6.099	0.4	µg/dry g	15.67
Arsenic	2001	5.51	2	µg/dry g	15.67
Arsenic	2004	7.06	1.95	µg/dry g	15.67
Benz[a]anthracene	1990	52.99	8	ng/dry g	33.67
Benz[a]anthracene	1994	125.31	1.8	ng/dry g	33.67
Benz[a]anthracene	1995	58.44	2.5	ng/dry g	33.67
Benz[a]anthracene	2001	6.5	1	ng/dry g	33.67
Benz[a]anthracene	2004	39.2	2.662	ng/dry g	33.67
Benzo[a]pyrene	1990	24.097	8.7	ng/dry g	10.92
Benzo[a]pyrene	1994	63.4	5	ng/dry g	10.92
Benzo[a]pyrene	1995	46.85	4.7	ng/dry g	10.92
Benzo[a]pyrene	2001	1.7	1.3	ng/dry g	10.92
Benzo[a]pyrene	2004	25.2	1.376	ng/dry g	10.92
Benzo[b]fluoranthene	1990	76.383	12	ng/dry g	37.75
Benzo[b]fluoranthene	1994	209.34	2.1	ng/dry g	37.75
Benzo[b]fluoranthene	1995	109.34	8.7	ng/dry g	37.75
Benzo[b]fluoranthene	2001	6.6	0.8	ng/dry g	37.75
Benzo[b]fluoranthene	2004	73.9	3.232	ng/dry g	37.75
Benzo[e]pyrene	1990	110.48	7.6	ng/dry g	36.06
Benzo[e]pyrene	1994	146.23	4	ng/dry g	36.06
Benzo[e]pyrene	1995	83.82	4.3	ng/dry g	36.06
Benzo[e]pyrene	2001	20.5	1.9	ng/dry g	36.06
Benzo[e]pyrene	2004	92.8	2.259	ng/dry g	36.06
Benzo[g,h,i]perylene	1990	26.243	3.3	ng/dry g	10.49
Benzo[g,h,i]perylene	1994	84.08	5.1	ng/dry g	10.49
Benzo[g,h,i]perylene	1995	44.85	4.1	ng/dry g	10.49
Benzo[g,h,i]perylene	2001	5	0.7	ng/dry g	10.49
Benzo[g,h,i]perylene	2004	18.8	2.017	ng/dry g	10.49
Benzo[k]fluoranthene	1990	50.093	18	ng/dry g	19.63
Benzo[k]fluoranthene	1994	68.51	4.7	ng/dry g	19.63
Benzo[k]fluoranthene	1995	32.31	5.4	ng/dry g	19.63
Benzo[k]fluoranthene	2001	5.4	0.7	ng/dry g	19.63
Benzo[k]fluoranthene	2004	48.1	2.374	ng/dry g	19.63
Beta-Hexachlorocyclohexane	1995	0.221		ng/dry g	0.97
Beta-Hexachlorocyclohexane	2001	0	0.26	ng/dry g	0.97
Beta-Hexachlorocyclohexane	2004	0.076	0.2	ng/dry g	0.97

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Biphenyl	1990	5.46	41	ng/dry g	9.96
Biphenyl	1994	3.17	4.8	ng/dry g	9.96
Biphenyl	1995	3.25	10	ng/dry g	9.96
Biphenyl	2001	8.5	2	ng/dry g	9.96
Biphenyl	2004	7.9	2.07	ng/dry g	9.96
C1-Chrysenes	1994	119.6	1.7	ng/dry g	27.47
C1-Chrysenes	1995	99.71	17	ng/dry g	27.47
C1-Chrysenes	2001	5.6	1.8	ng/dry g	27.47
C1-Chrysenes	2004	37.7	4.288	ng/dry g	27.47
C1-Dibenzothiophenes	1994	14.35	2.7	ng/dry g	15.7
C1-Dibenzothiophenes	1995	9.09	11	ng/dry g	15.7
C1-Dibenzothiophenes	2001	9.6	1.1	ng/dry g	15.7
C1-Dibenzothiophenes	2004	4.7	1.5	ng/dry g	15.7
C1-Fluoranthenes/Pyrenes	1994	195.28	5.2	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	1995	145.61	17	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	2001	41.6	1.6	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	2004	70.4	7.604	ng/dry g	77.86
C1-Fluorenes	1994	24.38	2.7	ng/dry g	19.9
C1-Fluorenes	1995	20.29	12	ng/dry g	19.9
C1-Fluorenes	2001	14.2	1.1	ng/dry g	19.9
C1-Fluorenes	2004	0	2.092	ng/dry g	19.9
C1-Naphthalenes	1994	10.09	19	ng/dry g	35.26
C1-Naphthalenes	1995	19.56	19	ng/dry g	35.26
C1-Naphthalenes	2001	361	4.6	ng/dry g	35.26
C1-Naphthalenes	2004	15.5	7.613	ng/dry g	35.26
C1-Phenanthrenes/Anthracenes	1994	60.46	5.5	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	1995	79.14	11	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2001	53.9	2.9	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2004	16.9	3.061	ng/dry g	65.3
C2-Chrysenes	1994	90.47	1.7	ng/dry g	23.96
C2-Chrysenes	1995	63.74	15	ng/dry g	23.96
C2-Chrysenes	2001	0	1.8	ng/dry g	23.96
C2-Chrysenes	2004	34.4	4.288	ng/dry g	23.96
C2-Dibenzothiophenes	1994	72.95	2.7	ng/dry g	43.5
C2-Dibenzothiophenes	1995	37.9	18	ng/dry g	43.5
C2-Dibenzothiophenes	2001	17	1.1	ng/dry g	43.5
C2-Dibenzothiophenes	2004	12.9	1.5	ng/dry g	43.5
C2-Fluoranthenes/Pyrenes	2004	36.7	7.604	ng/dry g	32.6

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C2-Fluorenes	1994	88.04	2.7	ng/dry g	54.15
C2-Fluorenes	1995	71.8	12	ng/dry g	54.15
C2-Fluorenes	2001	19.5	1.1	ng/dry g	54.15
C2-Fluorenes	2004	0	2.092	ng/dry g	54.15
C2-Naphthalenes	1994	16.85	19	ng/dry g	33.8
C2-Naphthalenes	1995	24.93	17	ng/dry g	33.8
C2-Naphthalenes	2001	217	4.6	ng/dry g	33.8
C2-Naphthalenes	2004	10	7.613	ng/dry g	33.8
C2-Phenanthrenes/Anthracenes	1994	177.29	5.5	ng/dry g	104
C2-Phenanthrenes/Anthracenes	1995	184.24	19	ng/dry g	104
C2-Phenanthrenes/Anthracenes	2001	43.7	2.9	ng/dry g	104
C2-Phenanthrenes/Anthracenes	2004	42.9	3.061	ng/dry g	104
C3-Chrysenes	1994	50.01	1.7	ng/dry g	0.6
C3-Chrysenes	1995	12.23	21	ng/dry g	0.6
C3-Chrysenes	2001	0	1.8	ng/dry g	0.6
C3-Chrysenes	2004	0	4.288	ng/dry g	0.6
C3-Dibenzothiophenes	1994	120.08	2.7	ng/dry g	54.31
C3-Dibenzothiophenes	1995	65.33	11	ng/dry g	54.31
C3-Dibenzothiophenes	2001	13.1	1.1	ng/dry g	54.31
C3-Dibenzothiophenes	2004	22.7	1.5	ng/dry g	54.31
C3-Fluoranthenes/Pyrenes	2004	12	7.604	ng/dry g	10.2
C3-Fluorenes	1994	146.05	2.7	ng/dry g	94.6
C3-Fluorenes	1995	166.77	12	ng/dry g	94.6
C3-Fluorenes	2001	12.5	1.1	ng/dry g	94.6
C3-Fluorenes	2004	0	2.092	ng/dry g	94.6
C3-Naphthalenes	1994	37.8	19	ng/dry g	45.31
C3-Naphthalenes	1995	47.33	17	ng/dry g	45.31
C3-Naphthalenes	2001	120	4.6	ng/dry g	45.31
C3-Naphthalenes	2004	5.2	7.613	ng/dry g	45.31
C3-Phenanthrenes/Anthracenes	1994	204.51	5.5	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	1995	180.86	19	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2001	25.1	2.9	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2004	41.4	3.061	ng/dry g	96.6
C4-Chrysenes	1994	0	1.7	ng/dry g	0.51
C4-Chrysenes	1995	15.31	17	ng/dry g	0.51
C4-Chrysenes	2001	0	1.8	ng/dry g	0.51
C4-Chrysenes	2004	0	4.288	ng/dry g	0.51
C4-Naphthalenes	1994	26.9	19	ng/dry g	47.27
C4-Naphthalenes	1995	52.95	11	ng/dry g	47.27
C4-Naphthalenes	2001	60.8	4.6	ng/dry g	47.27
C4-Naphthalenes	2004	8.7	7.613	ng/dry g	47.27

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C4-Phenanthrenes/Anthracenes	1994	116.97	5.5	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	1995	99.67	12	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2001	7.8	2.9	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2004	21.3	3.061	ng/dry g	58.4
Cadmium	1990	2.32	0.63	µg/dry g	5.42
Cadmium	1995	2.072	0.003	µg/dry g	5.42
Cadmium	2001	1.35	0.0397	µg/dry g	5.42
Cadmium	2004	1.97	0.195	µg/dry g	5.42
Chlorpyrifos	1995	2.183		ng/dry g	1.55
Chlorpyrifos	2001	2.181	0.28	ng/dry g	1.55
Chlorpyrifos	2004	0	0.219	ng/dry g	1.55
Chromium	1990	2.373	0.63	µg/dry g	3.02
Chromium	1995	10.761	0.5	µg/dry g	3.02
Chromium	2001	0	0.5	µg/dry g	3.02
Chromium	2004	25.2	0.488	µg/dry g	3.02
Chrysene	1990	130.58	12	ng/dry g	72.85
Chrysene	1994	206.11	1.7	ng/dry g	72.85
Chrysene	1995	122.6	5.8	ng/dry g	72.85
Chrysene	2001	21.2	0.9	ng/dry g	72.85
Chrysene	2004	95.5	4.288	ng/dry g	72.85
Cis-Nonachlor	1995	6.294		ng/dry g	3.91
Cis-Nonachlor	2001	2.617	0.26	ng/dry g	3.91
Cis-Nonachlor	2004	2.632	0.212	ng/dry g	3.91
Copper	1990	12.16	11	µg/dry g	183
Copper	1995	20.467	0.16	µg/dry g	183
Copper	2001	12.7	0.5	µg/dry g	183
Copper	2004	22.4	0.488	µg/dry g	183
Delta-Hexachlorocyclohexane	1995	0		ng/dry g	0.18
Delta-Hexachlorocyclohexane	2001	0	0.23	ng/dry g	0.18
Delta-Hexachlorocyclohexane	2004	0.015	0.202	ng/dry g	0.18
Dibenzo[a,h]anthracene	1990	4.3	7.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	1994	19.31	3.8	ng/dry g	2.17
Dibenzo[a,h]anthracene	1995	8.52	6.6	ng/dry g	2.17
Dibenzo[a,h]anthracene	2001	0	0.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	2004	4.5	1.989	ng/dry g	2.17
Dibenzofuran	1994	6.89		ng/dry g	11.55
Dibenzofuran	2004	3.4	2.22	ng/dry g	11.55
Dibenzothiophene	1994	4.02	2.7	ng/dry g	5.5
Dibenzothiophene	1995	4.49		ng/dry g	5.5
Dibenzothiophene	2001	34.9	0.5	ng/dry g	5.5
Dibenzothiophene	2004	0.9	1.5	ng/dry g	5.5

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Dibutyltin	1994	66.278	7.5	ng/dry g	22.61
Dibutyltin	1995	10.125		ng/dry g	22.61
Dibutyltin	2001	7.86	3.6	ng/dry g	22.61
Dibutyltin	2004	10.42	2.807	ng/dry g	22.61
Dieldrin	1990	21.243	2.9	ng/dry g	9.34
Dieldrin	1994	27.67	2.2	ng/dry g	9.34
Dieldrin	1995	11.229	1	ng/dry g	9.34
Dieldrin	2001	3.053	0.37	ng/dry g	9.34
Dieldrin	2004	4.281	0.196	ng/dry g	9.34
Endosulfan I	2001	2.012	0.26	ng/dry g	2.12
Endosulfan I	2004	4.498	0.219	ng/dry g	2.12
Endosulfan II	1995	0		ng/dry g	1.71
Endosulfan II	2001	0	0.26	ng/dry g	1.71
Endosulfan II	2004	0	0.219	ng/dry g	1.71
Endosulfan Sulfate	2001	0	0.29	ng/dry g	0.44
Endosulfan Sulfate	2004	0	0.238	ng/dry g	0.44
Endrin	1994	0		ng/dry g	0.71
Endrin	1995	0		ng/dry g	0.71
Endrin	2001	0	0.24	ng/dry g	0.71
Endrin	2004	0	0.181	ng/dry g	0.71
Fluoranthene	1990	206.58	25	ng/dry g	153.33
Fluoranthene	1994	257.63	5	ng/dry g	153.33
Fluoranthene	1995	192.24	5.8	ng/dry g	153.33
Fluoranthene	2001	100	0.8	ng/dry g	153.33
Fluoranthene	2004	75.5	7.604	ng/dry g	153.33
Fluorene	1990	2.26	12	ng/dry g	12.6
Fluorene	1994	6.9	2.7	ng/dry g	12.6
Fluorene	1995	13.1	6.8	ng/dry g	12.6
Fluorene	2001	64.1	0.6	ng/dry g	12.6
Fluorene	2004	2.7	2.092	ng/dry g	12.6
Gamma-Chlordane	1995	12.039		ng/dry g	5.18
Gamma-Chlordane	2001	4.798	0.29	ng/dry g	5.18
Gamma-Chlordane	2004	4.962	0.237	ng/dry g	5.18
Gamma-Hexachlorocyclohexane	1990	0	1.9	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1994	0	0.92	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1995	0.982	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2001	0	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2004	0.197	0.194	ng/dry g	2.15

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Heptachlor	1990	0.8	1.3	ng/dry g	0.54
Heptachlor	1994	0	0.85	ng/dry g	0.54
Heptachlor	1995	0	0.53	ng/dry g	0.54
Heptachlor	2001	0.145	0.28	ng/dry g	0.54
Heptachlor	2004	0	0.223	ng/dry g	0.54
Heptachlor-Epoxide	1990	0	1.4	ng/dry g	2.17
Heptachlor-Epoxide	1994	0	0.75	ng/dry g	2.17
Heptachlor-Epoxide	1995	0.346	6.5	ng/dry g	2.17
Heptachlor-Epoxide	2001	0.145	0.3	ng/dry g	2.17
Heptachlor-Epoxide	2004	0.378	0.201	ng/dry g	2.17
Hexachlorobenzene	1990	0.585	0.74	ng/dry g	0.69
Hexachlorobenzene	1994	0	0.74	ng/dry g	0.69
Hexachlorobenzene	1995	0.494	0.4	ng/dry g	0.69
Hexachlorobenzene	2001	0.291	0.24	ng/dry g	0.69
Hexachlorobenzene	2004	0.181	0.223	ng/dry g	0.69
Indeno[1,2,3-c,d]pyrene	1990	14.92	5.5	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1994	70.76	2.8	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1995	33.52		ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2001	1.6	1	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2004	22.6	2.821	ng/dry g	8.42
Iron	1990	636.667	180	µg/dry g	872
Iron	1995	3138.508	100	µg/dry g	872
Iron	2001	158	1.08	µg/dry g	872
Iron	2004	5460	1.101	µg/dry g	872
Lead	1990	2.433	0.13	µg/dry g	2.76
Lead	1995	13.491	0.11	µg/dry g	2.76
Lead	2001	0.879	0.055	µg/dry g	2.76
Lead	2004	22.8	0.043	µg/dry g	2.76
Manganese	1990	39.467	2.8	µg/dry g	39.04
Manganese	1995	148.507	3.8	µg/dry g	39.04
Manganese	2001	22.5	0.215	µg/dry g	39.04
Manganese	2004	245	0.195	µg/dry g	39.04
Mercury	1990	0.157	0.01	µg/dry g	0.21
Mercury	1995	0.221	0.012	µg/dry g	0.21
Mercury	2001	0.163	0.01	µg/dry g	0.21
Mercury	2004	0.246	0.01	µg/dry g	0.21
Mirex	1990	0.572	0.86	ng/dry g	0.97
Mirex	1994	0.59	2.1	ng/dry g	0.97
Mirex	1995	0.69	0.28	ng/dry g	0.97
Mirex	2001	0.291	0.28	ng/dry g	0.97
Mirex	2004	0	0.199	ng/dry g	0.97

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Monobutyltin	1994	0	7.6	ng/dry g	8.79
Monobutyltin	1995	2.079		ng/dry g	8.79
Monobutyltin	2001	0	1.95	ng/dry g	8.79
Monobutyltin	2004	4.47	0.319	ng/dry g	8.79
Naphthalene	1990	17.693	12	ng/dry g	30.04
Naphthalene	1994	17.46	19	ng/dry g	30.04
Naphthalene	1995	17.68		ng/dry g	30.04
Naphthalene	2001	639	2.3	ng/dry g	30.04
Naphthalene	2004	22.3	7.613	ng/dry g	30.04
Nickel	1990	4.007	1.5	µg/dry g	3.84
Nickel	1995	6.968	0.15	µg/dry g	3.84
Nickel	2001	0		µg/dry g	3.84
Nickel	2004	9.7	0.488	µg/dry g	3.84
Oxychlordane	1995	1.153		ng/dry g	1.34
Oxychlordane	2001	1.454	0.27	ng/dry g	1.34
Oxychlordane	2004	0.832	0.246	ng/dry g	1.34
PCB101/90	1990	85.56	2.6	ng/dry g	17.84
PCB101/90	1994	33.21	0.72	ng/dry g	17.84
PCB101/90	1995	35.13	0.47	ng/dry g	17.84
PCB101/90	2001	21.228	0.66	ng/dry g	17.84
PCB101/90	2004	5.55	0.32	Percent	17.84
PCB105	1990	19.803	2	ng/dry g	4.95
PCB105	1994	9.82	0.37	ng/dry g	4.95
PCB105	1995	12.672	1.2	ng/dry g	4.95
PCB105	2001	2.908	0.41	ng/dry g	4.95
PCB105	2004	6.248	0.293	ng/dry g	4.95
PCB118	1990	64.87	2.4	ng/dry g	17
PCB118	1994	31.63	0.88	ng/dry g	17
PCB118	1995	41.965	1.3	ng/dry g	17
PCB118	2001	16.866	0.67	ng/dry g	17
PCB118	2004	18.168	0.222	ng/dry g	17
PCB128	1990	9.11	1	ng/dry g	3.58
PCB128	1994	4.75	1.3	ng/dry g	3.58
PCB128	1995	6.299	0.62	ng/dry g	3.58
PCB128	2001	1.309	0.43	ng/dry g	3.58
PCB128	2004	2.072	0.477	ng/dry g	3.58
PCB138	1990	77.743	3.7	ng/dry g	25.33
PCB138	1994	42.71	0.76	ng/dry g	25.33
PCB138	1995	40.531	1	ng/dry g	25.33
PCB138	2001	13.086	0.87	ng/dry g	25.33
PCB138	2004	19.847	0.378	ng/dry g	25.33

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB153/132/168	1990	110.303	5.8	ng/dry g	34.12
PCB153/132/168	1994	40.24	1.1	ng/dry g	34.12
PCB153/132/168	1995	57.47	2.6	ng/dry g	34.12
PCB153/132/168	2001	27.626	0.67	ng/dry g	34.12
PCB153/132/168	2004	32.675	0.427	ng/dry g	34.12
PCB170/190	1990	0	0.66	ng/dry g	3.08
PCB170/190	1994	2.24	2.2	ng/dry g	3.08
PCB170/190	1995	4.909	2.4	ng/dry g	3.08
PCB170/190	2001	2.036	0.81	ng/dry g	3.08
PCB170/190	2004	1.679	0.285	ng/dry g	3.08
PCB18	1990	5.7	1.1	ng/dry g	2.3
PCB18	1994	6.26	1.5	ng/dry g	2.3
PCB18	1995	6.433	1.1	ng/dry g	2.3
PCB18	2001	3.635	0.52	ng/dry g	2.3
PCB18	2004	2.42	0.387	ng/dry g	2.3
PCB180	1990	12.878	1.6	ng/dry g	7.18
PCB180	1994	5.84	2.1	ng/dry g	7.18
PCB180	1995	17.01	0.76	ng/dry g	7.18
PCB180	2001	2.326	0.58	ng/dry g	7.18
PCB180	2004	6.702	0.214	ng/dry g	7.18
PCB187	1990	29.667	1.1	ng/dry g	10.6
PCB187	1994	14.38	0.86	ng/dry g	10.6
PCB187	1995	16.85	0.38	ng/dry g	10.6
PCB187	2001	7.997	0.62	ng/dry g	10.6
PCB187	2004	8.895	0.276	ng/dry g	10.6
PCB195/208	1990	0	0.44	ng/dry g	0.38
PCB195/208	1994	0.73	1.2	ng/dry g	0.38
PCB195/208	1995	0	0.82	ng/dry g	0.38
PCB195/208	2001	0	0.33	ng/dry g	0.38
PCB195/208	2004	0.378	0.236	ng/dry g	0.38
PCB206	1990	0	0.88	ng/dry g	0.21
PCB206	1994	0.16	1.9	ng/dry g	0.21
PCB206	1995	0.973	0.48	ng/dry g	0.21
PCB206	2001	0	0.31	ng/dry g	0.21
PCB206	2004	0.091	0.256	ng/dry g	0.21
PCB209	1990	0.071	0.88	ng/dry g	0.6
PCB209	1994	1.04	3.3	ng/dry g	0.6
PCB209	1995	1.039	1.1	ng/dry g	0.6
PCB209	2001	0	0.36	ng/dry g	0.6
PCB209	2004	0.091	0.216	ng/dry g	0.6

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB28	1990	23.067	0.92	ng/dry g	3.66
PCB28	1994	11.91	0.85	ng/dry g	3.66
PCB28	1995	15.202	0.75	ng/dry g	3.66
PCB28	2001	6.834	0.45	ng/dry g	3.66
PCB28	2004	6.823	0.19	ng/dry g	3.66
PCB44	1990	33.667	2	ng/dry g	5.23
PCB44	1994	14.14	1.3	ng/dry g	5.23
PCB44	1995	17.646	0.62	ng/dry g	5.23
PCB44	2001	6.834	0.35	ng/dry g	5.23
PCB44	2004	0	0.356	ng/dry g	5.23
PCB52	1990	58.557	1.4	ng/dry g	10.12
PCB52	1994	24.89	1.1	ng/dry g	10.12
PCB52	1995	35.415	1	ng/dry g	10.12
PCB52	2001	17.739	0.48	ng/dry g	10.12
PCB52	2004	17.669	0.21	ng/dry g	10.12
PCB66	1990	50.563	1.7	ng/dry g	6.43
PCB66	1994	24.18	0.67	ng/dry g	6.43
PCB66	1995	21.999	0.65	ng/dry g	6.43
PCB66	2001	11.777	0.43	ng/dry g	6.43
PCB66	2004	10.075	0.3	ng/dry g	6.43
PCB8/5	1990	0	0.99	ng/dry g	2.17
PCB8/5	1994	3.19	4.7	ng/dry g	2.17
PCB8/5	1995	0	1.4	ng/dry g	2.17
PCB8/5	2001	0	0.39	ng/dry g	2.17
PCB8/5	2004	0	0.318	ng/dry g	2.17
Pentachloroanisole	1995	0.921		ng/dry g	2.01
Pentachloroanisole	2001	1.309	0.28	ng/dry g	2.01
Pentachloroanisole	2004	0.65	0.162	ng/dry g	2.01
Pentachlorobenzene	1995	0		ng/dry g	0.94
Pentachlorobenzene	2001	0	0.26	ng/dry g	0.94
Pentachlorobenzene	2004	1.997	0.192	ng/dry g	0.94
Percent lipid dry weight	1990	8.667		Percent	10.33
Percent lipid dry weight	1994	7		Percent	10.33
Percent lipid dry weight	1995	3.083		Percent	10.33
Percent lipid dry weight	2001	3.46		Percent	10.33
Percent lipid dry weight	2004	0		ng/dry g	10.33
Perylene	1990	11.202	11	ng/dry g	13.32
Perylene	1994	24.79	6.7	ng/dry g	13.32
Perylene	1995	18.58	10.1	ng/dry g	13.32
Perylene	2001	2.1	2	ng/dry g	13.32
Perylene	2004	7.3	4.513	ng/dry g	13.32

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Phenanthrene	1990	26.264	24	ng/dry g	57.8
Phenanthrene	1994	46.61	5.5	ng/dry g	57.8
Phenanthrene	1995	81.2	6.6	ng/dry g	57.8
Phenanthrene	2001	339	1.5	ng/dry g	57.8
Phenanthrene	2004	14.5	3.061	ng/dry g	57.8
Pyrene	1990	280.16	20	ng/dry g	122.38
Pyrene	1994	296.09	5.2	ng/dry g	122.38
Pyrene	1995	220.36	5.6	ng/dry g	122.38
Pyrene	2001	173	1.4	ng/dry g	122.38
Pyrene	2004	166	4.817	ng/dry g	122.38
Selenium	1990	3.213	0.5	µg/dry g	3.86
Selenium	1995	6.058		µg/dry g	3.86
Selenium	2001	1.93	0.054	µg/dry g	3.86
Selenium	2004	5.32	0.049	µg/dry g	3.86
Silicon	1990	2066.667	110	µg/dry g	3000
Silver	1990	0.438	0.01	µg/dry g	3.7
Silver	1995	1.178	0.1	µg/dry g	3.7
Silver	2001	5.74	1.08	µg/dry g	3.7
Silver	2004	1.03	0.043	µg/dry g	3.7
Tetrabutyltin	1995	2.974		ng/dry g	0.11
Tetrabutyltin	2001	0	2.73	ng/dry g	0.11
Tetrabutyltin	2004	0	3.753	ng/dry g	0.11
Tin	1990	1.577	0.01	µg/dry g	0.35
Tin	1995	0.85	0.14	µg/dry g	0.35
Tin	2001	0	0.1	µg/dry g	0.35
Tin	2004	2.87	0.087	µg/dry g	0.35
Total butyltins	1994	66.278		ng/dry g	151.96
Total butyltins	1995	123.93		ng/dry g	151.96
Total butyltins	2001	29.73		ng/dry g	151.96
Total butyltins	2004	60.65		ng/dry g	151.96
Total chlordanes	1990	52.387		ng/dry g	22.5
Total chlordanes	1994	26.21		ng/dry g	22.5
Total chlordanes	1995	22.037		ng/dry g	22.5
Total chlordanes	2001	8.869		ng/dry g	22.5
Total chlordanes	2004	10.74		ng/dry g	22.5
Total DDT	1990	201.299		ng/dry g	88.66
Total DDT	1994	134.89		ng/dry g	88.66
Total DDT	1995	91.3		ng/dry g	88.66
Total DDT	2001	105.85		ng/dry g	88.66
Total DDT	2004	66.424		ng/dry g	88.66

Table 4. Analyte Concentration in Tissue from HRRB in All Years, Target Species: *Mytilus edulis*. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Total dieldrin	1990	21.243		ng/dry g	10.18
Total dieldrin	1994	27.67		ng/dry g	10.18
Total dieldrin	1995	11.229		ng/dry g	10.18
Total dieldrin	2001	3.053		ng/dry g	10.18
Total dieldrin	2004	4.281		ng/dry g	10.18
Total PAH	1990	1096.615		ng/dry g	783
Total PAH	1994	1722		ng/dry g	783
Total PAH	1995	1167.48		ng/dry g	783
Total PAH	2001	2094.4		ng/dry g	783
Total PAHhmw (4 or more rings)	1990	988.028		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1994	1571.56		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1995	971.43		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2001	343.6		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2004	669.4		ng/dry g	532.5
Total PAHlmw (2-3 rings)	1990	108.587		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1994	150.44		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1995	196.05		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2001	1750.8		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2004	107.3		ng/dry g	234.8
Total PCBcg	1990	1163.118		ng/dry g	324.86
Total PCBcg	1994	542.64		ng/dry g	324.86
Total PCBcg	1995	663.086		ng/dry g	324.86
Total PCBcg	2001	284.402		ng/dry g	324.86
Trans-Nonachlor	1990	24.037	0.99	ng/dry g	9.68
Trans-Nonachlor	1994	11.32	0.97	ng/dry g	9.68
Trans-Nonachlor	1995	9.52	0.25	ng/dry g	9.68
Trans-Nonachlor	2001	4.362	0.22	ng/dry g	9.68
Trans-Nonachlor	2004	4.19	0.193	ng/dry g	9.68
Tributyltin	1994	0	7.6	ng/dry g	110
Tributyltin	1995	111.726		ng/dry g	110
Tributyltin	2001	21.87	4.83	ng/dry g	110
Tributyltin	2004	45.76	3.921	ng/dry g	110
Zinc	1990	113.333	1	µg/dry g	2980
Zinc	1995	177.572	6.5	µg/dry g	2980
Zinc	2001	54.7	0.54	µg/dry g	2980
Zinc	2004	189	0.501	µg/dry g	2980

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006).

Sediment					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
1,2,3,4-Tetrachlorobenzene	1997	0.02		ng/dry g	0.12
1,2,3,4-Tetrachlorobenzene	2004	0.17	0.049	ng/dry g	0.12
1,2,4,5-Tetrachlorobenzene	1997	0		ng/dry g	0.53
1,2,4,5-Tetrachlorobenzene	2004	0	0.3	ng/dry g	0.53
1,6,7-Trimethylnaphthalene	1997	10.7	0.4	ng/dry g	8.2
1,6,7-Trimethylnaphthalene	2004	5.7	0.096	ng/dry g	8.2
1-Methylnaphthalene	1997	38.5	1.7	ng/dry g	13.9
1-Methylnaphthalene	2004	15.6	0.128	ng/dry g	13.9
1-Methylphenanthrene	1997	36.6	0.2	ng/dry g	21.34
1-Methylphenanthrene	2004	32.8	0.205	ng/dry g	21.34
2,4'-DDD	1986	0	0.2	ng/dry g	1.36
2,4'-DDD	1997	0.45	0.18	ng/dry g	1.36
2,4'-DDD	2004	1.547	0.11	ng/dry g	1.36
2,4'-DDE	1986	0	0.14	ng/dry g	0.4
2,4'-DDE	1997	0	0.08	ng/dry g	0.4
2,4'-DDE	2004	0	0.087	ng/dry g	0.4
2,4'-DDT	1986	0	0.23	ng/dry g	0.23
2,4'-DDT	1997	0	0.05	ng/dry g	0.23
2,4'-DDT	2004	0.128	0.101	ng/dry g	0.23
2,6-Dimethylnaphthalene	1997	25.4	0.6	ng/dry g	14.67
2,6-Dimethylnaphthalene	2004	21.3	0.205	ng/dry g	14.67
2-Methylnaphthalene	1997	***75.6***	1.7	ng/dry g	20.33
2-Methylnaphthalene	2004	***33.7***	0.205	ng/dry g	20.33
4,4'-DDD	1986	27.333	0.49	ng/dry g	4.18
4,4'-DDD	1997	0.18	0.07	ng/dry g	4.18
4,4'-DDD	2004	1.887	0.131	ng/dry g	4.18
4,4'-DDE	1986	15.833	0.16	ng/dry g	4.1
4,4'-DDE	1997	0.21	0.06	ng/dry g	4.1
4,4'-DDE	2004	2.242	0.145	ng/dry g	4.1
4,4'-DDT	1986	2.65	0.08	ng/dry g	1.73
4,4'-DDT	1997	0.29	0.09	ng/dry g	1.73

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
4,4'-DDT	2004	0.099	0.14	ng/dry g	1.73
Acenaphthene	1997	***55.5***	0.3	ng/dry g	8.6
Acenaphthene	2004	***23.7***	0.128	ng/dry g	8.6
Acenaphthylene	1997	***35.5***	0.5	ng/dry g	19.4
Acenaphthylene	2004	***82.8***	0.193	ng/dry g	19.4
Aldrin	1986	0	0.16	ng/dry g	0.23
Aldrin	1997	0.05	0.13	ng/dry g	0.23
Aldrin	2004	0	0.068	ng/dry g	0.23
Alpha-Chlordane	1986	4.2	0.08	ng/dry g	0.91
Alpha-Chlordane	1997	0.19	0.08	ng/dry g	0.91
Alpha-Chlordane	2004	0	0.085	ng/dry g	0.91
Alpha-Hexachlorocyclohexane	1997	0		ng/dry g	0.08
Alpha-Hexachlorocyclohexane	2004	0	0.071	ng/dry g	0.08
Aluminum	1986	60000	5000	µg/dry g	70000
Aluminum	1997	29183	106	µg/dry g	70000
Aluminum	2004	35800	4.882	µg/dry g	70000
Anthracene	1997	***120.8***	0.2	ng/dry g	45.5
Anthracene	2004	***152***	0.187	ng/dry g	45.5
Antimony	1986	6.033	0.8	µg/dry g	1.23
Antimony	1997	0.35	0.15	µg/dry g	1.23
Antimony	2004	0.539		µg/dry g	1.23
Arsenic	1986	***21.333***	1.7	µg/dry g	13
Arsenic	1997	5.5	0.31	µg/dry g	13
Arsenic	2004	***8.33***	1.95	µg/dry g	13
Benz[a]anthracene	1997	***266.6***	1.3	ng/dry g	135.6
Benz[a]anthracene	2004	***500***	0.128	ng/dry g	135.6
Benzo[a]pyrene	1997	***337.8***	0.6	ng/dry g	145.88
Benzo[a]pyrene	2004	***454***	0.219	ng/dry g	145.88
Benzo[b]fluoranthene	1997	280.7	0.5	ng/dry g	186.9
Benzo[b]fluoranthene	2004	256	0.289	ng/dry g	186.9

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Benzo[e]pyrene	1997	172.8	0.6	ng/dry g	105
Benzo[e]pyrene	2004	249	0.305	ng/dry g	105
Benzo[g,h,i]perylene	1997	244.5	1.3	ng/dry g	95.4
Benzo[g,h,i]perylene	2004	237	0.145	ng/dry g	95.4
Benzo[k]fluoranthene	1997	141.8	1.3	ng/dry g	76
Benzo[k]fluoranthene	2004	319	0.226	ng/dry g	76
Beta-Hexachlorocyclohexane	1997	0		ng/dry g	0.12
Beta-Hexachlorocyclohexane	2004	0	0.103	ng/dry g	0.12
Biphenyl	1997	19.5		ng/dry g	7.06
Biphenyl	2004	11.8	0.145	ng/dry g	7.06
C1-Chrysenes	1997	160.4	1.4	ng/dry g	95.16
C1-Chrysenes	2004	380	0.348	ng/dry g	95.16
C1-Dibenzothiophenes	1997	21.7	0.6	ng/dry g	13.6
C1-Dibenzothiophenes	2004	22	0.305	ng/dry g	13.6
C1-Fluoranthenes/Pyrenes	1997	238.2	2.1	ng/dry g	168.5
C1-Fluoranthenes/Pyrenes	2004	480	0.386	ng/dry g	168.5
C1-Fluorenes	1997	28.6	1	ng/dry g	12
C1-Fluorenes	2004	30.4	0.386	ng/dry g	12
C1-Naphthalenes	1997	114.1	2.3	ng/dry g	26.8
C1-Naphthalenes	2004	34	0.332	ng/dry g	26.8
C1-Phenanthrenes/Anthracenes	1997	154.2	0.5	ng/dry g	77.8
C1-Phenanthrenes/Anthracenes	2004	221	0.289	ng/dry g	77.8
C2-Chrysenes	1997	76.6	1.4	ng/dry g	66.5
C2-Chrysenes	2004	121	0.348	ng/dry g	66.5
C2-Dibenzothiophenes	1997	27.7	0.6	ng/dry g	27.2
C2-Dibenzothiophenes	2004	36.9	0.305	ng/dry g	27.2
C2-Fluoranthenes/Pyrenes	2004	147	0.386	ng/dry g	318

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C2-Fluorenes	1997	25.9	1	ng/dry g	23.1
C2-Fluorenes	2004	29.8	0.386	ng/dry g	23.1
C2-Naphthalenes	1997	58.4	1.2	ng/dry g	27.46
C2-Naphthalenes	2004	46.6	0.35	ng/dry g	27.46
C2-Phenanthrenes/Anthracenes	1997	82.9	0.5	ng/dry g	80.45
C2-Phenanthrenes/Anthracenes	2004	200	0.289	ng/dry g	80.45
C3-Chrysenes	1997	5.3	1.4	ng/dry g	10.5
C3-Chrysenes	2004	25.9	0.348	ng/dry g	10.5
C3-Dibenzothiophenes	1997	20.6	0.6	ng/dry g	26.77
C3-Dibenzothiophenes	2004	23.9	0.305	ng/dry g	26.77
C3-Fluoranthenes/Pyrenes	2004	76.3	0.386	ng/dry g	106
C3-Fluorenes	1997	22.2	1	ng/dry g	36.07
C3-Fluorenes	2004	26.1	0.386	ng/dry g	36.07
C3-Naphthalenes	1997	36.6	0.9	ng/dry g	31.7
C3-Naphthalenes	2004	43.5	0.35	ng/dry g	31.7
C3-Phenanthrenes/Anthracenes	1997	50	0.5	ng/dry g	71.7
C3-Phenanthrenes/Anthracenes	2004	124	0.289	ng/dry g	71.7
C4-Chrysenes	1997	26.9	1.4	ng/dry g	22.8
C4-Chrysenes	2004	30.2	0.348	ng/dry g	22.8
C4-Naphthalenes	1997	17.7	0.9	ng/dry g	24.41
C4-Naphthalenes	2004	28.6	0.35	ng/dry g	24.41
C4-Phenanthrenes/Anthracenes	1997	32	0.5	ng/dry g	44.1
C4-Phenanthrenes/Anthracenes	2004	44.1	0.289	ng/dry g	44.1
Cadmium	1986	*1.7*	0.08	µg/dry g	0.53
Cadmium	1997	0.1	0.003	µg/dry g	0.53
Cadmium	2004	0.584	0.195	µg/dry g	0.53
Chlorpyrifos	1997	0.07		ng/dry g	0.41
Chlorpyrifos	2004	0.241	0.082	ng/dry g	0.41

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Chromium	1986	***170***	6	µg/dry g	109.33
Chromium	1997	32	0.64	µg/dry g	109.33
Chromium	2004	***60.2***	0.488	µg/dry g	109.33
Chrysene	1997	***253.5***	0.7	ng/dry g	157.3
Chrysene	2004	***463***	0.174	ng/dry g	157.3
Cis-Nonachlor	1997	0.07		ng/dry g	0.3
Cis-Nonachlor	2004	0.213	0.089	ng/dry g	0.3
Clay	1986	29.333		Percent	38.67
Clay	1997	0.27		Percent	38.67
Clay	2004	7.8		Percent	38.67
Copper	1986	***150***	3	µg/dry g	43.8
Copper	1997	14	0.3	µg/dry g	43.8
Copper	2004	***59.6***	0.488	µg/dry g	43.8
Delta-Hexachlorocyclohexane	1997	0		ng/dry g	0.04
Delta-Hexachlorocyclohexane	2004	0	0.083	ng/dry g	0.04
Dibenzo[a,h]anthracene	1997	***62.7***	0.5	ng/dry g	46
Dibenzo[a,h]anthracene	2004	***57.8***	0.152	ng/dry g	46
Dibenzofuran	2004	17.4	2.22	ng/dry g	43.4
Dibenzothiophene	1997	19		ng/dry g	9
Dibenzothiophene	2004	15.2	0.152	ng/dry g	9
Dibutyltin	1997	0		ng/dry g	1.87
Dibutyltin	2004	0.216	0.412	ng/dry g	1.87
Dichlorobiphenyls	1986	0	0.62	ng/dry g	1.27
Dieldrin	1986	***7.92***	0.16	ng/dry g	0.99
Dieldrin	1997	***0.04***	0.04	ng/dry g	0.99
Dieldrin	2004	***0.255***	0.089	ng/dry g	0.99
Endosulfan I	2004	0	0.082	ng/dry g	0.3
Endosulfan II	1997	0		ng/dry g	0.28
Endosulfan II	2004	0.241	0.082	ng/dry g	0.28

