NEW YORK/NEW JERSEY HARBOR ESTUARY PROGRAM

MODULE 3.1: TOXICS CHARACTERIZATION REPORT

1990 - 20 Sample - Seabirds / Dredge cores
1991 - 30 Cods - Radio / Fish kills
1992 - 20 Cods - Radio / Brooke bank

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July, 1991
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INTRODUCTION

Since the early 1800's and the beginnings of the Industrial Revolution in America, the NY/NJ metropolitan area has been a major center of industrial activity and has supported one of the largest populations in the United States. Thus, it is not surprising that the NY/NJ Harbor Estuary surrounded by this metropolitan area has become one of the most chemically polluted estuaries in the nation (NOAA, 1988; Breteler, 1984; Segar and Davis, 1984). Sediments from sites within our Estuary rank within the top twenty out of 175 coastal and estuarine sites throughout the country in their concentrations of silver, arsenic, cadmium, chromium, copper, mercury, lead, antimony, tin, zinc, chlorinated pesticides, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) (NOAA, 1988).

This report represents a first step in an assessment of the impact of these toxic chemicals on the living resources of the NY/NJ Harbor Estuary (referred to as The Estuary). It provides 1) a summary of existing data for The Estuary, 2) an evaluation of potential impacts of chemicals in the system on marine biota and on human health due to the ingestion of fish and shellfish from The Estuary and 3) an identification of data that are needed for a better assessment of existing problems due to toxics in The Estuary.

The first section of this report presents a preliminary list of Toxics of Concern for The Estuary derived using a toxics categorization scheme developed by the Lake Ontario Toxics Management Plan (Lake Ontario Toxics Committee, 1989). The categorization of each chemical is based on a comparison of its ambient concentration in water or biota with federal and state marine water quality or fish tissue standards which have been established for the protection of marine life and human health.
The second section summarizes available sediment toxics data for The Estuary. Toxicant concentrations in sediments in different regions of The Estuary are presented for use in identifying possible sources of toxicants and to provide an understanding of the size of the sediment-bound pools of toxic chemicals in the system which themselves serve as a source of toxics to the water column and biota of The Estuary. A list of Toxics of Concern is also presented for sediment-bound toxics based on NOAA Effects Values (NOAA, 1990) used to assess the potential biological toxicity of sediment toxics.

Description of the Project Area

The drainage basin of the NY/NJ Harbor Estuary (primarily the Hudson and Raritan Rivers) covers about 16,300 square miles and includes much of eastern New York, most of northern New Jersey, and small portions of western Connecticut, Massachusetts, and Vermont (Rod et al., 1989). Within this basin, toxics enter the system through atmospheric deposition, municipal and industrial wastewater discharges, urban runoff, landfill leachates and accidental spills. Mueller and coworkers (1982) have estimated that 40-60 percent of the heavy metal loads to The Estuary come from wastewater discharges, with 20-40 percent coming from tributaries and 10-30 percent from urban runoff. Wastewater inputs are also the most significant source for most toxic organics entering The Estuary; however, accidental spills and urban runoff are important for certain chemicals (Mueller et al., 1982). More recent estimates of chemical inputs for The Estuary have been developed in coordination with this project as part of Module 7.1 of the NY/NJ Harbor Estuary Program (St. John et al., 1991).

The New York/New Jersey Harbor Estuary, as it is defined for this project, encompasses most of the Hudson-Raritan Estuary system (Figure 1). The area extends from Piermont Marsh on the Hudson River (River Mile 27) southward to
the Rockaway Transect (a line extending from Sandy Hook, NJ to Rockaway Point, NY). This transect separates the Estuary from the New York Bight for the purpose of the Estuary program. A toxics characterization for the Bight itself has been prepared by the New York Bight Restoration Plan (NYBRP) Toxics Inputs, Fate and Effects Work Group (1990). The Estuary area also includes the Raritan, Hackensack, and Passaic Rivers (to the Head of Tide); the Harlem River; the East River to the Throgs Neck Bridge; the Navesink and Shrewsbury Rivers in New Jersey; the Arthur Kill and Jamaica Bay.

The Harbor Estuary receives most (approximately 87%) of its freshwater input from the Hudson River (Mueller et al., 1982) which empties into the Upper Bay region of the Harbor at the southern tip of Manhattan Island. The tide of the Hudson River extends to the Federal Dam in Troy, NY, with the salt front generally extending to the Haverstraw Bay area (approximately 60 miles north of Manhattan Island); although during periods of low flow it intrudes as far north as Newburgh, NY (98 miles north of Manhattan Island) (Berg and Levinton, 1985). The Harlem River extends from the Hudson River at the northern end of Manhattan Island to the East River at Wards Island. The East River connects the Upper Bay with the Long Island Sound at its eastern end.

The lower portion of the Estuary consists of the Lower, Raritan, and Sandy Hook Bays which receive water from the Upper Bay, the Raritan River, and the New York Bight across the Rockaway Transect. The bay areas are shallow (averaging 6.7 m in depth in Raritan Bay and 8.5 m in the Lower Bay), and current patterns are complex due to the mixing of freshwater and saltwater inputs (Berg and Levinton, 1985).

The Arthur Kill, a tidal waterway about 21 km long and 0.8 km wide separating Staten Island from New Jersey, empties into Raritan Bay at its southern end. On the north, the Arthur Kill joins Newark Bay; however, water
from Newark Bay generally flows into the Upper Bay through the Kill Van Kull. (Berg and Levinton, 1985).

Jamaica Bay, located at the southwestern end of Long Island, NY, is a circular embayment consisting of low-lying islands and salt marshes. Tidal currents enter Jamaica Bay from the Lower Bay through Rockaway Inlet, a narrow channel approximately 1 km wide at its narrowest point (Franz and Harris, 1984).

Data Collection and Quality Assessment

The first task in this project was the identification and collection of existing ambient toxics data sets for The Estuary from 1970 to the present. Methodology and quality control information collected with each of the data sets was then used to provide an assessment of the reliability of the data prior to its use in the toxics categorizations which follow.

The quality assessment evaluation scheme used for this analysis is outlined in Table 1. The type and amount of quality assurance/quality control (QA/QC) information available for each of the studies generally fell into one of the four categories presented in Table 1. In most cases, the methods used to collect the samples were briefly described, and the analytical methods used were simply cited as published techniques. If the procedures used in the study are no longer considered acceptable, a QA/QC rating of Poor was given to the data. As long as the techniques described in the studies were standard techniques that are still considered acceptable, a QA/QC rating of Fair was awarded. If additional information was provided regarding procedures used to prevent sample contamination and to assure the precision and accuracy of the analytical methods, the data were given a rating of Good. A rating of Very Good was given to the data if complete QA/QC protocols were available for the studies.
<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
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<tr>
<td>Poor</td>
<td>Methods used for sample collection or analysis are no longer acceptable.</td>
</tr>
<tr>
<td>Fair</td>
<td>Data were collected using standard, still presently acceptable techniques; however insufficient QA/QC information was available to adequately assess the quality of the data.</td>
</tr>
<tr>
<td>Good</td>
<td>In addition to general information on the methodology used, specific QA/QC procedures used to assure the quality of the data were outlined, i.e.: 1) procedures used to prevent sample contamination during collection, transport, storage and analysis (e.g. decontamination of sampling equipment and bottles prior to use, etc.) and 2) procedures used to determine the precision and accuracy of the analytical techniques employed (e.g. the use of reference standards or interlaboratory comparisons, results of duplicate analyses, detection limits, etc.).</td>
</tr>
<tr>
<td>Very good</td>
<td>Full QA/QC documentation was available outlining the quality control programs in effect throughout the study.</td>
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The data sets assembled in this project are identified in Tables 2-4 together with their QA/QC ratings, a summary of the areas surveyed, and a list of the chemicals measured in each study. As one would expect, the best QA/QC programs were in effect for the most recently acquired data. Considerable attention has been given to quality control in the collection of environmental data in recent years, and the effort has significantly improved our confidence in using and comparing data from different studies and different laboratories. It is important to point out that a fair rating given to data in this project does not indicate that the data are not good; rather, it signifies that insufficient evidence is available to adequately judge the accuracy and precision of the data. Thus, conclusions drawn in this project based on these data need to be verified in future monitoring programs.

With two exceptions, all of the data from the studies listed in Tables 2-4 were used in the toxics categorizations and sediments evaluations which follow. Mercury water column concentration data were not used from any study except Battelle (1988). All other data were deemed unreliable due to recent evidence indicating that sample contamination is a primary problem in measuring mercury water column concentrations unless strict "trace-metal-clean" techniques are employed (Fitzgerald and Wetras, 1989). PCB and chlorinated pesticide sediment concentration data published by Bopp and co-worker's were also not used in the calculation of average sediment concentrations in the Estuary due to the difficulty of extrapolating from core slice data to concentrations representative of a grab sample from the same region. Bopp's work is discussed, however, with respect to the excellent temporal information it provides on the association of toxicants with sediments.

Although at first glance, these historical data sets appear to provide good coverage of the Estuary, they are limited in a number of ways. Some
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<td>ISC (1989)</td>
<td>Total metals</td>
<td>Jamaica Bay</td>
<td>1989</td>
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<td>Luther et al. (1986)</td>
<td>Dissolved metals</td>
<td>Passaic River, Arthur Kill, Kill van Kull</td>
<td>1979</td>
<td>Fair</td>
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<td>Luther et al. (1987)</td>
<td>Dissolved metals</td>
<td>Newark Bay</td>
<td>unknown</td>
<td>Fair</td>
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<tr>
<td>NYC DEP (1987)</td>
<td>Total metals, volatile organics, chlorinated hydrocarbons, PCBs, organochlorine pesticides</td>
<td>Hudson River, Harlem, East River, Upper and Lower Bays, Kill van Kull, Kill, Raritan Bay, Jamaica Bay</td>
<td>1974-1988 (Hg-Poor)</td>
<td>Fair</td>
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<td>NYS DEC (1982-1986)</td>
<td>Priority pollutants: organics and total</td>
<td>Bronx River, Newtown Creek, Flushing Creek, Freshkills Creek, Coney Island Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing</td>
<td>1982-1986</td>
<td>Fair</td>
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<tr>
<td>Data Set</td>
<td>Toxics Analyzed</td>
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<td>Segar &amp; Cantillo</td>
<td>Dissolved metals</td>
<td>Lower Bay</td>
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<td>Fair</td>
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<td>Waldhauer et al.</td>
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<td>Raritan Bay, Lower Bay</td>
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<td>Belton et al. (1982)</td>
<td>PCBs in fish and blue crabs</td>
<td>Hudson, Hackensack, Passaic and Raritan Rivers, Raritan Bay, Newark Bay</td>
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<td>Belton et al. (1983)</td>
<td>PCBs, chlordane in fish</td>
<td>Hudson, Passaic and Raritan Rivers, Raritan Bay and Arthur Kill</td>
<td>1981-1982</td>
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<td>Belton et al. (1985)</td>
<td>TCDD, TCDF, PCBs and pesticides in fish, lobsters &amp; blue crabs</td>
<td>Passaic, Hackensack and Hudson Rivers, Newark Bay, Raritan Bay</td>
<td>1982-1984</td>
<td>Good</td>
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<td>Dorn (1986)</td>
<td>PCBs and DDTs in blue crabs</td>
<td>Hudson River</td>
<td>1985</td>
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<td>HMDC (1986)</td>
<td>Mercury in fish and blue crabs</td>
<td>Berry's Creek Hackensack River area</td>
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<td>Hauge et al. (1990)</td>
<td>PCBs, chlordane and DDTs in fish and shellfish</td>
<td>Hudson, Hackensack, Passaic &amp; Raritan Rivers, Newark and Raritan Bay, Arthur Kill</td>
<td>1986-1987</td>
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<td>NOAA (1989)</td>
<td>Metals, PAHs, chlorinated pesticides bivalve molluscs</td>
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<td>NYSDEC (1978)</td>
<td>PCBs, Cd, Cr, Cu, Hg, Pb, Zn in fish</td>
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<td>NYSDEC (1988)</td>
<td>PCBs, pesticides mercury in fish</td>
<td>Hudson River, Upper and Lower Bays</td>
<td>1985,1987</td>
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<td>NYSDEC (unpublished)</td>
<td>PCBs, pesticides Cd, Cr, Cu, Hg, Pb, Ni, Zn in bivalve molluscs</td>
<td>Raritan Bay, Jamaica Bay</td>
<td>1982-1988</td>
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<td>O'Connor &amp; Moese (1984)</td>
<td>PAHs and metals in fish and shellfish</td>
<td>Hudson River, Upper and Lower Bays, Newark Bay, Raritan Bay</td>
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<td>Roberts et al. (1982)</td>
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<td>Sabounjian &amp; Galluzzi (1980)</td>
<td>Mercury in fish and invertebrates</td>
<td>Hackensack River - Berry's Creek area</td>
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<td>Santoro and Koepp (1986)</td>
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<td>Stainken and Rollwagen (1979)</td>
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<td>Bopp (1988)</td>
<td>TCDD, OCDD, DDD</td>
<td>Passaic and Hackensack Rivers, Newark Bay, Kill Van Kull, Arthur Kill, Lower Bay</td>
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<td>EPA (1981)</td>
<td>Metals, PAHs, and phthalates</td>
<td>Passaic River and Newark Bay</td>
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<td>Fair</td>
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<td>EPA (1982a)</td>
<td>Priority pollutant organics and metals</td>
<td>Arthur Kill and Newark Bay</td>
<td>1982</td>
<td>Fair</td>
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<td>DDT, DDE, DDD</td>
<td>Arthur Kill</td>
<td>1982</td>
<td>Fair</td>
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<td>Koons &amp; Thomas (1979)</td>
<td>Petroleum hydrocarbons</td>
<td>Hudson River, Upper and Lower Bays, Raritan Bays</td>
<td>1975</td>
<td>Fair</td>
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<td>Meyerson et al. (1981)</td>
<td>Metals: Cd, Hg, Pb, Zn</td>
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<tr>
<td>NYS DEC (1981-1986)</td>
<td>Organic and metal priority pollutants</td>
<td>Governors Canal, Coney Island Creek, Freshkills Creek, Bronx River, Flushing Creek, Newtown Creek,</td>
<td>1984</td>
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<tr>
<td>Pruell et al. (1990)</td>
<td>TCDD, TCDF, PCBs</td>
<td>Passaic River</td>
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<td>Hydrocarbons</td>
<td>Raritan Bay, Lower Bay</td>
<td>1977</td>
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<td>PCBs</td>
<td>Raritan Bay, Lower Bay</td>
<td>1977</td>
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</tbody>
</table>
chemicals have been intensively studied (e.g. the heavy metals and PCBs), while others have been sampled only sporadically. There is also an uneven distribution of sampling sites for most chemicals since a large proportion of the data is derived from surveys conducted by city, state, and interstate agencies [i.e., the New York City Department of Environmental Protection (NYC DEP), New York State Department of Environmental Conservation (NYS DEC), New Jersey Department of Environmental Protection (NJ DEP) and the Interstate Sanitation Commission (ISC)]. Sampling locations in these studies were limited to the jurisdictional areas of each agency. Thus, no one study provides data for the entire Estuary. Also, many of the sampling stations in these surveys were purposely located near sewage treatment plant outfalls, combined sewer overflows and tributaries, and were not selected at random to represent the Estuary as a whole. Studies conducted by universities, on the other hand, involved more comprehensive and representative sampling; however, the areas involved in these studies were usually small, and the toxics measured were limited (most often to the metals). Despite these shortcomings, however, these data provide a good basis upon which to begin a toxics characterization study and to help to identify data needs for the Estuary.

An overall summary of the toxics data sets assembled for this report, the average QA/QC ratings for the data and an assessment of the geographic coverage of the data for different groups of toxicants is given in Table 5. In general, the reliability of the water column data is the poorest for both metals and organic contaminants. Geographically, sampling has been inadequate for metals in biota of the Estuary and for organics in sediments.
<table>
<thead>
<tr>
<th></th>
<th>Water Column</th>
<th>Biota</th>
<th>Sediments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Metals/Organics</td>
<td>Metals/Organics</td>
<td>Metals/Organics</td>
</tr>
<tr>
<td>Total number of data sets</td>
<td>12</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Single surveys</td>
<td>10</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Average QA/QC</td>
<td>Fair</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Geographic coverage</td>
<td>Good</td>
<td>Fair</td>
<td>Good</td>
</tr>
</tbody>
</table>

---

**Table 5**

**Summary of Available Data Sets for Toxics in the NY/NJ Harbor Estuary**

1974–1988
Water Quality and Fish Tissue Toxics Categorizations

Categorization Scheme

The toxics categorizations presented in Appendices I and II are based on the scheme developed by the Lake Ontario Toxics Management Plan (Lake Ontario Toxics Committee, 1989) shown in Table 6. Briefly, each of the 129 priority pollutant chemicals was placed in one of the seven categories outlined in Table 6 based on available data for the chemical in the Harbor Estuary. Water column concentrations for each chemical were compared to water quality standards and criteria and chemical concentrations in biota in the Estuary were compared to fish tissue standards and criteria. The water quality categorization is presented in Appendix I; the fish tissue categorization is in Appendix II. In each case, a listing of the chemicals in each of the seven categories is followed by a Data Reference section which summarizes the available data used in the categorization of the chemicals. The standards and criteria used to assess the data are given in the tables and are underlined if exceedances were noted. In all cases, the most stringent classification for each chemical was used to establish its place within the categorization scheme. A chemical was classified as exceeding a standard or criterion if any concentration data for the chemical in the estuary fell above its standard or criterion concentration.

The water quality standards used in this project were those published by the New York State Department of Environmental Conservation (NYSDEC, 1986) for marine shellfishing and bathing water classifications (SA and SB) and New Jersey surface water quality standards applying to all classifications of marine waters (NDEP, 1985). Fish and invertebrate tissue concentrations were compared to Food and Drug Administration (FDA) and New York State Department of Environmental Conservation (NYS DEC) standards for chemicals in edible tissues.
Table 6

Toxics Categorization Scheme

Category I. Ambient Data Available

A. Concentration Exceeds Enforceable Standard  
B. Concentration Exceeds More Stringent, but Unforceable Criteria  
C. Concentration Is Less Than Most Stringent Criteria  
D. Criterion Is Lower Than Analytical Detection Limits of the Data Collected  
E. No Criterion Available

Category II. No Ambient Data Available

A. Evidence of Presence or Input  
B. No Evidence of Presence or Input
In instances when state or federal standards for chemicals were not exceeded or when standards did not exist for a chemical, NYS guidance values (NYSDEC, 1986) or EPA water quality and human health criteria (EPA, 1989) were used as the basis for categorization. The marine chronic criteria (MCC) were developed by the EPA to afford protection of marine life from chronic exposures to toxicants. The EPA's human health criteria are designed for the protection of human health based on a chemical's toxic or carcinogenic potential. For carcinogens, the criteria are based on an increased risk factor of $10^{-6}$. The EPA's human health water quality criteria are separated into two categories: (1) consumption of water and organisms and (2) consumption of organisms only. In this categorization, the human health criteria based on the consumption of organisms only were used since waters from The Estuary are not utilized by humans for drinking water purposes. EPA fish tissue concentration criteria developed by the EPA Region IV (EPA, 1989) were used in the categorization based on tissue concentration data when FDA or state standards were not available. These criteria were derived from the water quality standards using appropriate bioconcentration factors for each chemical and an increased risk factor for carcinogens of $10^{-6}$.

**Categorization Results**

**Water Quality Toxics Categorization**

Tables 7-8 show the toxics of concern for the NY/NJ Harbor Estuary highlighted by the water quality toxics categorization presented in Appendix I. The list of toxics in Table 7 are those which exceed enforceable standards (Category I.A.). Those exceeding standards designed to protect marine life include seven metals, three pesticides, and one industrial chemical. Water column concentrations of DDT and its metabolites and PCBs exceeded standards designed to protect wildlife. Standards designed to protect human health were
Table 7

Toxics of Concern in the NY/NJ Harbor Estuary

Water Quality Standards and Criteria Exceedances
Category I.A

<table>
<thead>
<tr>
<th>Metals</th>
<th>Marine Life</th>
<th>Wildlife</th>
<th>Human Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (T)</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Cadmium (T)</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel (T)</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver (T)</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc (T)</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Pesticides       |             |          |              |
| Aldrin           | +           |          |              |
| alpha-BHC        | +           |          |              |
| gamma-BHC (lindane)* | +     |          | +            |
| DDD              | +           | +        |              |
| DDE              | +           |          |              |
| DDT*             | +           |          | +            |
| Dieldrin         |             |          | +            |
| Endosulphan*     | +           |          | +            |
| Heptachlor*      |             |          | +            |

<table>
<thead>
<tr>
<th>Industrial Chemicals</th>
<th>Marine Life</th>
<th>Wildlife</th>
<th>Human Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexachlorobutadiene*</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCBs</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Trichlorethylene</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(T) Indicates that total metal data were used in the classification of this metal.
* Indicates the compound was placed in this category on the basis of a single exceedance of the standard.
exceeded by the concentrations of two metals, five pesticides, and two industrial chemicals.

Table 8 lists the toxics placed in Category I.B. in the water quality toxics categorization and represents those chemicals with water concentrations exceeding EPA water quality criteria or NY state guidance values. This list includes one metal (mercury), which exceeds the EPA criteria based on the protection of human health, and fourteen industrial chemicals of which four exceed marine life criteria and ten exceed human health based criteria.

The asterisks in Tables 7 and 8 identify those chemicals which have been placed in each of the categories on the basis of a single exceedance of their standard or criteria in the data which presently exist for Estuary waters. The placement of these chemicals, in particular, and the full extent of the impact of all of these chemicals on marine and wildlife of the Estuary and on the human health impacts of ingesting organisms from the Estuary, must be verified by further monitoring.

In addition to the fact that the QA/QC assessment of most of the water column toxics data was only fair, the use of available water column metals data for the purpose of developing this categorization for the Harbor Estuary was confounded by the fact that existing data included three different types of measurements of the concentration of metals in the water column: total, acid-soluble, or dissolved metals. With the exception of mercury, NY state water standards for metals are based on acid-soluble metal concentrations. Also, EPA water quality criteria were developed on the basis of "bioavailable" metal concentrations which are thought to be more equivalent to either dissolved or acid-soluble concentrations than total metal concentrations. Despite this, acid-soluble metals data for the Harbor Estuary are limited to a very few metals at a limited number of sites.
Table 8
Toxics of Concern in the NY/NJ Harbor Estuary

Water Quality Standards and Criteria Exceedances
Category I.B.

<table>
<thead>
<tr>
<th>Marine Life</th>
<th>Wildlife</th>
<th>Human Health</th>
</tr>
</thead>
</table>

**Metals**

- Mercury
- Beryllium (T)

**Industrial Chemicals**

- Benzene
- Bis (2-ethylhexyl) phthalate
- Carbon tetrachloride
- Chlorobenzene
- 1,4 Dichlorobenzene
- Ethylbenzene
- Methylene chloride
- Naphthalene
- N-Nitrosodi-N-propylamine
- 1,1,2,2-Tetrachloroethane
- Tetrachloroethylene
- 1,1,2-Trichloroethane

**Polycyclic Aromatic Hydrocarbons**

- Phenanthrene
- Pyrene

(T) Indicates that total metal data were used in the classification of this metal.

* Indicates the compound was placed in this category on the basis of a single exceedance of the standard.
For the purpose of this categorization, total metals data were used when acid-soluble data were unavailable. Metals placed in categories I.A or I.B. on the basis of total metals data are designated in Tables 7 and 8 by a (T) and are listed in Table 9. We highly recommend that the categorization of metals in The Estuary be re-examined when methods for measuring "bioavailable" metal concentrations are better developed and standardized. EPA Region II and the States of New Jersey and New York are currently conducting studies which will help to determine which analytical methods are best suited for assessing waterborne metal bioavailability and toxicity in estuarine waters. When the most appropriate methods are determined, they should be required as standard procedures for all future studies in The Estuary and should be used in the development of standards and criteria.

The data used to develop the water quality toxic categorization presented in Appendix I is provided on a chemical by chemical basis following the categorization tables in the Data Reference Section. The strength of the data supporting the categorization of the metals shown in Tables 7 and 8 is summarized in Table 9. All of the studies measuring acid soluble copper concentrations provide data indicating that the NYS standard of 2.0 ppb for acid soluble copper is exceeded in Estuary waters. For lead, exceedances of the NYS standard of 8.6 ppb (acid soluble) were observed in six out of eight studies measuring acid soluble concentrations, and for mercury, the EPA criteria of 0.025 ppb (acid soluble) was exceeded at one station in the Harbor in one study. For the other metals listed in Table 9, only total metal data were available. Concentrations of arsenic, beryllium, and silver exceeded NYS standards in all of the studies with data for these metals, while exceedances were observed for cadmium, nickel and zinc in approximately half of the studies which measured these metals.

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Table 9

Water Concentrations of Metals in the NY/NJ Harbor Estuary
Category I.A. and I.B. Metals

<table>
<thead>
<tr>
<th>Metals Exceeding Standards or Criteria Based on Acid Soluble Data</th>
<th>Standard or Criterion (ppb)</th>
<th>Acid soluble ppb</th>
<th>Total ppb</th>
<th>Studies Indicating Exceedances/Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>2.0</td>
<td>2.05 - 65.0</td>
<td>&lt;1.0 - 258</td>
<td>8/8</td>
</tr>
<tr>
<td>Lead</td>
<td>8.6</td>
<td>1.11 - 13.9</td>
<td>5.2 - 800</td>
<td>6/8</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.025</td>
<td>0.062 - 0.0497</td>
<td>-</td>
<td>1/1</td>
</tr>
</tbody>
</table>

| Metals Exceeding Standards or Criteria Based on Total Metal Data | | |
|---------------------------------------------------------------|-------------------|-----------|-------------------------------------|
| Arsenic                                                       | 63                | -         | 12 - 440                           | 3/3 |
| Beryllium                                                     | 0.12              | -         | < 2 - 30                           | 1/1 |
| Cadmium                                                      | 2.7               | 0.06 - 0.12 | 0.13 - 160                   | 5/8 |
| Nickel                                                       | 7.1               | 1.46 - 2.60 | 1.4 - 430                           | 4/5 |
| Silver                                                       | 2.3               | -         | 0.14 - 150                           | 3/3 |
| Zinc                                                          | 58.0              | 4.7 - 18.77 | 4.4 - 550                           | 5/8 |
A summary of the data for the organic chemicals exceeding standards or
criteria in Estuary waters is presented in Table 10. The standard and the
range of the data are shown, together with the number of studies showing
exceedances for these compounds. The data base available for organic chemicals
in the water column is much smaller than that for metals in the Estuary, and,
in general, exceedances were observed less often than for metals. Information
on areas of the Estuary where exceedances occurred is noted in the Data
Reference section following the categorization tables in Appendix I.

Fish Tissue Toxics Categorization

Table 11 lists the toxicants present in edible tissues of biota of the
Estuary in concentrations exceeding fish tissue standards and criteria. This
table summarizes the results of the fish tissue toxics categorization presented
in Appendix II.

Of the chemicals listed in Table 11, PCBs and TCDD are the major
chemicals of concern in biota of the NY/NJ Harbor Estuary. Fishing advisories
exist in both New York and New Jersey waters based on the presence of these
chemicals in fish and shellfish tissues (NYSDEC, 1988; NJDEP, 1985; Belton et
al., 1985).

Examples of the data showing exceedances for PCBs in striped bass and
other fish and shellfish in The Estuary are listed in Table 12. An entire
listing of the data for PCBs in biota of The Estuary is provided in the Data
Reference section in Appendix II. Due to the presence of PCBs in sediments of
the upper Hudson River, the New York State Department of Environmental
Conservation has paid considerable attention to the problem of PCBs in Hudson
River striped bass. A recent report summarizing ten years of monitoring (1978-
1987) (NYSDEC, 1988) concluded that a significant decline in the concentration
of total PCBs in Hudson River striped bass fillets occurred from 1978 through

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Table 10

Water Concentrations of Organic Chemicals in the NY/NJ Harbor Estuary

<table>
<thead>
<tr>
<th>Standard or Criterion (ppb)</th>
<th>Concentration Range (ppb)</th>
<th>Studies Indicating Exceedances/Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category I.A.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>alpha-BHC</td>
<td>0.004</td>
<td>&lt;0.00036 - 19.2</td>
</tr>
<tr>
<td>gamma-BHC (lindane)</td>
<td>0.004</td>
<td>&lt;0.00048 - 0.07</td>
</tr>
<tr>
<td>DDD</td>
<td>0.001</td>
<td>&lt;0.001 - 0.033</td>
</tr>
<tr>
<td>DDE</td>
<td>0.001</td>
<td>&lt;0.002 - 2.4</td>
</tr>
<tr>
<td>DDT</td>
<td>0.001</td>
<td>&lt;0.001 - 0.06</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>0.001</td>
<td>&lt;0.0007 - 0.028</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>0.001</td>
<td>&lt;0.00038 - 0.0011</td>
</tr>
<tr>
<td>Endosulfan</td>
<td>0.001</td>
<td>&lt;0.008 - 1.58</td>
</tr>
<tr>
<td>Hexachlorobutadiene</td>
<td>0.3</td>
<td>&lt;0.05 - 8.0</td>
</tr>
<tr>
<td>PCBs</td>
<td>0.001</td>
<td>&lt;0.002 - 1.3</td>
</tr>
<tr>
<td><strong>Category I.B.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>6</td>
<td>&lt;0.1 - 78</td>
</tr>
<tr>
<td>Bis(2-ethylhexyl) phthalate</td>
<td>592</td>
<td>13 - 140</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>4.42</td>
<td>&lt;1.0 - 1,696</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>5</td>
<td>&lt;1.0 - 66</td>
</tr>
<tr>
<td>1,4-bis-chlorobenzene</td>
<td>5</td>
<td>&lt;0.19 - 31</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>4.3</td>
<td>&lt;1.0 - 102</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>1,578</td>
<td>&lt;1.0 - 9,332</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>23.5</td>
<td>&lt;5.0 - 26</td>
</tr>
<tr>
<td>N-Nitrosodi-N-propylamine</td>
<td>8.6</td>
<td>&lt;10 - 20</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>0.031</td>
<td>&lt;10 - 11</td>
</tr>
<tr>
<td>Pyrene</td>
<td>0.031</td>
<td>&lt;10 - 17</td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
<td>10.8</td>
<td>&lt;1.0 - 53</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>1</td>
<td>&lt;1.0 - 100</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>11</td>
<td>&lt;1.0 - 53</td>
</tr>
<tr>
<td>Category I.A.: Exceed Standards</td>
<td>Category I.B.: Exceed Criteria</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td>PCBs</td>
<td>Arsenic</td>
<td></td>
</tr>
<tr>
<td>TCDD</td>
<td>DDT + DDD + DDE</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>Heptachlor</td>
<td></td>
</tr>
<tr>
<td>Chlordane</td>
<td>Heptachlor epoxide</td>
<td></td>
</tr>
<tr>
<td>Dieldrin</td>
<td>Hexachlorobenzene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>gamma-HCH (lindane)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PAHs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acenaphthylene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anthracene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benzo(a)anthracene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benzo(k)fluoranthene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benzo(a)pyrene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benzo(e)pyrene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chrysene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dibenzo(a,h)anthracene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fluorene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phenanthrene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pyrene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tetrachlorodibenzofurans</td>
<td></td>
</tr>
</tbody>
</table>
### Table 12

Representative Fish and Shellfish Data for Toxicants Exceeding Tissue Concentration Standards

<table>
<thead>
<tr>
<th>Toxicant (Standard)</th>
<th>Species</th>
<th>Concentration Average</th>
<th>Range</th>
<th>Location of Exceedances</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCBs (2.0 ppm)</td>
<td>Striped bass (f)</td>
<td>3.98</td>
<td>0.66-31.45 ppm</td>
<td>Hudson River (RM 12-76)</td>
<td>NYSDEC (1987)</td>
</tr>
<tr>
<td></td>
<td>White perch (f)</td>
<td>2.03</td>
<td>1.43-7.12 ppm</td>
<td>Upper Bay, et al.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>American eel</td>
<td>1.71</td>
<td>0.65-4.81 ppm</td>
<td>Hackensack, et al.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bluefish (f)</td>
<td>0.88</td>
<td>&lt;0.20-3.80 ppm</td>
<td>and Passaic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blue crab (h/m)</td>
<td>1.88</td>
<td>4.18-8.27 ppm</td>
<td>Rivers, Newark and Raritan Bay</td>
<td></td>
</tr>
<tr>
<td>TCDD (25 ppb)</td>
<td>Striped bass (f)</td>
<td>26.4</td>
<td>&lt;9-120 ppb</td>
<td>Hudson River, Belton</td>
<td>NYSDEC (1987)</td>
</tr>
<tr>
<td></td>
<td>Striped bass (f)</td>
<td>32.0</td>
<td>15-50 ppb</td>
<td>Newark Bay, et al.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Striped bass (f)</td>
<td>18.6</td>
<td>&lt;5-58 ppb</td>
<td>Passaic, Belton</td>
<td></td>
</tr>
<tr>
<td></td>
<td>American eel</td>
<td>38.0</td>
<td>&lt;5-51 ppb</td>
<td>Hackensack, et al.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Catfish (f)</td>
<td>57.0</td>
<td>&lt;6-50 ppb</td>
<td>Raritan River, et al.</td>
<td>(1985)</td>
</tr>
<tr>
<td></td>
<td>Blue crab (h)</td>
<td>409</td>
<td>&lt;4-1063 ppb</td>
<td>Newark and Raritan Bay</td>
<td></td>
</tr>
<tr>
<td>Mercury (1.0 ppm)</td>
<td>Striped bass (f)</td>
<td>0.63</td>
<td>0.18-1.40 ppm</td>
<td>NYC Harbor area</td>
<td>NYSDEC (1987)</td>
</tr>
<tr>
<td></td>
<td>American eel</td>
<td>0.54</td>
<td>0.30-1.37 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>White perch (m)</td>
<td>0.31</td>
<td>0.05-1.09 ppm</td>
<td>Hudson River, Ellis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Striped bass (m)</td>
<td>0.72</td>
<td>0.01-1.49 ppm</td>
<td>Hackensack, et al.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>American eel</td>
<td>0.33</td>
<td>0.01-2.10 ppm</td>
<td>Passaic and Raritan River</td>
<td>(1980)</td>
</tr>
<tr>
<td></td>
<td>Bluefish (m)</td>
<td>0.34</td>
<td>0.01-1.40 ppm</td>
<td>Raritan River, Raritan Bay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>White perch (m)</td>
<td>0.76</td>
<td>0.28-1.88 ppm</td>
<td>Hackensack, Sabourjian &amp; Galluzi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Herring (m)</td>
<td>1.27</td>
<td>0.78-1.71 ppm</td>
<td>Sabourjian &amp; Galluzi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weakfish (m)</td>
<td>0.68</td>
<td>0.44-1.03 ppm</td>
<td>Raritan River, Raritan Bay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blue crab (h)</td>
<td>0.39</td>
<td>&lt;0.02-1.67 ppm</td>
<td>Hackensack, NMC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blue crab (m)</td>
<td>0.56</td>
<td>&lt;0.02-1.55 ppm</td>
<td>River, (1986)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Killifish (f)</td>
<td>0.83</td>
<td>&lt;0.02-1.58 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carp (m)</td>
<td>0.60</td>
<td>0.22-1.96 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Catfish (m)</td>
<td>1.17</td>
<td>0.70-1.62 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>White perch (m)</td>
<td>1.43</td>
<td>0.90-1.82 ppm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations:  
- m = muscle  
- h = hepatopancreas  
- f = fillet
Table 12 (continued)

Representative Fish and Shellfish Data
for Toxicants Exceeding Tissue Concentration Standards

<table>
<thead>
<tr>
<th>Toxic (Standard)</th>
<th>Species</th>
<th>Concentration</th>
<th>Location of Exceedances</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlordane (0.3 ppm)</td>
<td>Carp (f)</td>
<td>0.37 0.23-0.58 ppm</td>
<td>Passaic River</td>
<td>Hauge et al. 1990</td>
</tr>
<tr>
<td></td>
<td>Striped bass (f)</td>
<td>0.09 &lt;0.01-0.83 ppm</td>
<td>NYC Harbor area</td>
<td>NYSDEC (1987)</td>
</tr>
<tr>
<td></td>
<td>American eel</td>
<td>0.36 0.10-0.83 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dieldrin (0.3 ppm)</td>
<td>Striped bass (f)</td>
<td>0.07 &lt;0.01-0.34 ppm</td>
<td>NYC Harbor area</td>
<td>NYSDEC (1987)</td>
</tr>
<tr>
<td></td>
<td>Am. lobster (h)</td>
<td>5.45 4.0-6.9 ppm(dry)</td>
<td>Raritan Bay</td>
<td>McLeod et al. (1981)</td>
</tr>
</tbody>
</table>

Abbreviations: m = muscle
h = hepatopancreas
f = fillet
1981. Although concentrations increased in 1982 and 1983, since 1983 they have again showed a decreasing trend, with 1987 concentrations significantly lower than 1983-1985 values. PCB concentrations still average above the FDA standard of 2 ppm in the Harbor area as well as in the mainstem of the Hudson River.

TCDD contamination of fish and shellfish of the NY/NJ Harbor Estuary appears to be related to presence of TCDD in sediments of the Passaic River near a former chemical manufacturing plant (Belton et al., 1985). Concentrations of TCDD in fish and shellfish tissues ranged from below detection limits (<5 ppb) to over 1063 ppb in the hepatopancreas of blue crabs, with higher concentrations generally occurring in biota from the Passaic and Hackensack Rivers and Newark Bay (Table 12 and Appendix II). Concentrations are well above the FDA levels of concern of 25 ppb and the NYS standard of 10 ppb.

Data supporting the categorization of mercury, chlordane, and dieldrin as toxics of concern in the Estuary are not as strong as those which exist for PCBs and TCDD, but there is sufficient evidence to suggest that these chemicals need attention. Mercury concentrations exceeding the FDA standard of 1 ppm have been reported in fish tissues by the NYS DEC (1978, 1987), Ellis et al. (1980), Sabounjian and Galluzzi (1980), and the Hackensack Meadowlands Commission (1986) (Table 13). Although other studies measuring mercury in shellfish from Estuary waters have not reported exceedances (see Appendix II), concentrations of this heavy metal in edible tissues of these organisms are above detection limits. and data from NOAA (1989) indicate that mercury concentrations in mussels from The Estuary have shown an increasing trend in recent years.

Chlordane concentrations exceeding the FDA standard of 0.3 ppm in fish tissues are not common but have been reported in carp fillets analyzed by Hauge...
et al. (1990) and in striped bass and American eels analyzed by the NYS DEC (1987) (Table 12). Other fish and shellfish tissues fall below the 0.3 ppm standard, however (Appendix II). Similarly, dieldrin concentrations exceeding the FDA standard of 0.3 ppm have been reported in striped bass fillets (NYS DEC, 1987) and the hepatopancreas of the American lobster (McLeod et al., 1981) but consistently fall below this standard in other fish and shellfish species. Decreasing trends were noted in molluscan concentration data for chlordane in organisms from the Lower Bay and for dieldrin in organisms from Lower Bay, Jamaica Bay, and Sandy Hook in the NOAA National Status and Trends program (NOAA, 1989); however, these trends were not apparent in other areas of the Estuary. Continued monitoring is recommended to establish the extent and magnitude of the problem that exists for these toxics in Estuary waters.

Further monitoring is also needed for the Category I.B. toxics identified by the fish tissue categorization (Appendix II, Table 11). Existing data indicate that tissue concentrations of these chemicals in certain organisms of the Estuary exceed EPA human health criteria. Arsenic concentrations above 0.0062 ppm have been measured in blue crab, lobster, and winter flounder muscle samples (O'Connor and Moese, 1984) and in the blue mussel (NOAA, 1989). Concentrations of DDT plus its metabolites are lower than the FDA and NYS standard of 5 ppm but are consistently higher than the EPA criteria of 0.032 ppm (Table 13). Heptachlor concentrations are generally lower than the EPA criteria of 0.002 ppm but exceedances have been seen in tissues of striped bass, American eels, and lobsters (Table 13 and Appendix II). Similar results have been reported for the pesticide hexachlorobenzene and gamma-BHC (lindane).

The categorization of the individual PAH compounds as Category I.B. toxics is supported by data from O'Connor and Moese (1988) and McLeod et al.
<table>
<thead>
<tr>
<th>Toxic (Criteria)</th>
<th>Concentration Range</th>
<th>Locations Where Exceedances Occurred</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (0.0062 ppm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>blue crab (m)</td>
<td>&lt;0.4-21.33 ppm (dry)</td>
<td>Hudson River</td>
<td>O'Connor</td>
</tr>
<tr>
<td>blue crab (h)</td>
<td>&lt;0.4-16.12 ppm (dry)</td>
<td>Upper &amp; Lower</td>
<td>&amp; Moese</td>
</tr>
<tr>
<td>lobster (m)</td>
<td>&lt;0.4-20.09 ppm (dry)</td>
<td>Bays, Sandy</td>
<td>(1984)</td>
</tr>
<tr>
<td>lobster (h)</td>
<td>&lt;0.4-29.05 ppm (dry)</td>
<td>Hook</td>
<td></td>
</tr>
<tr>
<td>winter flounder (m)</td>
<td>&lt;0.4-56.20 ppm (dry)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>blue mussel</td>
<td>7.6-10.0 ppm (dry)</td>
<td>Upper &amp; Lower</td>
<td>NOAA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bay, Jamaica</td>
<td>(1989)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&amp; Raritan Bay</td>
<td></td>
</tr>
<tr>
<td>pDDT (0.032 ppm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>striped bass (f)</td>
<td>&lt;0.02-0.61 ppm</td>
<td>Upper Bay</td>
<td>Hauge</td>
</tr>
<tr>
<td>white perch (f)</td>
<td>&lt;0.05-0.69 ppm</td>
<td>Hackensack &amp;</td>
<td>et al.</td>
</tr>
<tr>
<td>carp (f)</td>
<td>0.23-0.85 ppm</td>
<td>Passaic Rivers,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Newark Bay,</td>
<td></td>
</tr>
<tr>
<td>american eel</td>
<td>&lt;0.15-0.76 ppm</td>
<td>Raritan River,</td>
<td></td>
</tr>
<tr>
<td>blue crab (h)</td>
<td>0.22-0.79 ppm</td>
<td>Raritan Bay</td>
<td></td>
</tr>
<tr>
<td>bluefish (f)</td>
<td>&lt;0.02-0.46 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>striped bass (f)</td>
<td>0.01-0.85 ppm</td>
<td>Upper &amp; Lower</td>
<td>NYSDEC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bays</td>
<td>(1988)</td>
</tr>
<tr>
<td>striped bass (f)</td>
<td>0.05-1.45 ppm</td>
<td>Hudson River,</td>
<td>NYSDEC</td>
</tr>
<tr>
<td>american eel</td>
<td>0.08-1.27 ppm</td>
<td>Upper &amp; Lower</td>
<td>(1987)</td>
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<tr>
<td>bluefish (f)</td>
<td>0.07-0.20 ppm</td>
<td>Bays, Arthur</td>
<td></td>
</tr>
<tr>
<td>american shad (f)</td>
<td>0.05-0.08 ppm</td>
<td>Kill, East</td>
<td></td>
</tr>
<tr>
<td>winter flounder (f)</td>
<td>0.01-0.08 ppm</td>
<td>River</td>
<td></td>
</tr>
<tr>
<td>Heptachlor (0.0024 ppm)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>striped bass (f)</td>
<td>&lt;0.01-0.05 ppm</td>
<td>Hudson River</td>
<td>NYSDEC</td>
</tr>
<tr>
<td>american eel</td>
<td>&lt;0.01-0.04 ppm</td>
<td>Upper &amp; Lower</td>
<td>(1987)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bays, Arthur</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kill, East</td>
<td>River</td>
</tr>
<tr>
<td>lobster (h)</td>
<td>&lt;0.05-0.08 ppm</td>
<td>Raritan Bay</td>
<td>McLeod et al.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1981)</td>
</tr>
<tr>
<td>Heptachlor Epoxide (0.0024 ppm)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>blue mussel</td>
<td>&lt;0.1-0.0074 ppm (dry)</td>
<td>Upper &amp; Lower</td>
<td>NOAA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bay, Raritan Bay</td>
<td>(1989)</td>
</tr>
</tbody>
</table>

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Table 13 (continued)

Representative Fish and Shellfish Toxics Data
Showing Exceedances of Criteria for Category I.B. Pollutants

<table>
<thead>
<tr>
<th>Toxic Species</th>
<th>Concentration Range</th>
<th>Locations Where Exceedances Occurred</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexachlorobenzene (0.0064 ppm)</td>
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<tr>
<td>Striped bass (f)</td>
<td>&lt;0.01-0.04 ppm</td>
<td>Hudson River, Upper &amp; Lower Bays, Arthur Kill, East River, Jamaica Bay</td>
<td>NYSDEC (1987)</td>
</tr>
<tr>
<td>American eel</td>
<td>&lt;0.01-0.09 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobster (h)</td>
<td>0.2-0.5 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod et al. (1981)</td>
</tr>
<tr>
<td>Gamma-BHC (Lindane) (0.0081 ppm)</td>
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</tr>
<tr>
<td>Striped bass (f)</td>
<td>&lt;0.01-0.05 ppm</td>
<td>Hudson River, Upper &amp; Lower Bays, Arthur Kill, East River</td>
<td>NYSDEC (1987)</td>
</tr>
<tr>
<td>American eel (f)</td>
<td>&lt;0.01-0.02 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter flounder (f)</td>
<td>&lt;0.004-0.010 ppm (dry)</td>
<td>Lower Bay</td>
<td>McLeod et al. (1981)</td>
</tr>
<tr>
<td>Lobster (h)</td>
<td>&lt;0.05-0.10 ppm (dry)</td>
<td>Raritan Bay</td>
<td></td>
</tr>
<tr>
<td>Blue mussel</td>
<td>&lt;0.0006-0.025 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica &amp; Raritan Bays</td>
<td>NOAA (1989)</td>
</tr>
<tr>
<td>Polycyclic aromatic hydrocarbons (PAHs)</td>
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</tr>
<tr>
<td>Acenaphthylene (0.00093 ppm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobster (h)</td>
<td>&lt;d.l.-0.007 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod et al. (1981)</td>
</tr>
<tr>
<td>Blue mussel</td>
<td>&lt;d.l.-0.320 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica &amp; Raritan Bays</td>
<td>NOAA (1989)</td>
</tr>
<tr>
<td>Anthracene (0.00093 ppm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue crab (m)</td>
<td>&lt;d.l.-0.26 ppm</td>
<td>Hudson River, Upper Bay</td>
<td>O'Connor &amp; Moese (1984)</td>
</tr>
<tr>
<td>Blue crab (h)</td>
<td>&lt;d.l.-7.56 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobster (m)</td>
<td>&lt;d.l.-0.13 ppm</td>
<td>Newark Bay</td>
<td></td>
</tr>
<tr>
<td>Lobster (h)</td>
<td>&lt;d.l.-1.88 ppm</td>
<td>Arthur Kill</td>
<td></td>
</tr>
<tr>
<td>Lobster (h)</td>
<td>&lt;0.01-0.10 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod et al. (1981)</td>
</tr>
<tr>
<td>Blue mussel</td>
<td>&lt;0.005-0.05 ppm (dry)</td>
<td>Lower Bay</td>
<td></td>
</tr>
<tr>
<td>Blue mussel</td>
<td>&lt;d.l.-0.370 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica &amp; Bay</td>
<td>NOAA (1989)</td>
</tr>
</tbody>
</table>
Table 13 (continued)

Representative Fish and Shellfish Toxics Data
Showing Exceedances of Criteria for Category I.B. Pollutants

<table>
<thead>
<tr>
<th>Toxic Species</th>
<th>Concentration Range</th>
<th>Locations Where Exceedances Occurred</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benz(a)anthracene (0.00093 ppm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>blue crab (m)</td>
<td>&lt;d.1.-15.48 ppm</td>
<td>Newark Bay</td>
<td>O'Connor</td>
</tr>
<tr>
<td>blue crab (h)</td>
<td>&lt;d.1.-29.04 ppm</td>
<td>Arthur Kill</td>
<td>&amp; Moese</td>
</tr>
<tr>
<td>lobster (m)</td>
<td>&lt;d.1.-10.01 ppm</td>
<td>Upper &amp; Lower Bays, Raritan Bays</td>
<td>(1984)</td>
</tr>
<tr>
<td>lobster (h)</td>
<td>&lt;d.1.-5.69 ppm</td>
<td>Bays, Raritan Bay</td>
<td></td>
</tr>
<tr>
<td>winter flounder (m)</td>
<td>&lt;d.1.-0.49 ppm</td>
<td>Bay</td>
<td></td>
</tr>
<tr>
<td>lobster (h)</td>
<td>0.5-0.6 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod</td>
</tr>
<tr>
<td>blue mussel</td>
<td>&lt;0.005-0.70 ppm (dry)</td>
<td>Lower Bay</td>
<td>et al.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1981)</td>
</tr>
<tr>
<td>blue mussel</td>
<td>0.11-1.50 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica &amp; Raritan Bays</td>
<td>NOAA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1989)</td>
</tr>
</tbody>
</table>

Benzo(k)fluoranthene (0.00093 ppm)

<table>
<thead>
<tr>
<th>Toxic Species</th>
<th>Concentration Range</th>
<th>Locations Where Exceedances Occurred</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>lobster (h)</td>
<td>&lt;d.1.-0.03 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>et al.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1981)</td>
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</tbody>
</table>

Benzo(a)pyrene (0.00093 ppm)

<table>
<thead>
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<th>Toxic Species</th>
<th>Concentration Range</th>
<th>Locations Where Exceedances Occurred</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue crab (m)</td>
<td>&lt;d.1.-0.82 ppm</td>
<td>Hudson River</td>
<td>O'Connor</td>
</tr>
<tr>
<td>blue crab (h)</td>
<td>&lt;d.1.-5.51 ppm</td>
<td>Upper &amp; Lower Bays, Newark</td>
<td>&amp; Moese</td>
</tr>
<tr>
<td>lobster (m)</td>
<td>&lt;d.1.-0.10 ppm</td>
<td>Bays, Newark</td>
<td>(1984)</td>
</tr>
<tr>
<td>lobster (h)</td>
<td>&lt;d.1.-4.96 ppm</td>
<td>Bay, Arthur Kill</td>
<td></td>
</tr>
<tr>
<td>winter flounder (m)</td>
<td>&lt;d.1.-0.29 ppm</td>
<td>Raritan Bay</td>
<td></td>
</tr>
<tr>
<td>lobster (h)</td>
<td>0.30 ppm (dry)</td>
<td>Raritan Bay, Lower Bay</td>
<td>McLeod</td>
</tr>
<tr>
<td>blue mussel</td>
<td>&lt;0.0005-0.07 ppm (dry)</td>
<td>Lower Bay</td>
<td>et al.</td>
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<tr>
<td></td>
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<td></td>
<td>(1981)</td>
</tr>
<tr>
<td>blue mussel</td>
<td>&lt;d.1.-0.51 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica &amp; Raritan Bays</td>
<td>NOAA</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>(1989)</td>
</tr>
</tbody>
</table>

-32-
<table>
<thead>
<tr>
<th>Toxic (Criteria)</th>
<th>Species</th>
<th>Concentration Range</th>
<th>Locations Where Exceedances Occurred</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benzo(e)pyrene</strong></td>
<td>blue crab (m)</td>
<td>&lt;d.1.-2.57 ppm</td>
<td>Hudson River</td>
<td>O'Connor</td>
</tr>
<tr>
<td></td>
<td>blue crab (h)</td>
<td>&lt;d.1.-1.98 ppm</td>
<td>Upper &amp; Lower</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lobster (m)</td>
<td>&lt;d.1.-0.44 ppm</td>
<td>Bays, Newark</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lobster (h)</td>
<td>&lt;d.1.-0.71 ppm</td>
<td>Bay, Arthur Kill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lobster (h)</td>
<td>0.30-0.40 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod</td>
</tr>
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<td></td>
<td>blue mussel</td>
<td>&lt;0.005-0.067 ppm (dry)</td>
<td>Lower Bay</td>
<td>et al.</td>
</tr>
<tr>
<td></td>
<td>blue mussel</td>
<td>0.095-0.740 ppm (dry)</td>
<td>Upper &amp; Lower &amp; Raritan Bays</td>
<td>NOAA (1989)</td>
</tr>
<tr>
<td><strong>Chrysene</strong></td>
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<td>&lt;d.1.-18.67 ppm</td>
<td>Hudson River</td>
<td>O'Connor</td>
</tr>
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<td></td>
<td>blue crab (h)</td>
<td>&lt;d.1.-37.44 ppm</td>
<td>Upper &amp; Lower</td>
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<tr>
<td></td>
<td>lobster (m)</td>
<td>&lt;d.1.-7.63 ppm</td>
<td>Bays, Newark</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lobster (h)</td>
<td>&lt;d.1.-24.50 ppm</td>
<td>Bay, Arthur Kill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>winter flounder (m)</td>
<td>&lt;d.1.-0.79 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lobster (m)</td>
<td>&lt;0.006-0.008 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod</td>
</tr>
<tr>
<td></td>
<td>lobster (h)</td>
<td>0.80-0.90 ppm (dry)</td>
<td>Lower Bay</td>
<td>et al.</td>
</tr>
<tr>
<td></td>
<td>blue mussel</td>
<td>&lt;0.005-0.30 ppm (dry)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>blue mussel</td>
<td>&lt;d.1.-2.0 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica &amp; Raritan Bay</td>
<td>NOAA (1989)</td>
</tr>
<tr>
<td><strong>Dibenzo(a,h)anthracene</strong></td>
<td>blue mussel</td>
<td>&lt;d.1.-0.014 ppm (dry)</td>
<td>Upper &amp; Lower Bays</td>
<td>NOAA (1989)</td>
</tr>
<tr>
<td><strong>Fluorene</strong></td>
<td>lobster (h)</td>
<td>&lt;d.1.-0.008 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod</td>
</tr>
<tr>
<td></td>
<td>blue mussel</td>
<td>&lt;d.1.-0.810 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica &amp; Raritan Bay</td>
<td>NOAA (1989)</td>
</tr>
</tbody>
</table>
Table 13 (continued)