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Endosulfan Sulfate	2004	0	0.133	ng/dry g	0.34
Endrin	1997	0		ng/dry g	0.06
Endrin	2004	0	0.131	ng/dry g	0.06
Fines	1986	0.707		Decimal	0.86
Fines	1997	0.016		Decimal	0.86
Fluoranthene	1997	***504.2***	0.5	ng/dry g	266.6
Fluoranthene	2004	***548***	0.21	ng/dry g	266.6
Fluorene	1997	***40.4***	0.3	ng/dry g	16
Fluorene	2004	***25.6***	0.193	ng/dry g	16
Gamma-Chlordane	1997	0.29		ng/dry g	0.39
Gamma-Chlordane	2004	0.284	0.112	ng/dry g	0.39
Gamma-Hexachlorocyclohexane	1986	0.518	0.14	ng/dry g	0.3
Gamma-Hexachlorocyclohexane	1997	0	0.08	ng/dry g	0.3
Gamma-Hexachlorocyclohexane	2004	0	0.082	ng/dry g	0.3
Gravel	1986	3.5		Percent	3.23
Gravel	1997	0		Percent	3.23
Gravel	2004	17.1		Percent	3.23
Heptachlor	1986	1.137	0.14	ng/dry g	0.11
Heptachlor	1997	0	0.05	ng/dry g	0.11
Heptachlor	2004	0	0.088	ng/dry g	0.11
Heptachlor-Epoxide	1986	0	0.16	ng/dry g	0.17
Heptachlor-Epoxide	1997	0	0.04	ng/dry g	0.17
Heptachlor-Epoxide	2004	0	0.074	ng/dry g	0.17
Heptachlorobiphenyls	1986	27	0.14	ng/dry g	12.5
Hexachlorobenzene	1986	0.98	0.14	ng/dry g	0.57
Hexachlorobenzene	1997	0.02	0.07	ng/dry g	0.57
Hexachlorobenzene	2004	0.085	0.052	ng/dry g	0.57
Hexachlorobiphenyls	1986	43.333	0.42	ng/dry g	24
Indeno[1,2,3-c,d]pyrene	1997	215	1	ng/dry g	91.7

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Indeno[1,2,3-c,d]pyrene	2004	293	0.279	ng/dry g	91.7
Iron	1986	42333.333	6	µg/dry g	37400
Iron	1997	13044	290	µg/dry g	37400
Iron	2004	17800	1.101	µg/dry g	37400
Lead	1986	***196.667***	3	µg/dry g	37.67
Lead	1997	25.5	0.35	µg/dry g	37.67
Lead	2004	***50.1***	0.043	µg/dry g	37.67
Manganese	1986	1123.333	6	µg/dry g	750
Manganese	1997	398	2.5	µg/dry g	750
Manganese	2004	439	0.195	µg/dry g	750
Mercury	1986	***2.4***	0.01	µg/dry g	0.2
Mercury	1997	0.05	0.005	µg/dry g	0.2
Mercury	2004	***0.523***	0.01	µg/dry g	0.2
Mirex	1986	1.06	0.2	ng/dry g	0.22
Mirex	1997	0	0.11	ng/dry g	0.22
Mirex	2004	0	0.097	ng/dry g	0.22
Monobutyltin	1997	0		ng/dry g	2.84
Monobutyltin	2004	0.78	0.711	ng/dry g	2.84
Naphthalene	1997	***196.9***	2.2	ng/dry g	29.44
Naphthalene	2004	***63.1***	0.174	ng/dry g	29.44
Nickel	1986	***40.333***	4	µg/dry g	37
Nickel	1997	15.8	0.19	µg/dry g	37
Nickel	2004	15.2	0.488	µg/dry g	37
Nonachlorobiphenyls	1986	2.467	0.31	ng/dry g	1.6
Octachlorobiphenyls	1986	9.933	0.14	ng/dry g	4.43
Oxychlordane	1997	0		ng/dry g	0.08
Oxychlordane	2004	0	0.143	ng/dry g	0.08
PCB101/90	1997	0.15	0.15	ng/dry g	1.87
PCB101/90	2004	1.433	0.32	ng/dry g	1.87
PCB105	1997	0.06	0.06	ng/dry g	0.68

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB105	2004	0.951	0.096	ng/dry g	0.68
PCB118	1997	0.19	0.07	ng/dry g	1.88
PCB118	2004	2.767	0.103	ng/dry g	1.88
PCB128	1997	0.02	0.14	ng/dry g	0.66
PCB128	2004	1.731	0.113	ng/dry g	0.66
PCB138	1997	0.22	0.07	ng/dry g	2.6
PCB138	2004	2.596	0.145	ng/dry g	2.6
PCB153/132/168	1997	0.29	0.08	ng/dry g	2.35
PCB153/132/168	2004	3.249	0.109	ng/dry g	2.35
PCB170/190	1997	0	0.17	ng/dry g	1.39
PCB170/190	2004	4.37	0.13	ng/dry g	1.39
PCB18	1997	0	0.82	ng/dry g	0.65
PCB18	2004	1.078	0.084	ng/dry g	0.65
PCB180	1997	0.13	0.05	ng/dry g	1.24
PCB180	2004	1.022	0.105	ng/dry g	1.24
PCB187	1997	0.11	0.08	ng/dry g	0.84
PCB187	2004	1.078	0.086	ng/dry g	0.84
PCB195/208	1997	0.01	0.09	ng/dry g	0.36
PCB195/208	2004	0.312	0.112	ng/dry g	0.36
PCB206	1997	0	0.05	ng/dry g	0.37
PCB206	2004	0.568	0.092	ng/dry g	0.37
PCB209	1997	0.04	0.1	ng/dry g	0.54
PCB209	2004	0.412	0.115	ng/dry g	0.54
PCB28	1997	0.17	0.09	ng/dry g	1.36
PCB28	2004	5.831	0.085	ng/dry g	1.36
PCB44	1997	0.16	0.1	ng/dry g	0.95
PCB44	2004	1.745	0.076	ng/dry g	0.95
PCB52	1997	0.14	0.42	ng/dry g	1.62
PCB52	2004	2.596	0.085	ng/dry g	1.62

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
PCB66	1997	0.08	0.07	ng/dry g	1.52
PCB66	2004	3.504	0.086	ng/dry g	1.52
PCB8/5	1997	0	0.12	ng/dry g	1.13
PCB8/5	2004	0.525	0.098	ng/dry g	1.13
Pentachloroanisole	1997	0.02		ng/dry g	0.09
Pentachloroanisole	2004	0.043	0.084	ng/dry g	0.09
Pentachlorobenzene	1997	0.01		ng/dry g	0.14
Pentachlorobenzene	2004	0.128	0.057	ng/dry g	0.14
Pentachlorobiphenyls	1986	116.667	0.14	ng/dry g	26.6
Percent lipid dry weight	2004	0		Percent	0
Perylene	1997	158.2	0.6	ng/dry g	76.72
Perylene	2004	122	1.381	ng/dry g	76.72
Phenanthrene	1997	***288.9***	0.8	ng/dry g	113.33
Phenanthrene	2004	240	0.145	ng/dry g	113.33
Pyrene	1997	***492***	1.1	ng/dry g	260.43
Pyrene	2004	***510***	0.193	ng/dry g	260.43
Sand	1986	26		Percent	86.77
Sand	1997	98.39		Percent	86.77
Sand	2004	54.6		Percent	86.77
Selenium	1986	1.067	0.13	µg/dry g	0.73
Selenium	1997	0.14	0.02	µg/dry g	0.73
Selenium	2004	0.354	0.049	µg/dry g	0.73
Silicon	1986	280000	4000	µg/dry g	376666.67
Silicon	2004	252000		µg/dry g	376666.67
Silt	1986	41.333		Percent	49.96
Silt	1997	1.34		Percent	49.96
Silt	2004	20.5		Percent	49.96
Silver	1986	***4.8***	0.02	µg/dry g	0.48
Silver	1997	0.14	0.011	µg/dry g	0.48

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Silver	2004	***1.07***	0.043	µg/dry g	0.48
Tetrabutyltin	1997	0		ng/dry g	0.38
Tetrabutyltin	2004	0	0.492	ng/dry g	0.38
Tetrachlorobiphenyls	1986	150	0.16	ng/dry g	19.33
Thallium	1986	0.703	0.2	µg/dry g	0.51
Thallium	1997	0.24	0.04	µg/dry g	0.51
Tin	1986	30	1	µg/dry g	3
Tin	1997	5.1	0.11	µg/dry g	3
Tin	2004	9.68	0.087	µg/dry g	3
Total butyltins	1997	0		ng/dry g	9.09
Total butyltins	2004	1.482		ng/dry g	9.09
Total chlordanes	1986	9.05		ng/dry g	1.94
Total chlordanes	1997	0.37		ng/dry g	1.94
Total chlordanes	2004	0		ng/dry g	1.94
Total DDT	1986	***45.816***		ng/dry g	15.17
Total DDT	1997	1.13		ng/dry g	15.17
Total DDT	2004	***5.903***		ng/dry g	15.17
Total dieldrin	1986	7.92		ng/dry g	1.4
Total dieldrin	1997	0.09		ng/dry g	1.4
Total dieldrin	2004	0.255		ng/dry g	1.4
Total Inorganic Carbon	1986	0.086		Percent	1.03
Total Inorganic Carbon	1997	0.158		Percent	1.03
Total Inorganic Carbon	2004	1.4		Percent	1.03
Total Organic Carbon	1986	1.5		Percent	2.6
Total Organic Carbon	1997	0.131		Percent	2.6
Total Organic Carbon	2004	1.1		Percent	2.6
Total PAH	1997	***4074.1***		ng/dry g	1836.6
Total PAHhmw (4 or more rings)	1997	***3129.8***		ng/dry g	1640.65
Total PAHhmw (4 or more rings)	2004	***4008.8***		ng/dry g	1640.65
Total PAHlmw (2-3 rings)	1997	***944.3***		ng/dry g	317.7

Table 5. Analyte Concentration in Sediment from HRRB in 1997 and 2004. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Total PAHlmw (2-3 rings)	2004	***708.1***		ng/dry g	317.7
Total PCBcg	1997	3.54		ng/dry g	43.65
Trans-Nonachlor	1986	3.713	0.2	ng/dry g	0.63
Trans-Nonachlor	1997	0.18	0.1	ng/dry g	0.63
Trans-Nonachlor	2004	0	0.09	ng/dry g	0.63
Tributyltin	1997	0		ng/dry g	3.5
Tributyltin	2004	0.486	0.56	ng/dry g	3.5
Trichlorobiphenyls	1986	44.333	0.16	ng/dry g	6.03
Zinc	1986	***366.667***	2	µg/dry g	126.67
Zinc	1997	65	0.78	µg/dry g	126.67
Zinc	2004	***161***	0.501	µg/dry g	126.67

Blue: Concentration is above the TEL- Threshold Effect Levels (NOAA SQuiRT)
Pink: Concentration is above both the ERL and TEL (NOAA SQuiRT)

Table 6. Sand, Silt, and TOC Concentrations from HRRB in 1986, 1997, and 2004 (NOAA 2006)

Sediment					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Sand	1986	26		Percent	86.77
Sand	1997	98.39		Percent	86.77
Sand	2004	54.6		Percent	86.77
Silt	1986	41.333		Percent	49.96
Silt	1997	1.34		Percent	49.96
Silt	2004	20.5		Percent	49.96
Total Organic Carbon	1986	1.5		Percent	2.6
Total Organic Carbon	1997	0.131		Percent	2.6
Total Organic Carbon	2004	1.1		Percent	2.6

Table 7. HRRB Site Specific BAF for 2004.

ANALYTE NAME	Concentration		Units	SBAF
	Sediment	Tissue		
1,2,3,4-Tetrachlorobenzene	0.17	22.222	ng/dry g	130.718
1,2,4,5-Tetrachlorobenzene	0	ND	ng/dry g	
1,6,7-Trimethylnaphthalene	5.7	0.7	ng/dry g	0.123
1-Methylnaphthalene	15.6	1.5	ng/dry g	0.096
1-Methylphenanthrene	32.8	ND	ng/dry g	
2,4'-DDD	1.547	12.344	ng/dry g	7.979
2,4'-DDE	0	3.918	ng/dry g	0.000
2,4'-DDT	0.128	2.299	ng/dry g	17.961
2,6-Dimethylnaphthalene	21.3	3.6	ng/dry g	0.169
2-Methylnaphthalene	33.7	15.1	ng/dry g	0.448
4,4'-DDD	1.887	25.021	ng/dry g	13.260
4,4'-DDE	2.242	21.496	ng/dry g	9.588
4,4'-DDT	0.099	1.346	ng/dry g	13.596
Acenaphthene	23.7	2.5	ng/dry g	0.105
Acenaphthylene	82.8	10.2	ng/dry g	0.123
Aldrin	0	0	ng/dry g	0.000
Alpha-Chlordane	0	6.172	ng/dry g	0.000
Alpha-Hexachlorocyclohexane	0	0	ng/dry g	0.000
Aluminum	35800	1900	µg/dry g	0.053
Anthracene	152	18.6	ng/dry g	0.122
Antimony	0.539	ND	µg/dry g	
Arsenic	8.33	7.06	µg/dry g	0.848
Benz[a]anthracene	500	39.2	ng/dry g	0.078
Benzo[a]pyrene	454	25.2	ng/dry g	0.056
Benzo[b]fluoranthene	256	73.9	ng/dry g	0.289
Benzo[e]pyrene	249	92.8	ng/dry g	0.373
Benzo[g,h,i]perylene	237	18.8	ng/dry g	0.079
Benzo[k]fluoranthene	319	48.1	ng/dry g	0.151
Beta-Hexachlorocyclohexane	0	0.076	ng/dry g	0.000
Biphenyl	11.8	7.9	ng/dry g	0.669
C1-Chrysenes	380	37.7	ng/dry g	0.099
C1-Dibenzothiophenes	22	4.7	ng/dry g	0.214
C1-Fluoranthenes/Pyrenes	480	70.4	ng/dry g	0.147
C1-Fluorenes	30.4	0	ng/dry g	0.000
C1-Naphthalenes	34	15.5	ng/dry g	0.456
C1-Phenanthrenes/Anthracenes	221	16.9	ng/dry g	0.076
C2-Chrysenes	121	34.4	ng/dry g	0.284
C2-Dibenzothiophenes	36.9	12.9	ng/dry g	0.350
C2-Fluoranthenes/Pyrenes	147	36.7	ng/dry g	0.250
C2-Fluorenes	29.8	0	ng/dry g	0.000
C2-Naphthalenes	46.6	10	ng/dry g	0.215
C2-Phenanthrenes/Anthracenes	200	42.9	ng/dry g	0.215
C3-Chrysenes	25.9	0	ng/dry g	0.000
C3-Dibenzothiophenes	23.9	22.7	ng/dry g	0.950
C3-Fluoranthenes/Pyrenes	76.3	12	ng/dry g	0.157
C3-Fluorenes	26.1	0	ng/dry g	0.000
C3-Naphthalenes	43.5	5.2	ng/dry g	0.120
C3-Phenanthrenes/Anthracenes	124	41.4	ng/dry g	0.334

Table 7. HRRB Site Specific BAF for 2004. (Continued)

ANALYTE NAME	Concentration		Units	SBAF
	Sediment	Tissue		
C4-Chrysenes	30.2	0	ng/dry g	0.000
C4-Naphthalenes	28.6	8.7	ng/dry g	0.304
C4-Phenanthrenes/Anthracenes	44.1	21.3	ng/dry g	0.483
Cadmium	0.584	1.97	µg/dry g	3.373
Chlorpyrifos	0.241	0	ng/dry g	0.000
Chromium	60.2	25.2	µg/dry g	0.419
Chrysene	463	95.5	ng/dry g	0.206
Cis-Nonachlor	0.213	2.632	ng/dry g	12.357
Copper	59.6	22.4	µg/dry g	0.376
Delta-Hexachlorocyclohexane	0	0.015	ng/dry g	0.000
Dibenzo[a,h]anthracene	57.8	4.5	ng/dry g	0.078
Dibenzofuran	17.4	3.4	ng/dry g	0.195
Dibenzothiophene	15.2	0.9	ng/dry g	0.059
Dibutyltin	0.216	10.42	ng/dry g	48.241
Dieldrin	0.255	4.281	ng/dry g	16.788
Endosulfan I	0	4.498	ng/dry g	0.000
Endosulfan II	0.241	0	ng/dry g	0.000
Endosulfan Sulfate	0	0	ng/dry g	0.000
Endrin	0	0	ng/dry g	0.000
Fluoranthene	548	75.5	ng/dry g	0.138
Fluorene	25.6	2.7	ng/dry g	0.105
Gamma-Chlordane	0.284	4.962	ng/dry g	17.472
Gamma-Hexachlorocyclohexane	0	0.197	ng/dry g	0.000
Heptachlor	0	0	ng/dry g	0.000
Heptachlor-Epoxide	0	0.378	ng/dry g	0.000
Hexachlorobenzene	0.085	0.181	ng/dry g	2.129
Indeno[1,2,3-c,d]pyrene	293	22.6	ng/dry g	0.077
Iron	17800	5460	µg/dry g	0.307
Lead	50.1	22.8	µg/dry g	0.455
Manganese	439	245	µg/dry g	0.558
Mercury	0.523	0.246	µg/dry g	0.470
Mirex	0	0	ng/dry g	0.000
Monobutyltin	0.78	4.47	ng/dry g	5.731
Naphthalene	63.1	22.3	ng/dry g	0.353
Nickel	15.2	9.7	µg/dry g	0.638
Oxychlordane	0	0.832	ng/dry g	0.000
PCB101/90	1.433	5.55	ng/dry g	3.873
PCB105	0.951	6.248	ng/dry g	6.570
PCB118	2.767	18.168	ng/dry g	6.566
PCB128	1.731	2.072	ng/dry g	1.197
PCB138	2.596	19.847	ng/dry g	7.645
PCB153/132/168	3.249	32.675	ng/dry g	10.057
PCB170/190	4.37	1.679	ng/dry g	0.384
PCB18	1.078	2.42	ng/dry g	2.245
PCB180	1.022	6.702	ng/dry g	6.558
PCB187	1.078	8.895	ng/dry g	8.251
PCB195/208	0.312	0.378	ng/dry g	1.212
PCB206	0.568	0.091	ng/dry g	0.160

Table 7. HRRB Site Specific BAF for 2004. (Continued)

ANALYTE NAME	Concentration		Units	SBAF
	Sediment	Tissue		
PCB209	0.412	0.091	ng/dry g	0.221
PCB28	5.831	6.823	ng/dry g	1.170
PCB44	1.745	0	ng/dry g	0.000
PCB52	2.596	17.669	ng/dry g	6.806
PCB66	3.504	10.075	ng/dry g	2.875
PCB8/5	0.525	0	ng/dry g	0.000
Pentachloroanisole	0.043	0.65	ng/dry g	15.116
Pentachlorobenzene	0.128	1.997	ng/dry g	15.602
Perylene	122	7.3	ng/dry g	0.060
Phenanthrene	240	14.5	ng/dry g	0.060
Pyrene	510	166	ng/dry g	0.325
Selenium	0.354	5.32	µg/dry g	15.028
Silicon	252000	ND	µg/dry g	
Silver	1.07	1.03	µg/dry g	0.963
Tetrabutyltin	0	0	ng/dry g	0.000
Tin	9.68	2.87	µg/dry g	0.296
Total butyltins	1.482	60.65	ng/dry g	40.924
Total chlordanes	0	10.74	ng/dry g	0.000
Total DDT	5.903	66.424	ng/dry g	11.253
Total dieldrin	0.255	4.281	ng/dry g	16.788
Total Inorganic Carbon	1.4		Percent	1.400
Total Organic Carbon	1.1		Percent	1.100
Total PAHhmw (4 or more rings)	4008.8	669.4	ng/dry g	0.167
Total PAHlmw (2-3 rings)	708.1	107.3	ng/dry g	0.152
Trans-Nonachlor	0	4.19	ng/dry g	0.000
Tributyltin	0.486	45.76	ng/dry g	94.156
Zinc	161	189	µg/dry g	1.174

SBAF = Tissue/Sediment
ND: No Data- analyte was provided for tissue in NOAA data for 2004.

Table 8. Analyte Concentration in Tissue from HRUB in All Years, Target Species: *Mytilus edulis* (NOAA 2006).

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
2,4'-DDD	1986	9	0.75	ng/dry g	6.33
2,4'-DDD	1987	0	1.3	ng/dry g	6.33
2,4'-DDD	1988	24	1.4	ng/dry g	6.33
2,4'-DDE	1986	20	0.5	ng/dry g	3.22
2,4'-DDE	1987	0	0.17	ng/dry g	3.22
2,4'-DDE	1988	0	0.24	ng/dry g	3.22
2,4'-DDT	1986	9.667	0.85	ng/dry g	3.3
2,4'-DDT	1987	0	0.5	ng/dry g	3.3
2,4'-DDT	1988	6.6	0.49	ng/dry g	3.3
4,4'-DDD	1986	48.667	1.8	ng/dry g	19
4,4'-DDD	1987	126.667	0.38	ng/dry g	19
4,4'-DDD	1988	110	0.64	ng/dry g	19
4,4'-DDE	1986	74.333	0.6	ng/dry g	48
4,4'-DDE	1987	87.667	0.28	ng/dry g	48
4,4'-DDE	1988	93	0.27	ng/dry g	48
4,4'-DDT	1986	30.667	0.3	ng/dry g	4.39
4,4'-DDT	1987	20.667	1	ng/dry g	4.39
4,4'-DDT	1988	15	0.11	ng/dry g	4.39
Aldrin	1986	5.333	0.6	ng/dry g	0.69
Aldrin	1987	0	0.25	ng/dry g	0.69
Aldrin	1988	14	0.12	ng/dry g	0.69
Alpha-Chlordane	1986	42.333	0.3	ng/dry g	10.89
Alpha-Chlordane	1987	27.667	0.36	ng/dry g	10.89
Alpha-Chlordane	1988	25	0.32	ng/dry g	10.89
Aluminum	1986	636.667	27	µg/dry g	732
Aluminum	1987	493.333	27	µg/dry g	732
Aluminum	1988	1100	60	µg/dry g	732
Antimony	1986	0	0.4	µg/dry g	0.05
Antimony	1987	0.133	0.4	µg/dry g	0.05
Arsenic	1986	9.533	1.5	µg/dry g	15.67
Arsenic	1987	9.467	1.5	µg/dry g	15.67
Arsenic	1988	11	2	µg/dry g	15.67
Cadmium	1986	9.3	0.9	µg/dry g	5.42
Cadmium	1987	15.667	0.9	µg/dry g	5.42
Cadmium	1988	7.6	0.19	µg/dry g	5.42
Chromium	1986	10.967	0.21	µg/dry g	3.02
Chromium	1987	8.6	0.21	µg/dry g	3.02
Chromium	1988	15	0.12	µg/dry g	3.02

Table 8. Analyte Concentration in Tissue from HRUB in All Years, Target Species: *Mytilus edulis* (NOAA 2006). (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Copper	1986	16.667	3	µg/dry g	183
Copper	1987	20.333	3	µg/dry g	183
Copper	1988	25	3	µg/dry g	183
Dichlorobiphenyls	1986	4.167	2.3	ng/dry g	11.4
Dichlorobiphenyls	1987	1.7	2.3	ng/dry g	11.4
Dieldrin	1986	55	0.6	ng/dry g	9.34
Dieldrin	1987	43.333	0.52	ng/dry g	9.34
Dieldrin	1988	0	0.11	ng/dry g	9.34
Gamma-Hexachlorocyclohexane	1986	0.867	0.5	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1987	0.273	0.1	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1988	0	0.18	ng/dry g	2.15
Heptachlor	1986	1.367	0.5	ng/dry g	0.54
Heptachlor	1987	0	0.91	ng/dry g	0.54
Heptachlor	1988	0	0.15	ng/dry g	0.54
Heptachlor-Epoxide	1986	3.6	0.6	ng/dry g	2.17
Heptachlor-Epoxide	1987	0	0.29	ng/dry g	2.17
Heptachlor-Epoxide	1988	6	0.1	ng/dry g	2.17
Heptachlorobiphenyls	1986	86.667	0.5	ng/dry g	44.67
Heptachlorobiphenyls	1987	117.667	0.5	ng/dry g	44.67
Hexachlorobenzene	1986	1.133	0.5	ng/dry g	0.69
Hexachlorobenzene	1987	1.1	0.32	ng/dry g	0.69
Hexachlorobenzene	1988	2	0.34	ng/dry g	0.69
Hexachlorobiphenyls	1986	740	1.6	ng/dry g	190
Hexachlorobiphenyls	1987	353.333	1.6	ng/dry g	190
Iron	1986	1706.667	30	µg/dry g	872
Iron	1987	760	30	µg/dry g	872
Iron	1988	1700	5	µg/dry g	872
Lead	1986	14	0.06	µg/dry g	2.76
Lead	1987	28	0.06	µg/dry g	2.76
Lead	1988	26	0.17	µg/dry g	2.76
Manganese	1986	75.667	3	µg/dry g	39.04
Manganese	1987	69	3	µg/dry g	39.04
Mercury	1986	0.47	0.001	µg/dry g	0.21
Mercury	1987	0.59	0.001	µg/dry g	0.21
Mercury	1988	0.72	0.01	µg/dry g	0.21
Mirex	1986	3.633	0.75	ng/dry g	0.97
Mirex	1987	5.367	0.34	ng/dry g	0.97
Mirex	1988	0	0.19	ng/dry g	0.97

Table 8. Analyte Concentration in Tissue from HRUB in All Years, Target Species: *Mytilus edulis* (NOAA 2006). (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Nickel	1986	4.633	0.23	µg/dry g	3.84
Nickel	1987	6.667	0.23	µg/dry g	3.84
Nickel	1988	8.6	0.25	µg/dry g	3.84
Nonachlorobiphenyls	1986	1.733	1.2	ng/dry g	0.77
Nonachlorobiphenyls	1987	0	1.2	ng/dry g	0.77
Octachlorobiphenyls	1986	52.667	0.5	ng/dry g	3.53
Octachlorobiphenyls	1987	7.233	0.5	ng/dry g	3.53
PCB101/90	1988	82	0.28	ng/dry g	17.84
PCB105	1988	0	1.2	ng/dry g	4.95
PCB118	1988	71	0.38	ng/dry g	17
PCB128	1988	17	1.2	ng/dry g	3.58
PCB138	1988	120	0.43	ng/dry g	25.33
PCB153/132/168	1988	120	0.29	ng/dry g	34.12
PCB170/190	1988	28	0.11	ng/dry g	3.08
PCB18	1988	18	0.22	ng/dry g	2.3
PCB180	1988	26	0.08	ng/dry g	7.18
PCB187	1988	37	0.81	ng/dry g	10.6
PCB195/208	1988	0	0.09	ng/dry g	0.38
PCB206	1988	0	0.08	ng/dry g	0.21
PCB209	1988	0	0.06	ng/dry g	0.6
PCB28	1988	43	0.42	ng/dry g	3.66
PCB44	1988	42	0.25	ng/dry g	5.23
PCB52	1988	82	0.17	ng/dry g	10.12
PCB66	1988	96	0.43	ng/dry g	6.43
PCB8/5	1988	0	0.6	ng/dry g	2.17
Pentachlorobiphenyls	1986	1366.667	0.5	ng/dry g	245.33
Pentachlorobiphenyls	1987	450	0.5	ng/dry g	245.33

Table 8. Analyte Concentration in Tissue from HRUB in All Years, Target Species: *Mytilus edulis* (NOAA 2006). (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Percent lipid dry weight	1986	4.833		Percent	10.33
Percent lipid dry weight	1987	5.033		Percent	10.33
Percent lipid dry weight	1988	6		Percent	10.33
Selenium	1986	3.333	0.58	µg/dry g	3.86
Selenium	1987	4.067	0.58	µg/dry g	3.86
Selenium	1988	3.4	1	µg/dry g	3.86
Silicon	1986	4966.667	600	µg/dry g	3000
Silicon	1987	1666.667	600	µg/dry g	3000
Silver	1986	2.072	0.12	µg/dry g	3.7
Silver	1987	1.608	0.12	µg/dry g	3.7
Silver	1988	1.487	0.01	µg/dry g	3.7
Tetrachlorobiphenyls	1986	953.333	0.6	ng/dry g	135.33
Tetrachlorobiphenyls	1987	516.667	0.6	ng/dry g	135.33
Thallium	1986	0	0.05	µg/dry g	0
Thallium	1987	0	0.05	µg/dry g	0
Tin	1986	1.593	0.5	µg/dry g	0.35
Tin	1987	0.353	0.5	µg/dry g	0.35
Tin	1988	0	0.04	µg/dry g	0.35
Total chlordanes	1986	70.633		ng/dry g	22.5
Total chlordanes	1987	53.334		ng/dry g	22.5
Total chlordanes	1988	50		ng/dry g	22.5
Total DDT	1986	192.334		ng/dry g	88.66
Total DDT	1987	235.001		ng/dry g	88.66
Total DDT	1988	248.6		ng/dry g	88.66
Total dieldrin	1986	60.333		ng/dry g	10.18
Total dieldrin	1987	43.333		ng/dry g	10.18
Total dieldrin	1988	14		ng/dry g	10.18
Total PCBcg	1988	1564		ng/dry g	324.86
Trans-Nonachlor	1986	23.333	0.75	ng/dry g	9.68
Trans-Nonachlor	1987	25.667	0.34	ng/dry g	9.68
Trans-Nonachlor	1988	19	0.22	ng/dry g	9.68
Trichlorobiphenyls	1986	112.667	0.6	ng/dry g	33
Trichlorobiphenyls	1987	120	0.6	ng/dry g	33
Zinc	1986	133.333	2	µg/dry g	2980
Zinc	1987	220	2	µg/dry g	2980
Zinc	1988	150	5	µg/dry g	2980

Table 9. Analyte Concentration in Sediment from HRUB in All Years. (NOAA 2006)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
1,2,3,4-Tetrachlorobenzene	2004	0.897	0.049	ng/dry g	0.12
1,2,4,5-Tetrachlorobenzene	2004	1.108	0.3	ng/dry g	0.53
1,6,7-Trimethylnaphthalene	1989	22	0.79	ng/dry g	8.2
1,6,7-Trimethylnaphthalene	2004	11.4	0.096	ng/dry g	8.2
1-Methylnaphthalene	1989	40.5	0.63	ng/dry g	13.9
1-Methylnaphthalene	2004	63.8	0.128	ng/dry g	13.9
1-Methylphenanthrene	1989	54	1.3	ng/dry g	21.34
1-Methylphenanthrene	2004	92.5	0.205	ng/dry g	21.34
2,4'-DDD	1986	2.333	0.2	ng/dry g	1.36
2,4'-DDD	1987	0	0.36	ng/dry g	1.36
2,4'-DDD	1989	1.305	0.04	ng/dry g	1.36
2,4'-DDD	2004	3.668	0.11	ng/dry g	1.36
2,4'-DDE	1986	0	0.14	ng/dry g	0.4
2,4'-DDE	1987	0	0.05	ng/dry g	0.4
2,4'-DDE	1989	2.125	0.07	ng/dry g	0.4
2,4'-DDE	2004	0.844	0.087	ng/dry g	0.4
2,4'-DDT	1986	0	0.23	ng/dry g	0.23
2,4'-DDT	1987	0	0.13	ng/dry g	0.23
2,4'-DDT	1989	0.235	0.05	ng/dry g	0.23
2,4'-DDT	2004	6.122	0.101	ng/dry g	0.23
2,6-Dimethylnaphthalene	1989	59.5	1.1	ng/dry g	14.67
2,6-Dimethylnaphthalene	2004	123	0.205	ng/dry g	14.67
2-Methylnaphthalene	1989	87	0.72	ng/dry g	20.33
2-Methylnaphthalene	2004	144	0.205	ng/dry g	20.33
4,4'-DDD	1986	22.333	0.49	ng/dry g	4.18
4,4'-DDD	1987	1.6	0.1	ng/dry g	4.18
4,4'-DDD	1989	9.8	0.05	ng/dry g	4.18
4,4'-DDD	2004	6.741	0.131	ng/dry g	4.18
4,4'-DDE	1986	8.37	0.16	ng/dry g	4.1
4,4'-DDE	1987	4.643	0.07	ng/dry g	4.1
4,4'-DDE	1989	5.75	0.06	ng/dry g	4.1
4,4'-DDE	2004	1.28	0.145	ng/dry g	4.1
4,4'-DDT	1986	8.303	0.08	ng/dry g	1.73
4,4'-DDT	1987	3.3	0.27	ng/dry g	1.73
4,4'-DDT	1989	1.47	0.05	ng/dry g	1.73
4,4'-DDT	2004	1.082	0.14	ng/dry g	1.73
Acenaphthene	1989	50.5	0.28	ng/dry g	8.6
Acenaphthene	2004	71.1	0.128	ng/dry g	8.6

Table 9. Analyte Concentration in Sediment from HRUB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Acenaphthylene	1989	80.5	2	ng/dry g	19.4
Acenaphthylene	2004	243	0.193	ng/dry g	19.4
Aldrin	1986	0	0.16	ng/dry g	0.23
Aldrin	1987	0	0.07	ng/dry g	0.23
Aldrin	1989	0.8	0.07	ng/dry g	0.23
Aldrin	2004	0	0.068	ng/dry g	0.23
Alpha-Chlordane	1986	2.367	0.08	ng/dry g	0.91
Alpha-Chlordane	1987	1.08	0.1	ng/dry g	0.91
Alpha-Chlordane	1989	2.065	0.06	ng/dry g	0.91
Alpha-Chlordane	2004	2.098	0.085	ng/dry g	0.91
Alpha-Hexachlorocyclohexane	2004	0	0.071	ng/dry g	0.08
Aluminum	1987	57000	5000	µg/dry g	70000
Aluminum	1989	55500	1500	µg/dry g	70000
Aluminum	2004	65900	4.882	µg/dry g	70000
Anthracene	1989	180	1.3	ng/dry g	45.5
Anthracene	2004	461	0.187	ng/dry g	45.5
Antimony	1987	5	0.8	µg/dry g	1.23
Antimony	2004	1.07		µg/dry g	1.23
Arsenic	1987	23.167	1.7	µg/dry g	13
Arsenic	1989	6.85	2.1	µg/dry g	13
Arsenic	2004	16	1.95	µg/dry g	13
Benz[a]anthracene	1989	355	1.7	ng/dry g	135.6
Benz[a]anthracene	2004	679	0.128	ng/dry g	135.6
Benzo[a]pyrene	1989	350	0.67	ng/dry g	145.88
Benzo[a]pyrene	2004	863	0.219	ng/dry g	145.88
Benzo[b]fluoranthene	1989	325	2.9	ng/dry g	186.9
Benzo[b]fluoranthene	2004	660	0.289	ng/dry g	186.9
Benzo[e]pyrene	1989	234.5	0.84	ng/dry g	105
Benzo[e]pyrene	2004	549	0.305	ng/dry g	105
Benzo[g,h,i]perylene	1989	246	1.1	ng/dry g	95.4
Benzo[g,h,i]perylene	2004	420	0.145	ng/dry g	95.4
Benzo[k]fluoranthene	1989	186	1.1	ng/dry g	76
Benzo[k]fluoranthene	2004	626	0.226	ng/dry g	76
Beta-Hexachlorocyclohexane	2004	0.079	0.103	ng/dry g	0.12
Biphenyl	1989	26.5	0.66	ng/dry g	7.06
Biphenyl	2004	54.9	0.145	ng/dry g	7.06

Table 9. Analyte Concentration in Sediment from HRUB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C1-Chrysenes	2004	744	0.348	ng/dry g	95.16
C1-Dibenzothiophenes	2004	103	0.305	ng/dry g	13.6
C1-Fluoranthenes/Pyrenes	2004	880	0.386	ng/dry g	168.5
C1-Fluorenes	2004	141	0.386	ng/dry g	12
C1-Naphthalenes	2004	143	0.332	ng/dry g	26.8
C1-Phenanthrenes/Anthracenes	2004	527	0.289	ng/dry g	77.8
C2-Chrysenes	2004	277	0.348	ng/dry g	66.5
C2-Dibenzothiophenes	2004	142	0.305	ng/dry g	27.2
C2-Fluoranthenes/Pyrenes	2004	318	0.386	ng/dry g	318
C2-Fluorenes	2004	71.6	0.386	ng/dry g	23.1
C2-Naphthalenes	2004	240	0.35	ng/dry g	27.46
C2-Phenanthrenes/Anthracenes	2004	500	0.289	ng/dry g	80.45
C3-Chrysenes	2004	51.2	0.348	ng/dry g	10.5
C3-Dibenzothiophenes	2004	118	0.305	ng/dry g	26.77
C3-Fluoranthenes/Pyrenes	2004	106	0.386	ng/dry g	106
C3-Fluorenes	2004	63.5	0.386	ng/dry g	36.07
C3-Naphthalenes	2004	194	0.35	ng/dry g	31.7
C3-Phenanthrenes/Anthracenes	2004	300	0.289	ng/dry g	71.7
C4-Chrysenes	2004	58.5	0.348	ng/dry g	22.8
C4-Naphthalenes	2004	109	0.35	ng/dry g	24.41
C4-Phenanthrenes/Anthracenes	2004	57.5	0.289	ng/dry g	44.1
Cadmium	1987	0.933	0.08	µg/dry g	0.53
Cadmium	1989	0.875	0.01	µg/dry g	0.53
Cadmium	2004	0.599	0.195	µg/dry g	0.53
Chlorpyrifos	2004	1.266	0.082	ng/dry g	0.41
Chromium	1987	90.333	6	µg/dry g	109.33
Chromium	1989	102.5	6	µg/dry g	109.33
Chromium	2004	118	0.488	µg/dry g	109.33

Table 9. Analyte Concentration in Sediment from HRUB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Delta-Hexachlorocyclohexane	2004	0.211	0.083	ng/dry g	0.04
Dibenzo[a,h]anthracene	1989	55.5	1	ng/dry g	46
Dibenzo[a,h]anthracene	2004	124	0.152	ng/dry g	46
Dibenzofuran	2004	74.1	2.22	ng/dry g	43.4
Dibenzothiophene	2004	62	0.152	ng/dry g	9
Dibutyltin	2004	6.6	0.412	ng/dry g	1.87
Dichlorobiphenyls	1986	2.8	0.62	ng/dry g	1.27
Dichlorobiphenyls	1987	4.1	0.62	ng/dry g	1.27
Dieldrin	1986	4.157	0.16	ng/dry g	0.99
Dieldrin	1987	2.34	0.14	ng/dry g	0.99
Dieldrin	1989	2.25	0.07	ng/dry g	0.99
Dieldrin	2004	0.858	0.089	ng/dry g	0.99
Endosulfan I	2004	0	0.082	ng/dry g	0.3
Endosulfan II	2004	1.847	0.082	ng/dry g	0.28
Endosulfan Sulfate	2004	0	0.133	ng/dry g	0.34
Endrin	2004	0	0.131	ng/dry g	0.06
Fines	1986	0.157		Decimal	0.86
Fines	1987	0.767		Decimal	0.86
Fines	1989	0.268		Decimal	0.86
Fluoranthene	1989	455	1.5	ng/dry g	266.6
Fluoranthene	2004	919	0.21	ng/dry g	266.6
Fluorene	1989	46.5	0.51	ng/dry g	16
Fluorene	2004	87.3	0.193	ng/dry g	16
Gamma-Chlordane	2004	1.742	0.112	ng/dry g	0.39
Gamma-Hexachlorocyclohexane	1986	0	0.14	ng/dry g	0.3
Gamma-Hexachlorocyclohexane	1987	0.183	0.03	ng/dry g	0.3
Gamma-Hexachlorocyclohexane	1989	0.395	0.02	ng/dry g	0.3
Gamma-Hexachlorocyclohexane	2004	0	0.082	ng/dry g	0.3
Gravel	1986	8.467		Percent	3.23
Gravel	1987	3.733		Percent	3.23
Gravel	1989	10.57		Percent	3.23
Gravel	2004	0		Percent	3.23