Representative Fish and Shellfish Toxic Data
Showing Exceedances of Criteria for Category I.B. Pollutants

<table>
<thead>
<tr>
<th>Toxic (Criteria)</th>
<th>Species</th>
<th>Concentration Range</th>
<th>Locations Where Exceedances Occurred</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenanthrene (0.00093 ppm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>blue crab (m)</td>
<td>&lt;d.1.0.080 ppm</td>
<td>Hudson River</td>
<td>O'Connor</td>
</tr>
<tr>
<td></td>
<td>blue crab (h)</td>
<td>&lt;d.1.1.10 ppm</td>
<td>Upper &amp; Lower Bays, Newark</td>
<td>&amp; Moese</td>
</tr>
<tr>
<td></td>
<td>lobster (m)</td>
<td>&lt;d.1.0.06 ppm</td>
<td>Bay, Arthur Kill</td>
<td>(1984)</td>
</tr>
<tr>
<td></td>
<td>lobster (h)</td>
<td>&lt;d.1.2.55 ppm</td>
<td>Raritan Bay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lobster (m)</td>
<td>&lt;0.003-0.030 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod</td>
</tr>
<tr>
<td></td>
<td>lobster (h)</td>
<td>0.05-0.200 ppm (dry)</td>
<td>Lower Bay</td>
<td>et al.</td>
</tr>
<tr>
<td></td>
<td>blue mussel</td>
<td>0.02-0.08 ppm (dry)</td>
<td></td>
<td>(1981)</td>
</tr>
<tr>
<td></td>
<td>winter flounder (m)</td>
<td>&lt;0.004-0.005 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica</td>
<td></td>
</tr>
<tr>
<td></td>
<td>windowpane flounder (m)</td>
<td>&lt;0.006-0.009 ppm (dry)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>blue mussel</td>
<td>&lt;d.1.2.40 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica</td>
<td>NOAA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&amp; Raritan Bay</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrene (0.00093 ppm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>blue crab (m)</td>
<td>&lt;d.1.0.27 ppm</td>
<td>Hudson River</td>
<td>O'Connor</td>
</tr>
<tr>
<td></td>
<td>blue crab (h)</td>
<td>&lt;d.1.3.58 ppm</td>
<td>Upper &amp; Lower Bays, Newark</td>
<td>&amp; Moese</td>
</tr>
<tr>
<td></td>
<td>lobster (m)</td>
<td>&lt;d.1.0.05 ppm</td>
<td>Bay, Arthur Kill</td>
<td>(1984)</td>
</tr>
<tr>
<td></td>
<td>lobster (h)</td>
<td>&lt;d.1.2.74 ppm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lobster (m)</td>
<td>&lt;0.005-0.200 ppm (dry)</td>
<td>Raritan Bay</td>
<td>McLeod</td>
</tr>
<tr>
<td></td>
<td>lobster (h)</td>
<td>1.40-1.50 ppm (dry)</td>
<td>Lower Bay</td>
<td>et al.</td>
</tr>
<tr>
<td></td>
<td>blue mussel</td>
<td>0.01-1.10 ppm (dry)</td>
<td></td>
<td>(1981)</td>
</tr>
<tr>
<td></td>
<td>winter flounder (m)</td>
<td>&lt;0.005-0.005 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica</td>
<td></td>
</tr>
<tr>
<td></td>
<td>blue mussel</td>
<td>0.460-4.60 ppm (dry)</td>
<td>Upper &amp; Lower Bays, Jamaica</td>
<td>NOAA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&amp; Raritan Bay</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetrachlorodibenzo-p-dioxin (TCDF) (0.7 pprr)</td>
<td>striped bass (f)</td>
<td>16-76 pprr</td>
<td>Hudson River</td>
<td>NYSDEC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Newark Bay</td>
<td>(1987)</td>
</tr>
<tr>
<td></td>
<td>striped bass (f)</td>
<td>&lt;16-42 pprr</td>
<td>Passaic River</td>
<td>Belton</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Newark Bay</td>
<td>et al.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1985)</td>
</tr>
</tbody>
</table>

Abbreviations:  
- m = muscle  
- h = hepatopancreas  
- f = fillet
(1981), with exceedances occurring primarily in the hepatopancreas of the blue crab and the lobster (Table 13). Individual PAH compounds have also been measured by NOAA (1989) in blue mussels from four locations in the Estuary. Concentrations do not exceed 0.00093 ppm when converted to a wet weight basis (using an approximate conversion factor of 5); however, if the concentrations of these individual PAH compounds were summed, they would far exceed 0.00093 ppm. Due to the similar chemistries of these compounds, an additive approach should be considered when making judgements of their potential toxicities.

Comparison with the NY Bight Toxic Categorization

A comparison of the toxics of concern listed for The Estuary (Tables 7, 8 and 11) with those reported for the New York Bight (NYBEP, 1990) (Table 14) indicates that eight out of the nine pesticides present in the combined categories I.A. and I.B. for the Estuary are the same as those listed for the Bight. The number of industrial chemicals of concern in the Estuary is much larger than that found in the Bight, however, the primary chemicals, the PCBs and TCDD, are consistent. Also, the number of metals present in Categories I.A. and I.B. is larger in the Estuary than in the Bight. Mercury, arsenic, cadmium, copper, silver, and zinc are common between The Estuary and the Bight, while exceedances due to lead, nickel, and beryllium are unique to The Estuary. The presence of the petroleum derived PAHs is also consistent between the Estuary and the Bight, which emphasizes the need for greater attention to these potentially carcinogenic compounds in our waters and biota.

Sediment Toxics

Estuarine sediments act as both sinks and sources of toxic chemicals in impacted ecosystems. Most toxics, both organics and heavy metals, discharged into estuarine waters are either already bound to particulate material or rapidly associate with suspended particles as they enter the system. Thus, the
### Table 14
Toxics Categorization of the New York Bight
Summary Table

#### Toxics Exceeding Enforceable Water Quality or Fish Tissue Standards

**Metals and Inorganics**
- Mercury

**Industrial Chemicals**
- Polychlorinated Biphenyls (PCBs)
- 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)

#### Toxics Exceeding More Stringent but Unenforceable Water Quality or Fish Tissue Criteria

**Metals and Inorganics**
- Arsenic
- Cadmium
- Copper
- Silver
- Zinc

**Pesticides**
- Chlordane
- DDT + metabolites (DDD, DDE)
- Dieldrin
- Aldrin
- Heptachlor + Heptachlor epoxide
- Hexachlorobenzene
- Hexachlorocyclohexane (BHC)
  - a-alpha
  - r-gamma (Lindane)

**Petroleum Derivatives**
- Anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Chrysene
- Fluoranthene
- Phenanthrene
- Pyrene

Source: NYBP, 1990

-36-
largest pool of toxics in an estuary resides in its sediments.

Sediment-bound chemicals are not inert, however. Equilibria are established between the water, biota and sediment pools, and the bioavailability and toxicity of the chemicals are determined by complex interactions of chemical and physical properties of the compounds and the particles to which they are bound. Thus, sediments are important reservoirs for toxics in estuarine ecosystems. They serve as a source as well as a sink for toxic chemicals and play an important role in regulating water concentrations and the toxicity of these chemicals.

Metals

The metals data for sediments of the NY/NJ Harbor Estuary provide relatively good coverage of the area and a fair assessment of the ambient concentrations of eight of the eleven EPA priority pollutant metals in the Harbor. Studies providing these data are listed in Table 4 together with the date of the study, the toxics analyzed, and a summary of the areas of coverage.

These data have been compiled to provide the information given in Figures 2-8, which show average sediment concentrations for each metal in different regions of the Estuary. Below each average is the range of concentrations for the region. The data are presented as mg/kg dry weight. No corrections were made for the percentage of fines in the sediments or for total organic carbon concentrations (TOC). In the interpretation of these data, one must remember that the average calculated for each region represents the average of the sampling sites within the area and not a true average, since the sampling sites in most cases were not randomly chosen. Sampling in most cases, however, has provided good coverage of the areas.

Although the dates of the studies used to compile Figures 2-8 ranged over a period of 16 years (1972-1988), the data were combined and treated equally.
Results from a number of studies show no evidence of changes in sediment metal concentrations in The Estuary with time, at least over the years during which these data were collected. Temporal trends were not apparent in data collected by the New York City DEP Harbor Survey from 1983-1987 (NYCDEP, 1987).

Supporting this is the work of Williams et al. (1978), in which the analysis of post-industrial sediments from the Hudson River and Upper Bay regions showed relatively constant concentrations of Zn, Cu, and Pb along sediment cores.

A second consideration in the use of the data from the many data sets available for The Estuary was the different acid digestion methods used in the various studies. Metal concentrations reported by different studies for sediment samples collected from similar locations were comparable, however.

Also, Williams and coworkers (1978) demonstrated that measurements of Zn, Cu, Pb, Mn, and Fe were not different when samples were digested using concentrated nitric/sulfuric acid versus hydrofluoric acid. Thus, the data from these studies were considered equivalent in the preparation of the summary maps (Figures 2-8).

Geographical Distribution of Sediment Metals

The spatial distributions of sediment-bound metals throughout The Estuary are illustrated in Figures 2-8. Overall, these metals show similar profiles. Concentrations in Jamaica Bay and Lower Bay sediments are generally 5-10 times lower than concentrations in areas of high concentration, which include Newark Bay, the lower portions of the Passaic River, the Hackensack River, the Kill van Kull and the Arthur Kill.

Within each region, the distribution of metals appears to be determined by sediment type and tidal hydraulics as well as by sources of contamination. This is illustrated by a number of studies. In the NYC Harbor Survey Program (NYCDEP, 1987), metal concentrations were inversely correlated with the solids
content of the sediments suggesting that grain size and/or organic content are important in determining sediment metal concentrations. Consistent with this is the finding that higher metal concentrations occur in depositional areas of the Estuary. For example, in the East River, metal concentrations in the bays are approximately twice the concentrations measured in the main channel of the River. The lower portion of the Harlem River, in the restricted area near Ward's Island, also has higher metal concentrations than the upper reaches of the river or adjacent areas of the East River.

NYCDEP Harbor Survey data also indicate that Hudson River sediments vary little along the river from Yonkers to the tip of Manhattan (NYCDEP, 1987) (Figures 2-8). This probably reflects the similar sediment type that exists along the river and an even mixing of sediments which move up and down the river with the tide.

Greig and McGrath (1977) have also suggested that sediment-type plays an important role in establishing the spatial distribution of metals in their studies of Raritan Bay. The contour lines drawn in Figures 2-7 which separate Raritan Bay into three major areas with respect to sediment metal concentrations were suggested by Greig and McGrath (1977) on the basis of data for six metals in Raritan Bay sediments (Cd, Cr, Cu, Ni, Pb, and Zn). For all the metals, an area of high concentration extended across the mid-section of the Bay, from the western end eastward into Sandy Hook Bay. This section is bounded on both sides by areas with approximately half the metal concentrations observed in the central section. This pattern follows closely the composition of Raritan Bay sediments described by De Felco (1967) as presented in McGrath (1973). The central section is characterized as muddy (fine-grained) sediments while the upper and lower sections are composed primarily of sands.

The role of tidal hydraulics and sediment deposition in controlling
sediment metal concentrations was also described by Meyerson et al. (1982) in a study in Newark Bay. Data indicated that Cd, Hg, Pb, and Zn were more highly concentrated in sediments near the mouths of the Passaic and Hackensack Rivers, at the confluence of their plumes at the northern end of the Bay, and in areas around Shooter's Island at the lower end of the Bay (for examples, see Figures 9 and 10). The authors suggested that the higher concentrations observed at the mouth of the Passaic River compared to the Hackensack might be the result of flow characteristics of the Passaic River which allow a greater settling of suspended sediments. An area just south of Kearny Point, between the plumes of the Passaic and Hackensack Rivers, on the other hand, showed relatively low concentrations of metals. Meyerson et al. (1982) suggest that this is due to the fact that this area receives little or no flow from the two rivers and thus is an area of low sedimentation.

Source Information

Due to the movement and mixing of fine-grained sediments within The Estuary with river and tidal flows, it is difficult to identify many specific sources of metal contamination based on sediment data. However, there are a few "hot spots" which suggest point sources. Meyerson and coworkers (1982) reported concentrations of Pb in sediments near Morees Creek in the Arthur Kill that were higher by a factor of ten than surrounding sediments (Figure 9). Also, Zn concentrations in sediments collected near Pile's Creek measured over 2000 ppm compared to other sediments in the Arthur Kill, which ranged from 79 - 568 ppm Zn (Figure 10).

Meyerson and coworkers (1982) also suggested, on the basis of sediment data, that the Hackensack and Passaic Rivers serve as a source of metals to Newark Bay. This hypothesis is consistent with the high levels of municipal and industrial discharge received by these rivers. Mueller et al. (1976)
estimated these discharges at 6.5 m$^3$ s$^{-1}$, which equals approximately 14% of the flow of these rivers into Newark Bay. High concentrations of metals in sediments of the rivers themselves have been reported in other studies (EPA, 1981; Goeller, 1989; ERM Southeast Inc, 1985), particularly in the lower portions of the Passaic River and along the entire length of the Hackensack River from Overpeck Creek southward (for examples see Figures 11 and 12). The Berry's Creek area in the Hackensack Meadowlands in particular has been extensively studied, and results indicate that sediments in Berry's Creek Canal are highly contaminated due to the direct discharge of industrial wastes in this area in years past (Figures 2-8).

In contrast to conclusions reached by Meyerson and coworkers (1982), however, Goeller (1989) has suggested that Newark Bay serves as a source of metals to the lower portions of the Hackensack River. Goeller's evaluation of recent sediments of the Hackensack River indicate that sediments from the northern portion of the river contain higher concentrations of metals than the central section, due perhaps to effluents from the Little Ferry Sewage Treatment Plant and/or industrial plants such as the Public Service Gas and Electric (PSE&G) Plant on Overpeck Creek (Figure 11 and 12). Higher metal concentrations have also been reported in sediments in central portions of the river near a second PSE&G plant. Recent sediments in the lowest section of the Hackensack River were highest at the confluence of the river with Newark Bay suggesting a contribution of heavy metals to this area from Newark Bay. Although it has not been documented, it is possible that the high concentrations of metals in Newark Bay and the Arthur Kill may originate from petroleum sources due to the large number of oil refineries and port facilities in these areas.

Data from sediment cores in which sediments were dated on the basis of
radiological measurements of Cs-137 and Be-7 indicate that Ni and Cd sources to sediments in the main channel of the Hackensack River have remained relatively constant over the past 30 years (Goeller, 1989). Zn and Cr inputs to the river, however, are significantly less (approximately 2.5 fold lower) now than they were approximately 30 years ago. Enrichment factors for Cr in these studies by Goeller (1989) further indicate that a peak in Cr concentrations in sediments dating from the early 1960's appears to have been due to a large input of Cr from the Berry's Creek Canal area.

Sediment core studies such as those described above by Goeller (1989) provide substantial temporal as well as geographical information on metal inputs to the Estuary. As described above, the geographic pattern of sediment-bound metal concentrations in the Estuary is determined in large part by the movement of sediments with river and tidal flows. In depositional areas, the analysis of sediment concentrations with respect to the age of the sediments provides information on whether concentrations of the metals are increasing or decreasing with time. Data from sediment grab samples are ambiguous since sediments deposited at different times are mixed within the composited sample. In the only other sediment core study conducted for metals in the Estuary, Williams et al. (1978) have shown that Upper Bay sediments are richer in Cu than Zn compared to upper Hudson River sediments transported downstream, suggesting that there is a significant source of Cu relative to Zn in the Upper Bay. We recommend that more studies of this type be conducted in the Estuary for a better source analysis of metal contamination.

Organics

Organic chemical concentrations in sediments of the Estuary have not been as well monitored as the metals, with the exception perhaps of PCBs. In many cases, unlike metals, studies measuring organic chemicals have been limited to
areas containing very high levels of contamination due to a known or unknown point source discharge (e.g. DDT, TCDD). Data for organic chemical concentrations in The Estuary are presented here on a chemical by chemical basis.

Geographical Distribution of Sediment Organics

Polychlorinated Biphenyls (PCBs)

Average PCB sediment concentrations for areas of The Estuary are presented in Figure 13. The distribution of PCBs is surprisingly similar to that seen for the metal toxicants suggesting that sediment type and depositional patterns play an important role in determining the spatial distribution of this organic contaminant also. The lowest concentrations of PCBs are found in Lower Bay, Jamaica Bay, and the Harlem River, with averages ranging from 0.098 to 0.13 ppm (dry weight). The sediments of the Hudson River and Upper Bay are somewhat higher (0.38 and 0.55 ppm, respectively), due perhaps to an influx of PCBs from the Upper Hudson River.

The highest concentrations of PCBs in sediments of the system are not in the Hudson River, however. Sediments in Newark Bay and the Arthur Kill have average PCB concentrations of 1.13 and 1.56 ppm, respectively, and evidence of PCB contamination is apparent in the Passaic River (Pruell et al., 1990) (Figure 13). Studies have also shown that PCBs are present in the marshland sediments of the Berry's Creek area adjacent to the Hackensack River (Hackensack Meadowlands Commission, unpublished data). Data are not available for other locations along the Hackensack or Passaic Rivers, but are warranted in light of the high concentrations of PCBs in the areas which have been sampled.

The presence of PCBs in Newark Bay, the Arthur Kill and the Hackensack and Passaic Rivers in relatively high concentrations compared to the lower Hudson
River suggests that inputs of PCBs to the lower estuary other than the Upper Hudson are significant and play an important role in the mass balance of PCBs in the system. These results support the work of Bopp and Simpson (1989) and Thomann et al. (1989).

**Polycyclic Aromatic Hydrocarbons**

Polycyclic aromatic hydrocarbon (PAH) concentration data for sediments of the Estuary are sparse due to the relatively recent interest in PAHs as environmental contaminants. Original studies by Koons and Thomas (1979) provide data on the general distribution of C_{15+} hydrocarbons in the Hudson River, Upper Bay, and Raritan Bay (Figure 14). Sediment concentrations of total C_{15+} hydrocarbons in Raritan Bay were highest near the confluence of the Raritan River and the Arthur Kill and in the southeastern corner of Sandy Hook Bay. This pattern is similar to that observed for metals in Raritan Bay and suggests that sediment type and sedimentation patterns established by tidal hydraulics in the area are responsible for the distribution of PAHs among these sediments, with the Arthur Kill and/or the Raritan River serving as the major sources. Hydrocarbon sediment concentrations were also relatively high in the Upper Bay and the lowest reaches of the Hudson River near Manhattan Island.

Data for individual PAH compounds and total PAHs (tPAHs) in sediments of the Estuary have been reported by NOAA (1988), EPA (1981, 1982) and McLeod et al. (1981). The data shown in Figure 15 indicate that there are numerous locations within the Estuary with unusually high concentrations of tPAHs. Sediment samples collected from Newtown Creek off the East River, in particular, were found to have tPAH concentrations of approximately 181,000 ppb on a dry weight basis; while two locations in the lower reaches of the Passaic River contain sediments with tPAH concentrations of over 160,000 ppb.

The high PAH concentrations observed in Newark Bay and along the Arthur
Kill (Figure 15) are not unexpected considering the use of these areas as ports for the oil shipping industry and as oil refinery and storage areas. In fact, it is somewhat surprising that they are not the highest in the region. The dredging of the ship channels and the pier areas may maintain concentrations lower than local spill or discharge areas that are not routinely dredged. Also, the mixing of sediments which occurs as they are resuspended during dredging procedures may lower average concentrations in remaining sediments.

Particularly in light of the recent number of large oil spills in the Arthur Kill and the Kill van Kull areas, the data presented in Figure 15 must be accepted as a general representation of PAH data for the Harbor Estuary and not a reflection of current concentrations. Sampling needs to be conducted to determine present concentrations of PAHs in these areas already sampled and to examine areas for which data do not exist (i.e. Jamaica Bay, the Hackensack River and the East River).

**Pesticides**

Pesticide data for NY/NJ Harbor Estuary sediments have been broken down into two main groups: DDT and its metabolites (DDD and DDE) and the chlorinated pesticides (ChlP): aldrin, alpha-chlordane, trans-nonchlordane, dieldrin, heptachlor, heptachlor epoxide, hexachlorobenzene, gamma-BHC (lindane) and mirex.

**Total DDT (tDDT)**

Concentration data for DDT and its metabolites in sediments of the Estuary are shown in Figure 16. These data represent the results of studies by NOAA (1983), McLeod et al. (1981), Bopp et al. (1985) and EPA (1982). Concentrations in most areas of the Estuary for which there are data range from less than 0.1 to about 155 ppb (dry weight) except for sediments of the Arthur Kill and the lower portion of Newark Bay. A 1982 study by EPA indicated that
sediments along the mid-reaches of the Arthur Kill were severely contaminated with DDT with concentrations ranging up to 164,000 ppb. The source of this contamination is not known but appears to be the result of one or more point source discharges or spills. Data by Bopp (1985) also indicated that DDD concentrations in Arthur Kill sediments were much higher than those measured in other areas of the Estuary. Further investigations of the bioavailability of this source of DDT are needed to determine its relative contribution to organisms inhabiting the Estuary.

Pollution chronologies developed by Bopp and coworkers (Bopp et al., 1982 and Bopp and Simpson, 1989) for tDDT in sediments in the Upper Bay indicate that maximum concentrations are present in sediments dating from the 1960's and the early 1970's, which corresponds to the time of maximum use of DDT for insect control prior to its ban by the EPA in 1972. Thus, current inputs of DDT due to its continued use are apparently decreasing; however, inputs from the downstream transport and redistribution of presently contaminated sediments need to be considered.

**Chlorinated Pesticides Other Than DDT**

Chlorinated pesticides other than DDT have been measured in sediments of the Estuary by NOAA (1988) and McLeod et al. (1981) (Figure 17). Concentrations range from 0.02 ppb in the center of Lower Bay to 236 ppb at the southern end of Newark Bay near Shooter's Island. These areas of high and low concentration are similar to those observed for the metals, suggesting a relationship to sediment type as well as source. Studies by Bopp and coworkers (Bopp et al., 1982 and Bopp and Simpson, 1989) have suggested that major sources of chlorodane for the Estuary have been local, metropolitan area inputs rather than Hudson River sediments. As with DDT, the sediment core work conducted by Bopp and coworkers has also indicated that concentrations of
chlordane in recent sediments have been decreasing since the early 1970s, consistent with the banning of chlordane for general uses by the EPA in 1975 (Bopp and Simpson, 1989).

**Tetrachlorodibenzodioxin (TCDD)**

Concentration data for TCDD in sediments of The Estuary are limited to two recent studies concerned with TCDD contamination resulting from the discharge of a chemical manufacturing facility located on the Passaic River at 80 Lister Avenue during the 1960’s. Bopp et al. (1988) analyzed sediment core samples from seven locations in the Estuary. Concentrations were greatest in samples taken in the Passaic River near 80 Lister Avenue, with lower concentrations in Newark Bay and other areas of the Estuary (Figure 18). Pruell et al. (1990) analyzed four sediment samples collected from the Passaic River in the vicinity of the manufacturing facility. Concentrations ranged from 482 to 759 pppt.

Although TCDD contamination in the Estuary appears to be fairly limited in its distribution, the concentrations present are high and bioavailable. As described above, concentrations of TCDD in biota in The Estuary exceed acceptable limits for human consumption. Thus, further studies on TCDD are needed to more accurately determine the extent of its distribution.

**Effects of Dredging Activities**

It is important to point out that the data presented in this report were collected over a period of 20 years and probably do not precisely represent current metal concentrations in any one area of the Estuary. In addition to recent inputs and the continual redistribution of sediments with tidal flows, dredging activities in areas of the Harbor may have significantly altered sediment concentrations. The removal of large amounts of sediments from channels and pier areas not only removes sediments and toxicants but also redistributes remaining sediments which are suspended during the dredging.
processes. In fact, one reason that the concentrations of many toxicants appear fairly uniform within specific areas of the Estuary may be due to the mixing that occurs during dredging activities. Newark Bay and the Kill van Kull in particular have recently been the center of a major dredging project. The data reported in this report have not been analyzed with respect to changes that have occurred due to recent dredging activity.

Comparison of Sediment Toxics Concentrations with Other National Estuaries

The NOAA National Status and Trends program was initiated to collect consistent data on toxics from over 200 national estuaries to provide a basis for comparisons between estuaries. This study has shown that sediments from the six NOAA sites within the NY/NJ Harbor Estuary (Figure 19) rank within the twenty most contaminated estuaries in the country with respect to toxicant concentrations (NOAA, 1988). As shown in Table 15, sediments from Lower Bay, Raritan Bay, Jamaica Bay, and Sandy Hook contain silver, arsenic, cadmium, chromium, copper, mercury, lead, antimony, tin, zinc, total chlorinated pesticides (tChlP), total DDT (tDDT), total PCBs, and total PAHs in concentrations which rank in the top 20 in the nation. A second Raritan Bay site is lower in Cr than the top 20 estuaries, but concentrations of Pb at this site are the highest in the nation. Mercury sediment concentrations at all six sites in the Estuary are the highest in the nation. Thus, on the basis of sediment concentration data, the NY/NJ Harbor Estuary can be ranked as one of the most chemically polluted estuaries in the nation.

Evaluation of Sediment Toxicant Concentrations

Although the EPA is in the process of developing sediment quality criteria for evaluating the potential biological effects of sediment-bound toxicants, none exist at the present time. Therefore, NOAA Sediment Effects Values (NOAA, 1990) have been used in this project to provide estimates of toxicity for NY/NJ
Table 15

Comparison of Toxicant Concentrations in NY/NJ Harbor Estuary Fine-Grained Sediments With Other National Estuaries as Ranked in the NOAA National Status and Trends Program

<table>
<thead>
<tr>
<th>Site</th>
<th>Contaminants with Concentrations Ranking Among the Top 20 Estuaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Bay (HRUB)</td>
<td>Ag, As, Cu, Hg, Pb, Sb, Sn, tPAH</td>
</tr>
<tr>
<td>Lower Bay (HRLB)</td>
<td>Ag, As, Cd, Cr, Cu, Hg, Pb, Sb, Sn, Zn, tChlP, tDDT, tPCB, tPAH</td>
</tr>
<tr>
<td>Jamaica Bay (HRJB)</td>
<td>Ag, As, Cd, Cr, Cu, Hg, Pb, Sb, Sn, Zn, tChlP, tDDT, tPCB, tPAH</td>
</tr>
<tr>
<td>Raritan Bay (HRFB)</td>
<td>Ag, As, Cd, Cu, Hg, Pb, Sb, Sn, Zn, tChlP, tDDT, tPCB, tPAH</td>
</tr>
<tr>
<td>Raritan Bay (RAR)</td>
<td>Ag, As, Cd, Cr, Cu, Hg, Pb, Sb, Sn, Zn, tChlP, tDDT, tPCB, tPAH</td>
</tr>
<tr>
<td>Sandy Hook (NYSE)</td>
<td>Ag, As, Cd, Cr, Cu, Hg, Pb, Sb, Sn, Zn, tChlP, tDDT, tPCB, tPAH</td>
</tr>
</tbody>
</table>
Harbor Estuary sediments. These Effects Values, which are listed in Table 16, are not sediment toxicity standards but were developed to provide guidance in the evaluation of sediment chemical concentration data. As noted above, the concentrations of many of the toxicants in sediments of the Estuary rank among the highest in the nation (NOAA, 1988). As shown in Figures 20-32, many of these sediments also have a high potential for adverse biological effects.

In Figures 20-32, the minimum, maximum, and average concentrations of toxics in different regions of the Estuary are compared to NOAA Sediment Effects values ER-L and ER-M (NOAA, 1990). These values were developed by comparing the effects values predicted by six different approaches currently being used to assess sediment toxicity. These approaches include 1) the Background Approach in which sediment concentrations of toxicants are compared to reference (or background) concentrations for a particular region, 2) the Sediment-water Equilibrium Partitioning Approach which predicts the interstitial water concentration of a chemical that would result from a given sediment concentration based on the octanol/water partition coefficient (Kow) for the chemical and the organic carbon content of the sediment, 3) the Spiked-Sediment Bioassay Approach which involves exposing organisms to sediments spiked with known amounts of one or more chemicals, 4) the Screening Level Concentrations Approach which involves the use of field-collected data on the sediment concentrations of chemicals and analyses of benthic infaunal composition, 5) the Apparent Effects Threshold Approach which involves comparing laboratory measurements of effects of field-collected sediment samples with concentrations of chemicals in the sediment samples, and 6) the Bioeffects/Contaminant Co-Occurrence Analyses Approach which statistically develops effects values based on chemical concentrations of field-collected sediment samples determined to have high, intermediate or low indications of
<table>
<thead>
<tr>
<th>Chemical</th>
<th>ER-L Concentration</th>
<th>ER-M Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trace Elements (ppm)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Chromium</td>
<td>80</td>
<td>145</td>
</tr>
<tr>
<td>Copper</td>
<td>70</td>
<td>390</td>
</tr>
<tr>
<td>Lead</td>
<td>35</td>
<td>110</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.15</td>
<td>1.3</td>
</tr>
<tr>
<td>Nickel</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Silver</td>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td>Zinc</td>
<td>120</td>
<td>270</td>
</tr>
<tr>
<td><strong>Polychlorinated Biphenyls (ppb)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total PCBs</td>
<td>50</td>
<td>400</td>
</tr>
<tr>
<td><strong>Chlorinated Pesticides (ppb)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDT</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>DDD</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>DDE</td>
<td>2</td>
<td>15</td>
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<tr>
<td>Total DDT</td>
<td>3</td>
<td>350</td>
</tr>
<tr>
<td>Chlordane</td>
<td>0.5</td>
<td>6</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>0.02</td>
<td>8</td>
</tr>
<tr>
<td>Endrin</td>
<td>0.02</td>
<td>45</td>
</tr>
<tr>
<td><strong>Polynuclear Aromatic Hydrocarbons (ppb)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acenaphthene</td>
<td>150</td>
<td>650</td>
</tr>
<tr>
<td>Anthracene</td>
<td>85</td>
<td>960</td>
</tr>
<tr>
<td>Benzo(a)anthracene</td>
<td>230</td>
<td>1600</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>400</td>
<td>2500</td>
</tr>
<tr>
<td>Chrysene</td>
<td>400</td>
<td>2800</td>
</tr>
<tr>
<td>Dibenz(a,h)anthracene</td>
<td>65</td>
<td>260</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>600</td>
<td>3600</td>
</tr>
<tr>
<td>Fluorene</td>
<td>35</td>
<td>640</td>
</tr>
<tr>
<td>2-Methylnaphthalene</td>
<td>65</td>
<td>670</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>340</td>
<td>2100</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>225</td>
<td>1380</td>
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<tr>
<td>Pyrene</td>
<td>350</td>
<td>2200</td>
</tr>
<tr>
<td>Total PAHs</td>
<td>4000</td>
<td>35000</td>
</tr>
</tbody>
</table>

Table 16

NOAA Sediment Effects Values for Selected Toxics
(NOAA, 1990)
effects. The Effects Values derived by these six approaches were used by NOAA to develop consensus values: Effects Range - Low (ER-L) and Effects Range - Median (ER-M) which are the lower 10 and 50 percentiles in the data, respectively.

Using this approach, NOAA (1990) has published Effects Values for ten metals, total PCBs (tPCBs), six chlorinated pesticides, total polycyclic aromatic hydrocarbons (tPAHs) and twelve individual PAH compounds (Table 16). Comparisons of these values with toxic sediment concentrations for The Estuary (Figures 20-32) show that the concentrations of eight metals, six PAH compounds, total PCBs, total DDT, chlordane, dieldrin, and total PAHs exceed their ER-M values in at least one area of The Estuary (Table 17). In addition, antimony and five PAH compounds are present at concentrations exceeding their ER-L values. Arsenic is the only toxicant which is not present in sediments in concentrations above its NOAA Effect Values. A summary of the number of areas of The Estuary with average sediment concentrations exceeding either the ER-L or ER-M values for each of the toxicants is given in Table 18. This list identifies five compounds which are present in over 50% of the areas at concentrations exceeding their ER-M values: lead, mercury, silver, zinc, and chlordane.

These results suggest that the concentrations of toxicants in Estuary sediments are sufficiently high to be causing adverse effects on biota. It is highly recommended that a sediment bioassay program be established to verify the adverse effects predicted by this process. Benthic infaunal surveys should also be conducted, particularly in the more concentrated areas, to determine whether effects are indicated.

Due to toxicant interactions and the potential for additive effects, the total toxicity of a sediment sample may be greater than that predicted by
Table 17

Evaluation of NY/NJ Harbor Estuary Sediment Based on NOAA Sediment Effects Values

<table>
<thead>
<tr>
<th>Toxicants with Average Sediment Concentrations Above ER-M Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
</tr>
<tr>
<td>Chromium</td>
</tr>
<tr>
<td>Copper</td>
</tr>
<tr>
<td>Lead</td>
</tr>
<tr>
<td>Mercury</td>
</tr>
<tr>
<td>Nickel</td>
</tr>
<tr>
<td>Silver</td>
</tr>
<tr>
<td>Zinc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Toxicants With Average Sediment Concentrations Below ER-M But Exceeding ER-L Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
</tr>
<tr>
<td>Chrysene</td>
</tr>
<tr>
<td>Fluorene</td>
</tr>
<tr>
<td>Naphthalene</td>
</tr>
<tr>
<td>Dibenz(a,h)anthracene</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Toxicants With Average Sediment Concentrations Below ER-L Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
</tr>
</tbody>
</table>
### Table 18

**Summary of NY/NJ Harbor Estuary Sediment Toxics Evaluation Based on NOAA Sediment Effects Values**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Number of areas with Concentrations:</th>
<th>% Sites Exceeding ER-M</th>
<th>% Sites Exceeding ER-L</th>
<th>% Sites</th>
<th>ER-L</th>
<th>Exceeding ER-L</th>
<th>Exceeding ER-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Cadmium</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Chromium</td>
<td>7</td>
<td>3</td>
<td>6</td>
<td>38</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Copper</td>
<td>2</td>
<td>11</td>
<td>3</td>
<td>19</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>* Lead</td>
<td>0</td>
<td>4</td>
<td>14</td>
<td>77</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>* Mercury</td>
<td>0</td>
<td>7</td>
<td>8</td>
<td>53</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Nickel</td>
<td>10</td>
<td>2</td>
<td>4</td>
<td>25</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>* Silver</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>100</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>* Zinc</td>
<td>2</td>
<td>7</td>
<td>9</td>
<td>50</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>tDDT</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>28</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>* Chlordane</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>60</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>12</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>tPCBs</td>
<td>0</td>
<td>7</td>
<td>5</td>
<td>42</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>tPAH</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>38</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Acenaphthene</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Anthracene</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Benzo(a)anthracene</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>17</td>
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<td>1</td>
<td>0</td>
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<tr>
<td>Benzo(a)pyrene</td>
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<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Chrysene</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Fluorene</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Pyrene</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2-Methylnaphthalene</td>
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<td>4</td>
<td>1</td>
<td>17</td>
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<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Dibenz(a,h)anthracene</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

* Indicates that greater than 50% of the sites analyzed contained sediments with concentrations exceeding the compound's ER-M value.
single toxicant analyses, depending upon the mixture of chemicals present. The toxicity of sediments from the NY/NJ Harbor Estuary is potentially even greater than that suggested by the above analysis due to the large number of toxins present in most sediments of the Estuary. In recognition of this, NOAA (1990) calculated "total toxicity" indexes for sediments from estuaries around the nation and concluded that NY/NJ Harbor Estuary sediments have one of the highest potentials for toxicity in the nation.

Summary

The categorizations outlined above provide initial, comprehensive lists of toxics of potential concern in the Estuary. These lists can be combined as shown in Table 19 to indicate the extent to which these three approaches support each other in the identification of toxics requiring attention.

Twelve metals and 42 organic chemicals were identified as toxics requiring further study in the Estuary on the basis of their ambient concentrations in water, biota or sediments. Many of these chemicals are present in concentrations exceeding predicted effect levels in more than one type of sample. They have been classified in Table 19 according to their potential effects on either marine life, wildlife, or human health, based on the type of standard, criteria, or effect level exceeded.

As shown in Table 19, data indicate that mercury, dieldrin, total DDT, PCBs, phenanthrene, and pyrene exceed acceptable concentrations in water, biota, and sediments of the Estuary. These toxics pose potential problems with respect to their effects on organisms inhabiting the Estuary as well as to human health due to the consumption of fish and shellfish from the area.

High concentrations of six metals (Cd, Cu, Pb, Ni, Ag, and Zn) in both water and sediments support the categorization of these toxics as compounds of concern with respect to effects on marine life. High sediment concentrations
Table 19
Toxics of Concern in the NY/NJ Harbor Estuary

Summary

<table>
<thead>
<tr>
<th>Based On:</th>
<th>Marine Life</th>
<th>Wildlife</th>
<th>Human Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water, Biota and Sediment Data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>DDT + DDD + DDE</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>PCBs</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Pyrene</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Water and Biota Data</td>
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</tr>
<tr>
<td>Arsenic</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>gamma-BHC (lindane)</td>
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<td>+</td>
</tr>
<tr>
<td>Heptachlor</td>
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<td></td>
<td>+</td>
</tr>
<tr>
<td>Water and Sediment Data</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Napthalene</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biota and Sediment Data</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Anthracene</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Chlordane</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Chrysene</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Dibenz(a,h)anthracene</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
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<tr>
<td>TCDD</td>
<td>+</td>
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Table 19 (continued)
Toxics of Concern in the NY/NJ Harbor Estuary

Summary

<table>
<thead>
<tr>
<th>Based On:</th>
<th>Marine Life</th>
<th>Wildlife</th>
<th>Human Health</th>
</tr>
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<tbody>
<tr>
<td><strong>Water Data Only</strong></td>
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<td></td>
</tr>
<tr>
<td>Beryllium</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>alpha-BHC</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bis(2-ethylhexyl) phthalate</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>+</td>
<td></td>
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</tr>
<tr>
<td>Chlorobenzene</td>
<td>+</td>
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</tr>
<tr>
<td>1,4 Dichlorobenzene</td>
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<tr>
<td>Endosulphan</td>
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<tr>
<td>Ethylbenzene</td>
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<tr>
<td>Hexachlorobutadiene</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Methylene chloride</td>
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<tr>
<td>N-Nitrosodi-N-propylamine</td>
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<td>1,1,2,2-Tetrachloroethane</td>
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<tr>
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<td>Benzo(a)pyrene</td>
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<tr>
<td>Benzo(k)fluoranthene</td>
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<td>Heptachlor epoxide</td>
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<tr>
<td>Hexachlorobenzene</td>
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<td>Antimony</td>
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<td>Tin</td>
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<tr>
<td>Acenaphthene</td>
<td>+</td>
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<td>Biphenyl</td>
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<td>Fluoranthene</td>
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<tr>
<td>1-Methylnaphthalene</td>
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<tr>
<td>2-Methylnaphthalene</td>
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</tr>
<tr>
<td>Perylene</td>
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<tr>
<td>2,3,5-Trimethylnaphthalene</td>
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<td></td>
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</tbody>
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-57-
pose a hazard to benthic organisms, while larval and juvenile stages of fish and shellfish are particularly sensitive to water column concentrations of metals.

Results also indicate that PAH compounds are present in sediments of The Estuary in concentrations exceeding predicted effect levels, suggesting that sensitive benthic organisms are at risk in area sediments. These compounds also need to be more closely monitored due to evidence that at least some of them are accumulating in biota of The Estuary to concentrations exceeding "warning" levels. Although PAHs do not accumulate in fish tissues, due to their rapid metabolism, they are present in edible tissues of molluscs and shellfish.

Conclusions and Recommendations

The list of toxics of concern provided by this study (Table 19) is not intended to be an end-product, but rather to serve as a guide in the development of future research and monitoring programs. The next step is to verify the placement of the individual toxics on this list and to establish the extent of their impact on the health and well-being of The Estuary.

The strength of the data supporting the classifications of the chemicals on the list in Table 19 varies greatly. Concentrations of PCBs in striped bass in The Estuary, for example, are well documented and existing data provide a good understanding of the scope of this problem. Data for mercury, chlordane, dieldrin, and TCDD, however, are insufficient for accurately determining the full extent of the impact of these chemicals on the safety of seafood from the Estuary and need to be further examined. Similarly, copper concentrations in estuarine waters are quite certainly above concentrations considered safe for sensitive life stages of marine organisms, while water column data for other metals are ambiguous. Thus, it is our recommendation that the following

-58-
chemical and biological effects monitoring programs be established:

**Chemical Monitoring**

1. An Estuary-wide water quality monitoring program measuring dissolved, acid soluble, and total metal concentrations should be initiated and conducted under strict QA/QC conditions to provide reliable water column data for the Estuary.

2. Sediments also need to be monitored in a single, comprehensive survey to provide up-to-date chemical concentration data accompanied by measurements of total organic carbon, percentage of fines and acid volatile sulfide.

3. Monitoring programs currently in effect measuring PCB, TCDD, chlordane and total DDT concentrations in edible fish and shellfish tissues should be expanded to encompass mercury, arsenic, dieldrin, heptachlor, heptachlor epoxide, hexachlorobenzene, lindane, TCDF, and PAH compounds.

4. Trends in the bioavailability of toxicants in the Estuary should be determined through the establishment of an Estuary-wide "Mussel Watch" program.

**Biological Effects Monitoring**

Biological effects data are needed for all areas of The Estuary to verify the potential adverse effects predicted by chemical concentration data. This program should include:

1. Sediment and water bioassays for all segments of The Estuary under different tidal and water flow conditions.

2. Benthic infaunal community studies.

3. Histological studies in fish and shellfish with particular attention to alterations in reproductive tissues and the presence of neoplastic or preneoplastic lesions in hepatic tissues.

Studies such as these will significantly improve our understanding of the problem of toxic chemicals in The Estuary and will provide a firmer basis for the development of effective management programs.
References


---60---

827270063


EPA (Environmental Protection Agency) - Region II. 1982b. 4,4'-DDT, 4,4'-DDE, 4,4'-DDD in Arthur Kill Sediment April 13 and November 18, 1982. Draft report.


NJDEP (New Jersey Department of Environmental Protection). 1985b. Draft Report. Special Investigation Heavy Metals - Shellfish, Chemical Investigation of Shellfish from Northern Monmouth County Waters, Phase II.

NJDEP (New Jersey Department of Environmental Protection). 1985c. A Study of Toxic Hazards to Urban Recreational Fisherman and Crabbers. Office of Science and Research, Trenton, N.J.


Figure Legends

Figure 1: New York/New Jersey Harbor Estuary Project Area.

Figure 2: Average cadmium concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4. Numerical values give the average and range for each region.

Figure 3: Average chromium concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4. Numerical values give the average and the range for each region.

Figure 4: Average copper concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4. Numerical values give the average and the range for each region.

Figure 5: Average nickel concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4. Numerical values give the average and the range for each region.

Figure 6: Average lead concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4. Numerical values give the average and the range for each region.

Figure 7: Average zinc concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4. Numerical values give the average and the range for each region.

Figure 8: Average mercury concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4. Numerical values give the average and the range for each region.

Figure 9: Lead concentrations in Newark Bay sediments (from Meyerson et al., 1981).

Figure 10: Zinc concentrations in Newark Bay sediments (from Meyerson et al., 1981).

Figure 11: Zinc concentrations in Passaic and Hackensack River sediments (from Meyerson et al., 1981; Goeller, 1989; EPA, 1981).

Figure 12: Lead concentrations in Passaic and Hackensack River sediments (from Meyerson et al., 1981; Goeller, 1989; EPA, 1981).
Figure 13: Average polychlorinated biphenyl (PCB) concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4. Numerical values give the average and the range for each region.

Figure 14: Total C_{15+} hydrocarbon concentrations in sediments of the NY/NJ Harbor Estuary (from Koons and Thomas, 1979).

Figure 15: Total polycyclic aromatic hydrocarbon (TPAH) concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4.

Figure 16: Total DDT (DDT plus its metabolites) concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4.

Figure 17: Total chlorinated pesticide concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4.

Figure 18: Tetrachlorodibenzo-p-dioxin (TCDD) concentrations in sediments of the NY/NJ Harbor Estuary based on data compiled from the data sets listed in Table 4.

Figure 19: NOAA National Status and Trends Program sampling sites in the NY/NJ Harbor Estuary.

Figure 20: NY/NJ Harbor Estuary sediment silver concentrations versus NOAA's sediment effects values. Sampling sites are shown in Figure 19.

Figure 21: NY/NJ Harbor Estuary sediment cadmium concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 22: NY/NJ Harbor Estuary sediment chromium concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 23: NY/NJ Harbor Estuary sediment copper concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 24: NY/NJ Harbor Estuary sediment mercury concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.
Figure 25: NY/NJ Harbor Estuary sediment nickel concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 26: NY/NJ Harbor Estuary sediment lead concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 27: NY/NJ Harbor Estuary sediment zinc concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 28: NY/NJ Harbor Estuary sediment PCB concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 29: NY/NJ Harbor Estuary sediment PAH concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 30: NY/NJ Harbor Estuary sediment total DDT concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 31: NY/NJ Harbor Estuary sediment chlordane concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 32: NY/NJ Harbor Estuary sediment dieldrin concentrations versus NOAA's sediment effects values. Histograms show the maximum, minimum, and average concentrations for each region of the Estuary based on data provided by the data sets listed in Table 4. Area designations are shown in Figure 33.

Figure 33: Area designations for Figures 20 - 32.
Figure 2
Cd in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)

New Jersey

New York

Long Island Sound

Long Island

ppm

\[ \bar{x} = 2.94 \pm 0.53 \\
(2.6-3.5) \]

\[ \bar{x} = 1.22 \pm 0.78 \\
(0.5-2.2) \]

\[ \bar{x} = 2.74 \pm 0.72 \\
(1.5-3.2) \]

\[ \bar{x} = 0.98 \pm 1.15 \\
(0.02-4.1) \]

\[ \bar{x} = 1.93 \pm 2.59 \\
(<1-13) \]

\[ \bar{x} = 1.98 \pm 1.57 \\
(<1-5.5) \]

\[ \bar{x} = 4.0 \pm 1.6 \\
(<1-7) \]

\[ \bar{x} = 6.31 \pm 2.4 \\
(2.1-19) \]

\[ \bar{x} = 3.7 \pm 2.3 \\
(<0.4-5.2) \]

\[ \bar{x} = 8.62 \pm 5.6 \\
(<1-31) \]

\[ \bar{x} = 7.05 \pm 3.3 \\
(3.2-9) \]

\[ \bar{x} = 8.97 \pm 5.2 \\
(<1-22) \]

\[ \bar{x} = 8.25 \pm 4.63 \\
(5-15) \]

\[ \bar{x} = 1.99 \pm 0.93 \\
(<1-3.5) \]
Figure 3
Cr in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)

New Jersey

New York

Long Island Sound

ppm

≤50
>50-100
>100-200
>200-400
>400

56.1 ± 52.6
(3-171)

118.5 ± 47.0
(39-200)

29.7 ± 38.8
(2-166)

124.6 ± 64.7
(50-164)

67.0 ± 31.2
(32-92)

229.5
(229-230)

1196

245

2566

Berry's Creek

Mamaroneck

Bays

222.6 ± 30.4
(203-299)

74.0 ± 17.1
(77-98)

27.8 ± 20.1
(11-56)

338.6 ± 197.4
(206-920)

63.6 ± 53.3
(170-17)

85.5 ± 54.0
(34-142)

512.3 ± 183.4
(16-776)

185.0 ± 54.5
(130-220)

63.9 ± 50.6
(7-193)
Figure 4
Cu in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)

\[
\bar{x} = 340.4 \pm 404.8 \\
(52-1917)
\]

\[
\bar{x} = 83.5 \pm 61.3 \\
(25-190)
\]

\[
\bar{x} = 90.3 \pm 25.7 \\
(54-121)
\]

\[
\bar{x} = 39.2 \pm 24.9 \\
(18-75)
\]

\[
\bar{x} = 264.5 \\
(229-300)
\]

\[
\bar{x} = 86.8 \pm 47.1 \\
(203-299)
\]

\[
\bar{x} = 32.9 \pm 44.5 \\
(7.0-210)
\]

\[
\bar{x} = 94.7 \pm 42.8 \\
(48-132)
\]

\[
\bar{x} = 710.0 \pm 436.6 \\
(420-1230)
\]

\[
\bar{x} = 140.2 \pm 87.2 \\
(9.8-220)
\]

\[
\bar{x} = 231.2 \pm 117.3 \\
(21-410)
\]

ppm

\[
\leq 50
\]

\[
>50-100
\]

\[
>100-200
\]

\[
>200-400
\]

\[
>400
\]
Figure 5
Ni in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)
Figure 7
Zn in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)
Figure 8
Hg in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)
Figure 9
Pb Concentrations in Newark Bay Sediments (ppm)

Data from Meyerson et al. (1981)
Figure 10
Zn Concentrations in Newark Bay Sediments (ppm)

Data from Meyerson et al. (1981)
Figure 13
PCBs in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)
Figure 14
Total C15+ Hydrocarbons in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)

Data from Koons and Thomas (1979)
Figure 15
Total PAHs in Sediments of the NY/NJ Harbor Estuary (ppm dry wt)
Figure 16
Total DDT in Sediments of the NY/NJ Hudson Estuary (ppb dry wt)
Figure 17
Total Chlorinated Pesticides in Sediments of the NY/NJ Hudson Estuary (ppb dry wt)
Figure 21
NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Cd

ppm (dry weight)

Max. Ave. Min.

ER-M

ER-L

East River, East River Bays, Harlem River, Wards Island, Hudson River, Gowanus Canal, Kill Van Kull, Newark Bay, Hackensack River, Passaic River, Arthur Kill, Raritan Bay, Lower Bay, Jamaica Bay, V

82770092
Figure 22
NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Cr

ppm (dry weight)

Max.
Ave.
Min.

East River
East River Bays
Harlem River
Ward's Island
Hudson River
Upper Bay
Gowanus Canal
Kill Van Kull
Newark Bay
Hackensack River
Passaic River
Arthur Kill
Raritan Bay
Lower Bay
Jamaica Bay

ER-M
ER-L
No Data
Figure 23
NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Cu

Max. Ave. Min.

ppm (dry weight)

East River East River Bays Harlem River Wards Island Hudson River Upper Bay Gowanus Canal Kill Van Kull Newark Bay Hackensack River Passaic River Arthur Kill Raritan Bay Lower Bay Jamaica Bay

ER-M

ER-L

1917 1230

8272700738
Figure 25

NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS
VERSUS NOAA SEDIMENT EFFECTS VALUES

Ni

ppm (dry weight)

Max.
Ave.
Min.

ER-M
ER-L

East River Bays
Harlem River
Wards Island
Hudson River
Upper Bay
Gowanus Canal
Kill Van Kull
Newark Bay
Hackensack River
Passaic River
Arthur Kill
Raritan Bay
II

Jamaica Bay
II

No Data
Figure 26
NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Pb

ppm (dry weight)

Max.
Ave.
Min.

East River
Wards Island
Hudson River
Upper Bay
Gowanus Canal
Kill Van Kull
Newark Bay
Hackensack River
Passaic River
Arthur Kill
Raritan Bay
Lower Bay
Jamaica Bay

8277270097
Figure 27
NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Zn

ppm (dry weight)

Max.