Table 9. Analyte Concentration in Sediment from HRUB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Heptachlor	1986	0.719	0.14	ng/dry g	0.11
Heptachlor	1987	0.293	0.24	ng/dry g	0.11
Heptachlor	1989	0.655	0.04	ng/dry g	0.11
Heptachlor	2004	1.398	0.088	ng/dry g	0.11
Heptachlor-Epoxide	1986	0	0.16	ng/dry g	0.17
Heptachlor-Epoxide	1987	0.327	0.08	ng/dry g	0.17
Heptachlor-Epoxide	1989	1.29	0.06	ng/dry g	0.17
Heptachlor-Epoxide	2004	0.383	0.074	ng/dry g	0.17
Heptachlorobiphenyls	1986	16.667	0.14	ng/dry g	12.5
Heptachlorobiphenyls	1987	10.367	0.14	ng/dry g	12.5
Hexachlorobenzene	1986	0.35	0.14	ng/dry g	0.57
Hexachlorobenzene	1987	0.29	0.09	ng/dry g	0.57
Hexachlorobenzene	1989	0.49	0.03	ng/dry g	0.57
Hexachlorobenzene	2004	0.356	0.052	ng/dry g	0.57
Hexachlorobiphenyls	1986	19.667	0.42	ng/dry g	24
Hexachlorobiphenyls	1987	20.933	0.42	ng/dry g	24
Indeno[1,2,3-c,d]pyrene	1989	230.5	1.51	ng/dry g	91.7
Indeno[1,2,3-c,d]pyrene	2004	537	0.279	ng/dry g	91.7
Iron	1987	34000	6	µg/dry g	37400
Iron	1989	26500	3	µg/dry g	37400
Iron	2004	41400	1.101	µg/dry g	37400
Lead	1987	137.333	3	µg/dry g	37.67
Lead	1989	89.5	2.2	µg/dry g	37.67
Lead	2004	93.1	0.043	µg/dry g	37.67
Manganese	1987	616.667	6	µg/dry g	750
Manganese	2004	901	0.195	µg/dry g	750
Mercury	1987	3.293	0.01	µg/dry g	0.2
Mercury	1989	0.825	0.009	µg/dry g	0.2
Mercury	2004	0.963	0.01	µg/dry g	0.2
Mirex	1986	2.65	0.2	ng/dry g	0.22
Mirex	1987	2.1	0.09	ng/dry g	0.22
Mirex	1989	0	0.13	ng/dry g	0.22
Mirex	2004	0	0.097	ng/dry g	0.22
Monobutyltin	2004	2.84	0.711	ng/dry g	2.84
Naphthalene	1989	85	0.47	ng/dry g	29.44
Naphthalene	2004	208	0.174	ng/dry g	29.44
Nickel	1987	35.333	4	µg/dry g	37
Nickel	1989	41	2.1	µg/dry g	37
Nickel	2004	33.9	0.488	µg/dry g	37

Table 9. Analyte Concentration in Sediment from HRUB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Nonachlorobiphenyls	1986	0.93	0.31	ng/dry g	1.6
Nonachlorobiphenyls	1987	2.7	0.31	ng/dry g	1.6
Octachlorobiphenyls	1986	6.333	0.14	ng/dry g	4.43
Octachlorobiphenyls	1987	7.567	0.14	ng/dry g	4.43
Oxychlordane	2004	1.425	0.143	ng/dry g	0.08
PCB101/90	1989	7.35	0.1	ng/dry g	1.87
PCB101/90	2004	14.129	0.32	ng/dry g	1.87
PCB105	1989	3.9	0.1	ng/dry g	0.68
PCB105	2004	5.356	0.096	ng/dry g	0.68
PCB118	1989	7.25	0.06	ng/dry g	1.88
PCB118	2004	12.586	0.103	ng/dry g	1.88
PCB128	1989	1.245	0.09	ng/dry g	0.66
PCB128	2004	1.346	0.113	ng/dry g	0.66
PCB138	1989	8.55	0.08	ng/dry g	2.6
PCB138	2004	13.166	0.145	ng/dry g	2.6
PCB153/132/168	1989	8.9	0.1	ng/dry g	2.35
PCB153/132/168	2004	18.444	0.109	ng/dry g	2.35
PCB170/190	1989	2.43	0.1	ng/dry g	1.39
PCB170/190	2004	26.795	0.13	ng/dry g	1.39
PCB18	1989	5.05	0.06	ng/dry g	0.65
PCB18	2004	10.475	0.084	ng/dry g	0.65
PCB180	1989	4.55	0.12	ng/dry g	1.24
PCB180	2004	6.61	0.105	ng/dry g	1.24
PCB187	1989	3.17	0.08	ng/dry g	0.84
PCB187	2004	5.172	0.086	ng/dry g	0.84
PCB195/208	1989	0.8	0.09	ng/dry g	0.36
PCB195/208	2004	0.91	0.112	ng/dry g	0.36
PCB206	1989	1.22	0.09	ng/dry g	0.37
PCB206	2004	1.675	0.092	ng/dry g	0.37
PCB209	1989	0.8	0.12	ng/dry g	0.54
PCB209	2004	1.438	0.115	ng/dry g	0.54
PCB28	1989	11.8	0.07	ng/dry g	1.36
PCB28	2004	31.043	0.085	ng/dry g	1.36
PCB44	1989	4.85	0.07	ng/dry g	0.95
PCB44	2004	11.676	0.076	ng/dry g	0.95

Table 9. Analyte Concentration in Sediment from HRUB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Thallium	1987	0.62	0.2	µg/dry g	0.51
Tin	1987	14.833	1	µg/dry g	3
Tin	1989	9.4	0.06	µg/dry g	3
Tin	2004	14.5	0.087	µg/dry g	3
Total butyltins	2004	18.15		ng/dry g	9.09
Total chlordanes	1986	3.899		ng/dry g	1.94
Total chlordanes	1987	2.873		ng/dry g	1.94
Total chlordanes	1989	5.145		ng/dry g	1.94
Total chlordanes	2004	4.618		ng/dry g	1.94
Total DDT	1986	*41.339*		ng/dry g	15.17
Total DDT	1987	*9.543*		ng/dry g	15.17
Total DDT	1989	*20.685*		ng/dry g	15.17
Total DDT	2004	*19.737*		ng/dry g	15.17
Total dieldrin	1986	4.157		ng/dry g	1.4
Total dieldrin	1987	2.34		ng/dry g	1.4
Total dieldrin	1989	3.05		ng/dry g	1.4
Total dieldrin	2004	0.858		ng/dry g	1.4
Total Inorganic Carbon	1986	0.061		Percent	1.03
Total Inorganic Carbon	1987	0.256		Percent	1.03
Total Inorganic Carbon	1989	0.37		Percent	1.03
Total Inorganic Carbon	2004	0.6		Percent	1.03
Total Organic Carbon	1986	0.353		Percent	2.6
Total Organic Carbon	1987	2.133		Percent	2.6
Total Organic Carbon	1989	1.315		Percent	2.6
Total Organic Carbon	2004	2.5		Percent	2.6
Total PAH	1989	*4524.5*		ng/dry g	1836.6
Total PAHhmw (4 or more rings)	1989	*3537.5*		ng/dry g	1640.65
Total PAHhmw (4 or more rings)	2004	*7520*		ng/dry g	1640.65
Total PAHlmw (2-3 rings)	1989	*987*		ng/dry g	317.7
Total PAHlmw (2-3 rings)	2004	*2068*		ng/dry g	317.7
Total PCBcg	1989	*184.65*		ng/dry g	43.65

Table 9. Analyte Concentration in Sediment from HRUB in All Years. (NOAA 2006)_(Continued

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Trans-Nonachlor	1986	0.813	0.2	ng/dry g	0.63
Trans-Nonachlor	1987	1.173	0.09	ng/dry g	0.63
Trans-Nonachlor	1989	1.135	0.07	ng/dry g	0.63
Trans-Nonachlor	2004	0.739	0.09	ng/dry g	0.63
Tributyltin	2004	8.71	0.56	ng/dry g	3.5
Trichlorobiphenyls	1986	21.667	0.16	ng/dry g	6.03
Trichlorobiphenyls	1987	25.9	0.16	ng/dry g	6.03
Zinc	1987	204.667	2	µg/dry g	126.67
Zinc	1989	136.5	2.4	µg/dry g	126.67
Zinc	2004	224	0.501	µg/dry g	126.67

Blue: Concentration is above the TEL- Threshold Effect Levels (NOAA SQuiRT)
Pink: Concentration is above both the ERL and TEL (NOAA SQuiRT)

Table 10. Sand, Silt, and TOC Concentration in Sediment from HRUB in All Years. (NOAA 2006)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Sand	1986	76		Percent	86.77
Sand	1987	19.367		Percent	86.77
Sand	1989	63		Percent	86.77
Sand	2004	3.1		Percent	86.77
Silt	1986	7.367		Percent	49.96
Silt	1987	53.233		Percent	49.96
Silt	1989	19.5		Percent	49.96
Silt	2004	53.3		Percent	49.96
Total Organic Carbon	1986	0.353		Percent	2.6
Total Organic Carbon	1987	2.133		Percent	2.6
Total Organic Carbon	1989	1.315		Percent	2.6
Total Organic Carbon	2004	2.5		Percent	2.6

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
1,2,3,4-Tetrachlorobenzene	1999	1.179		ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2001	0.581	0.29	ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2002	0	0.29	ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2004	4.738	0.293	ng/dry g	1.33
1,2,4,5-Tetrachlorobenzene	1999	3.156		ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2001	0	0.27	ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2002	0	0.27	ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2004	31.543	0.3	ng/dry g	3.33
1,6,7-Trimethylnaphthalene	1993	19.43	1.8	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1999	4.43		ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2001	3.6	1	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2002	1.9	1	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2004	2.3	0.805	ng/dry g	10.34
1-Methylnaphthalene	1993	5.54	2.6	ng/dry g	16.6
1-Methylnaphthalene	1999	2.75		ng/dry g	16.6
1-Methylnaphthalene	2001	5.6	0.3	ng/dry g	16.6
1-Methylnaphthalene	2002	4.1	0.3	ng/dry g	16.6
1-Methylnaphthalene	2004	14.8	4.465	ng/dry g	16.6
1-Methylphenanthrene	1993	45.31	3	ng/dry g	16.9
1-Methylphenanthrene	1999	5.99		ng/dry g	16.9
1-Methylphenanthrene	2001	12	1.3	ng/dry g	16.9
1-Methylphenanthrene	2002	5.6	1.3	ng/dry g	16.9
1-Methylphenanthrene	2004	5.3	1.014	ng/dry g	16.9
2,4'-DDD	1987	22	1.3	ng/dry g	6.33
2,4'-DDD	1988	27.667	1.4	ng/dry g	6.33
2,4'-DDD	1993	21.25	4.1	ng/dry g	6.33
2,4'-DDD	1999	15.218		ng/dry g	6.33
2,4'-DDD	2001	13.082	0.29	ng/dry g	6.33
2,4'-DDD	2002	6.783	0.29	ng/dry g	6.33
2,4'-DDD	2004	8.052	0.198	ng/dry g	6.33
2,4'-DDE	1987	32.5	0.17	ng/dry g	3.22
2,4'-DDE	1988	16.667	0.24	ng/dry g	3.22
2,4'-DDE	1993	6.96	1.5	ng/dry g	3.22
2,4'-DDE	1999	8.846		ng/dry g	3.22
2,4'-DDE	2001	6.492	0.25	ng/dry g	3.22
2,4'-DDE	2002	3.6	0.25	ng/dry g	3.22
2,4'-DDE	2004	2.756	0.184	ng/dry g	3.22
2,4'-DDT	1987	0	0.5	ng/dry g	3.3
2,4'-DDT	1988	10.067	0.49	ng/dry g	3.3
2,4'-DDT	1993	11.47	3.1	ng/dry g	3.3
2,4'-DDT	1999	3.887		ng/dry g	3.3
2,4'-DDT	2001	5.33	0.25	ng/dry g	3.3
2,4'-DDT	2002	2.037	0.25	ng/dry g	3.3
2,4'-DDT	2004	2.09	0.216	ng/dry g	3.3

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
2,6-Dimethylnaphthalene	1993	6.75	3.6	ng/dry g	13.77
2,6-Dimethylnaphthalene	1999	2.28		ng/dry g	13.77
2,6-Dimethylnaphthalene	2001	4.7	0.5	ng/dry g	13.77
2,6-Dimethylnaphthalene	2002	3	0.5	ng/dry g	13.77
2,6-Dimethylnaphthalene	2004	10.1	2.975	ng/dry g	13.77
2-Methylnaphthalene	1993	9.53	2.3	ng/dry g	29.97
2-Methylnaphthalene	1999	4.88		ng/dry g	29.97
2-Methylnaphthalene	2001	7.6	0.6	ng/dry g	29.97
2-Methylnaphthalene	2002	10.3	0.6	ng/dry g	29.97
2-Methylnaphthalene	2004	25.9	7.349	ng/dry g	29.97
4,4'-DDD	1987	225	0.38	ng/dry g	19
4,4'-DDD	1988	125	0.64	ng/dry g	19
4,4'-DDD	1993	42.36	3.2	ng/dry g	19
4,4'-DDD	1999	36.408		ng/dry g	19
4,4'-DDD	2001	27.423	0.34	ng/dry g	19
4,4'-DDD	2002	15.992	0.34	ng/dry g	19
4,4'-DDD	2004	13.534	0.176	ng/dry g	19
4,4'-DDE	1987	160	0.28	ng/dry g	48
4,4'-DDE	1988	98.667	0.27	ng/dry g	48
4,4'-DDE	1993	86	2.6	ng/dry g	48
4,4'-DDE	1999	59.625		ng/dry g	48
4,4'-DDE	2001	41.571	0.24	ng/dry g	48
4,4'-DDE	2002	24.504	0.24	ng/dry g	48
4,4'-DDE	2004	22.454	0.192	ng/dry g	48
4,4'-DDT	1987	28.5	1	ng/dry g	4.39
4,4'-DDT	1988	21	0.11	ng/dry g	4.39
4,4'-DDT	1993	9.76	3.1	ng/dry g	4.39
4,4'-DDT	1999	3.288		ng/dry g	4.39
4,4'-DDT	2001	6.202	0.25	ng/dry g	4.39
4,4'-DDT	2002	2.149	0.25	ng/dry g	4.39
4,4'-DDT	2004	1.177	0.182	ng/dry g	4.39
Acenaphthene	1993	7.06	2.7	ng/dry g	9.7
Acenaphthene	1999	6.82		ng/dry g	9.7
Acenaphthene	2001	4.7	0.4	ng/dry g	9.7
Acenaphthene	2002	2.6	0.4	ng/dry g	9.7
Acenaphthene	2004	4.7	1.79	ng/dry g	9.7
Acenaphthylene	1993	16.88	2.1	ng/dry g	7.55
Acenaphthylene	1999	17.35		ng/dry g	7.55
Acenaphthylene	2001	8.8	0.5	ng/dry g	7.55
Acenaphthylene	2002	2.4	0.5	ng/dry g	7.55
Acenaphthylene	2004	24	1.872	ng/dry g	7.55

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Benzo[a]pyrene	1993	72.95	5	ng/dry g	10.92
Benzo[a]pyrene	1999	53.43		ng/dry g	10.92
Benzo[a]pyrene	2001	28.6	1.3	ng/dry g	10.92
Benzo[a]pyrene	2002	29.8	1.3	ng/dry g	10.92
Benzo[a]pyrene	2004	50.4	1.376	ng/dry g	10.92
Benzo[b]fluoranthene	1993	179.56	2.1	ng/dry g	37.75
Benzo[b]fluoranthene	1999	75.15		ng/dry g	37.75
Benzo[b]fluoranthene	2001	103	0.8	ng/dry g	37.75
Benzo[b]fluoranthene	2002	81.5	0.8	ng/dry g	37.75
Benzo[b]fluoranthene	2004	118	3.232	ng/dry g	37.75
Benzo[e]pyrene	1993	144.29	4	ng/dry g	36.06
Benzo[e]pyrene	1999	90.76		ng/dry g	36.06
Benzo[e]pyrene	2001	113	1.9	ng/dry g	36.06
Benzo[e]pyrene	2002	113	1.9	ng/dry g	36.06
Benzo[e]pyrene	2004	159	2.259	ng/dry g	36.06
Benzo[g,h,i]perylene	1993	38.3	5.1	ng/dry g	10.49
Benzo[g,h,i]perylene	1999	23.56		ng/dry g	10.49
Benzo[g,h,i]perylene	2001	15.6	0.7	ng/dry g	10.49
Benzo[g,h,i]perylene	2002	28	0.7	ng/dry g	10.49
Benzo[g,h,i]perylene	2004	17.9	2.017	ng/dry g	10.49
Benzo[k]fluoranthene	1993	72.2	4.7	ng/dry g	19.63
Benzo[k]fluoranthene	1999	42.72		ng/dry g	19.63
Benzo[k]fluoranthene	2001	40.3	0.7	ng/dry g	19.63
Benzo[k]fluoranthene	2002	76	0.7	ng/dry g	19.63
Benzo[k]fluoranthene	2004	106	2.374	ng/dry g	19.63
Beta-Hexachlorocyclohexane	1999	2.425		ng/dry g	0.97
Beta-Hexachlorocyclohexane	2001	0.097	0.26	ng/dry g	0.97
Beta-Hexachlorocyclohexane	2002	0.098	0.26	ng/dry g	0.97
Beta-Hexachlorocyclohexane	2004	0.124	0.2	ng/dry g	0.97
Biphenyl	1993	15.52	4.8	ng/dry g	9.96
Biphenyl	1999	2.75		ng/dry g	9.96
Biphenyl	2001	5.9	2	ng/dry g	9.96
Biphenyl	2002	3.7	2	ng/dry g	9.96
Biphenyl	2004	10	2.07	ng/dry g	9.96
C1-Chrysenes	1993	246.1	1.7	ng/dry g	27.47
C1-Chrysenes	1999	76.67		ng/dry g	27.47
C1-Chrysenes	2001	96.3	1.8	ng/dry g	27.47
C1-Chrysenes	2002	113	1.8	ng/dry g	27.47
C1-Chrysenes	2004	109	4.288	ng/dry g	27.47
C1-Dibenzothiophenes	1993	67.4	2.7	ng/dry g	15.7
C1-Dibenzothiophenes	1999	10.92		ng/dry g	15.7
C1-Dibenzothiophenes	2001	11.8	1.1	ng/dry g	15.7
C1-Dibenzothiophenes	2002	5.5	1.1	ng/dry g	15.7
C1-Dibenzothiophenes	2004	9.2	1.5	ng/dry g	15.7

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Aldrin	1987	2.75	0.25	ng/dry g	0.69
Aldrin	1988	0	0.12	ng/dry g	0.69
Aldrin	1993	0	1.8	ng/dry g	0.69
Aldrin	1999	0		ng/dry g	0.69
Aldrin	2001	0	0.25	ng/dry g	0.69
Aldrin	2002	0	0.25	ng/dry g	0.69
Aldrin	2004	0	0.215	ng/dry g	0.69
Alpha-Chlordane	1987	67.5	0.36	ng/dry g	10.89
Alpha-Chlordane	1988	25	0.32	ng/dry g	10.89
Alpha-Chlordane	1993	10.57	1.4	ng/dry g	10.89
Alpha-Chlordane	1999	8.285		ng/dry g	10.89
Alpha-Chlordane	2001	7.461	0.29	ng/dry g	10.89
Alpha-Chlordane	2002	4.465	0.29	ng/dry g	10.89
Alpha-Chlordane	2004	4.196	0.207	ng/dry g	10.89
Alpha-Hexachlorocyclohexane	1999	0.903		ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2001	0	0.25	ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2002	0	0.25	ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2004	0	0.203	ng/dry g	1.42
Aluminum	1987	115	27	µg/dry g	732
Aluminum	1988	296.667	60	µg/dry g	732
Aluminum	1993	190	18	µg/dry g	732
Aluminum	1999	310		µg/dry g	732
Aluminum	2001	108	5	µg/dry g	732
Aluminum	2002	179	4.882	µg/dry g	732
Aluminum	2004	184	4.882	µg/dry g	732
Anthracene	1993	34.04	2.4	ng/dry g	18.2
Anthracene	1999	26.35		ng/dry g	18.2
Anthracene	2001	13.8	1.7	ng/dry g	18.2
Anthracene	2002	4.9	1.7	ng/dry g	18.2
Anthracene	2004	32.2	0.992	ng/dry g	18.2
Antimony	1987	0	0.4	µg/dry g	0.05
Antimony	1993	0.07		µg/dry g	0.05
Arsenic	1987	7.6	1.5	µg/dry g	15.67
Arsenic	1988	8.567	2	µg/dry g	15.67
Arsenic	1993	8.2	2.6	µg/dry g	15.67
Arsenic	1999	5.62		µg/dry g	15.67
Arsenic	2001	13.1	2	µg/dry g	15.67
Arsenic	2002	8.32	1.95	µg/dry g	15.67
Arsenic	2004	7.08	1.95	µg/dry g	15.67
Benz[a]anthracene	1993	150.66	1.8	ng/dry g	33.67
Benz[a]anthracene	1999	76.32		ng/dry g	33.67
Benz[a]anthracene	2001	66.4	1	ng/dry g	33.67
Benz[a]anthracene	2004	110	2.662	ng/dry g	33.67

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C1-Fluoranthenes/Pyrenes	1993	544.36	5.2	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	1999	230.98		ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	2001	213	1.6	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	2002	235	1.6	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	2004	161	7.604	ng/dry g	77.86
C1-Fluorenes	1993	70.92	2.7	ng/dry g	19.9
C1-Fluorenes	1999	21.02		ng/dry g	19.9
C1-Fluorenes	2001	12	1.1	ng/dry g	19.9
C1-Fluorenes	2002	0	1.1	ng/dry g	19.9
C1-Fluorenes	2004	13.4	2.092	ng/dry g	19.9
C1-Naphthalenes	1993	11.94	19	ng/dry g	35.26
C1-Naphthalenes	1999	7.63		ng/dry g	35.26
C1-Naphthalenes	2001	9	4.6	ng/dry g	35.26
C1-Naphthalenes	2002	8.5	4.6	ng/dry g	35.26
C1-Naphthalenes	2004	27.6	7.613	ng/dry g	35.26
C1-Phenanthrenes/Anthracenes	1993	210.55	5.5	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	1999	45.11		ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2001	56.7	2.9	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2002	35.6	2.9	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2004	51.7	3.061	ng/dry g	65.3
C2-Chrysenes	1993	163.38	1.7	ng/dry g	23.96
C2-Chrysenes	1999	44.14		ng/dry g	23.96
C2-Chrysenes	2001	48	1.8	ng/dry g	23.96
C2-Chrysenes	2002	57.7	1.8	ng/dry g	23.96
C2-Chrysenes	2004	45.3	4.288	ng/dry g	23.96
C2-Dibenzothiophenes	1993	285.81	2.7	ng/dry g	43.5
C2-Dibenzothiophenes	1999	20.01		ng/dry g	43.5
C2-Dibenzothiophenes	2001	74.1	1.1	ng/dry g	43.5
C2-Dibenzothiophenes	2002	36.1	1.1	ng/dry g	43.5
C2-Dibenzothiophenes	2004	39.6	1.5	ng/dry g	43.5
C2-Fluoranthenes/Pyrenes	2004	105	7.604	ng/dry g	32.6
C2-Fluorenes	1993	328.01	2.7	ng/dry g	54.15
C2-Fluorenes	1999	30.58		ng/dry g	54.15
C2-Fluorenes	2001	41.8	1.1	ng/dry g	54.15
C2-Fluorenes	2002	0	1.1	ng/dry g	54.15
C2-Fluorenes	2004	40.9	2.092	ng/dry g	54.15
C2-Naphthalenes	1993	34.48	19	ng/dry g	33.8
C2-Naphthalenes	1999	11.64		ng/dry g	33.8
C2-Naphthalenes	2001	13	4.6	ng/dry g	33.8
C2-Naphthalenes	2002	7.8	4.6	ng/dry g	33.8
C2-Naphthalenes	2004	25	7.613	ng/dry g	33.8

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C3-Chrysenes	1993	0	1.7	ng/dry g	0.6
C3-Chrysenes	1999	2.17		ng/dry g	0.6
C3-Chrysenes	2001	16.7	1.8	ng/dry g	0.6
C3-Chrysenes	2002	0	1.8	ng/dry g	0.6
C3-Chrysenes	2004	0	4.288	ng/dry g	0.6
C3-Dibenzothiophenes	1993	462.8	2.7	ng/dry g	54.31
C3-Dibenzothiophenes	1999	31.51		ng/dry g	54.31
C3-Dibenzothiophenes	2001	110	1.1	ng/dry g	54.31
C3-Dibenzothiophenes	2002	61.8	1.1	ng/dry g	54.31
C3-Dibenzothiophenes	2004	66.4	1.5	ng/dry g	54.31
C3-Fluoranthenes/Pyrenes	2004	28.6	7.604	ng/dry g	10.2
C3-Fluorenes	1993	635.31	2.7	ng/dry g	94.6
C3-Fluorenes	1999	73.51		ng/dry g	94.6
C3-Fluorenes	2001	64.2	1.1	ng/dry g	94.6
C3-Fluorenes	2002	0	1.1	ng/dry g	94.6
C3-Fluorenes	2004	76.9	2.092	ng/dry g	94.6
C3-Naphthalenes	1993	158.14	19	ng/dry g	45.31
C3-Naphthalenes	1999	21.17		ng/dry g	45.31
C3-Naphthalenes	2001	26.8	4.6	ng/dry g	45.31
C3-Naphthalenes	2002	10.2	4.6	ng/dry g	45.31
C3-Naphthalenes	2004	20.5	7.613	ng/dry g	45.31
C3-Phenanthrenes/Anthracenes	1993	761.4	5.5	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	1999	135.08		ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2001	187	2.9	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2002	152	2.9	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2004	132	3.061	ng/dry g	96.6
C4-Chrysenes	1993	0	1.7	ng/dry g	0.51
C4-Chrysenes	1999	1.49		ng/dry g	0.51
C4-Chrysenes	2001	0	1.8	ng/dry g	0.51
C4-Chrysenes	2002	0	1.8	ng/dry g	0.51
C4-Chrysenes	2004	0	4.288	ng/dry g	0.51
C4-Naphthalenes	1993	476.12	19	ng/dry g	47.27
C4-Naphthalenes	1999	38.71		ng/dry g	47.27
C4-Naphthalenes	2001	47.7	4.6	ng/dry g	47.27
C4-Naphthalenes	2002	10.5	4.6	ng/dry g	47.27
C4-Naphthalenes	2004	25.5	7.613	ng/dry g	47.27
C4-Phenanthrenes/Anthracenes	1993	435.95	5.5	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	1999	55.96		ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2001	112	2.9	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2002	86.4	2.9	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2004	66.5	3.061	ng/dry g	58.4

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Cadmium	1987	7.25	0.9	µg/dry g	5.42
Cadmium	1988	3.067	0.19	µg/dry g	5.42
Cadmium	1993	2.47	0.54	µg/dry g	5.42
Cadmium	1999	2.05		µg/dry g	5.42
Cadmium	2001	2.4	0.0397	µg/dry g	5.42
Cadmium	2002	2.12	0.195	µg/dry g	5.42
Cadmium	2004	1.63	0.195	µg/dry g	5.42
Chlorpyrifos	1999	5.46		ng/dry g	1.55
Chlorpyrifos	2001	3.392	0.28	ng/dry g	1.55
Chlorpyrifos	2002	0	0.28	ng/dry g	1.55
Chlorpyrifos	2004	0.929	0.219	ng/dry g	1.55
Chromium	1987	2.45	0.21	µg/dry g	3.02
Chromium	1988	3.767	0.12	µg/dry g	3.02
Chromium	1993	3.61	0.58	µg/dry g	3.02
Chromium	1999	2.19		µg/dry g	3.02
Chromium	2001	1.48	0.5	µg/dry g	3.02
Chromium	2002	1.83	0.488	µg/dry g	3.02
Chromium	2004	2.34	0.488	µg/dry g	3.02
Chrysene	1993	143.63	1.7	ng/dry g	72.85
Chrysene	1999	120.3		ng/dry g	72.85
Chrysene	2001	143	0.9	ng/dry g	72.85
Chrysene	2002	133	0.9	ng/dry g	72.85
Chrysene	2004	175	4.288	ng/dry g	72.85
Cis-Nonachlor	1999	6.337		ng/dry g	3.91
Cis-Nonachlor	2001	5.136	0.26	ng/dry g	3.91
Cis-Nonachlor	2002	3.182	0.26	ng/dry g	3.91
Cis-Nonachlor	2004	2.602	0.212	ng/dry g	3.91
Copper	1987	13	3	µg/dry g	183
Copper	1988	15.333	3	µg/dry g	183
Copper	1993	13.3	2.2	µg/dry g	183
Copper	1999	8.67		µg/dry g	183
Copper	2001	10.7	0.5	µg/dry g	183
Copper	2002	12.1	0.488	µg/dry g	183
Copper	2004	14	0.488	µg/dry g	183
Delta-Hexachlorocyclohexane	1999	0		ng/dry g	0.18
Delta-Hexachlorocyclohexane	2001	0	0.23	ng/dry g	0.18
Delta-Hexachlorocyclohexane	2002	0.028	0.23	ng/dry g	0.18
Delta-Hexachlorocyclohexane	2004	0	0.202	ng/dry g	0.18
Dibenzo[a,h]anthracene	1993	9.46	3.8	ng/dry g	2.17
Dibenzo[a,h]anthracene	1999	4.12		ng/dry g	2.17
Dibenzo[a,h]anthracene	2001	4.5	0.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	2002	6.3	0.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	2004	7.2	1.989	ng/dry g	2.17

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Dibenzofuran	1993	10.44		ng/dry g	11.55
Dibenzofuran	2004	5.3	2.22	ng/dry g	11.55
Dibenzothiophene	1993	6.95	2.7	ng/dry g	5.5
Dibenzothiophene	1999	2.08		ng/dry g	5.5
Dibenzothiophene	2001	4.6	0.5	ng/dry g	5.5
Dibenzothiophene	2002	1.1	0.5	ng/dry g	5.5
Dibenzothiophene	2004	2	1.5	ng/dry g	5.5
Dibutyltin	1993	0	12	ng/dry g	22.61
Dibutyltin	1999	44.75		ng/dry g	22.61
Dibutyltin	2001	38.91	3.6	ng/dry g	22.61
Dibutyltin	2002	42.2	3.6	ng/dry g	22.61
Dibutyltin	2004	15.7	2.807	ng/dry g	22.61
Dichlorobiphenyls	1987	55	2.3	ng/dry g	11.4
Dieldrin	1987	54.5	0.52	ng/dry g	9.34
Dieldrin	1988	3.3	0.11	ng/dry g	9.34
Dieldrin	1993	21.36	2.3	ng/dry g	9.34
Dieldrin	1999	5.363		ng/dry g	9.34
Dieldrin	2001	3.585	0.37	ng/dry g	9.34
Dieldrin	2002	2.903	0.37	ng/dry g	9.34
Dieldrin	2004	2.369	0.196	ng/dry g	9.34
Endosulfan I	2001	6.071	0.26	ng/dry g	2.12
Endosulfan I	2002	0	0.26	ng/dry g	2.12
Endosulfan I	2004	2.207	0.219	ng/dry g	2.12
Endosulfan II	1999	2.028		ng/dry g	1.71
Endosulfan II	2001	0	0.26	ng/dry g	1.71
Endosulfan II	2002	0	0.26	ng/dry g	1.71
Endosulfan II	2004	5.265	0.219	ng/dry g	1.71
Endosulfan Sulfate	2001	0	0.29	ng/dry g	0.44
Endosulfan Sulfate	2002	0	0.29	ng/dry g	0.44
Endosulfan Sulfate	2004	0	0.238	ng/dry g	0.44
Endrin	1993	0		ng/dry g	0.71
Endrin	1999	0		ng/dry g	0.71
Endrin	2001	0	0.24	ng/dry g	0.71
Endrin	2002	0	0.24	ng/dry g	0.71
Endrin	2004	0	0.181	ng/dry g	0.71
Fluoranthene	1993	483.85	5	ng/dry g	153.33
Fluoranthene	1999	179.85		ng/dry g	153.33
Fluoranthene	2001	204	0.8	ng/dry g	153.33
Fluoranthene	2002	167	0.8	ng/dry g	153.33
Fluoranthene	2004	118	7.604	ng/dry g	153.33

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Fluorene	1993	8.51	2.7	ng/dry g	12.6
Fluorene	1999	4.3		ng/dry g	12.6
Fluorene	2001	5.9	0.6	ng/dry g	12.6
Fluorene	2002	2.2	0.6	ng/dry g	12.6
Fluorene	2004	5.7	2.092	ng/dry g	12.6
Gamma-Chlordane	1999	8.412		ng/dry g	5.18
Gamma-Chlordane	2001	4.748	0.29	ng/dry g	5.18
Gamma-Chlordane	2002	3.628	0.29	ng/dry g	5.18
Gamma-Chlordane	2004	4.166	0.237	ng/dry g	5.18
Gamma-Hexachlorocyclohexane	1987	0.75	0.1	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1988	0.433	0.18	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1993	0.95	1.8	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1999	0.564		ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2001	0.194	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2002	0.195	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2004	0.124	0.194	ng/dry g	2.15
Heptachlor	1987	0	0.91	ng/dry g	0.54
Heptachlor	1988	0	0.15	ng/dry g	0.54
Heptachlor	1993	0.97	3.3	ng/dry g	0.54
Heptachlor	1999	0.684		ng/dry g	0.54
Heptachlor	2001	0.388	0.28	ng/dry g	0.54
Heptachlor	2002	0	0.28	ng/dry g	0.54
Heptachlor	2004	0	0.223	ng/dry g	0.54
Heptachlor-Epoxide	1987	6	0.29	ng/dry g	2.17
Heptachlor-Epoxide	1988	2.033	0.1	ng/dry g	2.17
Heptachlor-Epoxide	1993	0	1.6	ng/dry g	2.17
Heptachlor-Epoxide	1999	0		ng/dry g	2.17
Heptachlor-Epoxide	2001	0.775	0.3	ng/dry g	2.17
Heptachlor-Epoxide	2002	0.126	0.3	ng/dry g	2.17
Heptachlor-Epoxide	2004	0	0.201	ng/dry g	2.17
Heptachlorobiphenyls	1987	117	0.5	ng/dry g	44.67
Hexachlorobenzene	1987	1.175	0.32	ng/dry g	0.69
Hexachlorobenzene	1988	1.333	0.34	ng/dry g	0.69
Hexachlorobenzene	1993	0.44	1	ng/dry g	0.69
Hexachlorobenzene	1999	0.642		ng/dry g	0.69
Hexachlorobenzene	2001	0.388	0.24	ng/dry g	0.69
Hexachlorobenzene	2002	0.781	0.24	ng/dry g	0.69
Hexachlorobenzene	2004	0.279	0.223	ng/dry g	0.69
Hexachlorobiphenyls	1987	390	1.6	ng/dry g	190
Indeno[1,2,3-c,d]pyrene	1993	27.6	2.8	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1999	15.76		ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2001	14.6	1	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2002	17.3	1	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2004	25.9	2.821	ng/dry g	8.42

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Fluorene	1993	8.51	2.7	ng/dry g	12.6
Fluorene	1999	4.3		ng/dry g	12.6
Iron	1987	230	30	µg/dry g	872
Iron	1988	343.333	5	µg/dry g	872
Iron	1993	540	34	µg/dry g	872
Iron	1999	385		µg/dry g	872
Iron	2001	351	1.08	µg/dry g	872
Iron	2002	520	1.101	µg/dry g	872
Iron	2004	533	1.101	µg/dry g	872
Lead	1987	9.45	0.06	µg/dry g	2.76
Lead	1988	4.833	0.17	µg/dry g	2.76
Lead	1993	6.8	0.059	µg/dry g	2.76
Lead	1999	4.02		µg/dry g	2.76
Lead	2001	3.65	0.055	µg/dry g	2.76
Lead	2002	3.83	0.043	µg/dry g	2.76
Lead	2004	3.94	0.043	µg/dry g	2.76
Manganese	1987	32	3	µg/dry g	39.04
Manganese	1993	27	6.7	µg/dry g	39.04
Manganese	1999	65.1		µg/dry g	39.04
Manganese	2001	52.6	0.215	µg/dry g	39.04
Manganese	2002	78.1	0.195	µg/dry g	39.04
Manganese	2004	100	0.195	µg/dry g	39.04
Mercury	1987	0.295	0.001	µg/dry g	0.21
Mercury	1988	0.367	0.01	µg/dry g	0.21
Mercury	1993	0.13	0.021	µg/dry g	0.21
Mercury	1999	0.175		µg/dry g	0.21
Mercury	2001	0.226	0.01	µg/dry g	0.21
Mercury	2002	0.282	0.01	µg/dry g	0.21
Mercury	2004	0.241	0.01	µg/dry g	0.21
Mirex	1987	1.4	0.34	ng/dry g	0.97
Mirex	1988	0.533	0.19	ng/dry g	0.97
Mirex	1993	1.07	2.1	ng/dry g	0.97
Mirex	1999	1.028		ng/dry g	0.97
Mirex	2001	1.066	0.28	ng/dry g	0.97
Mirex	2002	0.809	0.28	ng/dry g	0.97
Mirex	2004	0.48	0.199	ng/dry g	0.97
Monobutyltin	1993	90.21	12	ng/dry g	8.79
Monobutyltin	1999	9.8		ng/dry g	8.79
Monobutyltin	2001	6.17	1.95	ng/dry g	8.79
Monobutyltin	2002	5.36	1.95	ng/dry g	8.79
Monobutyltin	2004	6.03	0.319	ng/dry g	8.79
Naphthalene	1993	24.57	19	ng/dry g	30.04
Naphthalene	1999	6.33		ng/dry g	30.04
Naphthalene	2001	12	2.3	ng/dry g	30.04
Naphthalene	2002	17.3	2.3	ng/dry g	30.04
Naphthalene	2004	22	7.613	ng/dry g	30.04

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB170/190	1988	13	0.11	ng/dry g	3.08
PCB170/190	1993	3.12	2.2	ng/dry g	3.08
PCB170/190	1999	2.126		ng/dry g	3.08
PCB170/190	2001	1.841	0.81	ng/dry g	3.08
PCB170/190	2002	3.864	0.81	ng/dry g	3.08
PCB170/190	2004	2.555	0.285	ng/dry g	3.08
PCB18	1988	22.667	0.22	ng/dry g	2.3
PCB18	1993	8.89	2.2	ng/dry g	2.3
PCB18	1999	6.48		ng/dry g	2.3
PCB18	2001	6.492	0.52	ng/dry g	2.3
PCB18	2002	4.047	0.52	ng/dry g	2.3
PCB18	2004	1.889	0.387	ng/dry g	2.3
PCB180	1988	21.333	0.08	ng/dry g	7.18
PCB180	1993	10.66	2.5	ng/dry g	7.18
PCB180	1999	50.096		ng/dry g	7.18
PCB180	2001	19.768	0.58	ng/dry g	7.18
PCB180	2002	12.057	0.58	ng/dry g	7.18
PCB180	2004	11.258	0.214	ng/dry g	7.18
PCB187	1988	32.333	0.81	ng/dry g	10.6
PCB187	1993	26.97	2.5	ng/dry g	10.6
PCB187	1999	27.601		ng/dry g	10.6
PCB187	2001	20.155	0.62	ng/dry g	10.6
PCB187	2002	15.113	0.62	ng/dry g	10.6
PCB187	2004	17.638	0.276	ng/dry g	10.6
PCB195/208	1988	0	0.09	ng/dry g	0.38
PCB195/208	1993	0	1.7	ng/dry g	0.38
PCB195/208	1999	0		ng/dry g	0.38
PCB195/208	2001	0	0.33	ng/dry g	0.38
PCB195/208	2002	0.279	0.33	ng/dry g	0.38
PCB195/208	2004	0.279	0.236	ng/dry g	0.38
PCB206	1988	0	0.08	ng/dry g	0.21
PCB206	1993	0	1.6	ng/dry g	0.21
PCB206	1999	0		ng/dry g	0.21
PCB206	2001	0.194	0.31	ng/dry g	0.21
PCB206	2002	0	0.31	ng/dry g	0.21
PCB206	2004	0.046	0.256	ng/dry g	0.21
PCB209	1988	0	0.06	ng/dry g	0.6
PCB209	1993	0	1.9	ng/dry g	0.6
PCB209	1999	0.279		ng/dry g	0.6
PCB209	2001	0.581	0.36	ng/dry g	0.6
PCB209	2002	0	0.36	ng/dry g	0.6
PCB209	2004	0.046	0.216	ng/dry g	0.6