Ave.

Min.

Figure 29
NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Total PAHs (ppb)

ppb (dry weight)

ER-M

ppb (dry weight)

ER-L

Hudson River
Upper Bay
Kill Van Kull
Lower Bay + Raritan Bay
Jamaica Bay
Arthur Kill

Newtown Creek
Newark Bay
Passaic River

Max.  Ave.  Min.
Figure 30
NY / NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Total DDT

ppb (dry weight)

Hudson River
Pascack Bay
Lower Bay
Jamaica Bay

Newark Bay
Arthur Kill

ER-M

Max.
Ave.
Min.
Figure 31
NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Chlordane

ppb (dry weight)

Max.  Ave.  Min.

Hudson River  Raritan Bay  Jamaica Bay

Upper Bay  Newark Bay  Arthur Kill  Raritan River
Figure 32
NY/NJ HARBOR ESTUARY SEDIMENT TOXICS CONCENTRATIONS VERSUS NOAA SEDIMENT EFFECTS VALUES

Dieldrin

ppb (dry weight)

ER-M

ER-L

Hudson River
Upper Bay
Newark Bay
Arthur Kill
Raritan Bay
Raritan River
Lower Bay
Jamaica Bay
Appendix I
### Appendix I

**Water Quality Toxics Categorization for the NY/NJ Harbor Estuary**

**Water Quality Standards and Criteria**

<table>
<thead>
<tr>
<th></th>
<th>Saltwater Screening Value</th>
<th>Human Health</th>
<th>NY std</th>
<th>NY guidance std</th>
<th>NJ value</th>
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<tr>
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<td><strong>Metals</strong></td>
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<tr>
<td>Arsenic (T)</td>
<td>36 (III) MCC</td>
<td>0.14</td>
<td>63 (d)</td>
<td>36 (as)</td>
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<tr>
<td>Copper</td>
<td>2.9 MCC</td>
<td></td>
<td>2.0 (as)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>5.6 MCC</td>
<td></td>
<td>8.6 (as)</td>
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<td></td>
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<tr>
<td>Nickel</td>
<td>8.3 MCC</td>
<td>4,584</td>
<td>7.1 (as)</td>
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<tr>
<td>Silver (T)</td>
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<td></td>
<td>2.3 (as)</td>
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<td>Zinc (T)</td>
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<td><strong>Organic Compounds</strong></td>
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<td>Hexachlorobutadiene**</td>
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<td>49.7</td>
<td>0.3</td>
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<td>Polychlorinated biphenyls (PCBs)</td>
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<td>0.001 WL</td>
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<td>Aldrin</td>
<td>0.13 MCC</td>
<td>0.000136</td>
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<td>alpha-BHC</td>
<td>1400 MCC</td>
<td>0.0131</td>
<td>0.004</td>
<td></td>
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<td>0.016 MCC</td>
<td>0.0626</td>
<td>0.004</td>
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<td>0.14 MCC</td>
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<td>0.001 WL</td>
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<td>0.00059</td>
<td>0.001 WL</td>
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<td>0.025 MCC</td>
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<td>0.001 WL</td>
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<td>Dieldrin</td>
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<td>0.000144</td>
<td>0.001</td>
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<td>Endosulfan**</td>
<td>0.0087 MCC</td>
<td>1.99</td>
<td>0.001</td>
<td>0.0087</td>
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<td>Heptachlor</td>
<td>0.0036 HH</td>
<td>0.000214</td>
<td>0.001</td>
<td>0.0036</td>
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Water Quality Toxics Categorization for the NY/NJ Harbor Estuary

<table>
<thead>
<tr>
<th>EPA (1989) Criteria</th>
<th>NY std</th>
<th>NY guidance std</th>
<th>NJ value</th>
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<tbody>
<tr>
<td>Saltwater Human</td>
<td></td>
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</tr>
<tr>
<td>Screening Value</td>
<td></td>
<td></td>
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</table>

B. Exceed More Stringent But Unenforceable Criteria

Metals and Inorganics

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Beryllium (T)</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>9.3 MCC</td>
<td>2.7 (as)</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.025 MM</td>
<td>0.153</td>
</tr>
<tr>
<td></td>
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</table>

Organic Compounds

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Chemicals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>109 MCC</td>
<td>71.28</td>
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<tr>
<td>Di (2-ethylhexyl) Phthalate</td>
<td>5.92</td>
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<tr>
<td>Carbon Tetrachloride</td>
<td>1500 MCC</td>
<td>4.42</td>
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<tr>
<td>Chlorobenzene</td>
<td>105 MCC</td>
<td>20</td>
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<tr>
<td>1,4 Dichlorobenzene</td>
<td>19.9 MCC</td>
<td>5</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>4.3 MCC</td>
<td>28,718</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>2560 MCC</td>
<td>1578</td>
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<tr>
<td>(Dichloromethane)</td>
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<tr>
<td>Napthalene**</td>
<td>23.5 MCC</td>
<td>6</td>
</tr>
<tr>
<td>N-Nitrosodi-N-propylamine**</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td>1,1,2,2 Tetrachloroethane</td>
<td>90.2 MCC</td>
<td>10.8</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1,2 Trichloroethane**</td>
<td>41.99</td>
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<tr>
<td>Trichloroethylene</td>
<td>80.7</td>
<td>11</td>
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<tr>
<td>Toluene</td>
<td>37 MCC</td>
<td>301,941</td>
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Polycyclic aromatic hydrocarbons

<p>| | |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>Phenanthrene**</td>
<td>0.031</td>
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<tr>
<td>Pyrene**</td>
<td>0.031</td>
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</table>
### Water Quality Standards and Criteria

<table>
<thead>
<tr>
<th>EPA (1989) Criteria</th>
<th>NY std</th>
<th>NY guidance std</th>
<th>NJ std</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening Value</td>
<td>Health</td>
<td>(continuous)</td>
<td></td>
</tr>
</tbody>
</table>

#### C. Below Most Stringent Criteria

**Metals and Inorganics**

- Antimony: 4.308
- Selenium: 71 MCC
- Thallium: 21.3 MCC

**Organic Compounds**

**Industrial Chemicals**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Screening Value</th>
<th>Health</th>
<th>NY std</th>
<th>NY guidance std</th>
<th>NJ std</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromoform</td>
<td>540 MCC</td>
<td>470.8</td>
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<tr>
<td>Bromomethane (Methyl bromide)</td>
<td>120 MCC</td>
<td>470.8</td>
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<tr>
<td>Bromodichloromethane</td>
<td></td>
<td>470.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Chloroethylvinyl-ether</td>
<td></td>
<td>17.6</td>
<td></td>
<td></td>
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<tr>
<td>Chloroform</td>
<td>815 MCC</td>
<td>470.8</td>
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<tr>
<td>Dibromochloromethane</td>
<td></td>
<td>470.8</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1,2 Dichloroethane</td>
<td>1130 MCC</td>
<td>98.6</td>
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<tr>
<td>1,1 Dichloroethylene</td>
<td>2240 MCC</td>
<td>3.2</td>
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<tr>
<td>1,2 trans-Dichloroethylene</td>
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<td>136,319</td>
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<tr>
<td>1,2 Dichlorobenzene</td>
<td>19.7 MCC</td>
<td>2,600</td>
<td>5</td>
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<tr>
<td>1,3 Dichlorobenzene</td>
<td>28.5 MCC</td>
<td>2,600</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,4 Dichlorobenzene</td>
<td>19.9 MCC</td>
<td></td>
<td>5</td>
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<tr>
<td>1,2 Dichloropropane</td>
<td>2400 MCC</td>
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<tr>
<td>1,3 Dichloropropylene</td>
<td>7.9 MCC</td>
<td>31.3</td>
<td></td>
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<tr>
<td>Dichlorodifluoromethane</td>
<td></td>
<td>470.8</td>
<td></td>
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<tr>
<td>Diethyl phthalate</td>
<td>75.9 MCC</td>
<td>118,019</td>
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<tr>
<td>Dimethyl phthalate</td>
<td>580 MCC</td>
<td>2,900,000</td>
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<tr>
<td>2,4 Dimethylphenol</td>
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<td>400</td>
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<tr>
<td>2,4-Dinitrophenol</td>
<td>48.5 MCC</td>
<td>14,264</td>
<td>0.07</td>
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<tr>
<td>Hexachlorocyclopentadiene</td>
<td>0.07 MCC</td>
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<tr>
<td>Hexachloroethane</td>
<td>9.4 MCC</td>
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<tr>
<td>Isophorone</td>
<td>129 MCC</td>
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<td>Methyl chloride</td>
<td>2007 MCC</td>
<td>470.8</td>
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<tr>
<td>3-Methyl-4-chlorophenol</td>
<td></td>
<td>5000</td>
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<tr>
<td>2-Methyl-4,6-dinitrophenol</td>
<td></td>
<td>765</td>
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<td>4-Nitrophenol</td>
<td>71.7 MCC</td>
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<tr>
<td>N-Nitrosodiphenylamine</td>
<td>33,000 MCC</td>
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<td>Phenol</td>
<td>58 MCC</td>
<td>300</td>
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<tr>
<td>1,2,3 Trichlorobenzene</td>
<td>4.5 MCC</td>
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<td>1,1,1 Trichloroethane</td>
<td>312 MCC</td>
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<tr>
<td>Trichlorofluoromethane</td>
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<td>470.8</td>
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<tr>
<td>Vinyl chloride</td>
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<td>525</td>
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### Water Quality Standards and Criteria

<table>
<thead>
<tr>
<th>EPA (1989) Criteria</th>
<th>NY std</th>
<th>NY guidance std value</th>
<th>NJ std</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saltwater Screening Value (continuous) Human Health</td>
<td>0.002</td>
<td>0.0023</td>
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</table>

C. Below Most Stringent Criteria (continued)

**Pesticides**
- Endrin: 0.0023 HH
- Methoxychlor: 0.03 HH
### Water Quality Toxic Categorization for the NY/NJ Harbor Estuary

#### Water Quality Standards and Criteria

<table>
<thead>
<tr>
<th>Category</th>
<th>EPA (1989) Criteria</th>
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<th>NY Guidance Std</th>
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<td>Saltwater Screening Value</td>
<td>Human Health Value</td>
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<td>Industrial Chemicals</td>
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<tr>
<td>Benzidine</td>
<td>0.000535</td>
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<tr>
<td>Bis(2-chloroethyl) ether</td>
<td>1.42</td>
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<tr>
<td>Butyl benzyl Phthalate</td>
<td>29.4 MCC</td>
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<tr>
<td>Di-N-Butyl Phthalate</td>
<td>3.4 MCC</td>
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<td></td>
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<tr>
<td>2-Chlorophenol</td>
<td>0.1</td>
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<td>3,3 Dichlorophenazine</td>
<td>0.02</td>
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<td>2,4-Dichlorophenol</td>
<td>0.3</td>
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<tr>
<td>2,4 Dinitrotoluene</td>
<td>9.1</td>
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<td>1,2 Diphenylhydrazine</td>
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<tr>
<td>Pentachlorophenol</td>
<td>7.9 MCC</td>
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<tr>
<td>Pesticides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta-BHC (Hexachlorocyclohexane)</td>
<td>0.046</td>
<td>0.004</td>
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</tr>
<tr>
<td>Chlordane</td>
<td>0.00048</td>
<td>0.00059</td>
<td>0.002</td>
<td>0.004</td>
</tr>
<tr>
<td>o,p DDT</td>
<td>0.001 WL</td>
<td>0.00059</td>
<td>0.001 WL</td>
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</tr>
<tr>
<td>o,p DDD</td>
<td>0.025 MCC</td>
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<tr>
<td>Hexachlorobenzene</td>
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<tr>
<td>Mirex</td>
<td>0.001 MCC</td>
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<td>0.001</td>
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<tr>
<td>Toxaphene</td>
<td>0.002 HH</td>
<td>0.00075</td>
<td>0.005</td>
<td>0.005</td>
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<tr>
<td>Polycyclic Aromatic Hydrocarbons</td>
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</tr>
<tr>
<td>Acenaphthene</td>
<td>9.7 MCC</td>
<td></td>
<td>0.031</td>
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<tr>
<td>Acenaphthylene</td>
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<td>0.031</td>
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<tr>
<td>Anthracene</td>
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<td>0.031</td>
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</tr>
<tr>
<td>Benzo(a)anthracene</td>
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<td>0.031</td>
<td></td>
<td></td>
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<tr>
<td>Benzo(a)pyrene</td>
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<td>0.031</td>
<td></td>
<td></td>
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<tr>
<td>Benzo(b)fluoranthene</td>
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</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
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<td></td>
</tr>
<tr>
<td>Benzo(hg)pyrene</td>
<td></td>
<td>0.031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chrysene</td>
<td></td>
<td>0.031</td>
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<td></td>
</tr>
<tr>
<td>Dibenz(a,h)anthracene</td>
<td></td>
<td>0.031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>1.6 MCC</td>
<td></td>
<td>54</td>
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</tr>
<tr>
<td>Fluorene</td>
<td></td>
<td>0.031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indeno(1,2,3-cd)pyrene</td>
<td></td>
<td>0.031</td>
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</tbody>
</table>

D. Most Stringent Criterion Lower Than Detection Limit

---

I-5
### Water Quality Standards and Criteria

<table>
<thead>
<tr>
<th>EPA (1989) Criteria</th>
<th>NY</th>
<th>NY</th>
<th>NJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening Value</td>
<td>Human standard</td>
<td>guidance std</td>
<td>value</td>
</tr>
<tr>
<td>Saltwater</td>
<td>(continuous)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### E. No Criteria Available

#### Metals
- Chromium (total)
- Iron

#### Industrial Chemicals
- Bis(2-chloroethoxy)methane
- 4-Bromophenyl phenyl ether
- Chloroethane
- 2-Chloroanaphthalene
- Chlorotoluenes
- 4-Chlorophenyl phenyl ether
- 1,1-Dichloroethane
- 2,6-Dinitrotoluene
- Isopropyl benzene
- 2-Nitrophenol
- N-Propyl benzene
- Styrene (vinyl benzene)
- 1,2,4-Trimethylbenzene
- 1,3,5-Trimethylbenzene
- Xylenes

#### Pesticides
- 2,4-Dichlorophenoxy acetic acid (2,4-D)
### CATEGORY II. NO AMBIENT DATA AVAILABLE

**A. Evidence of input**

<table>
<thead>
<tr>
<th>Industrial Chemicals</th>
<th>NY</th>
<th>NY</th>
<th>NJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrolein</td>
<td>0.55 MCC</td>
<td>780</td>
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<tr>
<td>Acrylonitrile</td>
<td>0.665</td>
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<td></td>
</tr>
<tr>
<td>Bis(2-chloroisopropyl)ethane</td>
<td>4360</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,3,7,8 Tetrachloro-dibenzo-p-dioxin (TCDD)</td>
<td>0.00001 HH</td>
<td>0.014 ppq</td>
<td></td>
</tr>
</tbody>
</table>

| Pesticides                           |          |          |          |
| Delta-BHC (Hexachloro-cyclohexane)   | 0.004    |          |          |
| Endosulfan sulfate                   | 0.001    |          |          |
| Endrin aldehyde                      | 0.002    |          |          |
| Heptachlor epoxide                   | 0.0036 HH | 0.000214 | 0.001   |

**B. No Evidence of input**

| Bis (chloromethyl) ether              | 0.0777   |          |          |
| N-Nitrosodimethylamine               | 8.1      |          |          |

---

**Abbreviations:**

- MOC = Marine Chronic Criteria based on protection of marine life.
- WL = Standard or Criterion based on protection of wildlife.
- HH = Standard or Criterion based on protection of human health.
- ppb = parts per billion
- ppttr = parts per trillion
- ppq = parts per quadrillion
- (T) = Categorization based on total metal concentration data.
- (d) = dissolved
- (as) = acid soluble

* Underline indicates the standard or criterion exceeded.
** Criterion or standard exceeded only once; remaining data are below the most stringent criteria.
*** Detection limits of individual studies are given in the Data Reference Section.
**** Categorization of compounds in II.A. was based on input data reported by Mueller et al (1982).
Water Quality Toxics Categorization Data Reference

Metals and Inorganic Compounds

Antimony

Category I.C.  Criterion: 4.308 ppb (HH)
EPA, 1989

   Conc: < 5 - 3,000 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Freshkills Creek, Coney Island Creek, Flushing Creek, Gowanus Canal, Arthur Kill

Arsenic

Category I.B.  Criterion: 63 ppb (dissolved)
NYS std

   Conc: 12 - 440 ppb (total)
   Year: 1982
   Location: Arthur Kill (NYS std exceeded at 5/14 stations in the Arthur Kill at high tide).

2. EPA Passaic River Study (1981)
   Conc: < 2 - 380 ppb (total)
   Year: 1981
   Location: Passaic River (NYS std exceeded at 3/19 stations Sites exceeding the standard were in Newark Bay.)

   Conc: <10 - 110 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Freshkills Creek, Flushing Creek, Coney Island Creek, Gowanus Canal, Arthur Kill

Beryllium

Category I.B.  Criterion: 0.12 ppb (HH)
EPA, 1989

   Conc: < 2 ppb - 30 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing
Cadmium

Category I.A.
Criterion: 2.7 ppb (acid soluble)
NYS std

1. Luther et al. (1987)
Conc: 0.74 – 3.78 ppb (dissolved)
Year: 1979
Location: Kill van Kull, Passaic River, Arthur Kill

2. Klinkhammer and Bender (1981)
Conc: 0.17 – 0.30 ppb (dissolved)
Year: 1974/1975
Location: Hudson River and Upper and Lower NY Bays

Conc: Range: 0.055 – 0.121 ppb (acid soluble)
Year: 1988
Location: Upper and Lower NY Bays

4. Segar and Cantillo (1976)
Conc: 1.1 – 10 ppb (dissolved)
Year: 1974
Location: Lower NY Bay

Conc: 0.13 – 7.60 ppb (total)
Year: 1988
Location: NYS std exceeded at 15/52 stations in the Harbor
(Upper East River Bays, Harlem River, Lower NY Bay,
The Kills, Jamaica Bay)

6. ISC (1987)
Conc: 0.5 – 1.7 ppb (total)
Year: 1987
Location: Hudson River, Upper and Lower NY Bays, Raritan Bay

7. ISC (1989)
Conc: <0.5 – 29 ppb (total)
Year: 1989
Location: Jamaica Bay

Conc: < 1 – 160 ppb (total)
Year: 1982-1986
Location: Bronx River, Newtown Creek, Flushing Creek,
Coney Island Creek, Freshkills Creek, Gowanus
Canal, Arthur Kill at Outerbridge Crossing

Chromium (Total)

Category I.E.

Conc: 1.7 – 40 ppb (total)
Year: 1988
Location: 52 Stations throughout the Harbor
2. ISC (1987)
   Conc: <1.0 - 7.7 ppb (total)
   Year: 1987
   Location: Hudson River, Upper and Lower NY Bays, Raritan Bay

   Conc: < 10 - 2,700 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Hutchison River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing

---

<table>
<thead>
<tr>
<th>Metal</th>
<th>Category</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>I.A.</td>
<td>2.0 ppb (acid soluble)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NYS std</td>
</tr>
</tbody>
</table>

   Conc: 2.05-4.44 ppb (acid soluble)
   Year: 1988
   Location: NYS std of 2.0 ppb exceeded at 5/5 sites in the Upper and Lower Bays.

2. Waldhauer et al. (1978)
   Conc: 2.7-55 ppb (acid soluble)
   Year: 1974
   Location: NYS std of 2.0 ppb exceeded at 32/32 sites in Raritan Bay and Lower Bay.

   Conc: 2.1 - 3.6 ppb (dissolved)
   Year: 1974/1975
   Location: Lower Hudson River, Upper and Lower Bays

4. Segar and Cantillo (1976)
   Conc: 3.7 - 5.1 ppb (dissolved)
   Year: 1974
   Location: Lower NY Bay

   Conc: 5.3-54 ppb (total metal)
   Year: 1988
   Location: NYS std of 2.0 ppb exceeded at 27/27 stations throughout the Harbor.

   Conc: < 10 - 250 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Flushing Creek, Freshkills Creek, Coney Island Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing

---

I-10
7. **ISC (1987)**
   - Conc: 2 - 89 ppb (total)
   - Year: 1987
   - Location: Hudson River, Upper and Lower Bays, Raritan Bay

8. **ISC (1989)**
   - Conc: <1.0 - 258 ppb (total)
   - Year: 1989
   - Location: Jamaica Bay

**Iron**

<table>
<thead>
<tr>
<th>Source</th>
<th>Conc/Year/Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battelle (1988)</td>
<td>Conc: 84.5 - 345.0 ppb (acid soluble) Year: 1988 Location: Upper and Lower NY Bays</td>
</tr>
</tbody>
</table>

**Lead**

<table>
<thead>
<tr>
<th>Source</th>
<th>Conc/Year/Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walchauer et al. (1978)</td>
<td>Conc: 1.7 - 13.9 ppb (acid soluble) Year: 1974 Location: NYS std exceeded at 3/32 sites in Raritan Bay/Lower Bay. Sites exceeding the standard were located in western Raritan Bay.</td>
</tr>
<tr>
<td>Luther et al. (1987)</td>
<td>Conc: 2.3 - 17.6 ppb (dissolved) Year: 1979 Location: Kill Van Kull, Passaic River, Arthur Kill</td>
</tr>
</tbody>
</table>
   Conc: 5.2-29 ppb (total)
   Year: 1988
   Location: NYS std exceeded at 24/27 sites throughout the Harbor.

5. **ISC (1987)**
   Conc: 5 - 63 ppb (total)
   Year: 1987
   Location: Hudson River, Upper and Lower Bays, Raritan Bay

6. **ISC (1989)**
   Conc: 409-511 ppb (total)
   Year: 1989
   Location: Jamaica Bay

   Conc: < 10 - 800 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Flushing Creek, Coney Island Creek, Gowanus Canal, Arthur Kill, Freshkill Creek

---

**Mercury**

<table>
<thead>
<tr>
<th>Category</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.B.</td>
<td>0.025 ppb (HH) EPA (1989)</td>
</tr>
</tbody>
</table>

1. **Battelle (1988)**
   Conc: 0.062 - 0.0497 (acid soluble)
   Year: 1988
   Location: EPA criteria exceeded at 1/5 stations in the Upper and Lower Bays

---

**Nickel**

<table>
<thead>
<tr>
<th>Category</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.B.</td>
<td>7.1 ppb (acid soluble) NYS std</td>
</tr>
</tbody>
</table>

1. **Klinkhammer and Bender (1981)**
   Conc: 3.3 ± 1.2 - 5.9 ± 3.0 ppb (dissolved)
   Year: 1974/1975
   Location: Lower Hudson River, Upper and Lower Bays

   Conc: 1.46-2.60 ppb (acid soluble)
   Year: 1988
   Location: No exceedances at 5 sites in the Upper and Lower Bays.

   Conc: 1.4-38 ppb (total)
   Year: 1988
   Location: NYS std exceeded at 22/27 stations throughout the Harbor.
4. ISC (1987)
   Conc: 5 - 15 ppb (total)
   Year: 1986-1987
   Location: Hudson River, Upper and Lower Bays, Raritan Bay

   Conc: < 1 - 430 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Flushing Creek,
             Freshkills Creek, Coney Island Creek, Gowanus
             Canal, Arthur Kill at Outerbridge Crossing

<table>
<thead>
<tr>
<th>Selenium</th>
<th>Category I.C.</th>
<th>Criterion: 71 ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EPA, 1989</td>
</tr>
</tbody>
</table>

   Conc: < 5 - 35 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

<table>
<thead>
<tr>
<th>Silver</th>
<th>Category I.B.</th>
<th>Criterion: 2.3 ppb (acid soluble)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NYS std</td>
</tr>
</tbody>
</table>

   Conc: Range: 0.14 - 82 ppb (total)
   Year: 1988
   Location: NYS std exceeded at 27/52 stations throughout the
             Harbor (Jamaica Bay, The Kills, Gowanus Canal,
             Hudson River, Harlem River, East River)

2. ISC (1987)
   Conc: Range: 1.0 - 10 ppb (total)
   Year: 1987
   Location: Hudson River, Upper and Lower Bays, Raritan Bay

   Conc: Range: < 1 - 150 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

I-13
Thallium

Category I.C.
Criterion: 21.3 ppb (MCC)
EPA, 1989

1. NYS DEC Toxic Surveillance Network (1986)
   Conc: < 10 ppb (total)
   Year: 1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

Zinc

Category I. B.
Criterion: 58 ppb (acid soluble)
NYS std

1. ISC (1989)
   Conc: 233 - 366 ppb (total)
   Year: 1989
   Location: Jamaica Bay

2. ISC (1987)
   Conc: 1 - 168 ppb (total)
   Year: 1987
   Location: Hudson River, Upper and Lower NY Bays, Raritan Bay

   Conc: < 20 - 550 ppb (total)
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Flushing Creek, Coney
   Island Creek, Gowanus Canal, Arthur Kill, Freshkills Creek

   Conc: 4.4 - 98 ppb (total)
   Year: 1988
   Location: NYS std exceeded at 4/52 stations in the Harbor
   (Lower East River, Upper East River Bays, Western
   Long Island Sound, Harlem River)

   Conc: 140 - 390 ppb (total)
   Year: 1982
   Location: Arthur Kill

   Conc: 14 - 25 ppb (dissolved)
   Year: 1974
   Location: Lower NY Bay

   Conc: 4.7 - 18.77 ppb (acid soluble)
   Year: 1988
   Location: Upper and Lower NY Bays

I-14

116 827270119
8. Klinkhammer and Bender (1981)
Conc: 8.5 - 19 ppb (dissolved)
Year: 1974-1975
Location: Hudson River, Upper and Lower NY Bays

---

**Organic Compounds**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Category I.D.</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td></td>
<td>0.031 ppb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EPA, 1989</td>
</tr>
</tbody>
</table>

Conc: <10 ppb
Year: 1982-1986
Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing.

Conc: <10 ppb
Year: 1982
Location: 14 stations in the Arthur Kill

---

<table>
<thead>
<tr>
<th>Compound</th>
<th>Category I.D.</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphylene</td>
<td></td>
<td>0.031 ppb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EPA, 1989</td>
</tr>
</tbody>
</table>

Conc: <10 ppb
Year: 1982-1986
Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing.

Conc: <10 ppb
Year: 1982
Location: 14 stations in the Arthur Kill

---

<table>
<thead>
<tr>
<th>Compound</th>
<th>Category I.A.</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin</td>
<td></td>
<td>0.001 ppb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NYS std for Dieldrin + Aldrin</td>
</tr>
</tbody>
</table>

Conc: 0.16 ppb
Year: 1983
Location: Freshkills Creek

Conc: <0.00065 ppb
Year: 1985-1987
Location: 52 stations throughout the Harbor

---

I-15
   Conc: < 0.00036 - 0.0519 ppb
   Year: 1987
   Location: EPA criteria exceeded at 2/9 stations in the Harbor
             (1 station in the Harlem River; 1 station in the
             Gowanus canal).

2. ISC (1982)
   Conc: < d.l. - 19.2 ppb
   Year: 1982
   Location: EPA criterion exceeded in 3/37 stations in the Harbor
             (2 stations in Lower Bay and 1 station in Raritan Bay)

3. ISC (1981)
   Conc: < d.l. - 0.055 ppb
   Year: 1981
   Location: EPA criteria exceeded at 1/31 stations in the Harbor
             (1 station in the Arthur Kill)

---

**Anthracene**

   Conc: <10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing.

   Conc: <10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

---

**Benzo(a)anthracene**

   Conc: <30 ppb
   Year: 1982-1985
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing.

   Conc: <30 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

---

I-16
Benzo(a)pyrene  Category I.D.  Criterion: 0.031 ppb  EPA, 1989

Conc: <30 ppb  
Year: 1982-1986  
Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, 
Arthur Kill at Outerbridge Crossing.

Conc: <30 ppb  
Year: 1982  
Location: 14 stations in the Arthur Kill

Benzo(b)fluoranthene  Category I.D.  Criterion: 0.031 ppb  EPA, 1989

Conc: <30 ppb  
Year: 1982-1986  
Location: Bronx River, Newtown Creek, Coney Island Creek, 
Freshkills Creek, Flushing Creek, Gowanus Canal, 
Arthur Kill at Outerbridge Crossing.

Conc: <30 ppb  
Year: 1982  
Location: 14 stations in the Arthur Kill

Benzo(k)fluoranthene  Category I.D.  Criterion: 0.031 ppb  EPA, 1989

Conc: <30 ppb  
Year: 1982-1986  
Location: Bronx River, Newtown Creek, Coney Island Creek, 
Freshkills Creek, Flushing Creek, Gowanus Canal, 
Arthur Kill at Outerbridge Crossing.

Conc: <30 ppb  
Year: 1982  
Location: 14 stations in the Arthur Kill

Benzo(hgi)perylene  Category I.D.  Criterion: 0.031 ppb  EPA, 1999

Conc: <30 ppb  
Year: 1982-1986  
Location: Bronx River, Newtown Creek, Coney Island Creek, 
Freshkills Creek, Flushing Creek, Gowanus Canal, 
Arthur Kill at Outerbridge Crossing.

I-17  19

827270122
   Conc: <30 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

beta-BHC

<table>
<thead>
<tr>
<th>Category I.D.</th>
<th>Criterion: 0.004 ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYS std</td>
<td></td>
</tr>
</tbody>
</table>

   Conc: < 0.0047 ppb
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

   Conc: < d.l. (10 ppb)
   Location: 31 stations throughout the Harbor

gamma-BHC (Lindane)

<table>
<thead>
<tr>
<th>Category I.A.</th>
<th>Criterion: 0.004 ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYS std</td>
<td></td>
</tr>
</tbody>
</table>

   Conc: 0.06-0.07 ppb
   Year: 1983
   Location: Freshkills Creek

   Conc: <0.00048 ppb
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

Benzene

<table>
<thead>
<tr>
<th>Category I.B.</th>
<th>Criterion: 6 ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYS guidance value</td>
<td></td>
</tr>
</tbody>
</table>

   Conc: <1.0 - 78 ppb
   Year: 1984, 1986, 1988
   Location: NYS guidance value exceeded at 10/52 stations throughout the Harbor (Jamaica Bay, Raritan Bay, East River, Harlem River and Hudson River).

   Conc: <1.0 - 14 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing.

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill
Benzidine Category I.D. Criterion: 0.000535 ppb
EPA, 1989

   Conc: < 200 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing.

   Conc: <200 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

Bis(2-chloroethyl) ether Category I.D. Criterion: 1.42 ppb
EPA, 1989

   Conc: <10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing.

   Conc: <10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

Bis(2-ethylhexyl) phthalate Category I.B. Criterion: 5.92 ppb (HH)
EPA, 1989

   Conc: 13 - 140 ppb
   Year: 1984
   Location: Gowanus Canal, Coney Island Creek, Freshkills Creek

Bromodichloromethane Category I.C. Criterion: 470.8 ppb
EPA, 1989

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: <1.0 - 3 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

I-19
   Conc: < 1.0 - 31 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

Bromoform

Category I.C.

Criterion: 470 ppb
EPA, 1989

   Conc: <1.0 - 3.7 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

2. NYS DEC Toxics Surveillance Network (1982-1986)
   Conc: <1.0 - 5 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

   Conc: <1.0 - 60 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

Bromomethane (Methyl bromide)

Category I.C.

Criterion: 120 ppb (MCC)
EPA, 1989

   Conc: < 1 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

2. NYS DEC Toxics Surveillance Network (1982-1986)
   Conc: < 1 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

sec-Butyl Benzene

Category I.E.

1. NYS DEC Toxics Surveillance Network (1982-1986)
   Conc: < 1.0 - 3 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing
<table>
<thead>
<tr>
<th>Substance</th>
<th>Category</th>
<th>Criterion</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyl benzyl phthalate</td>
<td>I.D.</td>
<td>29.4 ppb (MCC)</td>
<td>EPA, 1989</td>
</tr>
<tr>
<td>Conc.: &lt;30 ppb</td>
<td>Year: 1982-1986</td>
<td>Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing.</td>
<td></td>
</tr>
<tr>
<td>Conc.: &lt; 30 ppb</td>
<td>Year: 1982</td>
<td>Location: 14 stations in the Arthur Kill</td>
<td></td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td>I.B.</td>
<td>4.42 ppb (HH)</td>
<td>EPA, 1989</td>
</tr>
<tr>
<td>Conc.: &lt; 1.0 ppb</td>
<td>Year: 1982</td>
<td>Location: 14 stations in the Arthur Kill</td>
<td></td>
</tr>
<tr>
<td>Conc.: &lt; 1.0 - 4 ppb</td>
<td>Year: 1982-1986</td>
<td>Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing</td>
<td></td>
</tr>
<tr>
<td>Conc.: &lt; 1.0 - 1,696 ppb</td>
<td>Year: 1984, 1986, 1988</td>
<td>Location: 52 stations throughout the Harbor</td>
<td></td>
</tr>
<tr>
<td>Chlordane</td>
<td>I.D.</td>
<td>0.002 ppb</td>
<td>NYS std</td>
</tr>
<tr>
<td>Conc.: &lt; 0.027 ppb</td>
<td>Year: 1985-1987</td>
<td>Location: 52 stations throughout the Harbor</td>
<td></td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>I.B.</td>
<td>20 ppb (HH)</td>
<td>EPA, 1989</td>
</tr>
<tr>
<td>Conc.: &lt; 1.0 ppb</td>
<td>Year: 1982</td>
<td>Location: 14 stations in the Arthur Kill</td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>827270126</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
   Conc: < 1.0 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
            Freshkills Creek, Flushing Creek, Gowanus Canal,
            Arthur Kill at Outerbridge Crossing

   Conc: < 1.0 - 66 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

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2-Chloroethylvinyl ether

   Conc: < 1 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
            Freshkills Creek, Flushing Creek, Gowanus Canal,
            Arthur Kill at Outerbridge Crossing

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Chloroform

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1.0 - 21 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
            Freshkills Creek, Flushing Creek, Gowanus Canal,
            Arthur Kill at Outerbridge Crossing

   Conc: < 1.0 - 75.7 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

---

2-Chloronaphthalene

   Conc: ≤0.012 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor
   Conc: < 10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

---

### Chlorophenol

<table>
<thead>
<tr>
<th>Category</th>
<th>I.D.</th>
<th>Criterion: 0.1 ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc: &lt; 10 ppb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year: 1982-1986</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Location: Bronx River, Newtown Creek, Coney Island Creek,
Freshkills Creek, Flushing Creek, Gowanus Canal,
Arthur Kill at Outerbridge Crossing. | | |

### Chlorotoluenes

<table>
<thead>
<tr>
<th>Category</th>
<th>I.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc: &lt; 1.0 - 3 ppb</td>
<td></td>
</tr>
<tr>
<td>Year: 1982-1986</td>
<td></td>
</tr>
</tbody>
</table>
| Location: Bronx River, Newtown Creek, Coney Island Creek,
Freshkills Creek, Flushing Creek, Gowanus Canal,
Arthur Kill at Outerbridge Crossing | |

### Chrysene

<table>
<thead>
<tr>
<th>Category</th>
<th>I.D.</th>
<th>Criterion: 0.031 ppb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc: &lt; 30 ppb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year: 1982-1986</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Location: Bronx River, Newtown Creek, Coney Island Creek,
Freshkills Creek, Flushing Creek, Gowanus Canal,
Arthur Kill at Outerbridge Crossing. | | |

   Conc: < 30 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill
1. **ISC (1982)**
   - Conc: < d.l. - 2.4 ppb
   - Year: 1982
   - Location: NYS std exceeded at 1/37 stations in the Harbor (Kill Van Rull)

   - Conc: < d.l. - 0.002 (1985)
     - 0.000835 (1986)
   - Location: 52 stations in the Harbor

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   - Conc: < 0.00124 - 0.0334 ppb
   - Year: 1985-1987
   - Location: 52 stations throughout the Harbor (exceedances at 8 stations in 1987)

   - Conc: < d.l.
   - Location: 31 stations throughout the Harbor

   - Conc: < d.l.
   - Year: 1983
   - Location: Freshkills Creek

---

   - Conc: < 0.0032 ppb (1985)
     - < 0.00155 ppb (1986)
   - Location: 52 stations throughout the Harbor

---

   - Conc: 0.06 ppb
   - Year: 1983
   - Location: Freshkills Creek at Freshkills
   Conc: < 0.004 (1985)
   < 0.00155 (1986)
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

   Conc: < d.l.
   Location: 31 stations throughout the Harbor

   Conc: < 0.0036 ppb (1985)
   < 0.0015 ppb (1986)
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

Dibenzo(a,h)anthracene
   Category I.D.
   Criterion: 0.031 ppb (EPA, 1989)

   Conc: <30 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing.

   Conc: <30 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

Dibromochloromethane
   Category I.C.
   Criterion: 470.8 ppb (EPA, 1989)

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1.0 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing.
Di-n-Butylphthalate Category I.D. Criterion: 3.4 ppb
EPA, 1989

   Conc: < 30 ppb
   Year: 1984
   Location: Gowanus Canal, Coney Island Creek, Freshkills Creek

1,2 Dichlorobenzene Category I.C. Criterion: 5 ppb
   NYS guidance value

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1.0 - 2 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

   Conc: <0.1 - 0.99 ppb
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

1,3 Dichlorobenzene Category I.C. Criterion: 5 ppb
   NYS guidance value

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations throughout the Harbor

   Conc: < 1.0 ppb - 2 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

   Conc: < 0.08 ppb
   Year: 1985-1987
   Location: 52 stations throughout the Harbor
1.4 Dichlorobenzene

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1.0 - 2 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

   Conc: < 0.19 - 31 ppb
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

3.3 Dichlorobenzidine

   Conc: < 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing.

Dichlorodifluoromethane

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1.0 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

1,1 Dichloroethane

   Conc: < 1.0 - 1.0 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing.
<table>
<thead>
<tr>
<th>Compound</th>
<th>Category</th>
<th>Criterion</th>
<th>Year</th>
<th>Location</th>
</tr>
</thead>
</table>
| 1,2 Dichloroethane         | I.C.     | 98.6 ppb  | 1989 | EPA Arthur Kill Water Quality Survey (1982)  
Conc: < 1.0 ppb  
Year: 1982  
Location: 14 stations in the Arthur Kill  
NYS DEC Toxic Surveillance Network (1982-1986)  
Conc: <1.0 - 2.0 ppb  
Year: 1982-1986  
Location: Bronx River, Newtown Creek, Flushing Creek, Coney Island Creek, Gowanus Canal, Arthur Kill, Freshkills Creek.  
Conc: <1.0 - 33 ppb  
Year: 1982, 1984, 1986  
Location: 52 stations throughout the Harbor |
| 1,1 Dichloroethylene       | I.C.     | 3.2 ppb   | 1989 | EPA, 1989  
Conc: < 1 ppb  
Year: 1982  
Location: 14 stations in the Arthur Kill  
NYS DEC Toxic Surveillance Network (1982-1986)  
Conc: < 1 ppb  
Year: 1982-1986  
Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing |
| 1,2-trans-Dichloroethylene | I.C.     | 136,319 ppb | 1989 | EPA, 1989  
Conc: < 1.0 ppb  
Year: 1982  
Location: 14 stations in Arthur Kill  
NYS DEC Toxic Surveillance Network (1982-1986)  
Conc: < 1.0 - 4 ppb  
Year: 1982-1986  
Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing.  
Conc: < 1.0 - 19 ppb  
Year: 1984, 1986, 1988  
Location: 52 stations throughout the Harbor |
2,4 Dichlorophenol

Category I.D.  
Criterion: 0.3 ppb
EPA, 1989

   Conc: <10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing.

2,4 Dichlorophenoxy acetic acid (2,4-D)

Category I.E.

1. NYS DEC Toxic Surveillance Network (1983)
   Conc: 1.2 ppb
   Year: 1983
   Location: Freshkills Creek

1,2 Dichloropropane

Category I.C.
Criterion: 2,400 ppb
EPA, 1989

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1.0 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing

   Conc: < 1.0 - 43
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

1,3 Dichloropropylene (cis, trans)

Category I.C.
Criterion: 7.9 ppb
EPA, 1989

   Conc: < 1 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing
Dieldrin

Category I.A.
Criterion: 0.001 ppb
NYS std for Dieldrin + Aldrin

   Conc: Range: <0.000775 - 0.028 ppb
   Year: 1985-1986
   Location: EPA gold book criteria for human health exceeded
   at 6/52 stations throughout the Harbor (3 Stations
   in the Hudson River; 2 in the Harlem River and
   1 in the Kill Van Kull).

Diethylphthalate

Category I.C.
Criterion: 75.9 ppb MCC
EPA, 1989

   Conc: 4 ppb
   Year: 1984
   Location: Coney Island Creek

   Conc: < 10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

2.4 Dimethylphenol

Category I.D.
Criterion: 5 ppb
NYS std

   Conc: <10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: <10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

Dimethyl phthalate

Category I.C.
Criterion: 580 ppb MCC
EPA, 1989

1. NYS DEC Toxic Surveillance Network (1983)
   Conc: <10 ppb
   Year: 1983
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

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827270135
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Category I.D.</th>
<th>Criterion</th>
<th>Source Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4 Dinitrophenol</td>
<td></td>
<td>5 ppb</td>
<td>NYS std</td>
</tr>
<tr>
<td>2. NYS DEC Toxic Surveillance Network (1982-1986)</td>
<td>Conc: &lt;10 ppb</td>
<td>Year: 1982-1986</td>
<td>Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing</td>
</tr>
<tr>
<td>2,4 Dinitrotoluene</td>
<td></td>
<td>9.1 ppb</td>
<td>EPA, 1989</td>
</tr>
<tr>
<td>1. NYS DEC Toxic Surveillance Network (1982-1986)</td>
<td>Conc: &lt;10 ppb</td>
<td>Year: 1982-1986</td>
<td>Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing</td>
</tr>
<tr>
<td>Di-n-octyl phthalate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Diphenylhydrazine</td>
<td></td>
<td>0.54 ppb</td>
<td>EPA, 1989</td>
</tr>
<tr>
<td>1. NYS DEC Toxic Surveillance Network (1982-1986)</td>
<td>Conc: &lt;10 ppb</td>
<td>Year: 1982-1986</td>
<td>Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td></td>
<td>4.3 ppb MCC</td>
<td>EPA, 1989</td>
</tr>
</tbody>
</table>
   Conc: < 1.0 - 20 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing.

   Conc: < 1.0 - 102 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

---

**Endosulfan**

<table>
<thead>
<tr>
<th>Category</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.A.</td>
<td>0.001 ppb</td>
</tr>
</tbody>
</table>

   Conc: Endosulfan I: 0.97 ppb
   Endosulfan II: 0.61 ppb
   Year: 1983
   Location: Freshkills Creek

   Conc: < 0.008 ppb
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

   Conc: < d.l.
   Year: 1985-1987
   Location: 31 stations throughout the Harbor

---

**Endrin**

<table>
<thead>
<tr>
<th>Category</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.C.</td>
<td>0.002 ppb</td>
</tr>
</tbody>
</table>

   Conc: <0.0032 ppb (1985)
   <0.00165 ppb (1986)
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

---

**Fluoranthene**

<table>
<thead>
<tr>
<th>Category</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.D.</td>
<td>1.6 ppb (MCC)</td>
</tr>
</tbody>
</table>

   Conc: <10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing.

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184 827270137
   Conc: <10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

Fluorene
   Category I.D.
   Criterion: 0.031 ppb
   EPA, 1989

   Conc: <10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing.

   Conc: <10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

Heptachlor
   Category I.A.
   Criterion: 0.001 ppb
   NYS std for Heptachlor
   + Heptachlor epoxide

   Conc: <0.000385 - 0.0011 ppb
   Year: 1985/1986
   Location: NYS std of 0.001 ppb exceeded at 1/52 stations in
   the Harbor (1 station in Jamaica Bay).

Hexachlorobenzene
   Category I.D.
   Criterion: 0.00074 ppb
   EPA, 1989

   Conc: < 0.0016
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

   Conc: < 10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing
### Hexachlorobutadiene

**Category I.A.**

**Criterion:** 0.03 ppb

   - **Conc:** <0.05 ppb
   - **Year:** 1985-1986
   - **Location:** 52 stations throughout the Harbor

   - **Conc:** < 10 ppb
   - **Year:** 1982
   - **Location:** 14 stations in the Arthur Kill

   - **Conc:** < 5 - 8 ppb
   - **Year:** 1982-1986
   - **Location:** Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing

### Hexachlorocyclopentadiene

**Category I.C.**

**Criterion:** 0.07 ppb

   - **Conc:** <0.024 ppb
   - **Year:** 1985-1987
   - **Location:** 52 stations throughout the Harbor

   - **Conc:** < 10 ppb
   - **Year:** 1982
   - **Location:** 14 stations in the Arthur Kill

   - **Conc:** < 10 ppb
   - **Year:** 1982-1986
   - **Location:** Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing

### Hexachloroethane

**Category I.C.**

**Criterion:** 8.8 ppb

   - **Conc:** < 10 ppb
   - **Year:** 1982
   - **Location:** 14 stations in the Arthur Kill
   Conc: < 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

   Conc: < 0.0015 - 0.028
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

<table>
<thead>
<tr>
<th>Compound</th>
<th>Category I.D.</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indeno(1,2,3-cd)pyrene</td>
<td></td>
<td>0.031 ppb</td>
</tr>
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<td></td>
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<td>EPA, 1989</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Compound</th>
<th>Category I.C.</th>
<th>Criterion</th>
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</thead>
<tbody>
<tr>
<td>Isophorone</td>
<td></td>
<td>129 ppb</td>
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<td></td>
<td></td>
<td>EPA, 1989</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compound</th>
<th>Category I.E.</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iso-propylbenzene</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Compound</th>
<th>Category I.C.</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methoxychlor</td>
<td></td>
<td>0.03 ppb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NYS std</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Compound</th>
<th>Category</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I-35</td>
<td>187</td>
</tr>
</tbody>
</table>

827270140
Methyl chloride (Chloromethane)  Category I.C.  Criterion: 470.8 ppb
EPA, 1989

   Conc: < 1.0 - 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

3-Methyl-4-chlorophenol  Category I.C.  Criterion: 3000 ppb
(p-Chloro-m-cresol)

   Conc: < 10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

2-Methyl-4,6-dinitrophenol  Category I.C.  Criterion: 765 ppb
(4,6-Dinitro-o-cresol)

   Conc: < 10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

Methylene chloride (Dichloromethane)  Category I.B.  Criterion: 1578 ppb
EPA, 1989

   Conc: < 1.0 - 14 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

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   Conc: < 1.0 - 9.332 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

Mirex
Category I.D.
Criterion: 0.001 ppb
NYS std

   Conc: < 0.008 ppb (1985)
       < 0.0064 ppb (1986)
   Year: 1985-1987
   Location: 52 stations throughout the Harbor

Naphthalene
Category I.B.
Criterion: 23.5 ppb
EPA, 1989

   Conc: < 5.0 - 26 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

   Conc: < 5 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

N-Nitrosodi-N-propylamine
Category I.B.
Criterion: 8.6 ppb
EPA, 1989

   Conc: < 10 - 20 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

   Conc: < 10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

Pentachlorophenol
Category I.D.
Criterion: 7.9 ppb (MCC)
EPA, 1989

   Conc: <10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing.
Phenanthrene

Category I.B.  Criterion: 0.031 ppb (HH)
EPA, 1989

   Conc: < 10 ppb - 11 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

   Conc: < 10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

---

Phenol

Category I.C.  Criterion: 5 ppb
              NYS guidance value

   Conc: < d.l. - 4.7 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

---

Polychlorinated Biphenyls (PCBs)

Category I.A.  Criterion: 0.001 ppb
                NYS std

   Conc: 1.3 ppb (Aroclor 1221)
   0.48 ppb (Aroclor 1221)
   0.67 ppb (Aroclor 1016/1242)
   Year: 1983, 1984
   Location: Freshkills Creek

   Conc: < 0.002 ppb (1985)
   < 0.02 ppb (1986)
   Year: 1985-1986
   Location: 52 stations in the Harbor

---

N-Propylbenzene

Category I.E.

   Conc: <1.0 - 8 ppb
   Year: 1984, 1985, 1988
   Location: 52 stations throughout the Harbor

---

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827270143
Pyrene

Category I.B.

Criterion: 0.031 ppb (HH)
EPA, 1989

   Conc: < 10 ppb - 17 ppb
   Year: 1983
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

   Conc: < 10 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

Styrene (Vinyl benzene)

Category I.E.

   Conc: < 1.0 - 4 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

1,1,2,2 Tetrachloroethane

Category I.B.

Criterion: 10.8 ppb
EPA, 1989

   Conc: <1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: <1.0 - 22 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

   Conc: < 1.0 - 53 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

Tetrachlorethylene

Category I.B.

Criterion: 1 ppb
NYS guidance value

   Conc: <1.0 - 100 ppb
   Year: 1984, 1986, 1988
   Location: NYS guidance value exceeded at 34/52 stations
   throughout the Harbor in 1988.
Conc: < 1.0 ppb
Year: 1982
Location: 14 stations in the Arthur Kill

Conc: <1.0 - 70 ppb
Year: 1982-1986
Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing

Toluene
Category I.B.
Criterion: 37 ppb (MCC)
EPA, 1989

Conc: < 1.0 - 2.0 ppb
Year: 1982
Location: 14 stations in the Arthur Kill

2. NYS DEC Toxics Surveillance Network (1982-1986)
Conc: < 1.0 - 20 ppb
Year: 1982-1986
Location: Bronx River, Newtown Creek, Coney Island Creek,
   Freshkills Creek, Flushing Creek, Gowanus Canal,
   Arthur Kill at Outerbridge Crossing.

Conc: < 1.0 - 155 ppb
Year: 1984, 1986, 1988
Location: 52 stations throughout the Harbor

Toxaphene
Category I.D.
Criterion: 0.002 ppb
NYS std

Conc: < 0.2 ppb
Year: 1985-1987
Location: 52 stations throughout the Harbor

1,2,4 Trichlorobenzene
Category I.C.
Criterion: 4.5 ppb
EPA, 1989

Conc: < 0.017 - 0.098 ppb
Year: 1985-1987
Location: 52 stations throughout the Harbor

Conc: < 10 ppb
Year: 1982
Location: 14 stations in the Arthur Kill

I-40  142  827270145
   Conc: < 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

---

1,1,1 Trichloroethane  Category I.C.  Criterion: 312 ppb
\[ \text{EPA, 1989} \]

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: <1.0 - 18 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing.

   Conc: < 1.0 - 251 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor

---

1,1,2 Trichloroethane  Category I.B.  Criterion: 42 ppb
\[ \text{EPA, 1989} \]

   Conc: <1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: <1.0 ppb
   Year: 1982
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing.

   Conc: < 1.0 - 63 ppb
   Year: 1984, 1986, 1988
   Location: 52 stations throughout the Harbor
Trichloroethylene Category I.A. Criterion: 11 ppb NYS std

   Conc: <1.0 - 53 ppb
   Year: 1984, 1986, 1988
   Location: NYS std exceeded at 5/52 stations throughout the Harbor in 1988 (3 stations in East River, 2 stations in Raritan Bay).

   Conc: < 1 - 11 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing

   Conc: <1.0 - 2.5 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

Trichlorofluorocromethane Category I.C. Criterion: 470.8 ppb EPA, 1989

   Conc: < 1 - 37 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: < 1.0 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing

1,2,4 Trimethylbenzene Category I.E.

   Conc: < 1.0 - 10 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing

1,3,5 Trimethylbenzene Category I.E.

   Conc: < 1.0 - 3 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek, Freshkills Creek, Flushing Creek, Gowanus Canal, Arthur Kill at Outerbridge Crossing
Vinyl Chloride

Category I.C.

Criterion: 525 ppb
EPA, 1989

   Conc: < 1.0 ppb
   Year: 1982
   Location: 14 stations in the Arthur Kill

   Conc: <1.0 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

Xylenes

Category I. E.

   Conc: ortho < 1.0 - 8 ppb
         meta < 1.0 - 5 ppb
         para < 1.0 - 3 ppb
   Year: 1982-1986
   Location: Bronx River, Newtown Creek, Coney Island Creek,
             Freshkills Creek, Flushing Creek, Gowanus Canal,
             Arthur Kill at Outerbridge Crossing

I-43
References


EPA (Environmental Protection Agency). 1981. Data from the Passaic River Sampling Stations, March 4 and December 1, 1981.