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB28	1988	41.333	0.42	ng/dry g	3.66
PCB28	1993	22.64	1.8	ng/dry g	3.66
PCB28	1999	15.053		ng/dry g	3.66
PCB28	2001	11.241	0.45	ng/dry g	3.66
PCB28	2002	9.377	0.45	ng/dry g	3.66
PCB28	2004	8.099	0.19	ng/dry g	3.66
PCB44	1988	43	0.25	ng/dry g	5.23
PCB44	1993	28.16	1.4	ng/dry g	5.23
PCB44	1999	22.516		ng/dry g	5.23
PCB44	2001	18.508	0.35	ng/dry g	5.23
PCB44	2002	13.145	0.35	ng/dry g	5.23
PCB44	2004	8.548	0.356	ng/dry g	5.23
PCB52	1988	82.667	0.17	ng/dry g	10.12
PCB52	1993	50.45	1.8	ng/dry g	10.12
PCB52	1999	43.465		ng/dry g	10.12
PCB52	2001	33.625	0.48	ng/dry g	10.12
PCB52	2002	23.834	0.48	ng/dry g	10.12
PCB52	2004	20.208	0.21	ng/dry g	10.12
PCB66	1988	84	0.43	ng/dry g	6.43
PCB66	1993	33.14	3.3	ng/dry g	6.43
PCB66	1999	29.497		ng/dry g	6.43
PCB66	2001	19.865	0.43	ng/dry g	6.43
PCB66	2002	16.187	0.43	ng/dry g	6.43
PCB66	2004	11.722	0.3	ng/dry g	6.43
PCB8/5	1988	0	0.6	ng/dry g	2.17
PCB8/5	1993	0	3.9	ng/dry g	2.17
PCB8/5	1999	2.276		ng/dry g	2.17
PCB8/5	2001	0	0.39	ng/dry g	2.17
PCB8/5	2002	0	0.39	ng/dry g	2.17
PCB8/5	2004	0	0.318	ng/dry g	2.17
Pentachloroanisole	1999	1.976		ng/dry g	2.01
Pentachloroanisole	2001	1.357	0.28	ng/dry g	2.01
Pentachloroanisole	2002	0.67	0.28	ng/dry g	2.01
Pentachloroanisole	2004	0.712	0.162	ng/dry g	2.01
Pentachlorobenzene	1999	0		ng/dry g	0.94
Pentachlorobenzene	2001	0	0.26	ng/dry g	0.94
Pentachlorobenzene	2002	0	0.26	ng/dry g	0.94
Pentachlorobenzene	2004	5.203	0.192	ng/dry g	0.94
Pentachlorobiphenyls	1987	515	0.5	ng/dry g	245.33

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Perylene	1993	38.41	6.7	ng/dry g	13.32
Perylene	1999	25.41		ng/dry g	13.32
Perylene	2001	21.2	2	ng/dry g	13.32
Perylene	2002	21	2	ng/dry g	13.32
Perylene	2004	22.5	4.513	ng/dry g	13.32
Phenanthrene	1993	56.88	5.5	ng/dry g	57.8
Phenanthrene	1999	18.04		ng/dry g	57.8
Phenanthrene	2001	57.2	1.5	ng/dry g	57.8
Phenanthrene	2002	15.9	1.5	ng/dry g	57.8
Phenanthrene	2004	20.4	3.061	ng/dry g	57.8
Pyrene	1993	619.36	5.2	ng/dry g	122.38
Pyrene	1999	316.11		ng/dry g	122.38
Pyrene	2001	263	1.4	ng/dry g	122.38
Pyrene	2002	307	1.4	ng/dry g	122.38
Pyrene	2004	272	4.817	ng/dry g	122.38
Selenium	1987	2.1	0.58	µg/dry g	3.86
Selenium	1988	3.067	1	µg/dry g	3.86
Selenium	1993	3.36	1	µg/dry g	3.86
Selenium	1999	2.31		µg/dry g	3.86
Selenium	2001	2.25	0.054	µg/dry g	3.86
Selenium	2002	3.1	0.049	µg/dry g	3.86
Selenium	2004	5.52	0.049	µg/dry g	3.86
Silicon	1987	0	600	µg/dry g	3000
Silicon	1993	0		µg/dry g	3000
Silver	1988	0.82	0.01	µg/dry g	3.7
Silver	1993	0.388	0.14	µg/dry g	3.7
Silver	1999	0.39		µg/dry g	3.7
Silver	2001	0.622	1.08	µg/dry g	3.7
Silver	2002	1.01	0.043	µg/dry g	3.7
Silver	2004	0.525	0.043	µg/dry g	3.7
Tetrabutyltin	2001	0	2.73	ng/dry g	0.11
Tetrabutyltin	2004	0	3.753	ng/dry g	0.11
Tetrachlorobiphenyls	1987	675	0.6	ng/dry g	135.33
Thallium	1987	0	0.05	µg/dry g	0
Tin	1987	0.63	0.5	µg/dry g	0.35
Tin	1988	0.413	0.04	µg/dry g	0.35
Tin	1993	0.48	0.35	µg/dry g	0.35
Tin	1999	0		µg/dry g	0.35
Tin	2001	0.365	0.1	µg/dry g	0.35
Tin	2002	0.607	0.087	µg/dry g	0.35
Tin	2004	0.604	0.087	µg/dry g	0.35

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Total butyltins	1993	90.21		ng/dry g	151.96
Total butyltins	1999	202.65		ng/dry g	151.96
Total butyltins	2001	151.91		ng/dry g	151.96
Total butyltins	2002	164.11		ng/dry g	151.96
Total butyltins	2004	116.94		ng/dry g	151.96
Total chlordanes	1987	110.5		ng/dry g	22.5
Total chlordanes	1988	47.366		ng/dry g	22.5
Total chlordanes	1993	21.23		ng/dry g	22.5
Total chlordanes	1999	17.756		ng/dry g	22.5
Total chlordanes	2001	15.407		ng/dry g	22.5
Total chlordanes	2002	8.638		ng/dry g	22.5
Total chlordanes	2004	7.185		ng/dry g	22.5
Total DDT	1987	468		ng/dry g	88.66
Total DDT	1988	299.068		ng/dry g	88.66
Total DDT	1993	177.8		ng/dry g	88.66
Total DDT	1999	127.272		ng/dry g	88.66
Total DDT	2001	100.1		ng/dry g	88.66
Total DDT	2002	55.065		ng/dry g	88.66
Total DDT	2004	50.063		ng/dry g	88.66
Total dieldrin	1987	57.25		ng/dry g	10.18
Total dieldrin	1988	3.3		ng/dry g	10.18
Total dieldrin	1993	21.36		ng/dry g	10.18
Total dieldrin	1999	5.363		ng/dry g	10.18
Total dieldrin	2001	3.585		ng/dry g	10.18
Total dieldrin	2002	2.903		ng/dry g	10.18
Total dieldrin	2004	2.369		ng/dry g	10.18
Total PAH	1993	2230.29		ng/dry g	783
Total PAH	1999	1125.76		ng/dry g	783
Total PAH	2001	1159		ng/dry g	783
Total PAH	2002	1053.8		ng/dry g	783
Total PAHhmw (4 or more rings)	1993	1980.27		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1999	1023.49		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2001	1017.2		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2002	979.9		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2004	1181.9		ng/dry g	532.5
Total PAHlmw (2-3 rings)	1993	250.02		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1999	102.27		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2001	141.8		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2002	73.9		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2004	177.4		ng/dry g	234.8
Total PCBcg	1988	1462.932		ng/dry g	324.86
Total PCBcg	1993	1111.1		ng/dry g	324.86
Total PCBcg	1999	1001.298		ng/dry g	324.86
Total PCBcg	2001	691.486		ng/dry g	324.86
Total PCBcg	2002	475.984		ng/dry g	324.86

Table 11. Analyte Concentration in Tissue from HRLB in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Trans-Nonachlor	1987	37	0.34	ng/dry g	9.68
Trans-Nonachlor	1988	20.333	0.22	ng/dry g	9.68
Trans-Nonachlor	1993	9.69	2.2	ng/dry g	9.68
Trans-Nonachlor	1999	8.787		ng/dry g	9.68
Trans-Nonachlor	2001	6.783	0.22	ng/dry g	9.68
Trans-Nonachlor	2002	4.047	0.22	ng/dry g	9.68
Trans-Nonachlor	2004	2.989	0.193	ng/dry g	9.68
Tributyltin	1993	0	19	ng/dry g	110
Tributyltin	1999	148.1		ng/dry g	110
Tributyltin	2001	106.83	4.83	ng/dry g	110
Tributyltin	2002	116.55	4.83	ng/dry g	110
Tributyltin	2004	95.21	3.921	ng/dry g	110
Trichlorobiphenyls	1987	140	0.6	ng/dry g	33
Zinc	1987	165	2	µg/dry g	2980
Zinc	1988	100	5	µg/dry g	2980
Zinc	1993	150	39	µg/dry g	2980
Zinc	1999	135		µg/dry g	2980
Zinc	2001	118	0.54	µg/dry g	2980
Zinc	2002	125	0.501	µg/dry g	2980
Zinc	2004	130	0.501	µg/dry g	2980

Table 12. Analyte Concentration in Sediment from HRLB in All Years. (NOAA 2006)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
1,2,3,4-Tetrachlorobenzene	2004	0.446	0.049	ng/dry g	0.12
1,2,4,5-Tetrachlorobenzene	2004	0.689	0.3	ng/dry g	0.53
1,6,7-Trimethylnaphthalene	2004	7.2	0.096	ng/dry g	8.2
1-Methylnaphthalene	2004	43.8	0.128	ng/dry g	13.9
1-Methylphenanthrene	2004	54.7	0.205	ng/dry g	21.34
2,4'-DDD	1986	0	0.2	ng/dry g	1.36
2,4'-DDD	1987	6.3	0.36	ng/dry g	1.36
2,4'-DDD	2004	2.77	0.11	ng/dry g	1.36
2,4'-DDE	1986	7.933	0.14	ng/dry g	0.4
2,4'-DDE	1987	0	0.05	ng/dry g	0.4
2,4'-DDE	2004	0.581	0.087	ng/dry g	0.4
2,4'-DDT	1986	0	0.23	ng/dry g	0.23
2,4'-DDT	1987	0	0.13	ng/dry g	0.23
2,4'-DDT	2004	0.27	0.101	ng/dry g	0.23
2,6-Dimethylnaphthalene	2004	76.6	0.205	ng/dry g	14.67
2-Methylnaphthalene	2004	105	0.205	ng/dry g	20.33
4,4'-DDD	1986	9.9	0.49	ng/dry g	4.18
4,4'-DDD	1987	27	0.1	ng/dry g	4.18
4,4'-DDD	2004	4.649	0.131	ng/dry g	4.18
4,4'-DDE	1986	5.367	0.16	ng/dry g	4.1
4,4'-DDE	1987	16.6	0.07	ng/dry g	4.1
4,4'-DDE	2004	6.743	0.145	ng/dry g	4.1
4,4'-DDT	1986	7.233	0.08	ng/dry g	1.73
4,4'-DDT	1987	10.867	0.27	ng/dry g	1.73
4,4'-DDT	2004	0.554	0.14	ng/dry g	1.73
Acenaphthene	2004	35.3	0.128	ng/dry g	8.6
Acenaphthylene	2004	123	0.193	ng/dry g	19.4
Aldrin	1986	0.467	0.16	ng/dry g	0.23
Aldrin	1987	0	0.07	ng/dry g	0.23
Aldrin	2004	0	0.068	ng/dry g	0.23
Alpha-Chlordane	1986	6.133	0.08	ng/dry g	0.91
Alpha-Chlordane	1987	3.767	0.1	ng/dry g	0.91
Alpha-Chlordane	2004	1.608	0.085	ng/dry g	0.91
Alpha-Hexachlorocyclohexane	2004	0	0.071	ng/dry g	0.08
Aluminum	1986	49333.333	5000	µg/dry g	70000
Aluminum	1987	49000	5000	µg/dry g	70000
Aluminum	2004	57200	4.882	µg/dry g	70000

Table 12. Analyte Concentration in Sediment from HRLB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Anthracene	2004	*214*	0.187	ng/dry g	45.5
Antimony	1986	3.067	0.8	µg/dry g	1.23
Antimony	1987	4.033	0.8	µg/dry g	1.23
Antimony	2004	0.886		µg/dry g	1.23
Arsenic	1986	*18.333*	1.7	µg/dry g	13
Arsenic	1987	*13.567*	1.7	µg/dry g	13
Arsenic	2004	*14.3*	1.95	µg/dry g	13
Benz[a]anthracene	2004	*413*	0.128	ng/dry g	135.6
Benzo[a]pyrene	2004	*503*	0.219	ng/dry g	145.88
Benzo[b]fluoranthene	2004	338	0.289	ng/dry g	186.9
Benzo[e]pyrene	2004	325	0.305	ng/dry g	105
Benzo[g,h,i]perylene	2004	292	0.145	ng/dry g	95.4
Benzo[k]fluoranthene	2004	423	0.226	ng/dry g	76
Beta-Hexachlorocyclohexane	2004	0.108	0.103	ng/dry g	0.12
Biphenyl	2004	36.6	0.145	ng/dry g	7.06
C1-Chrysenes	2004	409	0.348	ng/dry g	95.16
C1-Dibenzothiophenes	2004	48.1	0.305	ng/dry g	13.6
C1-Fluoranthenes/Pyrenes	2004	449	0.386	ng/dry g	168.5
C1-Fluorenes	2004	55.8	0.386	ng/dry g	12
C1-Naphthalenes	2004	103	0.332	ng/dry g	26.8
C1-Phenanthrenes/Anthracenes	2004	298	0.289	ng/dry g	77.8
C2-Chrysenes	2004	143	0.348	ng/dry g	66.5
C2-Dibenzothiophenes	2004	70.7	0.305	ng/dry g	27.2
C2-Fluoranthenes/Pyrenes	2004	156	0.386	ng/dry g	318
C2-Fluorenes	2004	65.7	0.386	ng/dry g	23.1
C2-Naphthalenes	2004	145	0.35	ng/dry g	27.46
C2-Phenanthrenes/Anthracenes	2004	290	0.289	ng/dry g	80.45

Table 12. Analyte Concentration in Sediment from HRLB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C3-Chrysenes	2004	29.6	0.348	ng/dry g	10.5
C3-Dibenzothiophenes	2004	59.5	0.305	ng/dry g	26.77
C3-Fluoranthenes/Pyrenes	2004	86.6	0.386	ng/dry g	106
C3-Fluorenes	2004	61.4	0.386	ng/dry g	36.07
C3-Naphthalenes	2004	111	0.35	ng/dry g	31.7
C3-Phenanthrenes/Anthracenes	2004	146	0.289	ng/dry g	71.7
C4-Chrysenes	2004	22.8	0.348	ng/dry g	22.8
C4-Naphthalenes	2004	54.8	0.35	ng/dry g	24.41
C4-Phenanthrenes/Anthracenes	2004	0	0.289	ng/dry g	44.1
Cadmium	1986	*1.533*	0.08	µg/dry g	0.53
Cadmium	1987	*1.503*	0.08	µg/dry g	0.53
Cadmium	2004	0.636	0.195	µg/dry g	0.53
Chlorpyrifos	2004	1.095	0.082	ng/dry g	0.41
Chromium	1986	*166.667*	6	µg/dry g	109.33
Chromium	1987	*127.667*	6	µg/dry g	109.33
Chromium	2004	*101*	0.488	µg/dry g	109.33
Chrysene	2004	*404*	0.174	ng/dry g	157.3
Cis-Nonachlor	2004	0.527	0.089	ng/dry g	0.3
Clay	1986	32.333		Percent	38.67
Clay	1987	18.2		Percent	38.67
Clay	2004	17.3		Percent	38.67
Copper	1986	*133.333*	3	µg/dry g	43.8
Copper	1987	*97.333*	3	µg/dry g	43.8
Copper	2004	*81.1*	0.488	µg/dry g	43.8
Delta-Hexachlorocyclohexane	2004	0	0.083	ng/dry g	0.04
Dibenzo[a,h]anthracene	2004	*73.1*	0.152	ng/dry g	46
Dibenzofuran	2004	43.4	2.22	ng/dry g	43.4
Dibenzothiophene	2004	31.7	0.152	ng/dry g	9
Dibutyltin	2004	3.37	0.412	ng/dry g	1.87
Dichlorobiphenyls	1986	1.153	0.62	ng/dry g	1.27
Dichlorobiphenyls	1987	7.433	0.62	ng/dry g	1.27

Table 12. Analyte Concentration in Sediment from HRLB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Dieldrin	1986	4.967	0.16	ng/dry g	0.99
Dieldrin	1987	5.767	0.14	ng/dry g	0.99
Dieldrin	2004	0.297	0.089	ng/dry g	0.99
Endosulfan I	2004	0	0.082	ng/dry g	0.3
Endosulfan II	2004	0.838	0.082	ng/dry g	0.28
Endosulfan Sulfate	2004	0.338	0.133	ng/dry g	0.34
Endrin	2004	0	0.131	ng/dry g	0.06
Fines	1986	0.71		Decimal	0.86
Fines	1987	0.447		Decimal	0.86
Fluoranthene	2004	473	0.21	ng/dry g	266.6
Fluorene	2004	51.2	0.193	ng/dry g	16
Gamma-Chlordane	2004	1.919	0.112	ng/dry g	0.39
Gamma-Hexachlorocyclohexane	1986	0.703	0.14	ng/dry g	0.3
Gamma-Hexachlorocyclohexane	1987	0	0.03	ng/dry g	0.3
Gamma-Hexachlorocyclohexane	2004	0.351	0.082	ng/dry g	0.3
Gravel	1986	1.65		Percent	3.23
Gravel	1987	0.435		Percent	3.23
Gravel	2004	0		Percent	3.23
Heptachlor	1986	0.903	0.14	ng/dry g	0.11
Heptachlor	1987	2.24	0.24	ng/dry g	0.11
Heptachlor	2004	0	0.088	ng/dry g	0.11
Heptachlor-Epoxide	1986	1.223	0.16	ng/dry g	0.17
Heptachlor-Epoxide	1987	0	0.08	ng/dry g	0.17
Heptachlor-Epoxide	2004	0.257	0.074	ng/dry g	0.17
Heptachlorobiphenyls	1986	23.333	0.14	ng/dry g	12.5
Heptachlorobiphenyls	1987	30	0.14	ng/dry g	12.5
Hexachlorobenzene	1986	1.7	0.14	ng/dry g	0.57
Hexachlorobenzene	1987	0.9	0.09	ng/dry g	0.57
Hexachlorobenzene	2004	0.243	0.052	ng/dry g	0.27
Hexachlorobiphenyls	1987	49.667	0.42	ng/dry g	24
Hexachlorobiphenyls	1986	83.667	0.42	ng/dry g	
Indeno[1,2,3-c,d]pyrene	2004	361	0.279	ng/dry g	91.7
Iron	1986	35000	6	µg/dry g	37400
Iron	1987	27666.667	6	µg/dry g	37400
Iron	2004	34200	1.101	µg/dry g	37400

Table 12. Analyte Concentration in Sediment from HRLB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Lead	1986	173.333	3	µg/dry g	37.67
Lead	1987	114	3	µg/dry g	37.67
Lead	2004	78.7	0.043	µg/dry g	37.67
Manganese	1986	923.333	6	µg/dry g	750
Manganese	1987	650	6	µg/dry g	750
Manganese	2004	578	0.195	µg/dry g	750
Mercury	1986	1.833	0.01	µg/dry g	0.2
Mercury	1987	1.383	0.01	µg/dry g	0.2
Mercury	2004	0.824	0.01	µg/dry g	0.2
Mirex	1986	1.833	0.2	ng/dry g	0.22
Mirex	1987	1.3	0.09	ng/dry g	0.22
Mirex	2004	0	0.097	ng/dry g	0.22
Monobutyltin	2004	5.73	0.711	ng/dry g	2.84
Naphthalene	2004	144	0.174	ng/dry g	29.44
Nickel	1986	37.667	4	µg/dry g	37
Nickel	1987	33.333	4	µg/dry g	37
Nickel	2004	35.8	0.488	µg/dry g	37
Nonachlorobiphenyls	1986	11.133	0.31	ng/dry g	1.6
Nonachlorobiphenyls	1987	4.167	0.31	ng/dry g	1.6
Octachlorobiphenyls	1986	30.333	0.14	ng/dry g	4.43
Octachlorobiphenyls	1987	17.867	0.14	ng/dry g	4.43
Oxychlordane	2004	0.595	0.143	ng/dry g	0.08
PCB101/90	2004	6.797	0.32	ng/dry g	1.87
PCB105	2004	2.892	0.096	ng/dry g	0.68
PCB118	2004	8.23	0.103	ng/dry g	1.88
PCB128	2004	2.595	0.113	ng/dry g	0.66
PCB138	2004	9.027	0.145	ng/dry g	2.6
PCB153/132/168	2004	9.027	0.109	ng/dry g	2.35
PCB170/190	2004	3.932	0.13	ng/dry g	1.39
PCB18	2004	5.581	0.084	ng/dry g	0.65
PCB180	2004	4.392	0.105	ng/dry g	1.24
PCB187	2004	3.541	0.086	ng/dry g	0.84

Table 12. Analyte Concentration in Sediment from HRLB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB195/208	2004	0.986	0.112	ng/dry g	0.36
PCB206	2004	0.946	0.092	ng/dry g	0.37
PCB209	2004	1.419	0.115	ng/dry g	0.54
PCB28	2004	22.923	0.085	ng/dry g	1.36
PCB44	2004	4.243	0.076	ng/dry g	0.95
PCB52	2004	8.162	0.085	ng/dry g	1.62
PCB66	2004	8.824	0.086	ng/dry g	1.52
PCB8/5	2004	4.284	0.098	ng/dry g	1.13
Pentachloroanisole	2004	0.149	0.084	ng/dry g	0.09
Pentachlorobenzene	2004	0.149	0.057	ng/dry g	0.14
Pentachlorobiphenyls	1986	113.333	0.14	ng/dry g	26.6
Pentachlorobiphenyls	1987	77	0.14	ng/dry g	26.6
Percent lipid dry weight	2004	0		Percent	0
Perylene	2004	226	1.381	ng/dry g	76.72
Phenanthrene	2004	292	0.145	ng/dry g	113.33
Pyrene	2004	549	0.193	ng/dry g	260.43
Sand	1986	27.667		Percent	86.77
Sand	1987	55		Percent	86.77
Sand	2004	20.1		Percent	86.77
Selenium	1986	1.3	0.13	µg/dry g	0.73
Selenium	1987	0.433	0.13	µg/dry g	0.73
Selenium	2004	0.627	0.049	µg/dry g	0.73
Silicon	1986	266666.667	4000	µg/dry g	376666.67
Silicon	1987	320000	4000	µg/dry g	376666.67
Silicon	2004	277000		µg/dry g	376666.67
Silt	1986	38.667		Percent	49.96
Silt	1987	26.667		Percent	49.96
Silt	2004	62.6		Percent	49.96
Silver	1986	5.333	0.02	µg/dry g	0.48
Silver	1987	3.933	0.02	µg/dry g	0.48
Silver	2004	2.24	0.043	µg/dry g	0.48

Table 12. Analyte Concentration in Sediment from HRLB in All Years. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Total DDT	1986	***30.433***		ng/dry g	15.17
Total DDT	1987	***60.767***		ng/dry g	15.17
Total DDT	2004	***15.567***		ng/dry g	15.17
Total dieldrin	1986	5.434		ng/dry g	1.4
Total dieldrin	1987	5.767		ng/dry g	1.4
Total dieldrin	2004	0.297		ng/dry g	1.4
Total Inorganic Carbon	1986	0.137		Percent	1.03
Total Inorganic Carbon	1987	0.237		Percent	1.03
Total Inorganic Carbon	2004	0.8		Percent	1.03
Total Organic Carbon	1986	1.767		Percent	2.6
Total Organic Carbon	1987	2.133		Percent	2.6
Total Organic Carbon	2004	2.2		Percent	2.6
Total PAHhmw (4 or more rings)	2004	***4380.1***		ng/dry g	1640.65
Total PAHlmw (2-3 rings)	2004	***1183.4***		ng/dry g	317.7
Trans-Nonachlor	1986	3.567	0.2	ng/dry g	0.63
Trans-Nonachlor	1987	3.3	0.09	ng/dry g	0.63
Trans-Nonachlor	2004	0.568	0.09	ng/dry g	0.63
Tributyltin	2004	5.47	0.56	ng/dry g	3.5
Trichlorobiphenyls	1986	41.667	0.16	ng/dry g	6.03
Trichlorobiphenyls	1987	56.667	0.16	ng/dry g	6.03
Zinc	1986	***250***	2	µg/dry g	126.67
Zinc	1987	***190***	2	µg/dry g	126.67
Zinc	2004	***194***	0.501	µg/dry g	126.67

Blue: Concentration is above the TEL- Threshold Effect Levels (NOAA SQuiRT)
Pink: Concentration is above both the ERL and TEL (NOAA SQuiRT)

Table 13. Analyte Concentration in Sediment from HRLB in All Years. (NOAA 2006)

Sediment					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Sand	1986	27.667		Percent	86.77
Sand	1987	55		Percent	86.77
Sand	2004	20.1		Percent	86.77
Silt	1986	38.667		Percent	49.96
Silt	1987	26.667		Percent	49.96
Silt	2004	62.6		Percent	49.96
Total Organic Carbon	1986	1.767		Percent	2.6
Total Organic Carbon	1987	2.133		Percent	2.6
Total Organic Carbon	2004	2.2		Percent	2.6

Table 14. HRLB Site Specific BAF for 2004.

ANALYTE NAME	Concentration		Units	SBAF
	Sediment	Tissue		
1,2,3,4-Tetrachlorobenzene	0.446	4.738	ng/dry g	10.623
1,2,4,5-Tetrachlorobenzene	0.689	31.543	ng/dry g	45.781
1,6,7-Trimethylnaphthalene	7.2	2.3	ng/dry g	0.319
1-Methylnaphthalene	43.8	14.8	ng/dry g	0.338
1-Methylphenanthrene	54.7	5.3	ng/dry g	0.097
2,4'-DDD	2.77	8.052	ng/dry g	2.907
2,4'-DDE	0.581	2.756	ng/dry g	4.744
2,4'-DDT	0.27	2.09	ng/dry g	7.741
2,6-Dimethylnaphthalene	76.6	10.1	ng/dry g	0.132
2-Methylnaphthalene	105	25.9	ng/dry g	0.247
4,4'-DDD	4.649	13.534	ng/dry g	2.911
4,4'-DDE	6.743	22.454	ng/dry g	3.330
4,4'-DDT	0.554	1.177	ng/dry g	2.125
Acenaphthene	35.3	4.7	ng/dry g	0.133
Acenaphthylene	123	24	ng/dry g	0.195
Aldrin	0	0	ng/dry g	0.000
Alpha-Chlordane	1.608	4.196	ng/dry g	2.609
Alpha-Hexachlorocyclohexane	0	0	ng/dry g	0.000
Aluminum	57200	184	µg/dry g	0.003
Anthracene	214	32.2	ng/dry g	0.150
Antimony	0.886		µg/dry g	0.000
Arsenic	14.3	7.08	µg/dry g	0.495
Benz[a]anthracene	413	110	ng/dry g	0.266
Benzo[a]pyrene	503	50.4	ng/dry g	0.100
Benzo[b]fluoranthene	338	118	ng/dry g	0.349
Benzo[e]pyrene	325	159	ng/dry g	0.489
Benzo[g,h,i]perylene	292	17.9	ng/dry g	0.061
Benzo[k]fluoranthene	423	106	ng/dry g	0.251
Beta-Hexachlorocyclohexane	0.108	0.124	ng/dry g	1.148
Biphenyl	36.6	10	ng/dry g	0.273
C1-Chrysenes	409	109	ng/dry g	0.267
C1-Dibenzothiophenes	48.1	9.2	ng/dry g	0.191
C1-Fluoranthenes/Pyrenes	449	161	ng/dry g	0.359
C1-Fluorenes	55.8	13.4	ng/dry g	0.240
C1-Naphthalenes	103	27.6	ng/dry g	0.268
C1-Phenanthrenes/Anthracenes	298	51.7	ng/dry g	0.173
C2-Chrysenes	143	45.3	ng/dry g	0.317
C2-Dibenzothiophenes	70.7	39.6	ng/dry g	0.560
C2-Fluoranthenes/Pyrenes	156	105	ng/dry g	0.673
C2-Fluorenes	65.7	40.9	ng/dry g	0.623
C2-Naphthalenes	145	25	ng/dry g	0.172
C2-Phenanthrenes/Anthracenes	290	120	ng/dry g	0.414
C3-Chrysenes	29.6	0	ng/dry g	0.000
C3-Dibenzothiophenes	59.5	66.4	ng/dry g	1.116
C3-Fluoranthenes/Pyrenes	86.6	28.6	ng/dry g	0.330
C3-Fluorenes	61.4	76.9	ng/dry g	1.252
C3-Naphthalenes	111	20.5	ng/dry g	0.185
C3-Phenanthrenes/Anthracenes	146	132	ng/dry g	0.904
C4-Chrysenes	22.8	0	ng/dry g	0.000
C4-Naphthalenes	54.8	25.5	ng/dry g	0.465
C4-Phenanthrenes/Anthracenes	0	66.5	ng/dry g	0.000

Table 14. HRLB Site Specific BAF for 2004. (Continued)

ANALYTE NAME	Concentration		Units	SBAF
	Sediment	Tissue		
Cadmium	0.636	1.63	µg/dry g	2.563
Chlorpyrifos	1.095	0.929	ng/dry g	0.848
Chromium	101	2.34	µg/dry g	0.023
Chrysene	404	175	ng/dry g	0.433
Cis-Nonachlor	0.527	2.602	ng/dry g	4.937
Copper	81.1	14	µg/dry g	0.173
Delta-Hexachlorocyclohexane	0	0	ng/dry g	0.000
Dibenzo[a,h]anthracene	73.1	7.2	ng/dry g	0.098
Dibenzofuran	43.4	5.3	ng/dry g	0.122
Dibenzothiophene	31.7	2	ng/dry g	0.063
Dibutyltin	3.37	15.7	ng/dry g	4.659
Dieldrin	0.297	2.369	ng/dry g	7.976
Endosulfan I	0	2.207	ng/dry g	0.000
Endosulfan II	0.838	5.265	ng/dry g	6.283
Endosulfan Sulfate	0.338	0	ng/dry g	0.000
Endrin	0	0	ng/dry g	0.000
Fluoranthene	473	118	ng/dry g	0.249
Fluorene	51.2	5.7	ng/dry g	0.111
Gamma-Chlordane	1.919	4.166	ng/dry g	2.171
Gamma-Hexachlorocyclohexane	0.351	0.124	ng/dry g	0.353
Heptachlor	0	0	ng/dry g	0.000
Heptachlor-Epoxide	0.257	0	ng/dry g	0.000
Hexachlorobenzene	0.243	0.279	ng/dry g	1.148
Indeno[1,2,3-c,d]pyrene	361	25.9	ng/dry g	0.072
Iron	34200	533	µg/dry g	0.016
Lead	78.7	3.94	µg/dry g	0.050
Manganese	578	100	µg/dry g	0.173
Mercury	0.824	0.241	µg/dry g	0.292
Mirex	0	0.48	ng/dry g	0.000
Monobutyltin	5.73	6.03	ng/dry g	1.052
Naphthalene	144	22	ng/dry g	0.153
Nickel	35.8	2.81	µg/dry g	0.078
Oxychlordane	0.595	1.1	ng/dry g	1.849
PCB101/90	6.797	5.54	ng/dry g	0.815
PCB105	2.892	7.975	ng/dry g	2.758
PCB118	8.23	23.832	ng/dry g	2.896
PCB128	2.595	4.088	ng/dry g	1.575
PCB138	9.027	27.517	ng/dry g	3.048
PCB153/132/168	9.027	57.745	ng/dry g	6.397
PCB170/190	3.932	2.555	ng/dry g	0.650
PCB18	5.581	1.889	ng/dry g	0.338
PCB180	4.392	11.258	ng/dry g	2.563
PCB187	3.541	17.638	ng/dry g	4.981
PCB195/208	0.986	0.279	ng/dry g	0.283

Table 14. HRLB Site Specific BAF for 2004. (Continued)

ANALYTE NAME	Concentration		Units	SBAF
	Sediment	Tissue		
PCB206	0.946	0.046	ng/dry g	0.049
PCB209	1.419	0.046	ng/dry g	0.032
PCB28	22.923	8.099	ng/dry g	0.353
PCB44	4.243	8.548	ng/dry g	2.015
PCB52	8.162	20.208	ng/dry g	2.476
PCB66	8.824	11.722	ng/dry g	1.328
PCB8/5	4.284	0	ng/dry g	0.000
Pentachloroanisole	0.149	0.712	ng/dry g	4.779
Pentachlorobenzene	0.149	5.203	ng/dry g	34.919
Percent lipid dry weight	0	14.246	Percent	0.000
Perylene	226	22.5	ng/dry g	0.100
Phenanthrene	292	20.4	ng/dry g	0.070
Pyrene	549	272	ng/dry g	0.495
Selenium	0.627	5.52	µg/dry g	8.804
Silicon	277000		µg/dry g	0.000
Silver	2.24	0.525	µg/dry g	0.234
Tetrabutyltin	0.369	0	ng/dry g	0.000
Tin	14.7	0.604	µg/dry g	0.041
Total butyltins	14.57	116.94	ng/dry g	8.026
Total chlordanes	2.433	7.185	ng/dry g	2.953
Total DDT	15.567	50.063	ng/dry g	3.216
Total dieldrin	0.297	2.369	ng/dry g	7.976
Total Inorganic Carbon	0.8		Percent	0.800
Total Organic Carbon	2.2		Percent	2.200
Total PAHhmw (4 or more rings)	4380.1		ng/dry g	0.000
Total PAHlmw (2-3 rings)	1183.4		ng/dry g	0.000
Trans-Nonachlor	0.568	2.989	ng/dry g	5.262
Tributyltin	5.47	95.21	ng/dry g	17.406
Zinc	194	130	µg/dry g	0.670

BAF = Tissue/Sediment

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
1,2,3,4-Tetrachlorobenzene	1995	0.278		ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	1997	1.55		ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	1999	1.464		ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2001	0	0.29	ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2002	0	0.29	ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2004	0	0.293	ng/dry g	1.33
1,2,4,5-Tetrachlorobenzene	1995	0		ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	1997	4.35		ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	1999	2.533		ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2001	0	0.27	ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2002	0	0.27	ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2004	26.13	0.3	ng/dry g	3.33
1,6,7-Trimethylnaphthalene	1989	0	4.4	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1990	11.77	9.7	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1992	4	5	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1995	10.51	8.4	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1997	13.4		ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1999	2.78		ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2001	2.2	1	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2002	2.3	1	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2004	2.8	0.805	ng/dry g	10.34
1-Methylnaphthalene	1989	4.65	3.5	ng/dry g	16.6
1-Methylnaphthalene	1990	7.34	22	ng/dry g	16.6
1-Methylnaphthalene	1992	5.72	5.7	ng/dry g	16.6
1-Methylnaphthalene	1995	6.49	6.4	ng/dry g	16.6
1-Methylnaphthalene	1997	6.2		ng/dry g	16.6
1-Methylnaphthalene	1999	6.89		ng/dry g	16.6
1-Methylnaphthalene	2001	4.4	0.3	ng/dry g	16.6
1-Methylnaphthalene	2002	15.4	0.3	ng/dry g	16.6
1-Methylnaphthalene	2004	10.8	4.465	ng/dry g	16.6
1-Methylphenanthrene	1989	0	7.1	ng/dry g	16.9
1-Methylphenanthrene	1990	14.797	22	ng/dry g	16.9
1-Methylphenanthrene	1992	6.96	9.3	ng/dry g	16.9
1-Methylphenanthrene	1995	8.86		ng/dry g	16.9
1-Methylphenanthrene	1997	16.4		ng/dry g	16.9
1-Methylphenanthrene	1999	3.56		ng/dry g	16.9
1-Methylphenanthrene	2001	7.2	1.3	ng/dry g	16.9
1-Methylphenanthrene	2002	4.7	1.3	ng/dry g	16.9
1-Methylphenanthrene	2004	9.6	1.014	ng/dry g	16.9

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
2,4'-DDD	1986	39.333	0.75	ng/dry g	6.33
2,4'-DDD	1987	3.667	1.3	ng/dry g	6.33
2,4'-DDD	1988	21.667	1.4	ng/dry g	6.33
2,4'-DDD	1989	0	0.21	ng/dry g	6.33
2,4'-DDD	1990	12.87	0.69	ng/dry g	6.33
2,4'-DDD	1992	21.78	0.58	ng/dry g	6.33
2,4'-DDD	1995	19.915	0.17	ng/dry g	6.33
2,4'-DDD	1997	34.28		ng/dry g	6.33
2,4'-DDD	1999	10.953		ng/dry g	6.33
2,4'-DDD	2001	9.386	0.29	ng/dry g	6.33
2,4'-DDD	2002	11.785	0.29	ng/dry g	6.33
2,4'-DDD	2004	9.955	0.198	ng/dry g	6.33
2,4'-DDE	1986	54.333	0.5	ng/dry g	3.22
2,4'-DDE	1987	30.933	0.17	ng/dry g	3.22
2,4'-DDE	1988	0	0.24	ng/dry g	3.22
2,4'-DDE	1989	7.05	0.39	ng/dry g	3.22
2,4'-DDE	1990	18.96	1.1	ng/dry g	3.22
2,4'-DDE	1992	9.88	1.1	ng/dry g	3.22
2,4'-DDE	1995	9.108	0.44	ng/dry g	3.22
2,4'-DDE	1997	11.98		ng/dry g	3.22
2,4'-DDE	1999	3.436		ng/dry g	3.22
2,4'-DDE	2001	4.235	0.25	ng/dry g	3.22
2,4'-DDE	2002	4.052	0.25	ng/dry g	3.22
2,4'-DDE	2004	2.873	0.184	ng/dry g	3.22
2,4'-DDT	1986	17.667	0.85	ng/dry g	3.3
2,4'-DDT	1987	0	0.5	ng/dry g	3.3
2,4'-DDT	1988	0	0.49	ng/dry g	3.3
2,4'-DDT	1989	0	0.27	ng/dry g	3.3
2,4'-DDT	1990	12.7	1.1	ng/dry g	3.3
2,4'-DDT	1992	5.69	0.9	ng/dry g	3.3
2,4'-DDT	1995	3.347	0.31	ng/dry g	3.3
2,4'-DDT	1997	6.13		ng/dry g	3.3
2,4'-DDT	1999	1.601		ng/dry g	3.3
2,4'-DDT	2001	2.518	0.25	ng/dry g	3.3
2,4'-DDT	2002	2.901	0.25	ng/dry g	3.3
2,4'-DDT	2004	1.997	0.216	ng/dry g	3.3
2,6-Dimethylnaphthalene	1989	0	6	ng/dry g	13.77
2,6-Dimethylnaphthalene	1990	6.664	38	ng/dry g	13.77
2,6-Dimethylnaphthalene	1992	4.48	8.6	ng/dry g	13.77
2,6-Dimethylnaphthalene	1995	5.42	10	ng/dry g	13.77
2,6-Dimethylnaphthalene	1997	5.7		ng/dry g	13.77
2,6-Dimethylnaphthalene	1999	3.58		ng/dry g	13.77
2,6-Dimethylnaphthalene	2001	5.1	0.5	ng/dry g	13.77
2,6-Dimethylnaphthalene	2002	11.2	0.5	ng/dry g	13.77
2,6-Dimethylnaphthalene	2004	7.3	2.975	ng/dry g	13.77

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
2-Methylnaphthalene	1989	13	4	ng/dry g	29.97
2-Methylnaphthalene	1990	11.149	20	ng/dry g	29.97
2-Methylnaphthalene	1992	9.04	5.5	ng/dry g	29.97
2-Methylnaphthalene	1995	11.91		ng/dry g	29.97
2-Methylnaphthalene	1997	7.1		ng/dry g	29.97
2-Methylnaphthalene	1999	12.46		ng/dry g	29.97
2-Methylnaphthalene	2001	8.7	0.6	ng/dry g	29.97
2-Methylnaphthalene	2002	32.8	0.6	ng/dry g	29.97
2-Methylnaphthalene	2004	20.7	7.349	ng/dry g	29.97
4,4'-DDD	1986	79.333	1.8	ng/dry g	19
4,4'-DDD	1987	109.333	0.38	ng/dry g	19
4,4'-DDD	1988	83	0.64	ng/dry g	19
4,4'-DDD	1989	145	0.27	ng/dry g	19
4,4'-DDD	1990	90.13	7.1	ng/dry g	19
4,4'-DDD	1992	53.97	1	ng/dry g	19
4,4'-DDD	1995	42.858	0.28	ng/dry g	19
4,4'-DDD	1997	69.73		ng/dry g	19
4,4'-DDD	1999	20.966		ng/dry g	19
4,4'-DDD	2001	18.086	0.34	ng/dry g	19
4,4'-DDD	2002	17	0.34	ng/dry g	19
4,4'-DDD	2004	17.295	0.176	ng/dry g	19
4,4'-DDE	1986	58.667	0.6	ng/dry g	48
4,4'-DDE	1987	66.667	0.28	ng/dry g	48
4,4'-DDE	1988	85.667	0.27	ng/dry g	48
4,4'-DDE	1989	155	0.34	ng/dry g	48
4,4'-DDE	1990	98.06	6.4	ng/dry g	48
4,4'-DDE	1992	74.58	2.3	ng/dry g	48
4,4'-DDE	1995	50.962	0.92	ng/dry g	48
4,4'-DDE	1997	74.01		ng/dry g	48
4,4'-DDE	1999	27.147		ng/dry g	48
4,4'-DDE	2001	21.978	0.24	ng/dry g	48
4,4'-DDE	2002	22.969	0.24	ng/dry g	48
4,4'-DDE	2004	20.068	0.192	ng/dry g	48
4,4'-DDT	1986	22.667	0.3	ng/dry g	4.39
4,4'-DDT	1987	10.233	1	ng/dry g	4.39
4,4'-DDT	1988	8.3	0.11	ng/dry g	4.39
4,4'-DDT	1989	0	0.29	ng/dry g	4.39
4,4'-DDT	1990	7.55	1.7	ng/dry g	4.39
4,4'-DDT	1992	4.34	2.1	ng/dry g	4.39
4,4'-DDT	1995	6.636	0.83	ng/dry g	4.39
4,4'-DDT	1997	10.01		ng/dry g	4.39
4,4'-DDT	1999	1.626		ng/dry g	4.39
4,4'-DDT	2001	3.205	0.25	ng/dry g	4.39
4,4'-DDT	2002	2.314	0.25	ng/dry g	4.39
4,4'-DDT	2004	1.393	0.182	ng/dry g	4.39

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Acenaphthene	1989	0	1.6	ng/dry g	9.7
Acenaphthene	1990	0	8.5	ng/dry g	9.7
Acenaphthene	1992	3.47	3.8	ng/dry g	9.7
Acenaphthene	1995	4.5	12	ng/dry g	9.7
Acenaphthene	1997	4.5		ng/dry g	9.7
Acenaphthene	1999	7.42		ng/dry g	9.7
Acenaphthene	2001	2.4	0.4	ng/dry g	9.7
Acenaphthene	2002	9.5	0.4	ng/dry g	9.7
Acenaphthene	2004	4.9	1.79	ng/dry g	9.7
Acenaphthylene	1989	13	11	ng/dry g	7.55
Acenaphthylene	1990	24.091	36	ng/dry g	7.55
Acenaphthylene	1992	19.06	10	ng/dry g	7.55
Acenaphthylene	1995	10.63	4.8	ng/dry g	7.55
Acenaphthylene	1997	15		ng/dry g	7.55
Acenaphthylene	1999	10.39		ng/dry g	7.55
Acenaphthylene	2001	5.7	0.5	ng/dry g	7.55
Acenaphthylene	2002	5.2	0.5	ng/dry g	7.55
Acenaphthylene	2004	13.5	1.872	ng/dry g	7.55
Aldrin	1986	11.833	0.6	ng/dry g	0.69
Aldrin	1987	2.2	0.25	ng/dry g	0.69
Aldrin	1988	0	0.12	ng/dry g	0.69
Aldrin	1989	0	0.38	ng/dry g	0.69
Aldrin	1990	0	0.39	ng/dry g	0.69
Aldrin	1992	0	0.66	ng/dry g	0.69
Aldrin	1995	0	0.41	ng/dry g	0.69
Aldrin	1997	0		ng/dry g	0.69
Aldrin	1999	0		ng/dry g	0.69
Aldrin	2001	0	0.25	ng/dry g	0.69
Aldrin	2002	0	0.25	ng/dry g	0.69
Aldrin	2004	0	0.215	ng/dry g	0.69
Alpha-Chlordane	1986	50.333	0.3	ng/dry g	10.89
Alpha-Chlordane	1987	39.667	0.36	ng/dry g	10.89
Alpha-Chlordane	1988	20.333	0.32	ng/dry g	10.89
Alpha-Chlordane	1989	6.5	0.32	ng/dry g	10.89
Alpha-Chlordane	1990	23.63	1.3	ng/dry g	10.89
Alpha-Chlordane	1992	11.73	1.2	ng/dry g	10.89
Alpha-Chlordane	1995	11.316		ng/dry g	10.89
Alpha-Chlordane	1997	14.95		ng/dry g	10.89
Alpha-Chlordane	1999	4.574		ng/dry g	10.89
Alpha-Chlordane	2001	3.777	0.29	ng/dry g	10.89
Alpha-Chlordane	2002	2.991	0.29	ng/dry g	10.89
Alpha-Chlordane	2004	3.548	0.207	ng/dry g	10.89

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Alpha-Hexachlorocyclohexane	1995	3.889		ng/dry g	1.42
Alpha-Hexachlorocyclohexane	1997	0.75		ng/dry g	1.42
Alpha-Hexachlorocyclohexane	1999	0.995		ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2001	0	0.25	ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2002	0	0.25	ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2004	0	0.203	ng/dry g	1.42
Aluminum	1986	97.333	27	µg/dry g	732
Aluminum	1987	266.667	27	µg/dry g	732
Aluminum	1988	223.333	60	µg/dry g	732
Aluminum	1989	300	0.78	µg/dry g	732
Aluminum	1990	1490	160	µg/dry g	732
Aluminum	1992	350	34	µg/dry g	732
Aluminum	1995	653.551	120	µg/dry g	732
Aluminum	1997	569		µg/dry g	732
Aluminum	1999	1080		µg/dry g	732
Aluminum	2001	557	5	µg/dry g	732
Aluminum	2002	421	4.882	µg/dry g	732
Aluminum	2004	835	4.882	µg/dry g	732
Anthracene	1989	7.5	7.2	ng/dry g	18.2
Anthracene	1990	40.61	23	ng/dry g	18.2
Anthracene	1992	25.33	5.5	ng/dry g	18.2
Anthracene	1995	13.67	4.5	ng/dry g	18.2
Anthracene	1997	24.5		ng/dry g	18.2
Anthracene	1999	17.45		ng/dry g	18.2
Anthracene	2001	9.7	1.7	ng/dry g	18.2
Anthracene	2002	7.8	1.7	ng/dry g	18.2
Anthracene	2004	15.5	0.992	ng/dry g	18.2
Antimony	1986	0	0.4	µg/dry g	0.05
Antimony	1987	0	0.4	µg/dry g	0.05
Antimony	1990	0.08	0.01	µg/dry g	0.05
Antimony	1992	0.05	0.03	µg/dry g	0.05
Arsenic	1986	8.8	1.5	µg/dry g	15.67
Arsenic	1987	8.467	1.5	µg/dry g	15.67
Arsenic	1988	9.133	2	µg/dry g	15.67
Arsenic	1989	9.55	2	µg/dry g	15.67
Arsenic	1990	10.72	5	µg/dry g	15.67
Arsenic	1992	10.12	1.2	µg/dry g	15.67
Arsenic	1995	8.099	0.4	µg/dry g	15.67
Arsenic	1997	8.8		µg/dry g	15.67
Arsenic	1999	6.63		µg/dry g	15.67
Arsenic	2001	19.6	2	µg/dry g	15.67
Arsenic	2002	5.36	1.95	µg/dry g	15.67
Arsenic	2004	6.15	1.95	µg/dry g	15.67

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Benz[a]anthracene	1989	79	9.4	ng/dry g	33.67
Benz[a]anthracene	1990	115.3	8	ng/dry g	33.67
Benz[a]anthracene	1992	90.1	8.6	ng/dry g	33.67
Benz[a]anthracene	1995	80	2.5	ng/dry g	33.67
Benz[a]anthracene	1997	82.1		ng/dry g	33.67
Benz[a]anthracene	1999	52.74		ng/dry g	33.67
Benz[a]anthracene	2001	77.2	1	ng/dry g	33.67
Benz[a]anthracene	2004	114	2.662	ng/dry g	33.67
Benzo[a]pyrene	1989	53.5	3.8	ng/dry g	10.92
Benzo[a]pyrene	1990	82.66	8.7	ng/dry g	10.92
Benzo[a]pyrene	1992	63.36	3.6	ng/dry g	10.92
Benzo[a]pyrene	1995	53.6	4.7	ng/dry g	10.92
Benzo[a]pyrene	1997	56.2		ng/dry g	10.92
Benzo[a]pyrene	1999	49.49		ng/dry g	10.92
Benzo[a]pyrene	2001	53.7	1.3	ng/dry g	10.92
Benzo[a]pyrene	2002	66	1.3	ng/dry g	10.92
Benzo[a]pyrene	2004	89.3	1.376	ng/dry g	10.92
Benzo[b]fluoranthene	1989	84.5	16	ng/dry g	37.75
Benzo[b]fluoranthene	1990	157.27	12	ng/dry g	37.75
Benzo[b]fluoranthene	1992	126.88	9.8	ng/dry g	37.75
Benzo[b]fluoranthene	1995	138.74	8.7	ng/dry g	37.75
Benzo[b]fluoranthene	1997	124.8		ng/dry g	37.75
Benzo[b]fluoranthene	1999	55.66		ng/dry g	37.75
Benzo[b]fluoranthene	2001	96.2	0.8	ng/dry g	37.75
Benzo[b]fluoranthene	2002	126	0.8	ng/dry g	37.75
Benzo[b]fluoranthene	2004	202	3.232	ng/dry g	37.75
Benzo[e]pyrene	1989	110	4.7	ng/dry g	36.06
Benzo[e]pyrene	1990	162.76	7.6	ng/dry g	36.06
Benzo[e]pyrene	1992	144.54	4.3	ng/dry g	36.06
Benzo[e]pyrene	1995	126.32	4.3	ng/dry g	36.06
Benzo[e]pyrene	1997	127.3		ng/dry g	36.06
Benzo[e]pyrene	1999	67.71		ng/dry g	36.06
Benzo[e]pyrene	2001	125	1.9	ng/dry g	36.06
Benzo[e]pyrene	2002	150	1.9	ng/dry g	36.06
Benzo[e]pyrene	2004	132	2.259	ng/dry g	36.06
Benzo[g,h,i]perylene	1989	26	6.2	ng/dry g	10.49
Benzo[g,h,i]perylene	1990	36.2	3.3	ng/dry g	10.49
Benzo[g,h,i]perylene	1992	42.75	6.7	ng/dry g	10.49
Benzo[g,h,i]perylene	1995	32.91	4.1	ng/dry g	10.49
Benzo[g,h,i]perylene	1997	33.2		ng/dry g	10.49
Benzo[g,h,i]perylene	1999	30.35		ng/dry g	10.49
Benzo[g,h,i]perylene	2001	27.4	0.7	ng/dry g	10.49
Benzo[g,h,i]perylene	2002	44.2	0.7	ng/dry g	10.49
Benzo[g,h,i]perylene	2004	42.5	2.017	ng/dry g	10.49

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C1-Phenanthrenes/Anthracenes	1995	64.36	11	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	1997	40.8		ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	1999	24.62		ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2001	38.9	2.9	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2002	29.7	2.9	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2004	50.3	3.061	ng/dry g	65.3
C2-Chrysenes	1995	105.84	15	ng/dry g	23.96
C2-Chrysenes	1997	115.9		ng/dry g	23.96
C2-Chrysenes	1999	29.26		ng/dry g	23.96
C2-Chrysenes	2001	65.8	1.8	ng/dry g	23.96
C2-Chrysenes	2002	103	1.8	ng/dry g	23.96
C2-Chrysenes	2004	123	4.288	ng/dry g	23.96
C2-Dibenzothiophenes	1995	60.35	18	ng/dry g	43.5
C2-Dibenzothiophenes	1997	91.4		ng/dry g	43.5
C2-Dibenzothiophenes	1999	9.17		ng/dry g	43.5
C2-Dibenzothiophenes	2001	51.1	1.1	ng/dry g	43.5
C2-Dibenzothiophenes	2002	27.4	1.1	ng/dry g	43.5
C2-Dibenzothiophenes	2004	0	1.5	ng/dry g	43.5
C2-Fluoranthenes/Pyrenes	2004	147	7.604	ng/dry g	32.6
C2-Fluorenes	1995	107.69	12	ng/dry g	54.15
C2-Fluorenes	1997	89.4		ng/dry g	54.15
C2-Fluorenes	1999	14.96		ng/dry g	54.15
C2-Fluorenes	2001	32.4	1.1	ng/dry g	54.15
C2-Fluorenes	2002	27.4	1.1	ng/dry g	54.15
C2-Fluorenes	2004	0	2.092	ng/dry g	54.15
C2-Naphthalenes	1995	14.63	17	ng/dry g	33.8
C2-Naphthalenes	1997	34.7		ng/dry g	33.8
C2-Naphthalenes	1999	13.25		ng/dry g	33.8
C2-Naphthalenes	2001	10.8	4.6	ng/dry g	33.8
C2-Naphthalenes	2002	22.5	4.6	ng/dry g	33.8
C2-Naphthalenes	2004	19.5	7.613	ng/dry g	33.8
C2-Phenanthrenes/Anthracenes	1995	307.15	19	ng/dry g	104
C2-Phenanthrenes/Anthracenes	1997	265.9		ng/dry g	104
C2-Phenanthrenes/Anthracenes	1999	51.51		ng/dry g	104
C2-Phenanthrenes/Anthracenes	2001	137	2.9	ng/dry g	104
C2-Phenanthrenes/Anthracenes	2002	59.2	2.9	ng/dry g	104
C2-Phenanthrenes/Anthracenes	2004	144	3.061	ng/dry g	104
C3-Chrysenes	1995	10.32	21	ng/dry g	0.6
C3-Chrysenes	1997	6.8		ng/dry g	0.6
C3-Chrysenes	1999	1.13		ng/dry g	0.6
C3-Chrysenes	2001	22.1	1.8	ng/dry g	0.6
C3-Chrysenes	2002	48.7	1.8	ng/dry g	0.6
C3-Chrysenes	2004	48.8	4.288	ng/dry g	0.6

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
C3-Dibenzothiophenes	1995	129.63	11	ng/dry g	54.31
C3-Dibenzothiophenes	1997	174.1		ng/dry g	54.31
C3-Dibenzothiophenes	1999	17.07		ng/dry g	54.31
C3-Dibenzothiophenes	2001	70.1	1.1	ng/dry g	54.31
C3-Dibenzothiophenes	2002	52.2	1.1	ng/dry g	54.31
C3-Dibenzothiophenes	2004	0	1.5	ng/dry g	54.31
C3-Fluoranthenes/Pyrenes	2004	114	7.604	ng/dry g	10.2
C3-Fluorenes	1995	264.66	12	ng/dry g	94.6
C3-Fluorenes	1997	246.8		ng/dry g	94.6
C3-Fluorenes	1999	31.57		ng/dry g	94.6
C3-Fluorenes	2001	37.2	1.1	ng/dry g	94.6
C3-Fluorenes	2002	47.1	1.1	ng/dry g	94.6
C3-Fluorenes	2004	0	2.092	ng/dry g	94.6
C3-Naphthalenes	1995	53.86	17	ng/dry g	45.31
C3-Naphthalenes	1997	99.4		ng/dry g	45.31
C3-Naphthalenes	1999	12.8		ng/dry g	45.31
C3-Naphthalenes	2001	14.4	4.6	ng/dry g	45.31
C3-Naphthalenes	2002	12.8	4.6	ng/dry g	45.31
C3-Naphthalenes	2004	27.8	7.613	ng/dry g	45.31
C3-Phenanthrenes/Anthracenes	1995	280.41	19	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	1997	408.2		ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	1999	50.87		ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2001	129	2.9	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2002	89.8	2.9	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2004	163	3.061	ng/dry g	96.6
C4-Chrysenes	1995	7.29	17	ng/dry g	0.51
C4-Chrysenes	1997	9.8		ng/dry g	0.51
C4-Chrysenes	1999	1.26		ng/dry g	0.51
C4-Chrysenes	2001	0	1.8	ng/dry g	0.51
C4-Chrysenes	2002	7.8	1.8	ng/dry g	0.51
C4-Chrysenes	2004	20.3	4.288	ng/dry g	0.51
C4-Naphthalenes	1995	128.54	11	ng/dry g	47.27
C4-Naphthalenes	1997	134.6		ng/dry g	47.27
C4-Naphthalenes	1999	17.77		ng/dry g	47.27
C4-Naphthalenes	2001	26.2	4.6	ng/dry g	47.27
C4-Naphthalenes	2002	17.2	4.6	ng/dry g	47.27
C4-Naphthalenes	2004	53.7	7.613	ng/dry g	47.27
C4-Phenanthrenes/Anthracenes	1995	210.03	12	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	1997	235.4		ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	1999	32.13		ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2001	68.4	2.9	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2002	86.8	2.9	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2004	107	3.061	ng/dry g	58.4

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Cadmium	1986	4.233	0.9	µg/dry g	5.42
Cadmium	1987	6.267	0.9	µg/dry g	5.42
Cadmium	1988	3.367	0.19	µg/dry g	5.42
Cadmium	1989	2.25	0.02	µg/dry g	5.42
Cadmium	1990	3.26	0.63	µg/dry g	5.42
Cadmium	1992	2.81	0.44	µg/dry g	5.42
Cadmium	1995	1.28	0.003	µg/dry g	5.42
Cadmium	1997	3.62		µg/dry g	5.42
Cadmium	1999	1.53		µg/dry g	5.42
Cadmium	2001	1.96	0.0397	µg/dry g	5.42
Cadmium	2002	1.96	0.195	µg/dry g	5.42
Cadmium	2004	1.46	0.195	µg/dry g	5.42
Chlorpyrifos	1995	4.304		ng/dry g	1.55
Chlorpyrifos	1997	8.26		ng/dry g	1.55
Chlorpyrifos	1999	3.12		ng/dry g	1.55
Chlorpyrifos	2001	3.549	0.28	ng/dry g	1.55
Chlorpyrifos	2002	1.483	0.28	ng/dry g	1.55
Chlorpyrifos	2004	0	0.219	ng/dry g	1.55
Chromium	1986	1.533	0.21	µg/dry g	3.02
Chromium	1987	3.233	0.21	µg/dry g	3.02
Chromium	1988	7.3	0.12	µg/dry g	3.02
Chromium	1989	2.25	0.1	µg/dry g	3.02
Chromium	1990	2.93	0.63	µg/dry g	3.02
Chromium	1992	2.76	0.4	µg/dry g	3.02
Chromium	1995	3.581	0.5	µg/dry g	3.02
Chromium	1997	2.8		µg/dry g	3.02
Chromium	1999	5.13		µg/dry g	3.02
Chromium	2001	2.7	0.5	µg/dry g	3.02
Chromium	2002	3.73	0.488	µg/dry g	3.02
Chromium	2004	11	0.488	µg/dry g	3.02
Chrysene	1989	150	3.1	ng/dry g	72.85
Chrysene	1990	172.95	12	ng/dry g	72.85
Chrysene	1992	161.95	9.9	ng/dry g	72.85
Chrysene	1995	165.57	5.8	ng/dry g	72.85
Chrysene	1997	140.4		ng/dry g	72.85
Chrysene	1999	80.83		ng/dry g	72.85
Chrysene	2001	158	0.9	ng/dry g	72.85
Chrysene	2002	154	0.9	ng/dry g	72.85
Chrysene	2004	136	4.288	ng/dry g	72.85
Cis-Nonachlor	1995	7.292		ng/dry g	3.91
Cis-Nonachlor	1997	6.75		ng/dry g	3.91
Cis-Nonachlor	1999	3.802		ng/dry g	3.91
Cis-Nonachlor	2001	2.747	0.26	ng/dry g	3.91
Cis-Nonachlor	2002	2.927	0.26	ng/dry g	3.91
Cis-Nonachlor	2004	2.284	0.212	ng/dry g	3.91

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Copper	1986	12.667	3	µg/dry g	183
Copper	1987	16.333	3	µg/dry g	183
Copper	1988	18	3	µg/dry g	183
Copper	1989	15.5	3	µg/dry g	183
Copper	1990	16.8	11	µg/dry g	183
Copper	1992	4.97	2.7	µg/dry g	183
Copper	1995	12.173	0.16	µg/dry g	183
Copper	1997	13.9		µg/dry g	183
Copper	1999	16.9		µg/dry g	183
Copper	2001	16	0.5	µg/dry g	183
Copper	2002	14.8	0.488	µg/dry g	183
Copper	2004	19.5	0.488	µg/dry g	183
Delta-Hexachlorocyclohexane	1995	0.244		ng/dry g	0.18
Delta-Hexachlorocyclohexane	1997	1.34		ng/dry g	0.18
Delta-Hexachlorocyclohexane	1999	0		ng/dry g	0.18
Delta-Hexachlorocyclohexane	2001	0	0.23	ng/dry g	0.18
Delta-Hexachlorocyclohexane	2002	0.064	0.23	ng/dry g	0.18
Delta-Hexachlorocyclohexane	2004	0	0.202	ng/dry g	0.18
Dibenzo[a,h]anthracene	1989	0	5.8	ng/dry g	2.17
Dibenzo[a,h]anthracene	1990	9	7.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	1992	7.34	7.2	ng/dry g	2.17
Dibenzo[a,h]anthracene	1995	7.19	6.6	ng/dry g	2.17
Dibenzo[a,h]anthracene	1997	7.3		ng/dry g	2.17
Dibenzo[a,h]anthracene	1999	4.06		ng/dry g	2.17
Dibenzo[a,h]anthracene	2001	10	0.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	2002	13.9	0.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	2004	17.4	1.989	ng/dry g	2.17
Dibenzofuran	2004	5.1	2.22	ng/dry g	11.55
Dibenzothiophene	1995	2.05		ng/dry g	5.5
Dibenzothiophene	1997	3.3		ng/dry g	5.5
Dibenzothiophene	1999	1.44		ng/dry g	5.5
Dibenzothiophene	2001	2.2	0.5	ng/dry g	5.5
Dibenzothiophene	2002	2.7	0.5	ng/dry g	5.5
Dibenzothiophene	2004	2.6	1.5	ng/dry g	5.5
Dibutyltin	1992	85.47		ng/dry g	22.61
Dibutyltin	1995	25.918		ng/dry g	22.61
Dibutyltin	1997	19		ng/dry g	22.61
Dibutyltin	1999	18.05		ng/dry g	22.61
Dibutyltin	2001	19.26	3.6	ng/dry g	22.61
Dibutyltin	2002	23.73	3.6	ng/dry g	22.61
Dibutyltin	2004	12.39	2.807	ng/dry g	22.61
Dichlorobiphenyls	1986	4.9	2.3	ng/dry g	11.4
Dichlorobiphenyls	1987	2.167	2.3	ng/dry g	11.4

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Dieldrin	1986	57	0.6	ng/dry g	9.34
Dieldrin	1987	33	0.52	ng/dry g	9.34
Dieldrin	1988	0	0.11	ng/dry g	9.34
Dieldrin	1989	0	0.39	ng/dry g	9.34
Dieldrin	1990	0	2.9	ng/dry g	9.34
Dieldrin	1992	26.3	0.82	ng/dry g	9.34
Dieldrin	1995	7.121	1	ng/dry g	9.34
Dieldrin	1997	13.31		ng/dry g	9.34
Dieldrin	1999	3.727		ng/dry g	9.34
Dieldrin	2001	2.518	0.37	ng/dry g	9.34
Dieldrin	2002	2.326	0.37	ng/dry g	9.34
Dieldrin	2004	2.672	0.196	ng/dry g	9.34
Endosulfan I	2001	1.959	0.26	ng/dry g	2.12
Endosulfan I	2002	12.758	0.26	ng/dry g	2.12
Endosulfan I	2004	3.09	0.219	ng/dry g	2.12
Endosulfan II	1995	0		ng/dry g	1.71
Endosulfan II	1997	0		ng/dry g	1.71
Endosulfan II	1999	1.075		ng/dry g	1.71
Endosulfan II	2001	0	0.26	ng/dry g	1.71
Endosulfan II	2002	0	0.26	ng/dry g	1.71
Endosulfan II	2004	4.367	0.219	ng/dry g	1.71
Endosulfan Sulfate	2001	0	0.29	ng/dry g	0.44
Endosulfan Sulfate	2002	0	0.29	ng/dry g	0.44
Endosulfan Sulfate	2004	0	0.238	ng/dry g	0.44
Endrin	1992	0		ng/dry g	0.71
Endrin	1995	0		ng/dry g	0.71
Endrin	1997	0		ng/dry g	0.71
Endrin	1999	0		ng/dry g	0.71
Endrin	2001	0	0.24	ng/dry g	0.71
Endrin	2002	0	0.24	ng/dry g	0.71
Endrin	2004	0	0.181	ng/dry g	0.71
Fluoranthene	1989	175	8.2	ng/dry g	153.33
Fluoranthene	1990	217.58	25	ng/dry g	153.33
Fluoranthene	1992	221.41	9.5	ng/dry g	153.33
Fluoranthene	1995	198.35	5.8	ng/dry g	153.33
Fluoranthene	1997	246.7		ng/dry g	153.33
Fluoranthene	1999	108.46		ng/dry g	153.33
Fluoranthene	2001	142	0.8	ng/dry g	153.33
Fluoranthene	2002	155	0.8	ng/dry g	153.33
Fluoranthene	2004	153	7.604	ng/dry g	153.33

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Fluorene	1989	0	2.9	ng/dry g	12.6
Fluorene	1990	0	12	ng/dry g	12.6
Fluorene	1992	3.16	6.4	ng/dry g	12.6
Fluorene	1995	3.34	6.8	ng/dry g	12.6
Fluorene	1997	8		ng/dry g	12.6
Fluorene	1999	4.74		ng/dry g	12.6
Fluorene	2001	3.1	0.6	ng/dry g	12.6
Fluorene	2002	5.3	0.6	ng/dry g	12.6
Fluorene	2004	5.4	2.092	ng/dry g	12.6
Gamma-Chlordane	1995	11.12		ng/dry g	5.18
Gamma-Chlordane	1997	12.45		ng/dry g	5.18
Gamma-Chlordane	1999	4.531		ng/dry g	5.18
Gamma-Chlordane	2001	3.434	0.29	ng/dry g	5.18
Gamma-Chlordane	2002	3.068	0.29	ng/dry g	5.18
Gamma-Chlordane	2004	3.045	0.237	ng/dry g	5.18
Gamma-Hexachlorocyclohexane	1986	5.8	0.5	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1987	0.113	0.1	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1988	5.167	0.18	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1989	0	0.11	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1990	0	1.9	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1992	3.7	1	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1995	1.206	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1997	0.52		ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1999	0.5		ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2001	0.229	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2002	0	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2004	0.187	0.194	ng/dry g	2.15
Heptachlor	1986	7	0.5	ng/dry g	0.54
Heptachlor	1987	0	0.91	ng/dry g	0.54
Heptachlor	1988	1.633	0.15	ng/dry g	0.54
Heptachlor	1989	0	0.21	ng/dry g	0.54
Heptachlor	1990	0	1.3	ng/dry g	0.54
Heptachlor	1992	0		ng/dry g	0.54
Heptachlor	1995	0	0.53	ng/dry g	0.54
Heptachlor	1997	1.62		ng/dry g	0.54
Heptachlor	1999	0.288		ng/dry g	0.54
Heptachlor	2001	0.229	0.28	ng/dry g	0.54
Heptachlor	2002	0.179	0.28	ng/dry g	0.54
Heptachlor	2004	0	0.223	ng/dry g	0.54

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Heptachlor-Epoxide	1986	11.833	0.6	ng/dry g	2.17
Heptachlor-Epoxide	1987	3.467	0.29	ng/dry g	2.17
Heptachlor-Epoxide	1988	2.833	0.1	ng/dry g	2.17
Heptachlor-Epoxide	1989	0	0.34	ng/dry g	2.17
Heptachlor-Epoxide	1990	0	1.4	ng/dry g	2.17
Heptachlor-Epoxide	1992	0	0.96	ng/dry g	2.17
Heptachlor-Epoxide	1995	0.323	6.5	ng/dry g	2.17
Heptachlor-Epoxide	1997	0		ng/dry g	2.17
Heptachlor-Epoxide	1999	0		ng/dry g	2.17
Heptachlor-Epoxide	2001	0.458	0.3	ng/dry g	2.17
Heptachlor-Epoxide	2002	0	0.3	ng/dry g	2.17
Heptachlor-Epoxide	2004	0	0.201	ng/dry g	2.17
Heptachlorobiphenyls	1986	111.667	0.5	ng/dry g	44.67
Heptachlorobiphenyls	1987	84	0.5	ng/dry g	44.67
Hexachlorobenzene	1986	0.767	0.5	ng/dry g	0.69
Hexachlorobenzene	1987	0.733	0.32	ng/dry g	0.69
Hexachlorobenzene	1988	0.627	0.34	ng/dry g	0.69
Hexachlorobenzene	1989	0.275	0.18	ng/dry g	0.69
Hexachlorobenzene	1990	0.454	0.74	ng/dry g	0.69
Hexachlorobenzene	1992	2.49	0.56	ng/dry g	0.69
Hexachlorobenzene	1995	0.664	0.4	ng/dry g	0.69
Hexachlorobenzene	1997	1.07		ng/dry g	0.69
Hexachlorobenzene	1999	0.713		ng/dry g	0.69
Hexachlorobenzene	2001	0.572	0.24	ng/dry g	0.69
Hexachlorobenzene	2002	0.511	0.24	ng/dry g	0.69
Hexachlorobenzene	2004	0.273	0.223	ng/dry g	0.69
Hexachlorobiphenyls	1986	490	1.6	ng/dry g	190
Hexachlorobiphenyls	1987	246.667	1.6	ng/dry g	190
Indeno[1,2,3-c,d]pyrene	1989	0	8.5	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1990	26.07	5.5	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1992	30.86	7.9	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1995	20.78		ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1997	18.7		ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1999	21.04		ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2001	37.2	1	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2002	47.6	1	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2004	53.4	2.821	ng/dry g	8.42
Iron	1986	200	30	µg/dry g	872
Iron	1987	666.667	30	µg/dry g	872
Iron	1988	1110	5	µg/dry g	872
Iron	1989	525	5	µg/dry g	872
Iron	1990	1200	180	µg/dry g	872
Iron	1992	760	26	µg/dry g	872
Iron	1995	851.948	100	µg/dry g	872
Iron	1997	822		µg/dry g	872
Iron	1999	1330		µg/dry g	872
Iron	2001	819	1.08	µg/dry g	872
Iron	2002	1000	1.101	µg/dry g	872
Iron	2004	2050	1.101	µg/dry g	872

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Lead	1986	6.033	0.06	µg/dry g	2.76
Lead	1987	12.667	0.06	µg/dry g	2.76
Lead	1988	9.6	0.17	µg/dry g	2.76
Lead	1989	8.75	0.02	µg/dry g	2.76
Lead	1990	6.46	0.13	µg/dry g	2.76
Lead	1992	8.4	0.09	µg/dry g	2.76
Lead	1995	4.747	0.11	µg/dry g	2.76
Lead	1997	7.5		µg/dry g	2.76
Lead	1999	5.52		µg/dry g	2.76
Lead	2001	7.03	0.055	µg/dry g	2.76
Lead	2002	7.38	0.043	µg/dry g	2.76
Lead	2004	13.6	0.043	µg/dry g	2.76
Manganese	1986	23.667	3	µg/dry g	39.04
Manganese	1987	61.333	3	µg/dry g	39.04
Manganese	1990	75.8	2.8	µg/dry g	39.04
Manganese	1992	83	1.8	µg/dry g	39.04
Manganese	1995	36.997	3.8	µg/dry g	39.04
Manganese	1997	25		µg/dry g	39.04
Manganese	1999	53.2		µg/dry g	39.04
Manganese	2001	25.8	0.215	µg/dry g	39.04
Manganese	2002	46.9	0.195	µg/dry g	39.04
Manganese	2004	121	0.195	µg/dry g	39.04
Mercury	1986	0.24	0.001	µg/dry g	0.21
Mercury	1987	0.25	0.001	µg/dry g	0.21
Mercury	1988	0.313	0.01	µg/dry g	0.21
Mercury	1989	0.225	0.01	µg/dry g	0.21
Mercury	1990	0.31	0.01	µg/dry g	0.21
Mercury	1992	0.31	0.006	µg/dry g	0.21
Mercury	1995	0.126	0.012	µg/dry g	0.21
Mercury	1997	0.253		µg/dry g	0.21
Mercury	1999	0.145		µg/dry g	0.21
Mercury	2001	0.274	0.01	µg/dry g	0.21
Mercury	2002	0.279	0.01	µg/dry g	0.21
Mercury	2004	0.298	0.01	µg/dry g	0.21
Mirex	1986	12.4	0.75	ng/dry g	0.97
Mirex	1987	7.8	0.34	ng/dry g	0.97
Mirex	1988	0.327	0.19	ng/dry g	0.97
Mirex	1989	0	0.76	ng/dry g	0.97
Mirex	1990	2.02	0.86	ng/dry g	0.97
Mirex	1992	0.43	0.55	ng/dry g	0.97
Mirex	1995	0.997	0.28	ng/dry g	0.97
Mirex	1997	1.11		ng/dry g	0.97
Mirex	1999	0.481		ng/dry g	0.97
Mirex	2001	0.687	0.28	ng/dry g	0.97
Mirex	2002	0.78	0.28	ng/dry g	0.97
Mirex	2004	0	0.199	ng/dry g	0.97

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Monobutyltin	1992	12.71		ng/dry g	8.79
Monobutyltin	1995	5.943		ng/dry g	8.79
Monobutyltin	1997	0		ng/dry g	8.79
Monobutyltin	1999	3.75		ng/dry g	8.79
Monobutyltin	2001	4.82	1.95	ng/dry g	8.79
Monobutyltin	2002	3.96	1.95	ng/dry g	8.79
Monobutyltin	2004	7.44	0.319	ng/dry g	8.79
Naphthalene	1989	13.4	2.6	ng/dry g	30.04
Naphthalene	1990	21.53	12	ng/dry g	30.04
Naphthalene	1992	15.1	11	ng/dry g	30.04
Naphthalene	1995	23.86		ng/dry g	30.04
Naphthalene	1997	17.3		ng/dry g	30.04
Naphthalene	1999	19.43		ng/dry g	30.04
Naphthalene	2001	12	2.3	ng/dry g	30.04
Naphthalene	2002	30.5	2.3	ng/dry g	30.04
Naphthalene	2004	22.2	7.613	ng/dry g	30.04
Nickel	1986	2.2	0.23	µg/dry g	3.84
Nickel	1987	4.433	0.23	µg/dry g	3.84
Nickel	1988	5.167	0.25	µg/dry g	3.84
Nickel	1989	2.55	0.07	µg/dry g	3.84
Nickel	1990	5.95	1.5	µg/dry g	3.84
Nickel	1992	4.69	0.54	µg/dry g	3.84
Nickel	1995	2.572	0.15	µg/dry g	3.84
Nickel	1997	3		µg/dry g	3.84
Nickel	1999	3.86		µg/dry g	3.84
Nickel	2001	3.72		µg/dry g	3.84
Nickel	2002	4.12	0.488	µg/dry g	3.84
Nickel	2004	4.24	0.488	µg/dry g	3.84
Nonachlorobiphenyls	1986	0	1.2	ng/dry g	0.77
Nonachlorobiphenyls	1987	0.567	1.2	ng/dry g	0.77
Octachlorobiphenyls	1986	19.233	0.5	ng/dry g	3.53
Octachlorobiphenyls	1987	8.667	0.5	ng/dry g	3.53
Oxychlordane	1995	1.448		ng/dry g	1.34
Oxychlordane	1997	6.82		ng/dry g	1.34
Oxychlordane	1999	2.232		ng/dry g	1.34
Oxychlordane	2001	1.259	0.27	ng/dry g	1.34
Oxychlordane	2002	1.317	0.27	ng/dry g	1.34
Oxychlordane	2004	0.819	0.246	ng/dry g	1.34
PCB101/90	1988	74	0.28	ng/dry g	17.84
PCB101/90	1989	145	0.55	ng/dry g	17.84
PCB101/90	1990	123.71	2.6	ng/dry g	17.84
PCB101/90	1992	85.53	1.5	ng/dry g	17.84
PCB101/90	1995	66.399	0.47	ng/dry g	17.84
PCB101/90	1997	75.66		ng/dry g	17.84
PCB101/90	1999	34.924		ng/dry g	17.84
PCB101/90	2001	27.702	0.66	ng/dry g	17.84
PCB101/90	2002	26.164	0.66	ng/dry g	17.84
PCB101/90	2004	4.91	0.32	Percent	17.84

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB105	1988	23	1.2	ng/dry g	4.95
PCB105	1989	0	0.54	ng/dry g	4.95
PCB105	1990	33.68	2	ng/dry g	4.95
PCB105	1992	13.82	0.46	ng/dry g	4.95
PCB105	1995	17.764	1.2	ng/dry g	4.95
PCB105	1997	30.51		ng/dry g	4.95
PCB105	1999	10.132		ng/dry g	4.95
PCB105	2001	6.983	0.41	ng/dry g	4.95
PCB105	2002	8.065	0.41	ng/dry g	4.95
PCB105	2004	6.838	0.293	ng/dry g	4.95
PCB118	1988	62.333	0.38	ng/dry g	17
PCB118	1989	155	0.34	ng/dry g	17
PCB118	1990	97.11	2.4	ng/dry g	17
PCB118	1992	67.1	2.4	ng/dry g	17
PCB118	1995	68.152	1.3	ng/dry g	17
PCB118	1997	69.92		ng/dry g	17
PCB118	1999	28.64		ng/dry g	17
PCB118	2001	21.749	0.67	ng/dry g	17
PCB118	2002	28.26	0.67	ng/dry g	17
PCB118	2004	19.522	0.222	ng/dry g	17
PCB128	1988	9.967	1.2	ng/dry g	3.58
PCB128	1989	2.3	0.48	ng/dry g	3.58
PCB128	1990	14.41	1	ng/dry g	3.58
PCB128	1992	7.24	1.2	ng/dry g	3.58
PCB128	1995	9.506	0.62	ng/dry g	3.58
PCB128	1997	12.31		ng/dry g	3.58
PCB128	1999	4.948		ng/dry g	3.58
PCB128	2001	3.663	0.43	ng/dry g	3.58
PCB128	2002	4.474	0.43	ng/dry g	3.58
PCB128	2004	3.505	0.477	ng/dry g	3.58
PCB138	1988	91	0.43	ng/dry g	25.33
PCB138	1989	170	0.45	ng/dry g	25.33
PCB138	1990	127.91	3.7	ng/dry g	25.33
PCB138	1992	84.27	0.65	ng/dry g	25.33
PCB138	1995	69.647	1	ng/dry g	25.33
PCB138	1997	75.21		ng/dry g	25.33
PCB138	1999	38.705		ng/dry g	25.33
PCB138	2001	30.22	0.87	ng/dry g	25.33
PCB138	2002	32.299	0.87	ng/dry g	25.33
PCB138	2004	27.064	0.378	ng/dry g	25.33

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB153/132/168	1988	101.667	0.29	ng/dry g	34.12
PCB153/132/168	1989	285	0.58	ng/dry g	34.12
PCB153/132/168	1990	171.52	5.8	ng/dry g	34.12
PCB153/132/168	1992	158.13	2.1	ng/dry g	34.12
PCB153/132/168	1995	104.424	2.6	ng/dry g	34.12
PCB153/132/168	1997	99.99		ng/dry g	34.12
PCB153/132/168	1999	51.601		ng/dry g	34.12
PCB153/132/168	2001	51.397	0.67	ng/dry g	34.12
PCB153/132/168	2002	56.789	0.67	ng/dry g	34.12
PCB153/132/168	2004	47.649	0.427	ng/dry g	34.12
PCB170/190	1988	0	0.11	ng/dry g	3.08
PCB170/190	1989	0	0.57	ng/dry g	3.08
PCB170/190	1990	4.57	0.66	ng/dry g	3.08
PCB170/190	1992	3.5	0.79	ng/dry g	3.08
PCB170/190	1995	7.376	2.4	ng/dry g	3.08
PCB170/190	1997	3.61		ng/dry g	3.08
PCB170/190	1999	1.543		ng/dry g	3.08
PCB170/190	2001	3.777	0.81	ng/dry g	3.08
PCB170/190	2002	2.352	0.81	ng/dry g	3.08
PCB170/190	2004	3.347	0.285	ng/dry g	3.08
PCB18	1988	19.333	0.22	ng/dry g	2.3
PCB18	1989	0	0.34	ng/dry g	2.3
PCB18	1990	16	1.1	ng/dry g	2.3
PCB18	1992	6.88	1.6	ng/dry g	2.3
PCB18	1995	5.833	1.1	ng/dry g	2.3
PCB18	1997	7.97		ng/dry g	2.3
PCB18	1999	3.685		ng/dry g	2.3
PCB18	2001	3.434	0.52	ng/dry g	2.3
PCB18	2002	3.413	0.52	ng/dry g	2.3
PCB18	2004	2.054	0.387	ng/dry g	2.3
PCB180	1988	19.333	0.08	ng/dry g	7.18
PCB180	1989	16	0.7	ng/dry g	7.18
PCB180	1990	22	1.6	ng/dry g	7.18
PCB180	1992	11.47	1.2	ng/dry g	7.18
PCB180	1995	28.066	0.76	ng/dry g	7.18
PCB180	1997	30.85		ng/dry g	7.18
PCB180	1999	18.721		ng/dry g	7.18
PCB180	2001	8.585	0.58	ng/dry g	7.18
PCB180	2002	15.696	0.58	ng/dry g	7.18
PCB180	2004	10.932	0.214	ng/dry g	7.18
PCB187	1988	35.667	0.81	ng/dry g	10.6
PCB187	1989	48.5	0.51	ng/dry g	10.6
PCB187	1990	52.33	1.1	ng/dry g	10.6
PCB187	1992	27.14	0.67	ng/dry g	10.6
PCB187	1995	26.038	0.38	ng/dry g	10.6
PCB187	1997	29.8		ng/dry g	10.6
PCB187	1999	17.871		ng/dry g	10.6
PCB187	2001	15.911	0.62	ng/dry g	10.6
PCB187	2002	18.853	0.62	ng/dry g	10.6
PCB187	2004	16.678	0.276	ng/dry g	10.6