Appendix II
Appendix II

Fish Tissue Toxics Categorization for the NY/NJ Harbor Estuary

<table>
<thead>
<tr>
<th>Fish Tissue Standards and Criteria</th>
<th>FDA standard</th>
<th>EPA 1989 standard</th>
<th>NY criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>in parts per million (ppm) or mg/kg</td>
<td></td>
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Category I - AMBIENT DATA AVAILABLE

A. Exceeds Enforceable Standards

**Metals and Inorganics**

<table>
<thead>
<tr>
<th>Substance</th>
<th>FDA</th>
<th>EPA</th>
<th>NY</th>
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</thead>
<tbody>
<tr>
<td>Mercury (Total)</td>
<td>1.0</td>
<td>1.0</td>
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**Organic Compounds**

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<thead>
<tr>
<th>Substance</th>
<th>FDA</th>
<th>EPA</th>
<th>NY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlordane</td>
<td>0.3</td>
<td>0.0083</td>
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<tr>
<td>Dieldrin</td>
<td>0.3</td>
<td></td>
<td>0.3</td>
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</table>

**Industrial Chemicals**

<table>
<thead>
<tr>
<th>Substance</th>
<th>FDA</th>
<th>EPA</th>
<th>NY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polychlorinated Biphenyls (PCBs)</td>
<td>2.0</td>
<td>0.0014</td>
<td>2.0</td>
</tr>
<tr>
<td>2,3,7,8-TCDD (Dioxin)</td>
<td>25 ppdr</td>
<td>0.07 ppotr</td>
<td>10 ppotr</td>
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</tbody>
</table>
Toxics Categorization for the NY/NJ Harbor Estuary

Fish Tissue Standards and Criteria
in parts per million (ppm) or mg/kg

<table>
<thead>
<tr>
<th></th>
<th>FDA standard</th>
<th>EPA 1989 standard</th>
<th>NY 1989 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

B. Exceeds More Stringent but Unenforceable Criteria

Metals and Inorganics

<table>
<thead>
<tr>
<th>Element</th>
<th>NY 1989 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>0.0062</td>
</tr>
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</table>

Organic Compounds

**Polycyclic Aromatic Hydrocarbons**

<table>
<thead>
<tr>
<th>Compound</th>
<th>NY 1989 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthylene</td>
<td>0.00093</td>
</tr>
<tr>
<td>Anthracene</td>
<td>0.00093</td>
</tr>
<tr>
<td>Benzo(a)anthracene</td>
<td>0.00093</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>0.00093</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
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<tr>
<td>Benzo(e)pyrene</td>
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<tr>
<td>Chrysene</td>
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<tr>
<td>Dibenz(a,h)anthracene</td>
<td>0.00093</td>
</tr>
<tr>
<td>Fluorene</td>
<td>0.00093</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>0.00093</td>
</tr>
<tr>
<td>Pyrene</td>
<td>0.00093</td>
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</table>

**Pesticides**

<table>
<thead>
<tr>
<th>Compound</th>
<th>NY 1989 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDT + metabolites (DDD + DDE)</td>
<td>0.0316</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>0.0024</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>0.0024</td>
</tr>
<tr>
<td>Hexachlorobenzene (HCB)</td>
<td>0.0064</td>
</tr>
<tr>
<td>gamma-Hexachlorocyclohexane (Lindane)</td>
<td>0.0081</td>
</tr>
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</table>

**Industrial Chemicals**

<table>
<thead>
<tr>
<th>Compound</th>
<th>NY 1989 standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetrachlorodibenzo-furans (TCDF)</td>
<td>250 ppotr** 0.7 ppotr 100ppotr</td>
</tr>
</tbody>
</table>
Toxics Categorization for the NY/NJ Harbor Estuary

Fish Tissue Standards and Criteria
in parts per million (ppm) or mg/kg

<table>
<thead>
<tr>
<th></th>
<th>FDA standard</th>
<th>EPA 1989</th>
<th>NY standard criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals and Inorganics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antimony</td>
<td>4.3</td>
<td></td>
<td></td>
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<tr>
<td>Nickel</td>
<td>215.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td>5.4</td>
<td></td>
<td></td>
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<tr>
<td>Silver</td>
<td>2.48</td>
<td></td>
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<tr>
<td>Thallium</td>
<td>5.71</td>
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</table>

Organic Compounds

Polycyclic Aromatic Hydrocarbons

Flouranthene   | 62.1          |

Pesticides

Endrin         | 0.3          |
Mirex          | 0.1          |

Industrial Chemicals

Dichlorobenzenes | 145          |

D. Most Stringent Criterion Lower Than Detection Limits

Organic Compounds

Pesticides

Aldrin         | 0.00064      |
Toxaphene      | 5.0          |

II-3
Toxics Categorization for the NY/NJ Harbor Estuary

Fish Tissue Standards and Criteria
in parts per million (ppm) or mg/kg

<table>
<thead>
<tr>
<th></th>
<th>FDA standard</th>
<th>EPA 1989</th>
<th>NY standard criteria</th>
</tr>
</thead>
</table>

E. No Criterion Available

Metals and Inorganics

Cadmium
Chromium (total)
Copper
Iron
Lead
Manganese
Tin
Vanadium
Zinc

Organic Compounds

Petroleum Derivatives
LMW PAHs
Acenaphthene
Biphenyl
1-Methylnaphthalene
2-Methylnaphthalene
1-Methylnaphthene
Naphthalene

HMW PAHs
Perylene

Pesticides
Methoxychlor
trans-Nonachlor

Industrial Chemicals
Dibenzothiophene
1,2-Dibromo-3-chloropropane
Octachlorostyrene
Toxics Categorization for the NY/NJ Harbor Estuary

Fish Tissue Standards and Criteria
in parts per million (ppm) or mg/kg

<table>
<thead>
<tr>
<th></th>
<th>FDA standard</th>
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<th>NY standard criteria</th>
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CATEGORY II - NO AMBIENT DATA AVAILABLE

A. Evidence of Input

Metals and Inorganics

<table>
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<tr>
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<th>NY standard criteria</th>
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<tbody>
<tr>
<td>Aluminum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beryllium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium (Hexavalent)</td>
<td></td>
<td>53.8</td>
<td></td>
</tr>
<tr>
<td>Chromium (Trivalent)</td>
<td></td>
<td>54,928</td>
<td></td>
</tr>
<tr>
<td>Cobalt</td>
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<tr>
<td>Magnesium</td>
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<td></td>
</tr>
<tr>
<td>Rubidium</td>
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Organic Compounds

Pesticides

<table>
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<th>FDA</th>
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<th>NY standard criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4-Dichlorophenol acetic acid (2,4-D)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2-(2,4,5-Trichlorophenoxy) proprionic acid (2,4,5-T)</td>
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<tr>
<td>Endosulfan</td>
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<td>0.54</td>
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<tr>
<td>Endosulfan sulfate</td>
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<tr>
<td>Endrin aldehyde</td>
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<tr>
<td>Hexachlorocyclohexane (HCB)</td>
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<td>hexachlorocyclohexane alpha</td>
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<td>hexachlorocyclohexane beta</td>
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<tr>
<td>hexachlorocyclohexane delta</td>
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<td></td>
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</tr>
<tr>
<td>Pentachlorophenol (PCP)</td>
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<td>320</td>
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<tr>
<td>Tributyltin</td>
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</table>

Petroleum Derivatives

<table>
<thead>
<tr>
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<th>FDA</th>
<th>EPA 1989</th>
<th>NY standard criteria</th>
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<tbody>
<tr>
<td>Benzene</td>
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<tr>
<td>Ethylbenzene</td>
<td>1100</td>
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<td>3,4-Benzofluoranthenene</td>
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<tr>
<td>Benzo(g,h,i)perylenne</td>
<td>0.000093</td>
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<tr>
<td>Indeno(1,2,3-cd)pyrene</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>3231</td>
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Industrial Chemicals

<table>
<thead>
<tr>
<th>Compound</th>
<th>FDA</th>
<th>EPA 1989</th>
<th>NY standard criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrolein</td>
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<tr>
<td>Acrylonitrile</td>
<td>0.02</td>
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<tr>
<td>Bis (2-chloroethoxy) methane</td>
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<td></td>
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<tr>
<td>Bis (Chloromethyl) ether</td>
<td>0.000049</td>
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<tr>
<td>Bromoform</td>
<td>1.77</td>
<td></td>
<td></td>
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</tbody>
</table>
### Fish Tissue Standards and Criteria
in parts per million (ppm) or mg/kg

<table>
<thead>
<tr>
<th></th>
<th>FDA standard</th>
<th>EPA 1989 standard</th>
<th>NY criteria</th>
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<tr>
<td></td>
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<td></td>
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</tr>
<tr>
<td>A. Evidence of Input (continued)</td>
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<td></td>
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</tr>
<tr>
<td><strong>Industrial Chemicals</strong></td>
<td></td>
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</tr>
<tr>
<td>Chlorobenzene</td>
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<tr>
<td>Chlorodibromomethane</td>
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<td>Chloroethane</td>
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<td></td>
<td></td>
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<tr>
<td>2-Chloronaphthalene</td>
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<tr>
<td>2-Chlorophenol</td>
<td>53.8</td>
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<td>Dichlorodifluoromethane</td>
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<td>1,1-Dichloroethane</td>
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<td>1,2-Dichloroethane</td>
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<td>Dichloropropane</td>
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<td>2,4-Dinitro-o-cresol</td>
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<td>2,4-Dinitrophenol</td>
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<tr>
<td>2,4-Dinitrotoluene</td>
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<td>Hexachlorobutadiene</td>
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<td>Isophorone</td>
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<td>2-Methyl-4,6-Dinitrophenol</td>
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<td>N-Nitrosodi-n-propylamine</td>
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<tr>
<td>Parachlorometacresol</td>
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<tr>
<td>Phenol</td>
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<tr>
<td>Phthalate Esters</td>
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</tr>
<tr>
<td>Bis (2-Ethylhexyl) phthalate</td>
<td></td>
<td>0.77</td>
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</tr>
<tr>
<td>Butylbenzyl phthalate</td>
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<td></td>
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<tr>
<td>Di-n-butyl phthalate</td>
<td></td>
<td>1077</td>
<td></td>
</tr>
<tr>
<td>Di-n-octyl phthalate</td>
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</tr>
<tr>
<td>Diethylphthalate</td>
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<td>8615</td>
<td></td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
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<td>0.054</td>
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<tr>
<td>Tetrachloroethylene</td>
<td></td>
<td>0.27</td>
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<tr>
<td>1,2-Transdichloroethylene</td>
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<td>215.4</td>
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<tr>
<td>1,2,4-Trichlorobenzene</td>
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<td>215.4</td>
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<tr>
<td>2,4,6 Trichlorophenol</td>
<td></td>
<td>0.54</td>
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</tr>
<tr>
<td>Vinyl chloride</td>
<td></td>
<td>0.614</td>
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</tbody>
</table>
Toxics Categorization for the NY/NJ Harbor Estuary

<table>
<thead>
<tr>
<th>Fish Tissue Standards and Criteria</th>
<th>in parts per million (ppm) or mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDA standard</td>
<td>EPA 1989 criteria</td>
</tr>
<tr>
<td>Bis (2-chloroisopropyl) ether</td>
<td>10.77</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>0.083</td>
</tr>
<tr>
<td>Chloroform</td>
<td>1.77</td>
</tr>
<tr>
<td>Dichlorobromomethane</td>
<td>1.77</td>
</tr>
<tr>
<td>Methyl bromide</td>
<td>1.77</td>
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<tr>
<td>Methyl chloride</td>
<td>1.77</td>
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<tr>
<td>Methylene chloride</td>
<td>1.44</td>
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<tr>
<td>Trichlorofluoromethane</td>
<td>1.77</td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
<td>969.2</td>
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<tr>
<td>1,1,2-Trichloroethane</td>
<td>0.189</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>0.855</td>
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</tbody>
</table>

A. Evidence of Input (continued)
Toxics Categorization for the NY/NJ Harbor Estuary

<table>
<thead>
<tr>
<th>Fish Tissue Standards and Criteria</th>
<th>FDA standard</th>
<th>EPA 1989 standard</th>
<th>NY standard criteria</th>
</tr>
</thead>
</table>

### B. No Evidence of Input

**Industrial Chemicals**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>FDA standard</th>
<th>EPA 1989 standard</th>
<th>NY standard criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzidine</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Bis (2-chloroethyl) ether</td>
<td>0.0098</td>
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<tr>
<td>2-Chloroethylinyl ether</td>
<td>0.0098</td>
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<tr>
<td>3,3'-Dichlorobenzidine</td>
<td>0.0062</td>
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<tr>
<td>1,1-Dichloroethylene</td>
<td>0.018</td>
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**Pesticides**

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**Abbreviations:**

- ppm = parts per million
- ppt = parts per trillion
- LMW PAHs = Low molecular weight polycyclic aromatic hydrocarbons
- HMW PAHs = High molecular weight polycyclic aromatic hydrocarbons

* Underline indicates the standard or criteria exceeded.
** Criteria is based on a TCDD Toxic Equivalency Factor of 0.1.
Toxics Categorization - Fish Tissue Data Reference
Metals and Inorganic Compounds

Antimony
Category I.C.  Criterion: 4.3 ppm
EPA, 1989

1. NOAA (1989)
Conc: <1.32 ppm (dry wt.) (Mytilus edulis)
Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Arsenic
Category I.B.  Criterion: 0.0062 ppm
EPA, 1989

Conc: <0.4 - 21.33 ppm (dry wt.) (blue crab, muscle)
<0.4 - 16.12 ppm (dry wt.) (blue crab, hepatopancreas)
<0.4 - 20.09 ppm (dry wt.) (lobster, muscle)
<0.4 - 29.05 ppm (dry wt.) (lobster, hepatopancreas)
<0.4 - 56.20 ppm (dry wt.) (winter flounder, muscle)
Location: Hudson River, Upper and Lower Bays, Newark Bay,
Arthur Kill, Raritan Bay
Year: 1982

2. NOAA (1989)
Conc: 7.8 - 10 ppm (dry wt.) (Mytilus edulis)
Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Cadmium
Category I.E.

1. NYS DEC (1987)
Conc: 0.05 - 1.06 ppm (blue crab, muscle)
0.13 - 18.06 ppm (blue crab, hepatopancreas)
Location: Hudson River, Lower Bay, East River, Jamaica Bay
Year: 1981

2. NYS DEC (1978)
Conc: <0.01 (american shad, fillet)
<0.01 (striped bass, fillet)
Location: Hudson River (Tappan Zee Bridge)
Year: 1975-1976

Conc: <0.02 - 1.41 ppm (dry wt.) (blue crab, muscle)
<0.02 - 21.80 ppm (dry wt.) (blue crab, hepatopancreas)
<0.02 - 5.80 ppm (dry wt.) (lobster, muscle)
<0.33 - 24.47 ppm (dry wt.) (lobster, hepatopancreas)
<0.02 - 0.34 ppm (dry wt.) (winter flounder, muscle)
Location: Hudson River, Upper and Lower Bays, Newark Bay,
Arthur Kill, Raritan Bay
Year: 1982
   Conc: <0.1 - 4.8 ppm (dry wt) (Mercenaria mercenaria)
   <0.1 - 2.0 ppm (dry wt) (Crepidula fornicata)
   Location: 27 locations in Jamaica Bay
   Year: 1981-1982

5. NJ DEP (unpublished data)
   Conc: 0.15 - 0.82 ppm (Mercenaria mercenaria)
   0.12 - 0.41 ppm (Mysa arenaria)
   Location: Raritan/Sandy Hook Bays, Navesink-Shrewsbury Rivers, Sandy Hook Cove
   Year: 1981-1984

6. NOAA (1989)
   Conc: 2.4 - 16 ppm (dry wt.) (Mytilus edulis)
   Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

7. Ellis et al. (1980)
   Conc: 0.01 - 1.5 ppm (white perch, muscle)
   0.01 - 0.7 ppm (striped bass, muscle)
   0.01 - 0.5 ppm (american eel)
   0.01 - 0.01 ppm (catfish, muscle)
   0.01 - 1.2 ppm (bluefish, muscle)
   0.01 - 0.7 ppm (sunfish, muscle)
   0.01 - 1.1 ppm (blue crab, muscle)
   0.01 - 4.4 ppm (ribbed mussel)
   0.01 - 0.01 ppm (soft clam)
   Location: Hudson, Hackensack, Passaic and Raritan Rivers and Raritan Bay
   Year: 1978-1979

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Chromium (Total) Category I.E.

1. NYS DEC (1978)
   Conc: 0.09 - 0.42 ppm (american shad, fillet)
   0.04 - 0.17 ppm (striped bass, fillet)
   Location: Hudson River (Tappan Zee Bridge)
   Year: 1975-1976

2. NJ DEP (unpublished)
   Conc: 0.19 - 2.18 ppm (Mercenaria mercenaria)
   1.30 - 13.72 ppm (Mysa arenaria)
   Location: Raritan/Sandy Hook Bay, Navesink-Shrewsbury Rivers, Sandy Hook Cove
   Year: 1981-1984

   Conc: <0.05 - 2.23 ppm (dry wt.) (blue crab, muscle)
   <0.05 - 2.46 ppm (blue crab, hepatopancreas)
   <0.05 - 6.35 ppm (dry wt.) (lobster, muscle)
   <0.05 - 2.98 ppm (dry wt.) (lobster, hepatopancreas)
   <0.05 - 3.09 ppm (dry wt.) (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay, Arthur Kill, Raritan Bay
   Year: 1982

158 827270161
4. NOAA (1989)
   Conc: 1 - 14 ppm (dry wt.) (Mytilus edulis)
   Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

Copper

Category I.E.

1. NYS DEC (1978)
   Conc: 1.11 - 1.22 (american shad, fillet)
   0.41 - 0.68 (striped bass, fillet)
   Location: Hudson River (Tappan Zee Bridge)
   Year: 1975-1976

   Conc: 20.18 - 180.25 ppm (dry wt.) (blue crab, muscle)
   63.03 - 1106.75 ppm (dry wt.) (blue crab, hepatopancreas)
   25.78 - 591.71 ppm (dry wt.) (lobster, muscle)
   86.90 - 2280.56 ppm (dry wt.) (lobster, hepatopancreas)
   0.76 - 3.02 ppm (dry wt.) (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay,
   Arthur Kill, Raritan Bay
   Year: 1982

3. Franz and Harris (1984)
   Conc: <19 - 28 ppm (dry wt) (Mytilus edulis)
   <2 - 25 ppm (dry wt) (Mercenaria mercenaria)
   2 - 98 ppm (dry wt) (Crepidula fornicata)
   432 - 1987 ppm (dry wt) (Ilyanassa obsoleta)
   Location: 27 locations in Jamaica Bay
   Year: 1981-1982

4. NOAA (1989)
   Conc: 0 - 25 ppm (dry wt.) (Mytilus edulis)
   Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

5. Ellis et al. (1980)
   Conc: 0.01 - 20.2 ppm (white perch, muscle)
   0.01 - 36.2 ppm (striped bass, muscle)
   0.01 - 35.1 ppm (american eel)
   0.01 - 6.2 ppm (catfish, muscle)
   0.01 - 45.6 ppm (bluefish, muscle)
   0.01 - 52.2 ppm (sunfish, muscle)
   0.01 - 39.1 ppm (blue crab, muscle)
   0.01 - 12.9 ppm (ribbed mussel)
   0.01 - 32.0 ppm (soft clam)
   Location: Hudson, Hackensack, Passaic and Raritan Rivers and Raritan Bay
   Year: 1978-1979
Iron

Category I.E.

1. Franz and Harris (1984)
   Conc: 192 - 2824 ppm (dry wt) (Mytilus edulis)
   56 - 1768 ppm (dry wt) (Mercenaria mercenaria)
   220 - 1472 ppm (dry wt) (Crepidula fornicata)
   226 - 1872 ppm (dry wt) (Ilyanassa obsoleta)
   Location: 27 locations in Jamaica Bay
   Year: 1981-1982

Lead

Category I.E.

1. NYS DEC (1978)
   Conc: 0.12 - 0.56 ppm (american shad, fillet)
   0.09 - 0.52 ppm (striped bass, fillet)
   Location: Hudson River (Tappen Zee Bridge)
   Year: 1975-1976

2. Franz and Harris (1984)
   Conc: 0.44 - 23 ppm (dry wt) (Mercenaria mercenaria)
   9 - 38 ppm (dry wt) (Crepidula fornicata)
   Location: 27 locations in Jamaica Bay
   Year: 1981-1982

3. NJ DEP (unpublished data)
   Conc: 0.10 - 2.8 ppm (Mercenaria mercenaria)
   0.66 - 8.32 ppm (Mysa arenaria)
   Location: Raritan/Sandy Hook Bays, Navesink-Shrewsbury Rivers,
             Sandy Hook Cove
   Year: 1981-1984

4. NOAA (1989)
   Conc: 3.1 - 28 ppm (dry wt.) (Mytilus edulis)
   Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

Manganese

Category I.E.

   Conc: 1.06 - 73.17 ppm (dry wt.) (blue crab, muscle)
   2.18 - 115.79 ppm (dry wt.) (blue crab, hepatopancreas)
   2.02 - 50.40 ppm (dry wt.) (lobster, muscle)
   6.70 - 124.58 ppm (dry wt.) (lobster, hepatopancreas)
   0.99 - 6.23 ppm (dry wt.) (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay,
             Arthur Kill, Raritan Bay
   Year: 1982

2. Franz and Harris (1984)
   Conc: 44 - 1140 ppm (dry wt) (Mercenaria mercenaria)
   10 - 228 ppm (dry wt) (Crepidula fornicata)
   Location: 27 locations in Jamaica Bay
   Year: 1981-1982
1. NYS DEC (1987)
   Conc: 0.18 - 1.40 ppm (striped bass, fillet)
   0.30 - 1.37 ppm (american eel)
   <0.10 - 0.22 ppm (winter flounder, fillet)
   0.10 - 0.30 ppm (blue fish, fillet)
   0.15 - 0.30 ppm (mummichog, fillet)
   0.13 - 0.16 ppm (tautog, fillet)
   0.10 (american shad, fillet)
   0.71 ppm (weakfish, fillet)
   <0.10 ppm (white perch, fillet)
   <0.10 ppm (common carp, fillet)
   Location: Hudson River, Upper and Lower NY Bays, Arthur Kill, Jamaica Bay, East River
   Year: 1980-1985

2. NYS DEC (1978)
   Conc: 0.12 - 1.30 ppm (striped bass, fillet)
   0.06 - 0.10 ppm (american shad, fillet)
   Location: Hudson River (Tappan Zee Bridge)
   Year: 1975-1976

3. NYS DEC (unpublished data)
   Conc: <d.l. - 0.15 ppm (M. mercenaria)
   Location: Raritan Bay, East River, Jamaica Bay
   Year: 1987-1988

4. NOAA (1989)
   Conc: 0.18 - 0.72 ppm (dry wt) (Mytilus edulis)
   0.03 - 0.11 ppm (wet wt) (conversion factor: 15% dry wt)
   Location: Upper and Lower NY Bays, Jamaica Bay and Sandy Hook
   Year: 1986-1988

5. NJ DEP (unpublished data)
   Conc: 0.01 - 0.17 ppm (M. mercenaria)
   Location: Raritan-Sandy Hook Bay, Navesink and Shrewsbury Rivers, Sandy Hook Cove.
   Year: 1981-1984

6. Ellis et al. (1980)
   Conc: 0.05 - 1.09 ppm (white perch, muscle)
   0.01 - 1.49 ppm (striped bass, muscle)
   0.01 - 2.10 ppm (american eel)
   0.01 - 0.79 ppm (catfish, muscle)
   0.01 - 1.4 ppm (bluefish, muscle)
   0.01 - 1.25 ppm (sunfish, muscle)
   0.01 - 0.25 ppm (blue crab, muscle)
   0.01 - 0.15 ppm (ribbed mussel)
   0.01 - 0.35 ppm (soft clam)
   Location: Hudson, Hackensack, Passaic and Raritan Rivers and Raritan Bay
   Year: 1978-1979
7. Roberts et al. (1982)
   Conc: 0.09 - 0.50 ppm (American lobster)
   Location: NY Harbor (Gravesend Bay)
   Year: unknown

   Conc: <0.10 - 0.808 ppm (killifish, muscle)
   0.052 - 0.528 ppm (carp, muscle)
   0.275 - 1.877 ppm (white perch, muscle)
   0.071 - 0.806 ppm (alewife, muscle)
   0.031 - 0.122 ppm (sunfish, muscle)
   0.761 - 1.269 ppm (herring, muscle)
   0.441 - 1.032 ppm (weakfish, muscle)
   0.264 - 0.540 ppm (American eel, muscle)
   0.206 - 0.231 ppm (pumpkinseed, muscle)
   <0.10 - 0.532 ppm (fiddler crab, muscle)
   <0.10 - 2.743 ppm (fiddler crab, viscera)
   0.107 - 0.761 ppm (blue crab, muscle)
   <0.1 - 0.517 ppm (grass shrimp)
   0.720 ppm (bluefish, muscle)
   0.708 ppm (common anchovy, muscle)
   0.572 ppm (Atlantic silverside, muscle)
   1.602 ppm (American shad, muscle)
   0.157 ppm (striped sea robin, muscle)
   Location: Hackensack River (Berry's Creek, Sawmill Creek,
             Overpeck Creek)
   Year: 1977-1978

   Conc: 0.29 ± 0.27 ppm (munnichog)
   0.24 ± 0.28 ppm (alewife)
   0.24 ± 0.14 ppm (white perch)
   0.12 ± 0.01 ppm (bluegill sunfish)
   0.11 ± 0.09 ppm (pumpkinseed sunfish)
   0.10 ± 0.07 ppm (carp)
   0.24 ± 0.17 ppm (green sunfish)
   0.44 ± 0.35 ppm (American eel)
   0.26 ppm (weakfish)
   0.21 ppm (American shad)
   0.26 ± 0.18 ppm (blue crab)
   0.11 ± 0.10 ppm (fiddler crab, U. pugmax)
   0.18 ± 0.08 ppm (fiddler crab, U. minax)
   0.11 ppm (grass shrimp)
   0.47 ppm (mud crab)
   0.39 ppm (blue crab, muscle)
   0.21 ppm (blue crab, hepatopancreas)
   0.26 ppm (blue crab, whole body)
   Location: Hackensack River, Berry's Creek, Overpeck Creek,
             Sawmill Creek
   Year: unknown
Conc: <0.02 - 1.67 ppm (blue crab, hepatopancreas)
<0.02 - 0.50 ppm (blue crab, gill)
<0.02 - 1.55 ppm (blue crab, muscle)
Location: Berry's Creek, Hackensack Meadowlands
Year: 1985

Conc: <0.02 - 1.38 ppm (killifish, whole)
<0.02 - 1.68 ppm (killifish, fillet)
0.22 - 1.96 ppm (carp, muscle)
0.70 - 1.62 ppm (brown bullhead catfish, muscle)
0.10 - 0.51 ppm (bluegill sunfish, muscle)
0.90 - 1.82 ppm (white perch, muscle)
Location: Mill Creek, Moonachie Creek, Bashes Creek,
Cedar Creek, Hackensack River (Hackensack Meadowlands)
Year: 1985

Nickel

<table>
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<th>Category I.C.</th>
<th>Criterion: 220 ppm EPA, 1989</th>
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</thead>
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Conc: <0.12 - 8.32 ppm (dry wt.) (blue crab, muscle)
<0.12 - 3.18 ppm (dry wt.) (blue crab, hepatopancreas)
<0.12 - 2.11 ppm (dry wt.) (lobster, muscle)
<0.12 - 4.56 ppm (dry wt.) (lobster, hepatopancreas)
<0.12 - 6.19 ppm (dry wt.) (winter flounder, muscle)
Location: Hudson River, Upper and Lower Bays, Newark Bay,
Arthur Kill, Raritan Bay
Year: 1982

2. Franz and Harris (1984)
Conc: <0.4 - 51 ppm (dry wt.) (Mercenaria mercenaria)
<0.4 - 24 ppm (dry wt.) (Crepidula fornicata)
Location: 27 locations in Jamaica Bay
Year: 1981-1982

3. NOAA (1989)
Conc: 1.2 - 8.2 ppm (dry wt.) (Mytilus edulis)
Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

4. Ellis et al. (1980)
Conc: 0.01 - 5.5 ppm (white perch, muscle)
0.01 - 23.5 ppm (striped bass, muscle)
0.01 - 27.1 ppm (american eel)
0.01 - 0.01 ppm (catfish, muscle)
0.01 - 19.0 ppm (bluefish, muscle)
0.01 - 10.9 ppm (sunfish, muscle)
0.01 - 6.9 ppm (blue crab, muscle)
0.01 - 0.01 ppm (ribbed mussel)
0.01 - 9.0 ppm (soft clam)
Location: Hudson, Hackensack, Passaic and Raritan
Rivers and Raritan Bay
Year: 1978-1979

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Selenium Category I.C. Criterion: 5.4 ppm EPA, 1989

Conc: <10 ppm (dry wt.) (blue crab, muscle)
<10 ppm (dry wt.) (blue crab, hepatopancreas)
<10 ppm (dry wt.) (lobster, muscle)
<10 ppm (dry wt.) (lobster, hepatopancreas)
<10 ppm (dry wt.) (winter flounder, muscle)
Location: Hudson River, Upper and Lower Bays, Newark Bay, Arthur Kill, Raritan Bay
Year: 1982

2. NOAA (1989)
Conc: 1.7 - 4.1 ppm (dry wt.) (Mytilus edulis)
Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Silver Category I.C. Criterion: 2.5 ppm EPA, 1989

1. Franz and Harris (1984)
Conc: <3.0 - 6 ppm (dry wt.) (Crepidula fornicatea)
Location: 27 locations in Jamaica Bay
Year: 1981-1982

2. NOAA (1989)
Conc: 0.29 - 1.9 ppm (dry wt.) (Mytilus edulis)
Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Thallium Category I.C. Criterion: 5.7 ppm EPA, 1989

1. NOAA (1989)
Conc: <0.20 ppm (dry wt.) (Mytilus edulis)
Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Tin Category I.E.