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB195/208	1988	0	0.09	ng/dry g	0.38
PCB195/208	1989	0	0.53	ng/dry g	0.38
PCB195/208	1990	0.88	0.44	ng/dry g	0.38
PCB195/208	1992	0	0.49	ng/dry g	0.38
PCB195/208	1995	1.266	0.82	ng/dry g	0.38
PCB195/208	1997	0.76		ng/dry g	0.38
PCB195/208	1999	0.717		ng/dry g	0.38
PCB195/208	2001	0.572	0.33	ng/dry g	0.38
PCB195/208	2002	0.345	0.33	ng/dry g	0.38
PCB195/208	2004	0.316	0.236	ng/dry g	0.38
PCB206	1988	0.16	0.08	ng/dry g	0.21
PCB206	1989	0	0.49	ng/dry g	0.21
PCB206	1990	0	0.88	ng/dry g	0.21
PCB206	1992	0	0.68	ng/dry g	0.21
PCB206	1995	1.024	0.48	ng/dry g	0.21
PCB206	1997	0		ng/dry g	0.21
PCB206	1999	0.112		ng/dry g	0.21
PCB206	2001	0.343	0.31	ng/dry g	0.21
PCB206	2002	0.371	0.31	ng/dry g	0.21
PCB206	2004	0.374	0.256	ng/dry g	0.21
PCB209	1988	0.38	0.06	ng/dry g	0.6
PCB209	1989	0	0.69	ng/dry g	0.6
PCB209	1990	0	0.88	ng/dry g	0.6
PCB209	1992	0	0.69	ng/dry g	0.6
PCB209	1995	0.888	1.1	ng/dry g	0.6
PCB209	1997	1.24		ng/dry g	0.6
PCB209	1999	1.041		ng/dry g	0.6
PCB209	2001	0.458	0.36	ng/dry g	0.6
PCB209	2002	0.971	0.36	ng/dry g	0.6
PCB209	2004	1.279	0.216	ng/dry g	0.6
PCB28	1988	38.667	0.42	ng/dry g	3.66
PCB28	1989	21	0.38	ng/dry g	3.66
PCB28	1990	27.94	0.92	ng/dry g	3.66
PCB28	1992	17.64	0.8	ng/dry g	3.66
PCB28	1995	16.591	0.75	ng/dry g	3.66
PCB28	1997	20.41		ng/dry g	3.66
PCB28	1999	8.299		ng/dry g	3.66
PCB28	2001	7.097	0.45	ng/dry g	3.66
PCB28	2002	9.957	0.45	ng/dry g	3.66
PCB28	2004	6.335	0.19	ng/dry g	3.66
PCB44	1988	39.667	0.25	ng/dry g	5.23
PCB44	1989	44	0.42	ng/dry g	5.23
PCB44	1990	52	2	ng/dry g	5.23
PCB44	1992	28.39	1.2	ng/dry g	5.23
PCB44	1995	25.883	0.62	ng/dry g	5.23
PCB44	1997	31.95		ng/dry g	5.23
PCB44	1999	12.62		ng/dry g	5.23
PCB44	2001	9.615	0.35	ng/dry g	5.23
PCB44	2002	14.009	0.35	ng/dry g	5.23
PCB44	2004	8.461	0.356	ng/dry g	5.23

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
PCB52	1988	67	0.17	ng/dry g	10.12
PCB52	1989	78.5	0.6	ng/dry g	10.12
PCB52	1990	98.12	1.4	ng/dry g	10.12
PCB52	1992	47.82	1.4	ng/dry g	10.12
PCB52	1995	52.276	1	ng/dry g	10.12
PCB52	1997	58.76		ng/dry g	10.12
PCB52	1999	24.825		ng/dry g	10.12
PCB52	2001	20.49	0.48	ng/dry g	10.12
PCB52	2002	18.022	0.48	ng/dry g	10.12
PCB52	2004	17.841	0.21	ng/dry g	10.12
PCB66	1988	80.333	0.43	ng/dry g	6.43
PCB66	1989	240	0.46	ng/dry g	6.43
PCB66	1990	72.92	1.7	ng/dry g	6.43
PCB66	1992	54.18	0.97	ng/dry g	6.43
PCB66	1995	35.568	0.65	ng/dry g	6.43
PCB66	1997	38.13		ng/dry g	6.43
PCB66	1999	16.726		ng/dry g	6.43
PCB66	2001	13.05	0.43	ng/dry g	6.43
PCB66	2002	18.239	0.43	ng/dry g	6.43
PCB66	2004	11.104	0.3	ng/dry g	6.43
PCB8/5	1988	0	0.6	ng/dry g	2.17
PCB8/5	1989	0	0.41	ng/dry g	2.17
PCB8/5	1990	1.33	0.99	ng/dry g	2.17
PCB8/5	1992	0	2.8	ng/dry g	2.17
PCB8/5	1995	0	1.4	ng/dry g	2.17
PCB8/5	1997	0		ng/dry g	2.17
PCB8/5	1999	1.876		ng/dry g	2.17
PCB8/5	2001	0	0.39	ng/dry g	2.17
PCB8/5	2002	0	0.39	ng/dry g	2.17
PCB8/5	2004	0	0.318	ng/dry g	2.17
Pentachloroanisole	1995	1.53		ng/dry g	2.01
Pentachloroanisole	1997	2.24		ng/dry g	2.01
Pentachloroanisole	1999	1.249		ng/dry g	2.01
Pentachloroanisole	2001	0.916	0.28	ng/dry g	2.01
Pentachloroanisole	2002	0.818	0.28	ng/dry g	2.01
Pentachloroanisole	2004	0.747	0.162	ng/dry g	2.01
Pentachlorobenzene	1995	0		ng/dry g	0.94
Pentachlorobenzene	1997	1.73		ng/dry g	0.94
Pentachlorobenzene	1999	0		ng/dry g	0.94
Pentachlorobenzene	2001	0	0.26	ng/dry g	0.94
Pentachlorobenzene	2002	0	0.26	ng/dry g	0.94
Pentachlorobenzene	2004	1.738	0.192	ng/dry g	0.94
Pentachlorobiphenyls	1986	690	0.5	ng/dry g	245.33
Pentachlorobiphenyls	1987	320	0.5	ng/dry g	245.33

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Percent lipid dry weight	1986	6.8		Percent	10.33
Percent lipid dry weight	1987	5.667		Percent	10.33
Percent lipid dry weight	1988	6.667		Percent	10.33
Percent lipid dry weight	1989	9		Percent	10.33
Percent lipid dry weight	1990	13		Percent	10.33
Percent lipid dry weight	1992	7.92		Percent	10.33
Percent lipid dry weight	1995	3.678		Percent	10.33
Percent lipid dry weight	1997	7		Percent	10.33
Percent lipid dry weight	1999	9.419		Percent	10.33
Percent lipid dry weight	2001	4.66		Percent	10.33
Percent lipid dry weight	2002	5.75		Percent	10.33
Percent lipid dry weight	2004	0		ng/dry g	10.33
Perylene	1989	23.5	2.2	ng/dry g	13.32
Perylene	1990	33.56	11	ng/dry g	13.32
Perylene	1992	37.17	5.1	ng/dry g	13.32
Perylene	1995	27.17	10.1	ng/dry g	13.32
Perylene	1997	34.1		ng/dry g	13.32
Perylene	1999	15.15		ng/dry g	13.32
Perylene	2001	19.8	2	ng/dry g	13.32
Perylene	2002	37.4	2	ng/dry g	13.32
Perylene	2004	39.8	4.513	ng/dry g	13.32
Phenanthrene	1989	9	5.2	ng/dry g	57.8
Phenanthrene	1990	21.373	24	ng/dry g	57.8
Phenanthrene	1992	16.91	7.1	ng/dry g	57.8
Phenanthrene	1995	21.58	6.6	ng/dry g	57.8
Phenanthrene	1997	22.2		ng/dry g	57.8
Phenanthrene	1999	17.62		ng/dry g	57.8
Phenanthrene	2001	21.8	1.5	ng/dry g	57.8
Phenanthrene	2002	24.3	1.5	ng/dry g	57.8
Phenanthrene	2004	27.4	3.061	ng/dry g	57.8
Pyrene	1989	285	8	ng/dry g	122.38
Pyrene	1990	319.05	20	ng/dry g	122.38
Pyrene	1992	338.93	6.8	ng/dry g	122.38
Pyrene	1995	325.47	5.6	ng/dry g	122.38
Pyrene	1997	369.1		ng/dry g	122.38
Pyrene	1999	160.41		ng/dry g	122.38
Pyrene	2001	177	1.4	ng/dry g	122.38
Pyrene	2002	241	1.4	ng/dry g	122.38
Pyrene	2004	238	4.817	ng/dry g	122.38

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Selenium	1986	3.8	0.58	µg/dry g	3.86
Selenium	1987	2.533	0.58	µg/dry g	3.86
Selenium	1988	3.467	1	µg/dry g	3.86
Selenium	1989	3.05	1	µg/dry g	3.86
Selenium	1990	2.6	0.5	µg/dry g	3.86
Selenium	1992	2.87	0.61	µg/dry g	3.86
Selenium	1995	3.38		µg/dry g	3.86
Selenium	1997	4.59		µg/dry g	3.86
Selenium	1999	4.46		µg/dry g	3.86
Selenium	2001	6.01	0.054	µg/dry g	3.86
Selenium	2002	4.56	0.049	µg/dry g	3.86
Selenium	2004	5.8	0.049	µg/dry g	3.86
Silicon	1986	900	600	µg/dry g	3000
Silicon	1987	1633.333	600	µg/dry g	3000
Silicon	1990	16000	110	µg/dry g	3000
Silicon	1992	1600	400	µg/dry g	3000
Silver	1986	0.576	0.12	µg/dry g	3.7
Silver	1987	0.608	0.12	µg/dry g	3.7
Silver	1988	0.433	0.01	µg/dry g	3.7
Silver	1992	0.306	0.3	µg/dry g	3.7
Silver	1995	0.789	0.1	µg/dry g	3.7
Silver	1997	1.13		µg/dry g	3.7
Silver	1999	1.21		µg/dry g	3.7
Silver	2001	0	1.08	µg/dry g	3.7
Silver	2002	3.83	0.043	µg/dry g	3.7
Silver	2004	1.18	0.043	µg/dry g	3.7
Tetrabutyltin	1995	0		ng/dry g	0.11
Tetrabutyltin	1997	0		ng/dry g	0.11
Tetrabutyltin	2001	0	2.73	ng/dry g	0.11
Tetrabutyltin	2004	0	3.753	ng/dry g	0.11
Tetrachlorobiphenyls	1986	436.667	0.6	ng/dry g	135.33
Tetrachlorobiphenyls	1987	310	0.6	ng/dry g	135.33
Thallium	1986	0	0.05	µg/dry g	0
Thallium	1987	0	0.05	µg/dry g	0
Tin	1986	0.357	0.5	µg/dry g	0.35
Tin	1987	0.703	0.5	µg/dry g	0.35
Tin	1988	0.213	0.04	µg/dry g	0.35
Tin	1989	0.39	0.005	µg/dry g	0.35
Tin	1990	0.12	0.01	µg/dry g	0.35
Tin	1992	0.58	0.74	µg/dry g	0.35
Tin	1995	0.59	0.14	µg/dry g	0.35
Tin	1997	0.86		µg/dry g	0.35
Tin	1999	0.531		µg/dry g	0.35
Tin	2001	0.385	0.1	µg/dry g	0.35
Tin	2002	0.755	0.087	µg/dry g	0.35
Tin	2004	1.75	0.087	µg/dry g	0.35

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Total butyltins	1992	226.28		ng/dry g	151.96
Total butyltins	1995	165.884		ng/dry g	151.96
Total butyltins	1997	84.4		ng/dry g	151.96
Total butyltins	1999	133.52		ng/dry g	151.96
Total butyltins	2001	137.24		ng/dry g	151.96
Total butyltins	2002	138.7		ng/dry g	151.96
Total butyltins	2004	89.11		ng/dry g	151.96
Total chlordanes	1986	107.166		ng/dry g	22.5
Total chlordanes	1987	63.801		ng/dry g	22.5
Total chlordanes	1988	41.799		ng/dry g	22.5
Total chlordanes	1989	22		ng/dry g	22.5
Total chlordanes	1990	48.49		ng/dry g	22.5
Total chlordanes	1992	22.83		ng/dry g	22.5
Total chlordanes	1995	21.36		ng/dry g	22.5
Total chlordanes	1997	28.92		ng/dry g	22.5
Total chlordanes	1999	9.164		ng/dry g	22.5
Total chlordanes	2001	7.44		ng/dry g	22.5
Total chlordanes	2002	5.79		ng/dry g	22.5
Total chlordanes	2004	5.2		ng/dry g	22.5
Total DDT	1986	272		ng/dry g	88.66
Total DDT	1987	220.833		ng/dry g	88.66
Total DDT	1988	198.634		ng/dry g	88.66
Total DDT	1989	307.05		ng/dry g	88.66
Total DDT	1990	240.27		ng/dry g	88.66
Total DDT	1992	170.24		ng/dry g	88.66
Total DDT	1995	132.826		ng/dry g	88.66
Total DDT	1997	206.14		ng/dry g	88.66
Total DDT	1999	65.729		ng/dry g	88.66
Total DDT	2001	59.408		ng/dry g	88.66
Total DDT	2002	61.021		ng/dry g	88.66
Total DDT	2004	53.581		ng/dry g	88.66
Total dieldrin	1986	68.833		ng/dry g	10.18
Total dieldrin	1987	35.2		ng/dry g	10.18
Total dieldrin	1988	0		ng/dry g	10.18
Total dieldrin	1989	0		ng/dry g	10.18
Total dieldrin	1990	0		ng/dry g	10.18
Total dieldrin	1992	26.3		ng/dry g	10.18
Total dieldrin	1995	7.121		ng/dry g	10.18
Total dieldrin	1997	13.31		ng/dry g	10.18
Total dieldrin	1999	3.727		ng/dry g	10.18
Total dieldrin	2001	2.518		ng/dry g	10.18
Total dieldrin	2002	2.326		ng/dry g	10.18
Total dieldrin	2004	2.672		ng/dry g	10.18

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Total PAH	1989	1117.05		ng/dry g	783
Total PAH	1990	1594.272		ng/dry g	783
Total PAH	1992	1461.7		ng/dry g	783
Total PAH	1995	1347.1		ng/dry g	783
Total PAH	1997	1423.7		ng/dry g	783
Total PAH	1999	797.54		ng/dry g	783
Total PAH	2001	1120		ng/dry g	783
Total PAH	2002	1334		ng/dry g	783
Total PAHhmw (4 or more rings)	1989	1056.5		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1990	1411.57		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1992	1344.16		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1995	1223.32		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1997	1280.8		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1999	688.05		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2001	1033.5		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2002	1174.1		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2004	1273.6		ng/dry g	532.5
Total PAHlmw (2-3 rings)	1989	60.55		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1990	182.702		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1992	117.54		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1995	123.78		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1997	142.9		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1999	109.49		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2001	86.5		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2002	159.9		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2004	149.8		ng/dry g	234.8
Total PCBcg	1988	1325.014		ng/dry g	324.86
Total PCBcg	1989	2410.6		ng/dry g	324.86
Total PCBcg	1990	1832.86		ng/dry g	324.86
Total PCBcg	1992	1226.22		ng/dry g	324.86
Total PCBcg	1995	1073.402		ng/dry g	324.86
Total PCBcg	1997	1174.16		ng/dry g	324.86
Total PCBcg	1999	553.972		ng/dry g	324.86
Total PCBcg	2001	450.092		ng/dry g	324.86
Total PCBcg	2002	516.558		ng/dry g	324.86
Trans-Nonachlor	1986	38	0.75	ng/dry g	9.68
Trans-Nonachlor	1987	20.667	0.34	ng/dry g	9.68
Trans-Nonachlor	1988	17	0.22	ng/dry g	9.68
Trans-Nonachlor	1989	15.5	0.39	ng/dry g	9.68
Trans-Nonachlor	1990	24.86	0.99	ng/dry g	9.68
Trans-Nonachlor	1992	11.1	1	ng/dry g	9.68
Trans-Nonachlor	1995	9.721	0.25	ng/dry g	9.68
Trans-Nonachlor	1997	12.35		ng/dry g	9.68
Trans-Nonachlor	1999	4.302		ng/dry g	9.68
Trans-Nonachlor	2001	2.976	0.22	ng/dry g	9.68
Trans-Nonachlor	2002	2.62	0.22	ng/dry g	9.68
Trans-Nonachlor	2004	1.652	0.193	ng/dry g	9.68

Table 15. Analyte Concentration in Tissue from NYSH in All Years. (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Tributyltin	1992	128.1		ng/dry g	110
Tributyltin	1995	134.023		ng/dry g	110
Tributyltin	1997	65.4		ng/dry g	110
Tributyltin	1999	111.72		ng/dry g	110
Tributyltin	2001	113.16	4.83	ng/dry g	110
Tributyltin	2002	111.01	4.83	ng/dry g	110
Tributyltin	2004	69.28	3.921	ng/dry g	110
Trichlorobiphenyls	1986	66.667	0.6	ng/dry g	33
Trichlorobiphenyls	1987	53.667	0.6	ng/dry g	33
Zinc	1986	143.333	2	µg/dry g	2980
Zinc	1987	193.333	2	µg/dry g	2980
Zinc	1988	133.333	5	µg/dry g	2980
Zinc	1989	200	5	µg/dry g	2980
Zinc	1990	270	1	µg/dry g	2980
Zinc	1992	190	27	µg/dry g	2980
Zinc	1995	137.901	6.5	µg/dry g	2980
Zinc	1997	172		µg/dry g	2980
Zinc	1999	120		µg/dry g	2980
Zinc	2001	161	0.54	µg/dry g	2980
Zinc	2002	127	0.501	µg/dry g	2980
Zinc	2004	161	0.501	µg/dry g	2980

Table 16. Analyte Concentration in Sediment from NYSH in 1986 and 1987. (NOAA 2006)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
2,4'-DDD	1986	0	0.2	ng/dry g	1.36
2,4'-DDD	1987	0	0.36	ng/dry g	1.36
2,4'-DDE	1986	7.4	0.14	ng/dry g	0.4
2,4'-DDE	1987	0	0.05	ng/dry g	0.4
2,4'-DDT	1986	4.333	0.23	ng/dry g	0.23
2,4'-DDT	1987	0	0.13	ng/dry g	0.23
4,4'-DDD	1986	6.767	0.49	ng/dry g	4.18
4,4'-DDD	1987	28	0.1	ng/dry g	4.18
4,4'-DDE	1986	3.967	0.16	ng/dry g	4.1
4,4'-DDE	1987	21.5	0.07	ng/dry g	4.1
4,4'-DDT	1986	2.1	0.08	ng/dry g	1.73
4,4'-DDT	1987	2.15	0.27	ng/dry g	1.73
Aldrin	1986	0.62	0.16	ng/dry g	0.23
Aldrin	1987	0	0.07	ng/dry g	0.23
Alpha-Chlordane	1986	3.1	0.08	ng/dry g	0.91
Alpha-Chlordane	1987	3.3	0.1	ng/dry g	0.91
Aluminum	1986	40666.667	5000	µg/dry g	70000
Aluminum	1987	61000	5000	µg/dry g	70000
Antimony	1986	4.4	0.8	µg/dry g	1.23
Antimony	1987	6	0.8	µg/dry g	1.23
Arsenic	1986	*18.033*	1.7	µg/dry g	13
Arsenic	1987	*18.5*	1.7	µg/dry g	13
Cadmium	1986	*1.427*	0.08	µg/dry g	0.53
Cadmium	1987	*1.6*	0.08	µg/dry g	0.53
Chromium	1986	*146.667*	6	µg/dry g	109.33
Chromium	1987	*155*	6	µg/dry g	109.33
Clay	1986	30.333		Percent	38.67
Clay	1987	20.335		Percent	38.67
Copper	1986	*110*	3	µg/dry g	43.8
Copper	1987	*115*	3	µg/dry g	43.8
Dichlorobiphenyls	1986	0.577	0.62	ng/dry g	1.27
Dichlorobiphenyls	1987	4.7	0.62	ng/dry g	1.27
Dieldrin	1986	*4.3*	0.16	ng/dry g	0.99
Dieldrin	1987	*7.3*	0.14	ng/dry g	0.99
Fines	1986	0.637		Decimal	0.86
Fines	1987	0.505		Decimal	0.86
Gamma-Hexachlorocyclohexane	1986	0.543	0.14	ng/dry g	0.3
Gamma-Hexachlorocyclohexane	1987	0	0.03	ng/dry g	0.3

Table 16. Analyte Concentration in Sediment from NYSH in 1986 and 1987. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Gravel	1986	14.87		Percent	3.23
Gravel	1987	1.36		Percent	3.23
Heptachlor	1986	0.733	0.14	ng/dry g	0.11
Heptachlor	1987	0	0.24	ng/dry g	0.11
Heptachlor-Epoxide	1986	1.013	0.16	ng/dry g	0.17
Heptachlor-Epoxide	1987	0.7	0.08	ng/dry g	0.17
Heptachlorobiphenyls	1986	17.767	0.14	ng/dry g	12.5
Heptachlorobiphenyls	1987	36	0.14	ng/dry g	12.5
Hexachlorobenzene	1986	0.803	0.14	ng/dry g	0.57
Hexachlorobenzene	1987	0.86	0.09	ng/dry g	0.57
Hexachlorobiphenyls	1986	64.667	0.42	ng/dry g	24
Hexachlorobiphenyls	1987	56.5	0.42	ng/dry g	24
Iron	1986	32333.333	6	µg/dry g	37400
Iron	1987	35500	6	µg/dry g	37400
Lead	1986	*142.333*	3	µg/dry g	37.67
Lead	1987	*135*	3	µg/dry g	37.67
Manganese	1986	790	6	µg/dry g	750
Manganese	1987	515	6	µg/dry g	750
Mercury	1986	*1.467*	0.01	µg/dry g	0.2
Mercury	1987	*1.7*	0.01	µg/dry g	0.2
Mirex	1986	1.06	0.2	ng/dry g	0.22
Mirex	1987	1.105	0.09	ng/dry g	0.22
Nickel	1986	*30.667*	4	µg/dry g	37
Nickel	1987	*33*	4	µg/dry g	37
Nonachlorobiphenyls	1986	8.967	0.31	ng/dry g	1.6
Nonachlorobiphenyls	1987	4.95	0.31	ng/dry g	1.6
Octachlorobiphenyls	1986	14.9	0.14	ng/dry g	4.43
Octachlorobiphenyls	1987	17.5	0.14	ng/dry g	4.43
Pentachlorobiphenyls	1986	111.333	0.14	ng/dry g	26.6
Pentachlorobiphenyls	1987	120	0.14	ng/dry g	26.6
Sand	1986	22		Percent	86.77
Sand	1987	47.85		Percent	86.77
Selenium	1986	1.233	0.13	µg/dry g	0.73
Selenium	1987	0.69	0.13	µg/dry g	0.73
Silicon	1986	206666.667	4000	µg/dry g	376666.67
Silicon	1987	290000	4000	µg/dry g	376666.67

Table 16. Analyte Concentration in Sediment from NYSH in 1986 and 1987. (NOAA 2006) (Continued)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Silt	1986	33.333		Percent	49.96
Silt	1987	30		Percent	49.96
Silver	1986	3.4	0.02	µg/dry g	0.48
Silver	1987	3.65	0.02	µg/dry g	0.48
Tetrachlorobiphenyls	1986	78.333	0.16	ng/dry g	19.33
Tetrachlorobiphenyls	1987	135	0.16	ng/dry g	19.33
Thallium	1986	0.52	0.2	µg/dry g	0.51
Thallium	1987	0.54	0.2	µg/dry g	0.51
Tin	1986	1.297	1	µg/dry g	3
Tin	1987	10.65	1	µg/dry g	3
Total chlordanes	1986	8.146		ng/dry g	1.94
Total chlordanes	1987	7.65		ng/dry g	1.94
Total DDT	1986	24.567		ng/dry g	15.17
Total DDT	1987	51.65		ng/dry g	15.17
Total dieldrin	1986	4.92		ng/dry g	1.4
Total dieldrin	1987	7.3		ng/dry g	1.4
Total Inorganic Carbon	1986	0.433		Percent	1.03
Total Inorganic Carbon	1987	0.23		Percent	1.03
Total Organic Carbon	1986	1.8		Percent	2.6
Total Organic Carbon	1987	2.05		Percent	2.6
Trans-Nonachlor	1986	3.3	0.2	ng/dry g	0.63
Trans-Nonachlor	1987	3.65	0.09	ng/dry g	0.63
Trichlorobiphenyls	1986	29.667	0.16	ng/dry g	6.03
Trichlorobiphenyls	1987	70	0.16	ng/dry g	6.03
Zinc	1986	260	2	µg/dry g	126.67
Zinc	1987	255	2	µg/dry g	126.67

Pink: Concentration is above both the ERL and TEL (NOAA SQuiRT)

Table 17. Analyte Concentration in Sediment from NYSH in 1986 and 1987. (NOAA 2006)

Sediment					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Sand	1986	22		Percent	86.77
Sand	1987	47.85		Percent	86.77
Silt	1986	33.333		Percent	49.96
Silt	1987	30		Percent	49.96
Total Organic Carbon	1986	1.8		Percent	2.6
Total Organic Carbon	1987	2.05		Percent	2.6

Table 18. NYSH Site Specific SBAF for 1987.

ANALYTE NAME	Concentration		Units	SBAF
	Sediment	Tissue		
2,4'-DDD	0	3.667	ng/dry g	0.000
2,4'-DDE	0	30.933	ng/dry g	0.000
2,4'-DDT	0	0	ng/dry g	0.000
4,4'-DDD	28	109.333	ng/dry g	3.905
4,4'-DDE	21.5	66.667	ng/dry g	3.101
4,4'-DDT	2.15	10.233	ng/dry g	4.760
Aldrin	0	2.2	ng/dry g	0.000
Alpha-Chlordane	3.3	39.667	ng/dry g	12.020
Aluminum	61000	266.667	µg/dry g	0.004
Antimony	6	0	µg/dry g	0.000
Arsenic	18.5	8.467	µg/dry g	0.458
Cadmium	1.6	6.267	µg/dry g	3.917
Chromium	155	3.233	µg/dry g	0.021
Copper	115	16.333	µg/dry g	0.142
Dichlorobiphenyls	4.7	2.167	ng/dry g	0.461
Dieldrin	7.3	33	ng/dry g	4.521
Gamma-Hexachlorocyclohexane	0	0.113	ng/dry g	0.000
Heptachlor	0	0	ng/dry g	0.000
Heptachlor-Epoxide	0.7	3.467	ng/dry g	4.953
Heptachlorobiphenyls	36	84	ng/dry g	2.333
Hexachlorobenzene	0.86	0.733	ng/dry g	0.852
Hexachlorobiphenyls	56.5	246.667	ng/dry g	4.366
Iron	35500	666.667	µg/dry g	0.019
Lead	135	12.667	µg/dry g	0.094
Manganese	515	61.333	µg/dry g	0.119
Mercury	1.7	0.25	µg/dry g	0.147
Mirex	1.105	7.8	ng/dry g	7.059
Nickel	33	4.433	µg/dry g	0.134
Nonachlorobiphenyls	4.95	0.567	ng/dry g	0.115
Octachlorobiphenyls	17.5	8.667	ng/dry g	0.495
Pentachlorobiphenyls	120	320	ng/dry g	2.667
Selenium	0.69	2.533	µg/dry g	3.671
Silicon	290000	1633.333	µg/dry g	0.006
Silver	3.65	0.608	µg/dry g	0.167
Tetrachlorobiphenyls	135	310	ng/dry g	2.296
Thallium	0.54	0	µg/dry g	0.000
Tin	10.65	0.703	µg/dry g	0.066
Total chlordanes	7.65	63.801	ng/dry g	8.340
Total DDT	51.65	220.833	ng/dry g	4.276
Total dieldrin	7.3	35.2	ng/dry g	4.822
Total Inorganic Carbon	0.23		Percent	0.230
Total Organic Carbon	2.05		Percent	2.050
Trans-Nonachlor	3.65	20.667	ng/dry g	5.662
Trichlorobiphenyls	70	53.667	ng/dry g	0.767
Zinc	255	193.333	µg/dry g	0.758

BAF = Tissue/Sediment

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
1,2,3,4-Tetrachlorobenzene	1995	0.813		ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	1997	0.58		ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	1999	0.371		ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2002	0.301	0.29	ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2003	0	0.342	ng/dry g	1.33
1,2,3,4-Tetrachlorobenzene	2004	0	0.293	ng/dry g	1.33
1,2,4,5-Tetrachlorobenzene	1995	0.872		ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	1997	2.48		ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	1999	3.773		ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2002	0	0.27	ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2003	0	0.3	ng/dry g	3.33
1,2,4,5-Tetrachlorobenzene	2004	16.041	0.3	ng/dry g	3.33
1,6,7-Trimethylnaphthalene	1989	29.333	4.4	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1990	84.58	9.7	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1991	23.107	5.5	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1992	21.19	5	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1993	21.66	1.8	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1995	14.24	8.4	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1997	37.5		ng/dry g	10.34
1,6,7-Trimethylnaphthalene	1999	10.13		ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2002	3.5	1	ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2003	6.1		ng/dry g	10.34
1,6,7-Trimethylnaphthalene	2004	3	0.805	ng/dry g	10.34
1-Methylnaphthalene	1989	16	3.5	ng/dry g	16.6
1-Methylnaphthalene	1990	19.705	22	ng/dry g	16.6
1-Methylnaphthalene	1991	13.433	5.6	ng/dry g	16.6
1-Methylnaphthalene	1992	20.31	5.7	ng/dry g	16.6
1-Methylnaphthalene	1993	8.34	2.6	ng/dry g	16.6
1-Methylnaphthalene	1995	7.55	6.4	ng/dry g	16.6
1-Methylnaphthalene	1997	13.5		ng/dry g	16.6
1-Methylnaphthalene	1999	9.07		ng/dry g	16.6
1-Methylnaphthalene	2002	6.6	0.3	ng/dry g	16.6
1-Methylnaphthalene	2003	21.5	5.45	ng/dry g	16.6
1-Methylnaphthalene	2004	8.5	4.465	ng/dry g	16.6
1-Methylphenanthrene	1989	39	7.1	ng/dry g	16.9
1-Methylphenanthrene	1990	72.373	22	ng/dry g	16.9
1-Methylphenanthrene	1991	57.503	7.5	ng/dry g	16.9
1-Methylphenanthrene	1992	30.41	9.3	ng/dry g	16.9
1-Methylphenanthrene	1993	53.82	3	ng/dry g	16.9
1-Methylphenanthrene	1995	15.72		ng/dry g	16.9
1-Methylphenanthrene	1997	38.1		ng/dry g	16.9
1-Methylphenanthrene	1999	31.75		ng/dry g	16.9
1-Methylphenanthrene	2002	10.5	1.3	ng/dry g	16.9
1-Methylphenanthrene	2003	19.7	1.237	ng/dry g	16.9
1-Methylphenanthrene	2004	17.4	1.014	ng/dry g	16.9

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
2,4'-DDD	1986	51.333	0.75	ng/dry g	6.33
2,4'-DDD	1987	7.6	1.3	ng/dry g	6.33
2,4'-DDD	1988	18.667	1.4	ng/dry g	6.33
2,4'-DDD	1989	3.967	0.21	ng/dry g	6.33
2,4'-DDD	1990	8.23	0.69	ng/dry g	6.33
2,4'-DDD	1991	3.133	0.37	ng/dry g	6.33
2,4'-DDD	1992	11.72	0.58	ng/dry g	6.33
2,4'-DDD	1993	7.86	4.1	ng/dry g	6.33
2,4'-DDD	1995	7.984	0.17	ng/dry g	6.33
2,4'-DDD	1997	20.84		ng/dry g	6.33
2,4'-DDD	1999	6.832		ng/dry g	6.33
2,4'-DDD	2002	4.986	0.29	ng/dry g	6.33
2,4'-DDD	2003	4.927	0.231	ng/dry g	6.33
2,4'-DDD	2004	5.908	0.198	ng/dry g	6.33
2,4'-DDE	1986	33.667	0.5	ng/dry g	3.22
2,4'-DDE	1987	5.667	0.17	ng/dry g	3.22
2,4'-DDE	1988	0	0.24	ng/dry g	3.22
2,4'-DDE	1989	6.867	0.39	ng/dry g	3.22
2,4'-DDE	1990	9.167	1.1	ng/dry g	3.22
2,4'-DDE	1991	3.797	0.74	ng/dry g	3.22
2,4'-DDE	1992	2.71	1.1	ng/dry g	3.22
2,4'-DDE	1993	1.69	1.5	ng/dry g	3.22
2,4'-DDE	1995	2.643	0.44	ng/dry g	3.22
2,4'-DDE	1997	0		ng/dry g	3.22
2,4'-DDE	1999	2.154		ng/dry g	3.22
2,4'-DDE	2002	1.535	0.25	ng/dry g	3.22
2,4'-DDE	2003	0.578	0.215	ng/dry g	3.22
2,4'-DDE	2004	1.3	0.184	ng/dry g	3.22
2,4'-DDT	1986	9.233	0.85	ng/dry g	3.3
2,4'-DDT	1987	0	0.5	ng/dry g	3.3
2,4'-DDT	1988	10.233	0.49	ng/dry g	3.3
2,4'-DDT	1989	8.833	0.27	ng/dry g	3.3
2,4'-DDT	1990	13.237	1.1	ng/dry g	3.3
2,4'-DDT	1991	3.08	0.34	ng/dry g	3.3
2,4'-DDT	1992	0.85	0.9	ng/dry g	3.3
2,4'-DDT	1993	37.23	3.1	ng/dry g	3.3
2,4'-DDT	1995	2.565	0.31	ng/dry g	3.3
2,4'-DDT	1997	4.58		ng/dry g	3.3
2,4'-DDT	1999	1.686		ng/dry g	3.3
2,4'-DDT	2002	4.063	0.25	ng/dry g	3.3
2,4'-DDT	2003	2.038	0.253	ng/dry g	3.3
2,4'-DDT	2004	2.219	0.216	ng/dry g	3.3
2,6-Dimethylnaphthalene	1989	31.667	6	ng/dry g	13.77
2,6-Dimethylnaphthalene	1990	85.667	38	ng/dry g	13.77
2,6-Dimethylnaphthalene	1991	25.603	6.6	ng/dry g	13.77
2,6-Dimethylnaphthalene	1992	25.12	8.6	ng/dry g	13.77
2,6-Dimethylnaphthalene	1993	11.61	3.6	ng/dry g	13.77
2,6-Dimethylnaphthalene	1995	9.38	10	ng/dry g	13.77
2,6-Dimethylnaphthalene	1997	26.5		ng/dry g	13.77
2,6-Dimethylnaphthalene	1999	15		ng/dry g	13.77
2,6-Dimethylnaphthalene	2002	7.9	0.5	ng/dry g	13.77
2,6-Dimethylnaphthalene	2003	12.1	3.632	ng/dry g	13.77
2,6-Dimethylnaphthalene	2004	10.6	2.975	ng/dry g	13.77

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
2-Methylnaphthalene	1989	24.667	4	ng/dry g	29.97
2-Methylnaphthalene	1990	34.72	20	ng/dry g	29.97
2-Methylnaphthalene	1991	20.69	5.4	ng/dry g	29.97
2-Methylnaphthalene	1992	32.7	5.5	ng/dry g	29.97
2-Methylnaphthalene	1993	14.02	2.3	ng/dry g	29.97
2-Methylnaphthalene	1995	11.09		ng/dry g	29.97
2-Methylnaphthalene	1997	18.9		ng/dry g	29.97
2-Methylnaphthalene	1999	19.05		ng/dry g	29.97
2-Methylnaphthalene	2002	14.3	0.6	ng/dry g	29.97
2-Methylnaphthalene	2003	31.4	8.971	ng/dry g	29.97
2-Methylnaphthalene	2004	17	7.349	ng/dry g	29.97
4,4'-DDD	1986	33.667	1.8	ng/dry g	19
4,4'-DDD	1987	67	0.38	ng/dry g	19
4,4'-DDD	1988	120	0.64	ng/dry g	19
4,4'-DDD	1989	41	0.27	ng/dry g	19
4,4'-DDD	1990	55.403	7.1	ng/dry g	19
4,4'-DDD	1991	20.167	0.47	ng/dry g	19
4,4'-DDD	1992	23.77	1	ng/dry g	19
4,4'-DDD	1993	13.48	3.2	ng/dry g	19
4,4'-DDD	1995	18.441	0.28	ng/dry g	19
4,4'-DDD	1997	31.64		ng/dry g	19
4,4'-DDD	1999	10.102		ng/dry g	19
4,4'-DDD	2002	9.301	0.34	ng/dry g	19
4,4'-DDD	2003	6.209	0.206	ng/dry g	19
4,4'-DDD	2004	7.844	0.176	ng/dry g	19
4,4'-DDE	1986	35	0.6	ng/dry g	48
4,4'-DDE	1987	36.333	0.28	ng/dry g	48
4,4'-DDE	1988	84.667	0.27	ng/dry g	48
4,4'-DDE	1989	52.667	0.34	ng/dry g	48
4,4'-DDE	1990	72.97	6.4	ng/dry g	48
4,4'-DDE	1991	30.21	0.95	ng/dry g	48
4,4'-DDE	1992	33.99	2.3	ng/dry g	48
4,4'-DDE	1993	24.45	2.6	ng/dry g	48
4,4'-DDE	1995	24.514	0.92	ng/dry g	48
4,4'-DDE	1997	39.58		ng/dry g	48
4,4'-DDE	1999	20.285		ng/dry g	48
4,4'-DDE	2002	12.943	0.24	ng/dry g	48
4,4'-DDE	2003	12.28	0.225	ng/dry g	48
4,4'-DDE	2004	12.536	0.192	ng/dry g	48
4,4'-DDT	1986	10.767	0.3	ng/dry g	4.39
4,4'-DDT	1987	11.233	1	ng/dry g	4.39
4,4'-DDT	1988	19.667	0.11	ng/dry g	4.39
4,4'-DDT	1989	10.3	0.29	ng/dry g	4.39
4,4'-DDT	1990	13.527	1.7	ng/dry g	4.39
4,4'-DDT	1991	6.817	1.5	ng/dry g	4.39
4,4'-DDT	1992	1.42	2.1	ng/dry g	4.39
4,4'-DDT	1993	7.19	3.1	ng/dry g	4.39
4,4'-DDT	1995	4.368	0.83	ng/dry g	4.39
4,4'-DDT	1997	12.94		ng/dry g	4.39
4,4'-DDT	1999	2.687		ng/dry g	4.39
4,4'-DDT	2002	1.911	0.25	ng/dry g	4.39
4,4'-DDT	2003	2.227	0.212	ng/dry g	4.39
4,4'-DDT	2004	1.526	0.182	ng/dry g	4.39

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Acenaphthene	1989	0	1.6	ng/dry g	9.7
Acenaphthene	1990	16.333	8.5	ng/dry g	9.7
Acenaphthene	1991	27.793	6.1	ng/dry g	9.7
Acenaphthene	1992	13.61	3.8	ng/dry g	9.7
Acenaphthene	1993	14.6	2.7	ng/dry g	9.7
Acenaphthene	1995	9.32	12	ng/dry g	9.7
Acenaphthene	1997	11.6		ng/dry g	9.7
Acenaphthene	1999	66.31		ng/dry g	9.7
Acenaphthene	2002	7.2	0.4	ng/dry g	9.7
Acenaphthene	2003	20.4	2.186	ng/dry g	9.7
Acenaphthene	2004	5.3	1.79	ng/dry g	9.7
Acenaphthylene	1989	22.667	11	ng/dry g	7.55
Acenaphthylene	1990	10.5	36	ng/dry g	7.55
Acenaphthylene	1991	12.9	11	ng/dry g	7.55
Acenaphthylene	1992	13.52	10	ng/dry g	7.55
Acenaphthylene	1993	6.59	2.1	ng/dry g	7.55
Acenaphthylene	1995	6.89	4.8	ng/dry g	7.55
Acenaphthylene	1997	9.2		ng/dry g	7.55
Acenaphthylene	1999	6.17		ng/dry g	7.55
Acenaphthylene	2002	3.5	0.5	ng/dry g	7.55
Acenaphthylene	2003	15.2	2.286	ng/dry g	7.55
Acenaphthylene	2004	11	1.872	ng/dry g	7.55
Aldrin	1986	7.5	0.6	ng/dry g	0.69
Aldrin	1987	0.29	0.25	ng/dry g	0.69
Aldrin	1988	0	0.12	ng/dry g	0.69
Aldrin	1989	0	0.38	ng/dry g	0.69
Aldrin	1990	0	0.39	ng/dry g	0.69
Aldrin	1991	18.57	0.68	ng/dry g	0.69
Aldrin	1992	0	0.66	ng/dry g	0.69
Aldrin	1993	0	1.8	ng/dry g	0.69
Aldrin	1995	0	0.41	ng/dry g	0.69
Aldrin	1997	0		ng/dry g	0.69
Aldrin	1999	0		ng/dry g	0.69
Aldrin	2002	0	0.25	ng/dry g	0.69
Aldrin	2003	0	0.251	ng/dry g	0.69
Aldrin	2004	0	0.215	ng/dry g	0.69
Alpha-Chlordane	1986	39	0.3	ng/dry g	10.89
Alpha-Chlordane	1987	37.667	0.36	ng/dry g	10.89
Alpha-Chlordane	1988	37.667	0.32	ng/dry g	10.89
Alpha-Chlordane	1989	22.333	0.32	ng/dry g	10.89
Alpha-Chlordane	1990	31.767	1.3	ng/dry g	10.89
Alpha-Chlordane	1991	13.32	0.36	ng/dry g	10.89
Alpha-Chlordane	1992	14.33	1.2	ng/dry g	10.89
Alpha-Chlordane	1993	68.35	1.4	ng/dry g	10.89
Alpha-Chlordane	1995	7.774		ng/dry g	10.89
Alpha-Chlordane	1997	10.4		ng/dry g	10.89
Alpha-Chlordane	1999	5.912		ng/dry g	10.89
Alpha-Chlordane	2002	5.614	0.29	ng/dry g	10.89
Alpha-Chlordane	2003	3.509	0.241	ng/dry g	10.89
Alpha-Chlordane	2004	4.692	0.207	ng/dry g	10.89

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Alpha-Hexachlorocyclohexane	1995	2.575		ng/dry g	1.42
Alpha-Hexachlorocyclohexane	1997	0		ng/dry g	1.42
Alpha-Hexachlorocyclohexane	1999	0.641		ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2002	0	0.25	ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2003	0	0.237	ng/dry g	1.42
Alpha-Hexachlorocyclohexane	2004	0	0.203	ng/dry g	1.42
Aluminum	1986	19.667	27	µg/dry g	732
Aluminum	1987	180	27	µg/dry g	732
Aluminum	1988	130	60	µg/dry g	732
Aluminum	1989	126.667	0.78	µg/dry g	732
Aluminum	1990	205	160	µg/dry g	732
Aluminum	1991	250	47	µg/dry g	732
Aluminum	1992	200	34	µg/dry g	732
Aluminum	1993	170	18	µg/dry g	732
Aluminum	1995	464.477	120	µg/dry g	732
Aluminum	1997	649		µg/dry g	732
Aluminum	1999	245		µg/dry g	732
Aluminum	2002	94.8	4.882	µg/dry g	732
Aluminum	2003	341	6.32	µg/dry g	732
Aluminum	2004	287	4.882	µg/dry g	732
Anthracene	1989	28.333	7.2	ng/dry g	18.2
Anthracene	1990	41.383	23	ng/dry g	18.2
Anthracene	1991	78.567	5	ng/dry g	18.2
Anthracene	1992	60.61	5.5	ng/dry g	18.2
Anthracene	1993	27.96	2.4	ng/dry g	18.2
Anthracene	1995	19.69	4.5	ng/dry g	18.2
Anthracene	1997	29.3		ng/dry g	18.2
Anthracene	1999	239.04		ng/dry g	18.2
Anthracene	2002	19.9	1.7	ng/dry g	18.2
Anthracene	2003	37.3	1.211	ng/dry g	18.2
Anthracene	2004	13.8	0.992	ng/dry g	18.2
Antimony	1986	0	0.4	µg/dry g	0.05
Antimony	1987	0.093	0.4	µg/dry g	0.05
Antimony	1990	0.047	0.01	µg/dry g	0.05
Antimony	1991	0.08	0.01	µg/dry g	0.05
Antimony	1992	0.03	0.03	µg/dry g	0.05
Antimony	1993	0.04		µg/dry g	0.05
Arsenic	1986	8.4	1.5	µg/dry g	15.67
Arsenic	1987	7.8	1.5	µg/dry g	15.67
Arsenic	1988	8.8	2	µg/dry g	15.67
Arsenic	1989	7.033	2	µg/dry g	15.67
Arsenic	1990	9.797	5	µg/dry g	15.67
Arsenic	1991	10.267	1.7	µg/dry g	15.67
Arsenic	1992	10.35	1.2	µg/dry g	15.67
Arsenic	1993	9.5	2.6	µg/dry g	15.67
Arsenic	1995	9.4	0.4	µg/dry g	15.67
Arsenic	1997	10		µg/dry g	15.67
Arsenic	1999	7.73		µg/dry g	15.67
Arsenic	2002	8.61	1.95	µg/dry g	15.67
Arsenic	2003	7.29	2.53	µg/dry g	15.67
Arsenic	2004	9.25	1.95	µg/dry g	15.67

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Benz[a]anthracene	1989	64.333	9.4	ng/dry g	33.67
Benz[a]anthracene	1990	127.117	8	ng/dry g	33.67
Benz[a]anthracene	1991	187.143	8.4	ng/dry g	33.67
Benz[a]anthracene	1992	132.63	8.6	ng/dry g	33.67
Benz[a]anthracene	1993	99.45	1.8	ng/dry g	33.67
Benz[a]anthracene	1995	109.91	2.5	ng/dry g	33.67
Benz[a]anthracene	1997	84.4		ng/dry g	33.67
Benz[a]anthracene	1999	192.77		ng/dry g	33.67
Benz[a]anthracene	2003	74.1	3.249	ng/dry g	33.67
Benz[a]anthracene	2004	54.1	2.662	ng/dry g	33.67
Benzo[a]pyrene	1989	25	3.8	ng/dry g	10.92
Benzo[a]pyrene	1990	44.71	8.7	ng/dry g	10.92
Benzo[a]pyrene	1991	60.933	7.4	ng/dry g	10.92
Benzo[a]pyrene	1992	45.75	3.6	ng/dry g	10.92
Benzo[a]pyrene	1993	45.59	5	ng/dry g	10.92
Benzo[a]pyrene	1995	33.16	4.7	ng/dry g	10.92
Benzo[a]pyrene	1997	47.7		ng/dry g	10.92
Benzo[a]pyrene	1999	54.91		ng/dry g	10.92
Benzo[a]pyrene	2002	7	1.3	ng/dry g	10.92
Benzo[a]pyrene	2003	24	1.68	ng/dry g	10.92
Benzo[a]pyrene	2004	21	1.376	ng/dry g	10.92
Benzo[b]fluoranthene	1989	53	16	ng/dry g	37.75
Benzo[b]fluoranthene	1990	249.943	12	ng/dry g	37.75
Benzo[b]fluoranthene	1991	126.573	8.5	ng/dry g	37.75
Benzo[b]fluoranthene	1992	109.73	9.8	ng/dry g	37.75
Benzo[b]fluoranthene	1993	121.27	2.1	ng/dry g	37.75
Benzo[b]fluoranthene	1995	128.24	8.7	ng/dry g	37.75
Benzo[b]fluoranthene	1997	109.5		ng/dry g	37.75
Benzo[b]fluoranthene	1999	83.1		ng/dry g	37.75
Benzo[b]fluoranthene	2002	34	0.8	ng/dry g	37.75
Benzo[b]fluoranthene	2003	93.2	3.945	ng/dry g	37.75
Benzo[b]fluoranthene	2004	94.7	3.232	ng/dry g	37.75
Benzo[e]pyrene	1989	79.333	4.7	ng/dry g	36.06
Benzo[e]pyrene	1990	120.933	7.6	ng/dry g	36.06
Benzo[e]pyrene	1991	121.623	10	ng/dry g	36.06
Benzo[e]pyrene	1992	96.51	4.3	ng/dry g	36.06
Benzo[e]pyrene	1993	73.44	4	ng/dry g	36.06
Benzo[e]pyrene	1995	102.9	4.3	ng/dry g	36.06
Benzo[e]pyrene	1997	82.3		ng/dry g	36.06
Benzo[e]pyrene	1999	50.86		ng/dry g	36.06
Benzo[e]pyrene	2002	34.9	1.9	ng/dry g	36.06
Benzo[e]pyrene	2003	86.3	2.759	ng/dry g	36.06
Benzo[e]pyrene	2004	92.2	2.259	ng/dry g	36.06
Benzo[g,h,i]perylene	1989	14.667	6.2	ng/dry g	10.49
Benzo[g,h,i]perylene	1990	28.68	3.3	ng/dry g	10.49
Benzo[g,h,i]perylene	1991	49.103	12	ng/dry g	10.49
Benzo[g,h,i]perylene	1992	32.41	6.7	ng/dry g	10.49
Benzo[g,h,i]perylene	1993	39.22	5.1	ng/dry g	10.49
Benzo[g,h,i]perylene	1995	23.91	4.1	ng/dry g	10.49
Benzo[g,h,i]perylene	1997	29.2		ng/dry g	10.49
Benzo[g,h,i]perylene	1999	14.55		ng/dry g	10.49
Benzo[g,h,i]perylene	2002	6.4	0.7	ng/dry g	10.49
Benzo[g,h,i]perylene	2003	17.1	2.463	ng/dry g	10.49
Benzo[g,h,i]perylene	2004	16.9	2.017	ng/dry g	10.49

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Benzo[k]fluoranthene	1989	45	6.3	ng/dry g	19.63
Benzo[k]fluoranthene	1990	0	18	ng/dry g	19.63
Benzo[k]fluoranthene	1991	95.083	7.1	ng/dry g	19.63
Benzo[k]fluoranthene	1992	73.99	4.6	ng/dry g	19.63
Benzo[k]fluoranthene	1993	41.33	4.7	ng/dry g	19.63
Benzo[k]fluoranthene	1995	45.4	5.4	ng/dry g	19.63
Benzo[k]fluoranthene	1997	42.5		ng/dry g	19.63
Benzo[k]fluoranthene	1999	46.72		ng/dry g	19.63
Benzo[k]fluoranthene	2002	28.1	0.7	ng/dry g	19.63
Benzo[k]fluoranthene	2003	65.4	2.899	ng/dry g	19.63
Benzo[k]fluoranthene	2004	87.7	2.374	ng/dry g	19.63
Beta-Hexachlorocyclohexane	1995	0.317		ng/dry g	0.97
Beta-Hexachlorocyclohexane	1997	0		ng/dry g	0.97
Beta-Hexachlorocyclohexane	1999	16.756		ng/dry g	0.97
Beta-Hexachlorocyclohexane	2002	0	0.26	ng/dry g	0.97
Beta-Hexachlorocyclohexane	2003	0.137	0.234	ng/dry g	0.97
Beta-Hexachlorocyclohexane	2004	0.24	0.2	ng/dry g	0.97
Biphenyl	1989	0	3.7	ng/dry g	9.96
Biphenyl	1990	19.967	41	ng/dry g	9.96
Biphenyl	1991	9.377	4.1	ng/dry g	9.96
Biphenyl	1992	10.71	8.8	ng/dry g	9.96
Biphenyl	1993	9.66	4.8	ng/dry g	9.96
Biphenyl	1995	3.74	10	ng/dry g	9.96
Biphenyl	1997	3.3		ng/dry g	9.96
Biphenyl	1999	10.12		ng/dry g	9.96
Biphenyl	2002	6	2	ng/dry g	9.96
Biphenyl	2003	7.7	2.526	ng/dry g	9.96
Biphenyl	2004	19.6	2.07	ng/dry g	9.96
C1-Chrysenes	1993	91	1.7	ng/dry g	27.47
C1-Chrysenes	1995	96.62	17	ng/dry g	27.47
C1-Chrysenes	1997	123.7		ng/dry g	27.47
C1-Chrysenes	1999	34.39		ng/dry g	27.47
C1-Chrysenes	2002	24.8	1.8	ng/dry g	27.47
C1-Chrysenes	2003	69.4	5.234	ng/dry g	27.47
C1-Chrysenes	2004	62.3	4.288	ng/dry g	27.47
C1-Dibenzothiophenes	1993	61.66	2.7	ng/dry g	15.7
C1-Dibenzothiophenes	1995	16.74	11	ng/dry g	15.7
C1-Dibenzothiophenes	1997	31.8		ng/dry g	15.7
C1-Dibenzothiophenes	1999	15.45		ng/dry g	15.7
C1-Dibenzothiophenes	2002	13.1	1.1	ng/dry g	15.7
C1-Dibenzothiophenes	2003	18.5	1.831	ng/dry g	15.7
C1-Dibenzothiophenes	2004	14.6	1.5	ng/dry g	15.7
C1-Fluoranthenes/Pyrenes	1993	250.2	5.2	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	1995	207.5	17	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	1997	300.6		ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	1999	175.68		ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	2002	100	1.6	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	2003	172	5.88	ng/dry g	77.86
C1-Fluoranthenes/Pyrenes	2004	103	7.604	ng/dry g	77.86

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
C1-Fluorenes	1993	55.94	2.7	ng/dry g	19.9
C1-Fluorenes	1995	27.52	12	ng/dry g	19.9
C1-Fluorenes	1997	43.7		ng/dry g	19.9
C1-Fluorenes	1999	77.95		ng/dry g	19.9
C1-Fluorenes	2002	11.9	1.1	ng/dry g	19.9
C1-Fluorenes	2003	12.8	2.554	ng/dry g	19.9
C1-Fluorenes	2004	16.9	2.092	ng/dry g	19.9
C1-Naphthalenes	1993	16.54	19	ng/dry g	35.26
C1-Naphthalenes	1995	18.64	19	ng/dry g	35.26
C1-Naphthalenes	1997	32.3		ng/dry g	35.26
C1-Naphthalenes	1999	28.12		ng/dry g	35.26
C1-Naphthalenes	2002	13.3	4.6	ng/dry g	35.26
C1-Naphthalenes	2003	27.6	9.294	ng/dry g	35.26
C1-Naphthalenes	2004	17.4	7.613	ng/dry g	35.26
C1-Phenanthrenes/Anthracenes	1993	237.76	5.5	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	1995	119.03	11	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	1997	167.7		ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	1999	157.11		ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2002	62.6	2.9	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2003	92.8	3.736	ng/dry g	65.3
C1-Phenanthrenes/Anthracenes	2004	103	3.061	ng/dry g	65.3
C2-Chrysenes	1993	62.25	1.7	ng/dry g	23.96
C2-Chrysenes	1995	57.49	15	ng/dry g	23.96
C2-Chrysenes	1997	99.9		ng/dry g	23.96
C2-Chrysenes	1999	11.66		ng/dry g	23.96
C2-Chrysenes	2002	15.7	1.8	ng/dry g	23.96
C2-Chrysenes	2003	46.5	5.234	ng/dry g	23.96
C2-Chrysenes	2004	33.9	4.288	ng/dry g	23.96
C2-Dibenzothiophenes	1993	194.67	2.7	ng/dry g	43.5
C2-Dibenzothiophenes	1995	68.95	18	ng/dry g	43.5
C2-Dibenzothiophenes	1997	122.3		ng/dry g	43.5
C2-Dibenzothiophenes	1999	15.5		ng/dry g	43.5
C2-Dibenzothiophenes	2002	28.7	1.1	ng/dry g	43.5
C2-Dibenzothiophenes	2003	41.5	1.831	ng/dry g	43.5
C2-Dibenzothiophenes	2004	44.7	1.5	ng/dry g	43.5
C2-Fluoranthenes/Pyrenes	2003	81.7	5.88	ng/dry g	32.6
C2-Fluoranthenes/Pyrenes	2004	56.1	7.604	ng/dry g	32.6
C2-Fluorenes	1993	200.25	2.7	ng/dry g	54.15
C2-Fluorenes	1995	108.63	12	ng/dry g	54.15
C2-Fluorenes	1997	158.5		ng/dry g	54.15
C2-Fluorenes	1999	35.91		ng/dry g	54.15
C2-Fluorenes	2002	35.4	1.1	ng/dry g	54.15
C2-Fluorenes	2003	32.2	2.554	ng/dry g	54.15
C2-Fluorenes	2004	83.1	2.092	ng/dry g	54.15

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
C2-Naphthalenes	1993	55.5	19	ng/dry g	33.8
C2-Naphthalenes	1995	30.41	17	ng/dry g	33.8
C2-Naphthalenes	1997	69.5		ng/dry g	33.8
C2-Naphthalenes	1999	38.21		ng/dry g	33.8
C2-Naphthalenes	2002	25	4.6	ng/dry g	33.8
C2-Naphthalenes	2003	40.7	9.294	ng/dry g	33.8
C2-Naphthalenes	2004	32.1	7.613	ng/dry g	33.8
C2-Phenanthrenes/Anthracenes	1993	564.74	5.5	ng/dry g	104
C2-Phenanthrenes/Anthracenes	1995	331.84	19	ng/dry g	104
C2-Phenanthrenes/Anthracenes	1997	410.2		ng/dry g	104
C2-Phenanthrenes/Anthracenes	1999	99.37		ng/dry g	104
C2-Phenanthrenes/Anthracenes	2002	97.1	2.9	ng/dry g	104
C2-Phenanthrenes/Anthracenes	2003	170	3.736	ng/dry g	104
C2-Phenanthrenes/Anthracenes	2004	287	3.061	ng/dry g	104
C3-Chrysenes	1993	22.96	1.7	ng/dry g	0.6
C3-Chrysenes	1995	5.76	21	ng/dry g	0.6
C3-Chrysenes	1997	8.7		ng/dry g	0.6
C3-Chrysenes	1999	0.05		ng/dry g	0.6
C3-Chrysenes	2002	8.7	1.8	ng/dry g	0.6
C3-Chrysenes	2003	0	5.234	ng/dry g	0.6
C3-Chrysenes	2004	0	4.288	ng/dry g	0.6
C3-Dibenzothiophenes	1993	296.36	2.7	ng/dry g	54.31
C3-Dibenzothiophenes	1995	117.16	11	ng/dry g	54.31
C3-Dibenzothiophenes	1997	225.8		ng/dry g	54.31
C3-Dibenzothiophenes	1999	22.21		ng/dry g	54.31
C3-Dibenzothiophenes	2002	31.8	1.1	ng/dry g	54.31
C3-Dibenzothiophenes	2003	41.9	1.831	ng/dry g	54.31
C3-Dibenzothiophenes	2004	65.9	1.5	ng/dry g	54.31
C3-Fluoranthenes/Pyrenes	2003	34.7	5.88	ng/dry g	10.2
C3-Fluoranthenes/Pyrenes	2004	17.8	7.604	ng/dry g	10.2
C3-Fluorenes	1993	364.69	2.7	ng/dry g	94.6
C3-Fluorenes	1995	249.88	12	ng/dry g	94.6
C3-Fluorenes	1997	285.4		ng/dry g	94.6
C3-Fluorenes	1999	85.94		ng/dry g	94.6
C3-Fluorenes	2002	33.3	1.1	ng/dry g	94.6
C3-Fluorenes	2003	58.5	2.554	ng/dry g	94.6
C3-Fluorenes	2004	138	2.092	ng/dry g	94.6
C3-Naphthalenes	1993	191.13	19	ng/dry g	45.31
C3-Naphthalenes	1995	76.1	17	ng/dry g	45.31
C3-Naphthalenes	1997	221.1		ng/dry g	45.31
C3-Naphthalenes	1999	39.06		ng/dry g	45.31
C3-Naphthalenes	2002	24.3	4.6	ng/dry g	45.31
C3-Naphthalenes	2003	40.7	9.294	ng/dry g	45.31
C3-Naphthalenes	2004	74.9	7.613	ng/dry g	45.31

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
C3-Phenanthrenes/Anthracenes	1993	492.35	5.5	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	1995	312.37	19	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	1997	495.7		ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	1999	63.72		ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2002	64.5	2.9	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2003	169	3.736	ng/dry g	96.6
C3-Phenanthrenes/Anthracenes	2004	290	3.061	ng/dry g	96.6
C4-Chrysenes	1993	0	1.7	ng/dry g	0.51
C4-Chrysenes	1995	6.3	17	ng/dry g	0.51
C4-Chrysenes	1997	7.5		ng/dry g	0.51
C4-Chrysenes	1999	0.04		ng/dry g	0.51
C4-Chrysenes	2002	8.1	1.8	ng/dry g	0.51
C4-Chrysenes	2003	0	5.234	ng/dry g	0.51
C4-Chrysenes	2004	0	4.288	ng/dry g	0.51
C4-Naphthalenes	1993	350.48	19	ng/dry g	47.27
C4-Naphthalenes	1995	111.72	11	ng/dry g	47.27
C4-Naphthalenes	1997	250		ng/dry g	47.27
C4-Naphthalenes	1999	34.37		ng/dry g	47.27
C4-Naphthalenes	2002	19.1	4.6	ng/dry g	47.27
C4-Naphthalenes	2003	38.7	9.294	ng/dry g	47.27
C4-Naphthalenes	2004	113	7.613	ng/dry g	47.27
C4-Phenanthrenes/Anthracenes	1993	250.51	5.5	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	1995	172.4	12	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	1997	240.7		ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	1999	27.88		ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2002	31.3	2.9	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2003	62.4	3.736	ng/dry g	58.4
C4-Phenanthrenes/Anthracenes	2004	126	3.061	ng/dry g	58.4
Cadmium	1986	2.2	0.9	µg/dry g	5.42
Cadmium	1987	2.433	0.9	µg/dry g	5.42
Cadmium	1988	1.8	0.19	µg/dry g	5.42
Cadmium	1989	1.333	0.02	µg/dry g	5.42
Cadmium	1990	1.4	0.63	µg/dry g	5.42
Cadmium	1991	1.733	0.21	µg/dry g	5.42
Cadmium	1992	1.05	0.44	µg/dry g	5.42
Cadmium	1993	1.27	0.54	µg/dry g	5.42
Cadmium	1995	0.838	0.003	µg/dry g	5.42
Cadmium	1997	2.48		µg/dry g	5.42
Cadmium	1999	0.981		µg/dry g	5.42
Cadmium	2002	0.58	0.195	µg/dry g	5.42
Cadmium	2003	0.969	0.25	µg/dry g	5.42
Cadmium	2004	1.1	0.195	µg/dry g	5.42
Chlorpyrifos	1995	4.925		ng/dry g	1.55
Chlorpyrifos	1997	11.21		ng/dry g	1.55
Chlorpyrifos	1999	3.569		ng/dry g	1.55
Chlorpyrifos	2002	0	0.28	ng/dry g	1.55
Chlorpyrifos	2003	0.956	0.256	ng/dry g	1.55
Chlorpyrifos	2004	0	0.219	ng/dry g	1.55

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Chromium	1986	1.02	0.21	µg/dry g	3.02
Chromium	1987	2.1	0.21	µg/dry g	3.02
Chromium	1988	2.333	0.12	µg/dry g	3.02
Chromium	1989	1.8	0.1	µg/dry g	3.02
Chromium	1990	1.97	0.63	µg/dry g	3.02
Chromium	1991	3.6	0.37	µg/dry g	3.02
Chromium	1992	2.13	0.4	µg/dry g	3.02
Chromium	1993	2.71	0.58	µg/dry g	3.02
Chromium	1995	2.43	0.5	µg/dry g	3.02
Chromium	1997	4.2		µg/dry g	3.02
Chromium	1999	1.6		µg/dry g	3.02
Chromium	2002	1.19	0.488	µg/dry g	3.02
Chromium	2003	3.41	0.63	µg/dry g	3.02
Chromium	2004	4	0.488	µg/dry g	3.02
Chrysene	1989	140	3.1	ng/dry g	72.85
Chrysene	1990	209.197	12	ng/dry g	72.85
Chrysene	1991	285.263	5.9	ng/dry g	72.85
Chrysene	1992	230.63	9.9	ng/dry g	72.85
Chrysene	1993	107.82	1.7	ng/dry g	72.85
Chrysene	1995	143.29	5.8	ng/dry g	72.85
Chrysene	1997	137.7		ng/dry g	72.85
Chrysene	1999	132.73		ng/dry g	72.85
Chrysene	2002	67.3	0.9	ng/dry g	72.85
Chrysene	2003	144	5.234	ng/dry g	72.85
Chrysene	2004	124	4.288	ng/dry g	72.85
Cis-Nonachlor	1995	5.17		ng/dry g	3.91
Cis-Nonachlor	1997	4.82		ng/dry g	3.91
Cis-Nonachlor	1999	4.657		ng/dry g	3.91
Cis-Nonachlor	2002	3.236	0.26	ng/dry g	3.91
Cis-Nonachlor	2003	2.196	0.248	ng/dry g	3.91
Cis-Nonachlor	2004	2.53	0.212	ng/dry g	3.91
Copper	1986	10	3	µg/dry g	183
Copper	1987	13	3	µg/dry g	183
Copper	1988	13	3	µg/dry g	183
Copper	1989	12.667	3	µg/dry g	183
Copper	1990	13.367	11	µg/dry g	183
Copper	1991	13.333	3.7	µg/dry g	183
Copper	1992	14.4	2.7	µg/dry g	183
Copper	1993	12.3	2.2	µg/dry g	183
Copper	1995	14.021	0.16	µg/dry g	183
Copper	1997	14.9		µg/dry g	183
Copper	1999	8.5		µg/dry g	183
Copper	2002	9.24	0.488	µg/dry g	183
Copper	2003	22.6	0.63	µg/dry g	183
Copper	2004	16.8	0.488	µg/dry g	183
Delta-Hexachlorocyclohexane	1995	0		ng/dry g	0.18
Delta-Hexachlorocyclohexane	1997	0.6		ng/dry g	0.18
Delta-Hexachlorocyclohexane	1999	0		ng/dry g	0.18
Delta-Hexachlorocyclohexane	2002	0.045	0.23	ng/dry g	0.18
Delta-Hexachlorocyclohexane	2003	0.095	0.235	ng/dry g	0.18
Delta-Hexachlorocyclohexane	2004	0	0.202	ng/dry g	0.18

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Dibenzo[a,h]anthracene	1989	0	5.8	ng/dry g	2.17
Dibenzo[a,h]anthracene	1990	0	7.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	1991	8.44	6.1	ng/dry g	2.17
Dibenzo[a,h]anthracene	1992	9.4	7.2	ng/dry g	2.17
Dibenzo[a,h]anthracene	1993	8.37	3.8	ng/dry g	2.17
Dibenzo[a,h]anthracene	1995	4.39	6.6	ng/dry g	2.17
Dibenzo[a,h]anthracene	1997	6.6		ng/dry g	2.17
Dibenzo[a,h]anthracene	1999	2.09		ng/dry g	2.17
Dibenzo[a,h]anthracene	2002	2.5	0.4	ng/dry g	2.17
Dibenzo[a,h]anthracene	2003	3.3	2.428	ng/dry g	2.17
Dibenzo[a,h]anthracene	2004	2.8	1.989	ng/dry g	2.17
Dibenzofuran	1993	14.79		ng/dry g	11.55
Dibenzofuran	2003	11.9	2.22	µg/dry g	11.55
Dibenzofuran	2004	6	2.22	ng/dry g	11.55
Dibenzothiophene	1993	10.9	2.7	ng/dry g	5.5
Dibenzothiophene	1995	5.52		ng/dry g	5.5
Dibenzothiophene	1997	7.6		ng/dry g	5.5
Dibenzothiophene	1999	26.54		ng/dry g	5.5
Dibenzothiophene	2002	6.2	0.5	ng/dry g	5.5
Dibenzothiophene	2003	10.1	1.831	ng/dry g	5.5
Dibenzothiophene	2004	2.6	1.5	ng/dry g	5.5
Dibutyltin	1989	60.9		ng/dry g	22.61
Dibutyltin	1990	61.47		ng/dry g	22.61
Dibutyltin	1991	0		ng/dry g	22.61
Dibutyltin	1992	17.93		ng/dry g	22.61
Dibutyltin	1993	0	12	ng/dry g	22.61
Dibutyltin	1995	0		ng/dry g	22.61
Dibutyltin	1997	10.8		ng/dry g	22.61
Dibutyltin	1999	14.14		ng/dry g	22.61
Dibutyltin	2002	8.07	3.6	ng/dry g	22.61
Dibutyltin	2003	5.77	3.305	ng/dry g	22.61
Dibutyltin	2004	10.78	2.807	ng/dry g	22.61
Dichlorobiphenyls	1986	2.467	2.3	ng/dry g	11.4
Dichlorobiphenyls	1987	7.567	2.3	ng/dry g	11.4
Dieldrin	1986	24	0.6	ng/dry g	9.34
Dieldrin	1987	13.667	0.52	ng/dry g	9.34
Dieldrin	1988	0	0.11	ng/dry g	9.34
Dieldrin	1989	0	0.39	ng/dry g	9.34
Dieldrin	1990	0	2.9	ng/dry g	9.34
Dieldrin	1991	5.893	7.3	ng/dry g	9.34
Dieldrin	1992	48.01	0.82	ng/dry g	9.34
Dieldrin	1993	16.18	2.3	ng/dry g	9.34
Dieldrin	1995	7.874	1	ng/dry g	9.34
Dieldrin	1997	9.17		ng/dry g	9.34
Dieldrin	1999	3.815		ng/dry g	9.34
Dieldrin	2002	4.259	0.37	ng/dry g	9.34
Dieldrin	2003	2.111	0.229	ng/dry g	9.34
Dieldrin	2004	2.714	0.196	ng/dry g	9.34

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Endosulfan I	2002	2.236	0.26	ng/dry g	2.12
Endosulfan I	2003	0	0.256	ng/dry g	2.12
Endosulfan I	2004	3.979	0.219	ng/dry g	2.12
Endosulfan II	1995	0		ng/dry g	1.71
Endosulfan II	1997	0		ng/dry g	1.71
Endosulfan II	1999	0.785		ng/dry g	1.71
Endosulfan II	2002	2.814	0.26	ng/dry g	1.71
Endosulfan II	2003	0	0.256	ng/dry g	1.71
Endosulfan II	2004	3.152	0.219	ng/dry g	1.71
Endosulfan Sulfate	2002	0	0.29	ng/dry g	0.44
Endosulfan Sulfate	2003	0	0.278	ng/dry g	0.44
Endosulfan Sulfate	2004	0	0.238	ng/dry g	0.44
Endrin	1991	0		ng/dry g	0.71
Endrin	1992	0		ng/dry g	0.71
Endrin	1993	0		ng/dry g	0.71
Endrin	1995	0		ng/dry g	0.71
Endrin	1997	0		ng/dry g	0.71
Endrin	1999	0		ng/dry g	0.71
Endrin	2002	0.06	0.24	ng/dry g	0.71
Endrin	2003	0.704	0.211	ng/dry g	0.71
Endrin	2004	0	0.181	ng/dry g	0.71
Fluoranthene	1989	370	8.2	ng/dry g	153.33
Fluoranthene	1990	564.433	25	ng/dry g	153.33
Fluoranthene	1991	804.063	4.9	ng/dry g	153.33
Fluoranthene	1992	472.37	9.5	ng/dry g	153.33
Fluoranthene	1993	408.46	5	ng/dry g	153.33
Fluoranthene	1995	328.74	5.8	ng/dry g	153.33
Fluoranthene	1997	307.2		ng/dry g	153.33
Fluoranthene	1999	905.48		ng/dry g	153.33
Fluoranthene	2002	225	0.8	ng/dry g	153.33
Fluoranthene	2003	315	9.283	ng/dry g	153.33
Fluoranthene	2004	155	7.604	ng/dry g	153.33
Fluorene	1989	13.333	2.9	ng/dry g	12.6
Fluorene	1990	28.83	12	ng/dry g	12.6
Fluorene	1991	45.437	6.6	ng/dry g	12.6
Fluorene	1992	25.27	6.4	ng/dry g	12.6
Fluorene	1993	18.76	2.7	ng/dry g	12.6
Fluorene	1995	17.44	6.8	ng/dry g	12.6
Fluorene	1997	13.3		ng/dry g	12.6
Fluorene	1999	143.2		ng/dry g	12.6
Fluorene	2002	12.5	0.6	ng/dry g	12.6
Fluorene	2003	20.7	2.554	ng/dry g	12.6
Fluorene	2004	4.8	2.092	ng/dry g	12.6
Gamma-Chlordane	1995	7.539		ng/dry g	5.18
Gamma-Chlordane	1997	9.2		ng/dry g	5.18
Gamma-Chlordane	1999	5.082		ng/dry g	5.18
Gamma-Chlordane	2002	4.44	0.29	ng/dry g	5.18
Gamma-Chlordane	2003	3.341	0.276	ng/dry g	5.18
Gamma-Chlordane	2004	3.986	0.237	ng/dry g	5.18

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Gamma-Hexachlorocyclohexane	1986	2.267	0.5	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1987	0.203	0.1	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1988	0	0.18	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1989	14	0.11	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1990	5.033	1.9	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1991	4.913	0.7	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1992	0	1	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1993	0.63	1.8	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1995	1.352	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1997	0.67		ng/dry g	2.15
Gamma-Hexachlorocyclohexane	1999	0.807		ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2002	0.346	0.25	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2003	0	0.227	ng/dry g	2.15
Gamma-Hexachlorocyclohexane	2004	0.339	0.194	ng/dry g	2.15
Heptachlor	1986	2.9	0.5	ng/dry g	0.54
Heptachlor	1987	1.533	0.91	ng/dry g	0.54
Heptachlor	1988	0	0.15	ng/dry g	0.54
Heptachlor	1989	0	0.21	ng/dry g	0.54
Heptachlor	1990	2.133	1.3	ng/dry g	0.54
Heptachlor	1991	0	1.4	ng/dry g	0.54
Heptachlor	1992	0		ng/dry g	0.54
Heptachlor	1993	12.75	3.3	ng/dry g	0.54
Heptachlor	1995	0	0.53	ng/dry g	0.54
Heptachlor	1997	0		ng/dry g	0.54
Heptachlor	1999	0.755		ng/dry g	0.54
Heptachlor	2002	0.241	0.28	ng/dry g	0.54
Heptachlor	2003	0.368	0.26	ng/dry g	0.54
Heptachlor	2004	0	0.223	ng/dry g	0.54
Heptachlor-Epoxide	1986	4.4	0.6	ng/dry g	2.17
Heptachlor-Epoxide	1987	0.967	0.29	ng/dry g	2.17
Heptachlor-Epoxide	1988	0	0.1	ng/dry g	2.17
Heptachlor-Epoxide	1989	7.3	0.34	ng/dry g	2.17
Heptachlor-Epoxide	1990	3.833	1.4	ng/dry g	2.17
Heptachlor-Epoxide	1991	1.557	0.78	ng/dry g	2.17
Heptachlor-Epoxide	1992	0	0.96	ng/dry g	2.17
Heptachlor-Epoxide	1993	1.59	1.6	ng/dry g	2.17
Heptachlor-Epoxide	1995	0.385	6.5	ng/dry g	2.17
Heptachlor-Epoxide	1997	0		ng/dry g	2.17
Heptachlor-Epoxide	1999	0		ng/dry g	2.17
Heptachlor-Epoxide	2002	0.286	0.3	ng/dry g	2.17
Heptachlor-Epoxide	2003	0.073	0.234	ng/dry g	2.17
Heptachlor-Epoxide	2004	0.466	0.201	ng/dry g	2.17
Heptachlorobiphenyls	1986	73.667	0.5	ng/dry g	44.67
Heptachlorobiphenyls	1987	26.667	0.5	ng/dry g	44.67

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Hexachlorobenzene	1986	0	0.5	ng/dry g	0.69
Hexachlorobenzene	1987	0.567	0.32	ng/dry g	0.69
Hexachlorobenzene	1988	0.313	0.34	ng/dry g	0.69
Hexachlorobenzene	1989	4.067	0.18	ng/dry g	0.69
Hexachlorobenzene	1990	1.133	0.74	ng/dry g	0.69
Hexachlorobenzene	1991	0.77	0.9	ng/dry g	0.69
Hexachlorobenzene	1992	0	0.56	ng/dry g	0.69
Hexachlorobenzene	1993	0.2	1	ng/dry g	0.69
Hexachlorobenzene	1995	0.549	0.4	ng/dry g	0.69
Hexachlorobenzene	1997	0.97		ng/dry g	0.69
Hexachlorobenzene	1999	0.326		ng/dry g	0.69
Hexachlorobenzene	2002	0.482	0.24	ng/dry g	0.69
Hexachlorobenzene	2003	0.242	0.26	ng/dry g	0.69
Hexachlorobenzene	2004	1.102	0.223	ng/dry g	0.69
Hexachlorobiphenyls	1986	266.667	1.6	ng/dry g	190
Hexachlorobiphenyls	1987	74.333	1.6	ng/dry g	190
Indeno[1,2,3-c,d]pyrene	1989	9.667	8.5	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1990	27.187	5.5	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1991	42.39	8.9	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1992	29.93	7.9	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1993	36.06	2.8	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1995	17.87		ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1997	20.7		ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	1999	16.75		ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2002	11.6	1	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2003	21.9	3.443	ng/dry g	8.42
Indeno[1,2,3-c,d]pyrene	2004	18.8	2.821	ng/dry g	8.42
Iron	1986	116.667	30	µg/dry g	872
Iron	1987	276.667	30	µg/dry g	872
Iron	1988	310	5	µg/dry g	872
Iron	1989	253.333	5	µg/dry g	872
Iron	1990	380	180	µg/dry g	872
Iron	1991	523.333	33	µg/dry g	872
Iron	1992	560	26	µg/dry g	872
Iron	1993	680	34	µg/dry g	872
Iron	1995	579.485	100	µg/dry g	872
Iron	1997	1253		µg/dry g	872
Iron	1999	413		µg/dry g	872
Iron	2002	328	1.101	µg/dry g	872
Iron	2003	1130	1.27	µg/dry g	872
Iron	2004	862	1.101	µg/dry g	872
Lead	1986	3.133	0.06	µg/dry g	2.76
Lead	1987	7.367	0.06	µg/dry g	2.76
Lead	1988	5.9	0.17	µg/dry g	2.76
Lead	1989	6.533	0.02	µg/dry g	2.76
Lead	1990	4.093	0.13	µg/dry g	2.76
Lead	1991	7.833	0.04	µg/dry g	2.76
Lead	1992	6.25	0.09	µg/dry g	2.76
Lead	1993	6.4	0.059	µg/dry g	2.76
Lead	1995	4.097	0.11	µg/dry g	2.76
Lead	1997	11.4		µg/dry g	2.76
Lead	1999	4.33		µg/dry g	2.76
Lead	2002	3.68	0.043	µg/dry g	2.76
Lead	2003	8.35	0.06	µg/dry g	2.76
Lead	2004	6.57	0.043	µg/dry g	2.76

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Manganese	1986	14	3	µg/dry g	39.04
Manganese	1987	34.667	3	µg/dry g	39.04
Manganese	1990	23.067	2.8	µg/dry g	39.04
Manganese	1991	56.667	0.28	µg/dry g	39.04
Manganese	1992	31	1.8	µg/dry g	39.04
Manganese	1993	33	6.7	µg/dry g	39.04
Manganese	1995	37.341	3.8	µg/dry g	39.04
Manganese	1997	36		µg/dry g	39.04
Manganese	1999	69.9		µg/dry g	39.04
Manganese	2002	28.5	0.195	µg/dry g	39.04
Manganese	2003	44.1	0.25	µg/dry g	39.04
Manganese	2004	125	0.195	µg/dry g	39.04
Mercury	1986	0.21	0.001	µg/dry g	0.21
Mercury	1987	0.283	0.001	µg/dry g	0.21
Mercury	1988	0.283	0.01	µg/dry g	0.21
Mercury	1989	0.233	0.01	µg/dry g	0.21
Mercury	1990	0.227	0.01	µg/dry g	0.21
Mercury	1991	0.34	0.005	µg/dry g	0.21
Mercury	1992	0.28	0.006	µg/dry g	0.21
Mercury	1993	0.26	0.021	µg/dry g	0.21
Mercury	1995	0.174	0.012	µg/dry g	0.21
Mercury	1997	0.287		µg/dry g	0.21
Mercury	1999	0.142		µg/dry g	0.21
Mercury	2002	0.151	0.01	µg/dry g	0.21
Mercury	2003	0.148	0.03	µg/dry g	0.21
Mercury	2004	0.296	0.01	µg/dry g	0.21
Mirex	1986	3.4	0.75	ng/dry g	0.97
Mirex	1987	2.267	0.34	ng/dry g	0.97
Mirex	1988	3.267	0.19	ng/dry g	0.97
Mirex	1989	0	0.76	ng/dry g	0.97
Mirex	1990	1.237	0.86	ng/dry g	0.97
Mirex	1991	0.18	0.52	ng/dry g	0.97
Mirex	1992	0	0.55	ng/dry g	0.97
Mirex	1993	1.25	2.1	ng/dry g	0.97
Mirex	1995	1.188	0.28	ng/dry g	0.97
Mirex	1997	2.05		ng/dry g	0.97
Mirex	1999	1.385		ng/dry g	0.97
Mirex	2002	0.512	0.28	ng/dry g	0.97
Mirex	2003	0.735	0.232	ng/dry g	0.97
Mirex	2004	0.975	0.199	ng/dry g	0.97
Monobutyltin	1989	23.66		ng/dry g	8.79
Monobutyltin	1990	13.4		ng/dry g	8.79
Monobutyltin	1991	0		ng/dry g	8.79
Monobutyltin	1992	13.01		ng/dry g	8.79
Monobutyltin	1993	31.68	12	ng/dry g	8.79
Monobutyltin	1995	0		ng/dry g	8.79
Monobutyltin	1997	0		ng/dry g	8.79
Monobutyltin	1999	4.22		ng/dry g	8.79
Monobutyltin	2002	1.494	1.95	ng/dry g	8.79
Monobutyltin	2003	2.03	0.479	ng/dry g	8.79
Monobutyltin	2004	4.81	0.319	ng/dry g	8.79

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Naphthalene	1989	9.033	2.6	ng/dry g	30.04
Naphthalene	1990	17.327	12	ng/dry g	30.04
Naphthalene	1991	24.393	11.5	ng/dry g	30.04
Naphthalene	1992	29.48	11	ng/dry g	30.04
Naphthalene	1993	21.77	19	ng/dry g	30.04
Naphthalene	1995	13.05		ng/dry g	30.04
Naphthalene	1997	20.4		ng/dry g	30.04
Naphthalene	1999	6.55		ng/dry g	30.04
Naphthalene	2002	14.1	2.3	ng/dry g	30.04
Naphthalene	2003	40.7	9.294	ng/dry g	30.04
Naphthalene	2004	22.8	7.613	ng/dry g	30.04
Nickel	1986	1.2	0.23	µg/dry g	3.84
Nickel	1987	2.333	0.23	µg/dry g	3.84
Nickel	1988	3.4	0.25	µg/dry g	3.84
Nickel	1989	1.6	0.07	µg/dry g	3.84
Nickel	1990	2.193	1.5	µg/dry g	3.84
Nickel	1991	3.2	0.96	µg/dry g	3.84
Nickel	1992	2.66	0.54	µg/dry g	3.84
Nickel	1993	2.76	0.79	µg/dry g	3.84
Nickel	1995	2.056	0.15	µg/dry g	3.84
Nickel	1997	2.9		µg/dry g	3.84
Nickel	1999	1.99		µg/dry g	3.84
Nickel	2002	1.43	0.488	µg/dry g	3.84
Nickel	2003	2.74	0.63	µg/dry g	3.84
Nickel	2004	3.01	0.488	µg/dry g	3.84
Nonachlorobiphenyls	1986	0	1.2	ng/dry g	0.77
Nonachlorobiphenyls	1987	0	1.2	ng/dry g	0.77
Octachlorobiphenyls	1986	8.333	0.5	ng/dry g	3.53
Octachlorobiphenyls	1987	3.533	0.5	ng/dry g	3.53
Oxychlordane	1995	0.89		ng/dry g	1.34
Oxychlordane	1997	2.79		ng/dry g	1.34
Oxychlordane	1999	0		ng/dry g	1.34
Oxychlordane	2002	1.264	0.27	ng/dry g	1.34
Oxychlordane	2003	0.567	0.287	ng/dry g	1.34
Oxychlordane	2004	1.159	0.246	ng/dry g	1.34
PCB101/90	1988	41.333	0.28	ng/dry g	17.84
PCB101/90	1989	45.667	0.55	ng/dry g	17.84
PCB101/90	1990	66.377	2.6	ng/dry g	17.84
PCB101/90	1991	25.54	0.6	ng/dry g	17.84
PCB101/90	1992	38.24	1.5	ng/dry g	17.84
PCB101/90	1993	24.81	1.5	ng/dry g	17.84
PCB101/90	1995	24.327	0.47	ng/dry g	17.84
PCB101/90	1997	37.99		ng/dry g	17.84
PCB101/90	1999	20.847		ng/dry g	17.84
PCB101/90	2002	16.284	0.66	ng/dry g	17.84
PCB101/90	2003	12.68	0.32	ng/dry g	17.84
PCB101/90	2004	7.44	0.32	Percent	17.84

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
PCB105	1988	0	1.2	ng/dry g	4.95
PCB105	1989	0	0.54	ng/dry g	4.95
PCB105	1990	14.65	2	ng/dry g	4.95
PCB105	1991	7.147	0.52	ng/dry g	4.95
PCB105	1992	6.09	0.46	ng/dry g	4.95
PCB105	1993	9.29	2.3	ng/dry g	4.95
PCB105	1995	9.123	1.2	ng/dry g	4.95
PCB105	1997	19.93		ng/dry g	4.95
PCB105	1999	5.641		ng/dry g	4.95
PCB105	2002	2.694	0.41	ng/dry g	4.95
PCB105	2003	3.025	0.342	ng/dry g	4.95
PCB105	2004	3.448	0.293	ng/dry g	4.95
PCB118	1988	51	0.38	ng/dry g	17
PCB118	1989	42.333	0.34	ng/dry g	17
PCB118	1990	53.143	2.4	ng/dry g	17
PCB118	1991	21.397	0.49	ng/dry g	17
PCB118	1992	27.41	2.4	ng/dry g	17
PCB118	1993	19.55	2.6	ng/dry g	17
PCB118	1995	31.057	1.3	ng/dry g	17
PCB118	1997	43.41		ng/dry g	17
PCB118	1999	18.281		ng/dry g	17
PCB118	2002	14.734	0.67	ng/dry g	17
PCB118	2003	11.198	0.259	ng/dry g	17
PCB118	2004	13.497	0.222	ng/dry g	17
PCB128	1988	10.3	1.2	ng/dry g	3.58
PCB128	1989	4.733	0.48	ng/dry g	3.58
PCB128	1990	9.363	1	ng/dry g	3.58
PCB128	1991	5.837	1.1	ng/dry g	3.58
PCB128	1992	3.09	1.2	ng/dry g	3.58
PCB128	1993	2.94	1.9	ng/dry g	3.58
PCB128	1995	4.37	0.62	ng/dry g	3.58
PCB128	1997	10.73		ng/dry g	3.58
PCB128	1999	4.167		ng/dry g	3.58
PCB128	2002	2.829	0.43	ng/dry g	3.58
PCB128	2003	2.08	0.558	ng/dry g	3.58
PCB128	2004	2.148	0.477	ng/dry g	3.58
PCB138	1988	79	0.43	ng/dry g	25.33
PCB138	1989	55	0.45	ng/dry g	25.33
PCB138	1990	75.527	3.7	ng/dry g	25.33
PCB138	1991	32.003	0.63	ng/dry g	25.33
PCB138	1992	37.84	0.65	ng/dry g	25.33
PCB138	1993	23.9	2.1	ng/dry g	25.33
PCB138	1995	33.271	1	ng/dry g	25.33
PCB138	1997	48.73		ng/dry g	25.33
PCB138	1999	28.362		ng/dry g	25.33
PCB138	2002	16.525	0.87	ng/dry g	25.33
PCB138	2003	19.529	0.442	ng/dry g	25.33
PCB138	2004	20.818	0.378	ng/dry g	25.33

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
PCB153/132/168	1988	88.667	0.29	ng/dry g	34.12
PCB153/132/168	1989	70.667	0.58	ng/dry g	34.12
PCB153/132/168	1990	101.767	5.8	ng/dry g	34.12
PCB153/132/168	1991	45.29	0.88	ng/dry g	34.12
PCB153/132/168	1992	60.21	2.1	ng/dry g	34.12
PCB153/132/168	1993	35.34	4.5	ng/dry g	34.12
PCB153/132/168	1995	44.566	2.6	ng/dry g	34.12
PCB153/132/168	1997	60.51		ng/dry g	34.12
PCB153/132/168	1999	33.781		ng/dry g	34.12
PCB153/132/168	2002	33.456	0.67	ng/dry g	34.12
PCB153/132/168	2003	30.108	0.499	ng/dry g	34.12
PCB153/132/168	2004	34.514	0.427	ng/dry g	34.12
PCB170/190	1988	14	0.11	ng/dry g	3.08
PCB170/190	1989	0	0.57	ng/dry g	3.08
PCB170/190	1990	4.637	0.66	ng/dry g	3.08
PCB170/190	1991	8.577	1.4	ng/dry g	3.08
PCB170/190	1992	0.45	0.79	ng/dry g	3.08
PCB170/190	1993	0.85	2.2	ng/dry g	3.08
PCB170/190	1995	5.133	2.4	ng/dry g	3.08
PCB170/190	1997	3.76		ng/dry g	3.08
PCB170/190	1999	0.984		ng/dry g	3.08
PCB170/190	2002	2.036	0.81	ng/dry g	3.08
PCB170/190	2003	2.238	0.333	ng/dry g	3.08
PCB170/190	2004	2.007	0.285	ng/dry g	3.08
PCB18	1988	7.933	0.22	ng/dry g	2.3
PCB18	1989	8.867	0.34	ng/dry g	2.3
PCB18	1990	9.521	1.1	ng/dry g	2.3
PCB18	1991	1.427	2.8	ng/dry g	2.3
PCB18	1992	5.88	1.6	ng/dry g	2.3
PCB18	1993	2.42	2.2	ng/dry g	2.3
PCB18	1995	1.844	1.1	ng/dry g	2.3
PCB18	1997	5.04		ng/dry g	2.3
PCB18	1999	2.479		ng/dry g	2.3
PCB18	2002	3.191	0.52	ng/dry g	2.3
PCB18	2003	0.925	0.452	ng/dry g	2.3
PCB18	2004	1.427	0.387	ng/dry g	2.3
PCB180	1988	18.667	0.08	ng/dry g	7.18
PCB180	1989	10.367	0.7	ng/dry g	7.18
PCB180	1990	12.6	1.6	ng/dry g	7.18
PCB180	1991	11.827	0.46	ng/dry g	7.18
PCB180	1992	0	1.2	ng/dry g	7.18
PCB180	1993	4.17	2.5	ng/dry g	7.18
PCB180	1995	23.344	0.76	ng/dry g	7.18
PCB180	1997	29.63		ng/dry g	7.18
PCB180	1999	21.377		ng/dry g	7.18
PCB180	2002	7.284	0.58	ng/dry g	7.18
PCB180	2003	9.413	0.25	ng/dry g	7.18
PCB180	2004	9.893	0.214	ng/dry g	7.18

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
PCB187	1988	28.333	0.81	ng/dry g	10.6
PCB187	1989	15.333	0.51	ng/dry g	10.6
PCB187	1990	31.137	1.1	ng/dry g	10.6
PCB187	1991	15.44	0.63	ng/dry g	10.6
PCB187	1992	15.29	0.67	ng/dry g	10.6
PCB187	1993	8.82	2.5	ng/dry g	10.6
PCB187	1995	13.552	0.38	ng/dry g	10.6
PCB187	1997	22.72		ng/dry g	10.6
PCB187	1999	13.552		ng/dry g	10.6
PCB187	2002	10.279	0.62	ng/dry g	10.6
PCB187	2003	9.591	0.323	ng/dry g	10.6
PCB187	2004	9.893	0.276	ng/dry g	10.6
PCB195/208	1988	0	0.09	ng/dry g	0.38
PCB195/208	1989	0	0.53	ng/dry g	0.38
PCB195/208	1990	0.532	0.44	ng/dry g	0.38
PCB195/208	1991	0.497	1.5	ng/dry g	0.38
PCB195/208	1992	0	0.49	ng/dry g	0.38
PCB195/208	1993	0	1.7	ng/dry g	0.38
PCB195/208	1995	0.528	0.82	ng/dry g	0.38
PCB195/208	1997	0.54		ng/dry g	0.38
PCB195/208	1999	0.402		ng/dry g	0.38
PCB195/208	2002	0.331	0.33	ng/dry g	0.38
PCB195/208	2003	0	0.276	ng/dry g	0.38
PCB195/208	2004	0	0.236	ng/dry g	0.38
PCB206	1988	0	0.08	ng/dry g	0.21
PCB206	1989	0	0.49	ng/dry g	0.21
PCB206	1990	0.492	0.88	ng/dry g	0.21
PCB206	1991	0	0.94	ng/dry g	0.21
PCB206	1992	0	0.68	ng/dry g	0.21
PCB206	1993	0	1.6	ng/dry g	0.21
PCB206	1995	0.633	0.48	ng/dry g	0.21
PCB206	1997	0		ng/dry g	0.21
PCB206	1999	0		ng/dry g	0.21
PCB206	2002	0.075	0.31	ng/dry g	0.21
PCB206	2003	0.242	0.3	ng/dry g	0.21
PCB206	2004	0.198	0.256	ng/dry g	0.21
PCB209	1988	0	0.06	ng/dry g	0.6
PCB209	1989	0	0.69	ng/dry g	0.6
PCB209	1990	1.04	0.88	ng/dry g	0.6
PCB209	1991	0	2.8	ng/dry g	0.6
PCB209	1992	0	0.69	ng/dry g	0.6
PCB209	1993	0	1.9	ng/dry g	0.6
PCB209	1995	0.668	1.1	ng/dry g	0.6
PCB209	1997	3.31		ng/dry g	0.6
PCB209	1999	0.225		ng/dry g	0.6
PCB209	2002	0	0.36	ng/dry g	0.6
PCB209	2003	0.273	0.252	ng/dry g	0.6
PCB209	2004	0	0.216	ng/dry g	0.6

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
PCB28	1988	11.333	0.42	ng/dry g	3.66
PCB28	1989	25	0.38	ng/dry g	3.66
PCB28	1990	19.41	0.92	ng/dry g	3.66
PCB28	1991	9.34	1.1	ng/dry g	3.66
PCB28	1992	9.28	0.8	ng/dry g	3.66
PCB28	1993	5.27	1.8	ng/dry g	3.66
PCB28	1995	6.146	0.75	ng/dry g	3.66
PCB28	1997	9.54		ng/dry g	3.66
PCB28	1999	5.1		ng/dry g	3.66
PCB28	2002	6.818	0.45	ng/dry g	3.66
PCB28	2003	2.5	0.221	ng/dry g	3.66
PCB28	2004	3.943	0.19	ng/dry g	3.66
PCB44	1988	21	0.25	ng/dry g	5.23
PCB44	1989	15.667	0.42	ng/dry g	5.23
PCB44	1990	28	2	ng/dry g	5.23
PCB44	1991	6.587	1	ng/dry g	5.23
PCB44	1992	16.13	1.2	ng/dry g	5.23
PCB44	1993	8.15	1.4	ng/dry g	5.23
PCB44	1995	10.343	0.62	ng/dry g	5.23
PCB44	1997	14.87		ng/dry g	5.23
PCB44	1999	6.817		ng/dry g	5.23
PCB44	2002	8.91	0.35	ng/dry g	5.23
PCB44	2003	4.685	0.415	ng/dry g	5.23
PCB44	2004	5.95	0.356	ng/dry g	5.23
PCB52	1988	38	0.17	ng/dry g	10.12
PCB52	1989	34.333	0.6	ng/dry g	10.12
PCB52	1990	49.153	1.4	ng/dry g	10.12
PCB52	1991	13.783	1.7	ng/dry g	10.12
PCB52	1992	25.02	1.4	ng/dry g	10.12
PCB52	1993	12.72	1.8	ng/dry g	10.12
PCB52	1995	22.529	1	ng/dry g	10.12
PCB52	1997	28.64		ng/dry g	10.12
PCB52	1999	16.316		ng/dry g	10.12
PCB52	2002	14.282	0.48	ng/dry g	10.12
PCB52	2003	14.392	0.246	ng/dry g	10.12
PCB52	2004	9.978	0.21	ng/dry g	10.12
PCB66	1988	57	0.43	ng/dry g	6.43
PCB66	1989	35.667	0.46	ng/dry g	6.43
PCB66	1990	38.993	1.7	ng/dry g	6.43
PCB66	1991	12.75	0.61	ng/dry g	6.43
PCB66	1992	20.13	0.97	ng/dry g	6.43
PCB66	1993	8.01	3.3	ng/dry g	6.43
PCB66	1995	13.571	0.65	ng/dry g	6.43
PCB66	1997	17.41		ng/dry g	6.43
PCB66	1999	8.458		ng/dry g	6.43
PCB66	2002	9.105	0.43	ng/dry g	6.43
PCB66	2003	5.074	0.35	ng/dry g	6.43
PCB66	2004	5.922	0.3	ng/dry g	6.43

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
PCB8/5	1988	0	0.6	ng/dry g	2.17
PCB8/5	1989	3.567	0.41	ng/dry g	2.17
PCB8/5	1990	7.857	0.99	ng/dry g	2.17
PCB8/5	1991	2.02	4	ng/dry g	2.17
PCB8/5	1992	0	2.8	ng/dry g	2.17
PCB8/5	1993	0	3.9	ng/dry g	2.17
PCB8/5	1995	0	1.4	ng/dry g	2.17
PCB8/5	1997	3.68		ng/dry g	2.17
PCB8/5	1999	5.518		ng/dry g	2.17
PCB8/5	2002	0	0.39	ng/dry g	2.17
PCB8/5	2003	0	0.372	ng/dry g	2.17
PCB8/5	2004	0	0.318	ng/dry g	2.17
Pentachloroanisole	1995	1.403		ng/dry g	2.01
Pentachloroanisole	1997	3.05		ng/dry g	2.01
Pentachloroanisole	1999	1.724		ng/dry g	2.01
Pentachloroanisole	2002	0.813	0.28	ng/dry g	2.01
Pentachloroanisole	2003	0.861	0.19	ng/dry g	2.01
Pentachloroanisole	2004	0.919	0.162	ng/dry g	2.01
Pentachlorobenzene	1995	3.765		ng/dry g	0.94
Pentachlorobenzene	1997	2.22		ng/dry g	0.94
Pentachlorobenzene	1999	0		ng/dry g	0.94
Pentachlorobenzene	2002	0.677	0.26	ng/dry g	0.94
Pentachlorobenzene	2003	0	0.224	ng/dry g	0.94
Pentachlorobenzene	2004	0	0.192	ng/dry g	0.94
Pentachlorobiphenyls	1986	423.333	0.5	ng/dry g	245.33
Pentachlorobiphenyls	1987	110.333	0.5	ng/dry g	245.33
Percent lipid dry weight	1986	5.467		Percent	10.33
Percent lipid dry weight	1987	4.067		Percent	10.33
Percent lipid dry weight	1988	8		Percent	10.33
Percent lipid dry weight	1989	8.667		Percent	10.33
Percent lipid dry weight	1990	9.333		Percent	10.33
Percent lipid dry weight	1991	17.457		Percent	10.33
Percent lipid dry weight	1992	7.47		Percent	10.33
Percent lipid dry weight	1993	7.56		Percent	10.33
Percent lipid dry weight	1995	3.632		Percent	10.33
Percent lipid dry weight	1997	5.7		Percent	10.33
Percent lipid dry weight	1999	8.882		Percent	10.33
Percent lipid dry weight	2002	5.39		Percent	10.33
Percent lipid dry weight	2003	6.77		Percent	10.33
Percent lipid dry weight	2004	0		ng/dry g	10.33
Perylene	1989	13	2.2	ng/dry g	13.32
Perylene	1990	23.54	11	ng/dry g	13.32
Perylene	1991	25.757	5.5	ng/dry g	13.32
Perylene	1992	20.98	5.1	ng/dry g	13.32
Perylene	1993	19.78	6.7	ng/dry g	13.32
Perylene	1995	16.62	10.1	ng/dry g	13.32
Perylene	1997	27.9		ng/dry g	13.32
Perylene	1999	14.56		ng/dry g	13.32
Perylene	2002	14.4	2	ng/dry g	13.32
Perylene	2003	15.2	5.51	ng/dry g	13.32
Perylene	2004	12.1	4.513	ng/dry g	13.32

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Phenanthrene	1989	80.667	5.2	ng/dry g	57.8
Phenanthrene	1990	205.813	24	ng/dry g	57.8
Phenanthrene	1991	358.347	5.1	ng/dry g	57.8
Phenanthrene	1992	169.32	7.1	ng/dry g	57.8
Phenanthrene	1993	132.79	5.5	ng/dry g	57.8
Phenanthrene	1995	100.75	6.6	ng/dry g	57.8
Phenanthrene	1997	88.7		ng/dry g	57.8
Phenanthrene	1999	575.95		ng/dry g	57.8
Phenanthrene	2002	103	1.5	ng/dry g	57.8
Phenanthrene	2003	176	3.736	ng/dry g	57.8
Phenanthrene	2004	35.9	3.061	ng/dry g	57.8
Pyrene	1989	413.333	8	ng/dry g	122.38
Pyrene	1990	578.66	20	ng/dry g	122.38
Pyrene	1991	700.3	6	ng/dry g	122.38
Pyrene	1992	505.14	6.8	ng/dry g	122.38
Pyrene	1993	374.67	5.2	ng/dry g	122.38
Pyrene	1995	318.93	5.6	ng/dry g	122.38
Pyrene	1997	320.4		ng/dry g	122.38
Pyrene	1999	659.48		ng/dry g	122.38
Pyrene	2002	179	1.4	ng/dry g	122.38
Pyrene	2003	310	5.88	ng/dry g	122.38
Pyrene	2004	148	4.817	ng/dry g	122.38
Selenium	1986	2.267	0.58	µg/dry g	3.86
Selenium	1987	1.967	0.58	µg/dry g	3.86
Selenium	1988	1.7	1	µg/dry g	3.86
Selenium	1989	1.7	1	µg/dry g	3.86
Selenium	1990	2.44	0.5	µg/dry g	3.86
Selenium	1991	1.8	0.77	µg/dry g	3.86
Selenium	1992	2.96	0.61	µg/dry g	3.86
Selenium	1993	2.56	1	µg/dry g	3.86
Selenium	1995	3.818		µg/dry g	3.86
Selenium	1997	2.58		µg/dry g	3.86
Selenium	1999	2.11		µg/dry g	3.86
Selenium	2002	2.26	0.049	µg/dry g	3.86
Selenium	2003	3.24	0.03	µg/dry g	3.86
Selenium	2004	3.43	0.049	µg/dry g	3.86
Silicon	1986	0	600	µg/dry g	3000
Silicon	1987	613.333	600	µg/dry g	3000
Silicon	1990	2966.667	110	µg/dry g	3000
Silicon	1991	400	5000	µg/dry g	3000
Silicon	1992	2400	400	µg/dry g	3000
Silicon	1993	8100		µg/dry g	3000

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Silver	1986	0.323	0.12	µg/dry g	3.7
Silver	1987	0.397	0.12	µg/dry g	3.7
Silver	1988	0.251	0.01	µg/dry g	3.7
Silver	1989	0.193	0.03	µg/dry g	3.7
Silver	1990	0.209	0.01	µg/dry g	3.7
Silver	1991	0.211	0.09	µg/dry g	3.7
Silver	1992	0.372	0.3	µg/dry g	3.7
Silver	1993	0.284	0.14	µg/dry g	3.7
Silver	1995	0.564	0.1	µg/dry g	3.7
Silver	1997	0		µg/dry g	3.7
Silver	1999	0.056		µg/dry g	3.7
Silver	2002	0.817	0.043	µg/dry g	3.7
Silver	2003	0.278	0.05	µg/dry g	3.7
Silver	2004	0.256	0.043	µg/dry g	3.7
Tetrabutyltin	1995	3.052		ng/dry g	0.11
Tetrabutyltin	1997	0		ng/dry g	0.11
Tetrabutyltin	2004	0	3.753	ng/dry g	0.11
Tetrachlorobiphenyls	1986	186.667	0.6	ng/dry g	135.33
Tetrachlorobiphenyls	1987	115.667	0.6	ng/dry g	135.33
Thallium	1986	0	0.05	µg/dry g	0
Thallium	1987	0	0.05	µg/dry g	0
Tin	1986	0.203	0.5	µg/dry g	0.35
Tin	1987	0.34	0.5	µg/dry g	0.35
Tin	1988	0.403	0.04	µg/dry g	0.35
Tin	1989	0.203	0.005	µg/dry g	0.35
Tin	1990	0.4	0.01	µg/dry g	0.35
Tin	1991	0.83	0.55	µg/dry g	0.35
Tin	1992	0.17	0.74	µg/dry g	0.35
Tin	1993	0.26	0.35	µg/dry g	0.35
Tin	1995	0.573	0.14	µg/dry g	0.35
Tin	1997	0.53		µg/dry g	0.35
Tin	1999	0.603		µg/dry g	0.35
Tin	2002	0.203	0.087	µg/dry g	0.35
Tin	2003	1.04	0.13	µg/dry g	0.35
Tin	2004	0.639	0.087	µg/dry g	0.35
Total butyltins	1989	188.58		ng/dry g	151.96
Total butyltins	1990	226.1		ng/dry g	151.96
Total butyltins	1991	0		ng/dry g	151.96
Total butyltins	1992	85.18		ng/dry g	151.96
Total butyltins	1993	31.68		ng/dry g	151.96
Total butyltins	1995	66.336		ng/dry g	151.96
Total butyltins	1997	74		ng/dry g	151.96
Total butyltins	1999	68.79		ng/dry g	151.96
Total butyltins	2002	33.474		ng/dry g	151.96
Total butyltins	2003	39.47		ng/dry g	151.96
Total butyltins	2004	49.82		ng/dry g	151.96

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Total chlordanes	1986	79.967		ng/dry g	22.5
Total chlordanes	1987	62.834		ng/dry g	22.5
Total chlordanes	1988	70.667		ng/dry g	22.5
Total chlordanes	1989	52.3		ng/dry g	22.5
Total chlordanes	1990	69.32		ng/dry g	22.5
Total chlordanes	1991	28.987		ng/dry g	22.5
Total chlordanes	1992	27.69		ng/dry g	22.5
Total chlordanes	1993	123.17		ng/dry g	22.5
Total chlordanes	1995	15.628		ng/dry g	22.5
Total chlordanes	1997	20.78		ng/dry g	22.5
Total chlordanes	1999	14.711		ng/dry g	22.5
Total chlordanes	2002	9.723		ng/dry g	22.5
Total chlordanes	2003	6.776		ng/dry g	22.5
Total chlordanes	2004	8.55		ng/dry g	22.5
Total DDT	1986	173.667		ng/dry g	88.66
Total DDT	1987	127.833		ng/dry g	88.66
Total DDT	1988	253.234		ng/dry g	88.66
Total DDT	1989	123.634		ng/dry g	88.66
Total DDT	1990	172.534		ng/dry g	88.66
Total DDT	1991	67.204		ng/dry g	88.66
Total DDT	1992	74.46		ng/dry g	88.66
Total DDT	1993	91.9		ng/dry g	88.66
Total DDT	1995	60.515		ng/dry g	88.66
Total DDT	1997	109.58		ng/dry g	88.66
Total DDT	1999	43.746		ng/dry g	88.66
Total DDT	2002	34.739		ng/dry g	88.66
Total DDT	2003	28.259		ng/dry g	88.66
Total DDT	2004	31.333		ng/dry g	88.66
Total dieldrin	1986	31.5		ng/dry g	10.18
Total dieldrin	1987	13.957		ng/dry g	10.18
Total dieldrin	1988	0		ng/dry g	10.18
Total dieldrin	1989	0		ng/dry g	10.18
Total dieldrin	1990	0		ng/dry g	10.18
Total dieldrin	1991	24.463		ng/dry g	10.18
Total dieldrin	1992	48.01		ng/dry g	10.18
Total dieldrin	1993	16.18		ng/dry g	10.18
Total dieldrin	1995	7.874		ng/dry g	10.18
Total dieldrin	1997	9.17		ng/dry g	10.18
Total dieldrin	1999	3.815		ng/dry g	10.18
Total dieldrin	2002	4.259		ng/dry g	10.18
Total dieldrin	2003	2.111		ng/dry g	10.18
Total dieldrin	2004	2.714		ng/dry g	10.18
Total PAH	1989	1522.033		ng/dry g	783
Total PAH	1990	2611.598		ng/dry g	783
Total PAH	1991	3203.821		ng/dry g	783
Total PAH	1992	2211.72		ng/dry g	783
Total PAH	1993	1717.04		ng/dry g	783
Total PAH	1995	1502.22		ng/dry g	783
Total PAH	1997	1526.4		ng/dry g	783
Total PAH	1999	3306.34		ng/dry g	783
Total PAH	2002	819.2		ng/dry g	783

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Total PAHhmw (4 or more rings)	1989	1227.333		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1990	1974.4		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1991	2506.671		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1992	1759.47		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1993	1375.46		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1995	1273.36		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1997	1216.1		ng/dry g	532.5
Total PAHhmw (4 or more rings)	1999	2174		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2002	610.2		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2003	1169.5		ng/dry g	532.5
Total PAHhmw (4 or more rings)	2004	827.3		ng/dry g	532.5
Total PAHlmw (2-3 rings)	1989	294.7		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1990	637.198		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1991	697.15		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1992	452.25		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1993	341.58		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1995	228.86		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1997	310.3		ng/dry g	234.8
Total PAHlmw (2-3 rings)	1999	1132.34		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2002	209		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2003	408.8		ng/dry g	234.8
Total PAHlmw (2-3 rings)	2004	169.7		ng/dry g	234.8
Total PCBcg	1988	933.132		ng/dry g	324.86
Total PCBcg	1989	734.402		ng/dry g	324.86
Total PCBcg	1990	1048.398		ng/dry g	324.86
Total PCBcg	1991	438.924		ng/dry g	324.86
Total PCBcg	1992	530.12		ng/dry g	324.86
Total PCBcg	1993	332.48		ng/dry g	324.86
Total PCBcg	1995	490.01		ng/dry g	324.86
Total PCBcg	1997	720.88		ng/dry g	324.86
Total PCBcg	1999	384.614		ng/dry g	324.86
Total PCBcg	2002	297.666		ng/dry g	324.86
Trans-Nonachlor	1986	33.667	0.75	ng/dry g	9.68
Trans-Nonachlor	1987	22.667	0.34	ng/dry g	9.68
Trans-Nonachlor	1988	33	0.22	ng/dry g	9.68
Trans-Nonachlor	1989	22.667	0.39	ng/dry g	9.68
Trans-Nonachlor	1990	31.587	0.99	ng/dry g	9.68
Trans-Nonachlor	1991	14.11	0.47	ng/dry g	9.68
Trans-Nonachlor	1992	13.36	1	ng/dry g	9.68
Trans-Nonachlor	1993	40.48	2.2	ng/dry g	9.68
Trans-Nonachlor	1995	7.469	0.25	ng/dry g	9.68
Trans-Nonachlor	1997	10.38		ng/dry g	9.68
Trans-Nonachlor	1999	8.044		ng/dry g	9.68
Trans-Nonachlor	2002	3.582	0.22	ng/dry g	9.68
Trans-Nonachlor	2003	2.826	0.225	ng/dry g	9.68
Trans-Nonachlor	2004	3.392	0.193	ng/dry g	9.68

Table 19. Analyte Concentration in Tissue from HRJB in All Years, Target Species: *Mytilus edulis.* (NOAA 2006) (Continued)

Tissue					
ANALYTE NAME	**YEAR**	**CONCENTRATION**	**DETECTION LIMIT**	**UNITS**	**85TH PERCENTILE**
Tributyltin	1989	104.02		ng/dry g	110
Tributyltin	1990	151.23		ng/dry g	110
Tributyltin	1991	0		ng/dry g	110
Tributyltin	1992	54.24		ng/dry g	110
Tributyltin	1993	0	19	ng/dry g	110
Tributyltin	1995	66.336		ng/dry g	110
Tributyltin	1997	63.2		ng/dry g	110
Tributyltin	1999	50.43		ng/dry g	110
Tributyltin	2002	23.91	4.83	ng/dry g	110
Tributyltin	2003	31.67	4.616	ng/dry g	110
Tributyltin	2004	34.23	3.921	ng/dry g	110
Trichlorobiphenyls	1986	32.667	0.6	ng/dry g	33
Trichlorobiphenyls	1987	37.333	0.6	ng/dry g	33
Zinc	1986	84.333	2	µg/dry g	2980
Zinc	1987	133.333	2	µg/dry g	2980
Zinc	1988	133.333	5	µg/dry g	2980
Zinc	1989	120	5	µg/dry g	2980
Zinc	1990	160	1	µg/dry g	2980
Zinc	1991	143.333	37	µg/dry g	2980
Zinc	1992	140	27	µg/dry g	2980
Zinc	1993	120	39	µg/dry g	2980
Zinc	1995	133.774	6.5	µg/dry g	2980
Zinc	1997	160		µg/dry g	2980
Zinc	1999	131		µg/dry g	2980
Zinc	2002	106	0.501	µg/dry g	2980
Zinc	2003	135	1.18	µg/dry g	2980
Zinc	2004	131	0.501	µg/dry g	2980

PERCENTILE 85th: 85 percentile based on all sites and all years in the Mussel Watch database by matrix (sediment or tissue).

Mussels and oysters accumulate copper (Cu), zinc (Zn), and lead (Pb) differently. For example in the early 1990s, oysters collected from Long Island Sound, NY had Cu and Zn concentrations ten- times higher than mussels, while lead levels were three-times higher in mussels relative to oysters.

Reference : O'Connor, T. P. and Beliaeff, B. 1995. Recent trends in coastal environmental quality: Results from the Mussel Watch Project. NOAA, National Status and Trends Program, Silver Spring, MD. 40pp.

Table 20. Analyte Concentration in Sediment from HRJB in 1986. (NOAA 2006)

Sediment				
ANALYTE NAME	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
2,4'-DDD	0	0.2	ng/dry g	1.36
2,4'-DDE	0	0.14	ng/dry g	0.4
2,4'-DDT	0	0.23	ng/dry g	0.23
4,4'-DDD	12.555	0.49	ng/dry g	4.18
4,4'-DDE	10.45	0.16	ng/dry g	4.1
4,4'-DDT	4.21	0.08	ng/dry g	1.73
Aldrin	0.665	0.16	ng/dry g	0.23
Alpha-Chlordane	4.66	0.08	ng/dry g	0.91
Aluminum	40500	5000	µg/dry g	70000
Antimony	2.15	0.8	µg/dry g	1.23
Arsenic	***9.75***	1.7	µg/dry g	13
Cadmium	***0.78***	0.08	µg/dry g	0.53
Chromium	***80.5***	6	µg/dry g	109.33
Clay	13.3		Percent	38.67
Copper	***50.4***	3	µg/dry g	43.8
Dichlorobiphenyls	10.95	0.62	ng/dry g	1.27
Dieldrin	***3.79***	0.16	ng/dry g	0.99
Fines	0.32		Decimal	0.86
Gamma-Hexachlorocyclohexane	1.295	0.14	ng/dry g	0.3
Gravel	0.11		Percent	3.23
Heptachlor	0.386	0.14	ng/dry g	0.11
Heptachlor-Epoxide	0.51	0.16	ng/dry g	0.17
Heptachlorobiphenyls	28.65	0.14	ng/dry g	12.5
Hexachlorobenzene	0.735	0.14	ng/dry g	0.57
Hexachlorobiphenyls	38.45	0.42	ng/dry g	24
Iron	17500	6	µg/dry g	37400
Lead	***69***	3	µg/dry g	37.67
Manganese	520	6	µg/dry g	750
Mercury	***0.694***	0.01	µg/dry g	0.2
Mirex	1.5	0.2	ng/dry g	0.22
Nickel	***18.8***	4	µg/dry g	37
Nonachlorobiphenyls	1.25	0.31	ng/dry g	1.6
Octachlorobiphenyls	6.335	0.14	ng/dry g	4.43
Pentachlorobiphenyls	59.25	0.14	ng/dry g	26.6
Sand	68		Percent	86.77
Selenium	0.45	0.13	µg/dry g	0.73
Silicon	340000	4000	µg/dry g	376666.67
Silt	18.75		Percent	49.96
Silver	***1.76***	0.02	µg/dry g	0.48
Tetrachlorobiphenyls	68.35	0.16	ng/dry g	19.33

Table 20. Analyte Concentration in Sediment from HRJB in 1986. (NOAA 2006) (Continued)

Sediment				
ANALYTE NAME	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Thallium	0.275	0.2	µg/dry g	0.51
Tin	8.345	1	µg/dry g	3
Total chlordanes	8.151		ng/dry g	1.94
Total DDT	***27.215***		ng/dry g	15.17
Total dieldrin	4.455		ng/dry g	1.4
Total Inorganic Carbon	0.08		Percent	1.03
Total Organic Carbon	1.21		Percent	2.6
Trans-Nonachlor	2.595	0.2	ng/dry g	0.63
Trichlorobiphenyls	19.3	0.16	ng/dry g	6.03
Zinc	110.5	2	µg/dry g	126

Blue: Concentration is above the TEL- Threshold Effect Levels (NOAA SQuiRT)
Pink: Concentration is above both the ERL and TEL (NOAA SQuiRT)

PERCENTILE 85th: 85 percentile based on all sites and all years in the Mussel Watch database by matrix (sediment or tissue).

Table 21. Sand, Silt, and TOC Concentration from HRJB in 1986. (NOAA 2006)

Sediment					
ANALYTE NAME	YEAR	CONCENTRATION	DETECTION LIMIT	UNITS	85TH PERCENTILE
Sand	1986	68		Percent	86.77
Silt	1986	18.75		Percent	49.96
Total Inorganic Carbon	1986	0.08		Percent	1.03

PERCENTILE 85th: 85 percentile based on all sites and all years in the Mussel Watch database by matrix (sediment or tissue).

Table 22. HRJB Site Specific BAF for 1986.

ANALYTE NAME	Concentration		Units	SBAF
	Sediment	Tissue		
2,4'-DDD	0	51.333	ng/dry g	0.000
2,4'-DDE	0	33.667	ng/dry g	0.000
2,4'-DDT	0	9.233	ng/dry g	0.000
4,4'-DDD	12.555	33.667	ng/dry g	2.682
4,4'-DDE	10.45	35	ng/dry g	3.349
4,4'-DDT	4.21	10.767	ng/dry g	2.557
Aldrin	0.665	7.5	ng/dry g	11.278
Alpha-Chlordane	4.66	39	ng/dry g	8.369
Aluminum	40500	19.667	µg/dry g	0.000
Antimony	2.15	0	µg/dry g	0.000
Arsenic	9.75	8.4	µg/dry g	0.862
Cadmium	0.78	2.2	µg/dry g	2.821
Chromium	80.5	1.02	µg/dry g	0.013
Copper	50.4	10	µg/dry g	0.198
Dichlorobiphenyls	10.95	2.467	ng/dry g	0.225
Dieldrin	3.79	24	ng/dry g	6.332
Gamma-Hexachlorocyclohexane	1.295	2.267	ng/dry g	1.751
Heptachlor	0.386	2.9	ng/dry g	7.513
Heptachlor-Epoxide	0.51	4.4	ng/dry g	8.627
Heptachlorobiphenyls	28.65	73.667	ng/dry g	2.571
Hexachlorobenzene	0.735	0	ng/dry g	0.000
Hexachlorobiphenyls	38.45	266.667	ng/dry g	6.935
Iron	17500	116.667	µg/dry g	0.007
Lead	69	3.133	µg/dry g	0.045
Manganese	520	14	µg/dry g	0.027
Mercury	0.694	0.21	µg/dry g	0.303
Mirex	1.5	3.4	ng/dry g	2.267
Nickel	18.8	1.2	µg/dry g	0.064
Nonachlorobiphenyls	1.25	0	ng/dry g	0.000
Octachlorobiphenyls	6.335	8.333	ng/dry g	1.315
Pentachlorobiphenyls	59.25	423.333	ng/dry g	7.145
Selenium	0.45	2.267	µg/dry g	5.038
Silicon	340000	0	µg/dry g	0.000
Silver	1.76	0.323	µg/dry g	0.184
Tetrachlorobiphenyls	68.35	186.667	ng/dry g	2.731
Thallium	0.275	0	µg/dry g	0.000
Tin	8.345	0.203	µg/dry g	0.024
Total chlordanes	8.151	79.967	ng/dry g	9.811
Total DDT	27.215	173.667	ng/dry g	6.381
Total dieldrin	4.455	31.5	ng/dry g	7.071
Total Inorganic Carbon	0.08		Percent	0.080
Total Organic Carbon	1.21		Percent	1.210
Trans-Nonachlor	2.595	33.667	ng/dry g	12.974
Trichlorobiphenyls	19.3	32.667	ng/dry g	1.693
Zinc	110.5	84.333	µg/dry g	0.763

BAF = Tissue/Sediment

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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