1. NOAA (1989)
Conc: <0.14 - 1.6 ppm (dry wt.) (Mytilus edulis)
Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

II-16

164 827270167
Vanadium

Category I.E.

   Conc: <0.06 - 33.88 ppm (dry wt.) (blue crab, muscle)
   0.34 - 25.33 ppm (dry wt.) (blue crab, hepatopancreas)
   <0.06 ppm (dry wt.) (lobster, muscle)
   <0.06 - 0.44 ppm (dry wt.) (lobster, hepatopancreas)
   <0.06 ppm (dry wt.) (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay,
   Arthur Kill, Raritan Bay
   Year: 1982

Zinc

Category I.E.

1. NYS DEC (1978)
   Conc: 6.19 - 7.76 ppm (american shad, fillet)
   5.04 - 10.74 ppm (striped bass, fillet)
   Location: Hudson River (Tappan Zee Bridge)
   Year: 1975-1976

   Conc: 84.70 - 541.58 ppm (dry wt.) (blue crab, muscle)
   44.49 - 352.62 ppm (dry wt.) (blue crab, hepatopancreas)
   64.94 - 312.03 ppm (dry wt.) (lobster, muscle)
   62.69 - 657.14 ppm (dry wt.) (lobster, hepatopancreas)
   24.75 - 72.54 ppm (dry wt.) (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay,
   Arthur Kill, Raritan Bay
   Year: 1982

3. Franz and Harris (1984)
   Conc: 32 - 274 ppm, dry wt. (Mytilus edulis)
   46 - 290 ppm, dry wt. (Mercenaria mercenaria)
   8 - 152 ppm, dry wt. (Crepidula fornicata)
   375 - 1746 ppm, dry wt. (Ilvarassa obsoleta)
   Location: 27 locations in Jamaica Bay
   Year: 1981-1982

4. NOAA (1989)
   Conc: 84 - 220 ppm (dry wt.) (Mytilus edulis)
   Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

5. Ellis et al. (1980)
   Conc: 2.0 - 76.7 ppm (white perch, muscle)
   5.0 - 113.4 ppm (striped bass, muscle)
   0.01 - 130.9 ppm (american eel)
   0.01 - 32.1 ppm (catfish, muscle)
   0.01 - 118.8 ppm (bluefish, muscle)
   5.0 - 46.5 ppm (sunfish, muscle)
   0.01 - 92.4 ppm (blue crab, muscle)
   1.6 - 50.1 ppm (ribbed mussel)
   14.5 - 75.0 ppm (soft clam)
   Location: Hudson, Hackensack, Passaic and Raritan
   Rivers and Raritan Bay
   Year: 1978-1979
Organic Compounds

Acenaphthylene

Category I.B.  
Criterion: 0.00093 ppm  
EPA, 1989

1. McLeod et al. (1981)
Conc: <d.l. - 7 ppb (dry wt.) (lobster, hepatopancreas)
Location: Raritan Bay
Year: 1977-1980

2. NOAA (1989)
Conc: <d.l. - 320 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Aldrin

Category I.D.  
Criterion: 0.00064 ppm  
EPA, 1989

1. McLeod et al. (1981)
Conc: <4 ppb (dry wt.) (winter flounder, muscle)
<50 ppb (dry wt.) (winter flounder, liver)
<4 ppb (dry wt.) (windowpane flounder, muscle)
<6 ppb (dry wt.) (striped bass, muscle)
<0.6 ppb (dry wt.) (lobster, muscle)
<100 ppb (dry wt.) (lobster, digestive gland)
<1.0 ppb (dry wt.) (blue mussel)
<3.0 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

Anthracene

Category I.B.  
Criterion: 0.00093 ppm  
EPA, 1989

Conc: <d.l. - 0.26 ppm (blue crab, muscle)
<d.l. - 7.56 ppm (blue crab, hepatopancreas)
<d.l. - 0.13 ppm (lobster, muscle)
<d.l. - 1.88 ppm (lobster, hepatopancreas)
<d.l. - 0.36 ppm (winter flounder, muscle)
Location: Hudson River, Upper and Lower Bays, Newark Bay, Arthur Kill, Raritan Bay
Year: 1982

2. McLeod et al. (1981)
Conc: <4 ppb (dry wt.) (winter flounder, muscle)
<6 ppb (dry wt.) (winter flounder, liver)
<6 ppb (dry wt.) (windowpane flounder, muscle)
<4 ppb (dry wt.) (striped bass, muscle)
<5 ppb (dry wt.) (lobster, muscle)
<10 - 100 ppb (dry wt.) (lobster, hepatopancreas)
<5 - 50 ppb (dry wt.) (blue mussel)
<6.8 ppb (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

II-18
3. NOAA (1989)
Conc: <d.l. - 370 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

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**Benz(a)anthracene**

Category I.B.

Criterion: 0.00093 ppm

EPA, 1989

   Conc: <d.l. - 15.48 ppm (blue crab, muscle)
   <d.l. - 29.04 ppm (blue crab, hepatopancreas)
   <d.l. - 10.01 ppm (lobster, muscle)
   <d.l. - 5.69 ppm (lobster, hepatopancreas)
   <d.l. - 0.49 ppm (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay,
   Arthur Kill, Raritan Bay
   Year: 1982

2. McLeod et al. (1981)
   Conc: <10 ppb (dry wt.) (winter flounder, flesh)
   <10 ppb (dry wt.) (winter flounder, liver)
   <10 ppb (dry wt.) (windowpane flounder, flesh)
   <7 ppb (dry wt.) (striped bass, flesh)
   <10 ppb (dry wt.) (lobster, muscle)
   500 - 600 ppb (dry wt.) (lobster, hepatopancreas)
   <5 - 700 ppb (dry wt.) (blue mussel)
   <46 - 170 ppb (dry wt.) (grass shrimp)
   Location: Raritan Bay, Hudson River, Lower Bay
   Year: 1977-1980

3. NOAA (1989)
   Conc: 110 - 1,500 ppb (dry wt.) (Mytilus edulis)
   Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

---

**Benz(b)fluoranthene**

Category I.B.

Criterion: 0.00093 ppm

EPA, 1989

1. McLeod et al. (1981)
   Conc: <d.l. - 30 ppb (dry wt.) (lobster, digestive gland)
   Location: Raritan Bay
   Year: 1977-1980

II-19

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827270170
Conc: <d.l. - 0.82 ppm (blue crab, muscle)
< d.l. - 5.51 ppm (blue crab, hepatopancreas)
< d.l. - 0.10 ppm (lobster, muscle)
< d.l. - 4.96 ppm (lobster, hepatopancreas)
< d.l. - 0.29 ppm (winter flounder, muscle)
Location: Hudson River, Upper and Lower Bays, Newark Bay,
Arthur Kill, Raritan Bay
Year: 1982

2. McLeod et al. (1981)
Conc: < 20 ppb (dry wt.) (winter flounder, muscle)
< 8 ppb (dry wt.) (winter flounder, liver)
< 10 ppb (dry wt.) (windowpane flounder, muscle)
< 6 ppb (dry wt.) (striped bass, muscle)
< 7 ppb (dry wt.) (lobster, muscle)
300 ppb (dry wt.) (lobster, hepatopancreas)
< 5 - 70 ppb (dry wt.) (blue mussel)
< 30 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977 - 1980

3. NOAA (1989)
Conc: < d.l. - 5.0 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1985 - 1988
3. NOAA (1989)
Conc: 95 - 740 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Biphenyl
Category I.E.

1. McLeod et al. (1981)
Conc: <5 ppb (dry wt.) (winter flounder, muscle)
   30 - 200 ppb (dry wt.) (winter flounder, liver)
   <2 - 20 ppb (dry wt.) (windowpane flounder, muscle)
   <3 - 20 ppb (dry wt.) (striped bass, muscle)
   <3 - 30 ppb (dry wt.) (lobster, muscle)
   90 - 200 ppb (dry wt.) (lobster, hepatopancreas)
   <10 - 300 ppb (dry wt.) (blue mussel)
   <17 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

2. NOAA (1989)
Conc: <0.1 - 140 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Chlordane (alpha and gamma)
Category I.A.
Criterion: 0.3 ppm
FDA

1. Belton et al. (1985)
Conc: 10.17 - 11.00 ppb (American lobster, muscle + hepatopancreas)
Location: Raritan Bay
Year: 1984

2. Belton et al. (1983)
Conc: 2.5 - 284.5 ppb (bluefish, fillet)
Location: Hudson River, Raritan/Sandy Hook Bays
Year: 1981-1982

3. Hauge et al. (1990)
Conc: 36.29 - 150.33 ppb (American eel)
   31.41 - 123.16 ppb (white perch, fillet)
   <8.28 - 62.46 ppb (blue crab, hepatopancreas + muscle)
   <5.99 - 10.29 ppb (blue crab, muscle)
   29.41 - 150.15 ppb (blue crab, hepatopancreas)
   <5.00 - 159.96 ppb (striped bass, fillet)
   228.03 - 584.16 ppb (carp, fillet)
   <5.00 - 136.72 ppb (bluefish, fillet)
   11.34 - 39.14 ppb (weakfish, fillet)
   12.93 ppb (largemouth bass, fillet)
Location: 13 locations throughout the Harbor Estuary
Year: 1986-1987

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4. **NYSDEC (1987)**

<table>
<thead>
<tr>
<th>Conc:</th>
<th></th>
<th>Location: Hudson River, Upper and Lower NY Bays, Arthur Kill, Jamaica Bay, East River</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.01 - 0.83 ppm (striped bass, fillet)</td>
<td></td>
<td>Year: 1980 - 1985</td>
</tr>
<tr>
<td>0.10 - 0.83 ppm (american eel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01 - 0.05 ppm (winter flounder, fillet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.03 - 0.04 ppm (american shad, fillet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.03 - 0.08 ppm (bluefish, fillet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.03 - 0.12 ppm (mummichog, fillet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.07 - 0.10 ppm (carp, fillet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.09 ppm (tautog, fillet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.09 ppm (white perch, fillet)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. **McLeod et al. (1981)**

<table>
<thead>
<tr>
<th>Conc:</th>
<th></th>
<th>Location: Raritan Bay, Hudson River, Lower Bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 ppb (dry wt.) (winter flounder, muscle)</td>
<td></td>
<td>Year: 1977-1980</td>
</tr>
<tr>
<td>50 - 60 ppb (dry wt.) (winter flounder, liver)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 30 ppb (dry wt.) (windowpane flounder, muscle)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600 - 700 ppb (dry wt.) (striped bass, muscle)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - 30 ppb (dry wt.) (lobster, muscle)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1400 - 2100 ppb (dry wt.) (lobster, hepatopancreas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30 - 80 ppb (dry wt.) (blue mussel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 - 13 ppb (dry wt.) (grass shrimp)</td>
<td></td>
<td></td>
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</tbody>
</table>

6. **NOAA (1989)**

<table>
<thead>
<tr>
<th>Conc:</th>
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<th>Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay</th>
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</thead>
<tbody>
<tr>
<td>28 - 140 ppb (dry wt.) (Mytilus edulis)</td>
<td></td>
<td>Year: 1986-1988</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Chrysonene</th>
<th>Category I.B.</th>
<th>Criterion: 0.000093 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>EPA, 1989</td>
</tr>
</tbody>
</table>

1. **O'Connor and Moese (1984)**

<table>
<thead>
<tr>
<th>Conc:</th>
<th></th>
<th>Location: Hudson River, Upper and Lower Bays, Newark Bay, Arthur Kill, Raritan Bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;d,1. - 18.67 ppm (blue crab, muscle)</td>
<td></td>
<td>Year: 1982</td>
</tr>
<tr>
<td>&lt;d,1. - 37.44 ppm (blue crab, hepatopancreas)</td>
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<tr>
<td>&lt;d,1. - 7.63 ppm (lobster, muscle)</td>
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<tr>
<td>&lt;d,1. - 24.50 ppm (lobster, hepatopancreas)</td>
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</tr>
<tr>
<td>&lt;d,1. - 0.79 ppm (winter flounder, muscle)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. **McLeod et al. (1981)**

<table>
<thead>
<tr>
<th>Conc:</th>
<th></th>
<th>Location: Raritan Bay, Hudson River, Lower Bay</th>
</tr>
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<tbody>
<tr>
<td>&lt;8 ppb (dry wt.) (winter flounder, muscle)</td>
<td></td>
<td>Year: 1977-1980</td>
</tr>
<tr>
<td>&lt;8 ppb (dry wt.) (winter flounder, liver)</td>
<td></td>
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<tr>
<td>&lt;7 ppb (dry wt.) (windowpane flounder, muscle)</td>
<td></td>
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<tr>
<td>&lt;4 ppb (dry wt.) (striped bass)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 - 8 ppb (dry wt.) (lobster, muscle)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800 - 900 ppb (dry wt.) (lobster, hepatopancreas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;8 - 300 ppb (dry wt.) (blue mussel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;24 - 140 ppb (dry wt.) (grass shrimp)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. NOAA (1989)
Conc: <d.l. - 2,000 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

DOT + DDD + DDE
Category I.B.
Criterion: 0.0316 ppm
EPA, 1989

1. Belton et al. (1985)
Conc: 25.57 - 27.80 ppb (American lobster, hepatopancreas + muscle)
Location: Raritan Bay
Year: 1964

2. Hauge et al. (1990)
Conc: <150.40 - 763.51 ppb (American eel)
<54.99 - 695.68 ppb (white perch, fillet)
<52.34 - 319.17 ppb (blue crab, hepatopancreas + muscle)
215.91 - 790.55 ppb (blue crab, hepatopancreas)
<33.59 - <65.53 ppb (blue crab, muscle)
<25.00 - 606.43 ppb (striped bass, fillet)
227.79 - 805.09 ppb (carp, fillet)
<25.00 - 458.71 ppb (bluefish, fillet)
<49.82 - <87.96 ppb (weakfish, fillet)
<29.69 ppb (largemouth bass, fillet)
Location: 13 locations throughout the Harbor Estuary
Year: 1986-1987

3. NYS DEC (1987)
Conc: 0.05 - 1.45 ppm (striped bass, fillet)
0.08 - 1.27 (american eel)
0.05 - 0.08 ppm (american shad, fillet)
0.01 - 0.08 ppm (winter flounder, fillet)
0.07 - 0.20 ppm (bluefish, fillet)
0.04 - 0.54 ppm (mummichog, fillet)
0.03 - 0.33 (carp, fillet)
0.19 ppm (weakfish, fillet)
0.34 ppm (white perch, fillet)
0.09 ppm (tautog, fillet)
Location: Hudson River, Upper and Lower NY Bays, Arthur Kill,
Jamaica Bay, East River
Year: 1980 - 1985

4. NYS DEC (1988)
Conc: 0.01 - 0.85 ppm (striped bass, fillet)
Location: Upper and Lower NY Bays
Year: 1987

5. Dunn (1988)
Conc: 0.91 - 1.29 ppm (blue crab, hepatopancreas)
0.006 - 0.012 ppm (blue crab, muscle)
Location: Hudson River (Tappen Zee)
Year: 1985
Conc: <45 - 80 ppb (dry wt.) (winter flounder, muscle)
<30 - 1900 ppb (dry wt.) (winter flounder, liver)
60 - 110 ppb (dry wt.) (windowpane flounder, muscle)
1900 - 3300 ppb (dry wt.) (striped bass, muscle)
60 - 130 ppb (dry wt.) (lobster, muscle)
1300 - 2400 ppb (dry wt.) (lobster, hepatopancreas)
<155 - 470 ppb (dry wt.) (blue mussel)
92.7 - 94.0 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

7. NOAA (1989)
Conc: 130 - 1100 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

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Dibenzo thiophene

1. McLeod et al. (1981)
Conc: <9.0 ppb (dry wt.) (winter flounder, muscle)
<4.0 - 20 ppb (dry wt.) (winter flounder, liver)
<10 ppb (dry wt.) (windowpane flounder, muscle)
<6.0 ppb (dry wt.) (striped bass, muscle)
<8.0 ppb (dry wt.) (lobster, muscle)
<20 ppb (dry wt.) (lobster, hepatopancreas)
<10 ppb (dry wt.) (blue mussel)
<24 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

---

1,2-Dibromo-3-chloropropane

1. McLeod et al. (1981)
Conc: <10 ppb (dry wt.) (winter flounder, muscle)
<200 ppb (dry wt.) (winter flounder, liver)
<9 ppb (dry wt.) (windowpane flounder, muscle)
<20 ppb (dry wt.) (striped bass, muscle)
<2.0 ppb (dry wt.) (lobster, muscle)
<200 ppb (dry wt.) (lobster, hepatopancreas)
<0.6 - 20 ppb (dry wt.) (blue mussel)
<1.3 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

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Dibenzo(a,h)anthracene

1. NOAA (1989)
Conc: <0.1 - 14 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

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II-24

827270175
1. NYS DEC (1987)
   Conc: <0.01 - 0.34 ppm (striped bass, fillet)
   <0.01 - 0.08 ppm (american eel)
   <0.01 - 0.02 ppm (mummichog, fillet)
   <0.01 ppm (American shad, fillet)
   <0.01 ppm (winter flounder, fillet)
   <0.01 ppm (bluefish, fillet)
   <0.01 ppm (weakfish, fillet)
   <0.01 ppm (white perch, fillet)
   <0.01 ppm (carp, fillet)
   <0.01 ppm (tautog, fillet)
   Location: Hudson River, Upper and Lower NY Bays, Arthur Kill, East River, Jamaica Bay
   Year: 1980-1985

2. NYS DEC (1988)
   Conc: <0.01 - 0.03 ppm (striped bass, fillet)
   Location: Upper and Lower NY Bays
   Year: 1987

3. McLeod et al. (1981)
   Conc: <5 - 20 ppb (dry wt.) (winter flounder, muscle)
   <50 ppb (dry wt.) (winter flounder, liver)
   <8 - 20 ppb (dry wt.) (windowpane flounder, muscle)
   <6 ppb (dry wt.) (striped bass)
   <0.1 - 40 (dry wt.) (lobster, muscle)
   4000 - 6900 (dry wt.) (lobster, hepatopancreas)
   <0.5 - 10 ppb (dry wt.) (blue mussel)
   <2.9 ppb (dry wt.) (grass shrimp)
   Location: Raritan Bay, Hudson River, Lower Bay
   Year: 1977-1980

4. NOAA (1988)
   Conc: <1.4 - 160 ppb (dry wt.) (Mytilus edulis)
   Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
   Year: 1985-1988
Endrin

Category I.C.

Criterion: 0.3 ppm

FDA

1. NYS DEC (1987)
   Conc: <0.01 - 0.12 ppm (striped bass, fillet)
         <0.01 - 0.01 ppm (American eel)
         <0.01 ppm (American shad, fillet)
         <0.01 ppm (winter flounder, fillet)
         <0.01 ppm (bluefish, fillet)
         <0.01 ppm (mummichog, fillet)
         <0.01 ppm (weakfish, fillet)
         <0.01 ppm (white perch, fillet)
         <0.01 ppm (carp, fillet)
         <0.01 ppm (tautog, fillet)
   Location: Hudson River, Upper and Lower NY Bays, Arthur Kill,
             East River, Jamaica Bay
   Year: 1980-1985

2. McLeod et al. (1981)
   Conc: <4 ppb (dry wt.) (winter flounder, muscle)
         <10 ppb (dry wt.) (windowpane flounder, muscle)
         <10 ppb (dry wt.) (striped bass, muscle)
         <1 ppb (dry wt.) (lobster, muscle)
         <100 ppb (dry wt.) (lobster, hepatopancreas)
         <3 ppb (dry wt.) (blue mussel)
         <10 ppb (dry wt.) (grass shrimp)
   Location: Raritan Bay, Hudson River, Lower Bay
   Year: 1977-1980

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Fluoranthene

Category I.C.

Criterion: 62.1 ppm

EPA, 1989

   Conc: <0.1 - 0.18 ppm (blue crab, muscle)
         <0.1 - 4.60 ppm (blue crab, hepatopancreas)
         <0.1 - 0.09 ppm (lobster, muscle)
         <0.1 - 2.14 ppm (lobster, hepatopancreas)
         <0.1 - 0.05 ppm (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay,
             Arthur Kill, Raritan Bay
   Year: 1982

2. McLeod et al. (1981)
   Conc: <5 - 30 ppb (dry wt.) (winter flounder, muscle)
         <7 ppb (dry wt.) (winter flounder, liver)
         <6 - 40 ppb (dry wt.) (windowpane flounder, muscle)
         <4 ppb (dry wt.) (striped bass, muscle)
         40 - 100 ppb (dry wt.) (lobster, muscle)
         200 - 400 ppb (dry wt.) (lobster, hepatopancreas)
         20 - 1000 ppb (dry wt.) (blue mussel)
         28 - 170 ppb (dry wt.) (grass shrimp)
   Location: Raritan Bay, Hudson River, Lower Bay
   Year: 1977 - 1980

II-25

827270177
3. NOAA (1989)
   Conc: 207 - 5,900 ppb (dry wt.) (Mytilus edulis)
   Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

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**Fluorene**

Category I.B.  
Criterion: 0.00093 ppm  
EPA, 1969

1. McLeod et al. (1981)
   Conc: <d.1. - 8 ppb (dry wt.) (lobster, hepatopancreas)
   Location: Raritan Bay
   Year: 1977-1980

2. NOAA (1989)
   Conc: <d.1. - 810 ppb (dry wt.) (Mytilus edulis)
   Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

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**Heptachlor**

Category I.B.  
Criterion: 0.0024 ppm  
EPA, 1989

1. NYS DEC (1987)
   Conc: <0.01 - 0.05 ppm (striped bass, fillet)
   <0.01 - 0.04 ppm (american eel)
   <0.01 ppm (American shad, fillet)
   <0.01 ppm (winter flounder, fillet)
   <0.01 ppm (bluefish, fillet)
   <0.01 ppm (mummichog, fillet)
   <0.01 ppm (weakfish, fillet)
   <0.01 ppm (white perch, fillet)
   <0.01 ppm (carp, fillet)
   <0.01 ppm (tautog, fillet)
   Location: Hudson River, Upper and Lower NY Bays, Arthur Kill, East River, Jamaica Bay
   Year: 1980-1985

2. McLeod et al. (1981)
   Conc: <5 ppb (dry wt.) (winter flounder, muscle)
   <50 ppb (dry wt.) (winter flounder, liver)
   <6 ppb (dry wt.) (windowpane flounder, muscle)
   <9 ppb (dry wt.) (striped bass, muscle)
   <0.01 - 5 ppb (dry wt.) (lobster, muscle)
   <50 - 80 ppb (dry wt.) (lobster, hepatopancreas)
   <1 ppb (dry wt.) (blue mussel)
   <1.6 ppb (dry wt.) (grass shrimp)
   Location: Raritan Bay, Hudson River, Lower Bay
   Year: 1977 - 1980

3. NOAA (1989)
   Conc: <d.1. - 6.8 ppb (dry wt.) (Mytilus edulis)
   Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988
<table>
<thead>
<tr>
<th>Substance</th>
<th>Category</th>
<th>Criterion</th>
<th>Source</th>
<th>Concentration Details</th>
<th>Location</th>
<th>Year</th>
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<tbody>
<tr>
<td>Heptachlor epoxide</td>
<td>I.B.</td>
<td>0.0024 ppb</td>
<td>EPA, 1989</td>
<td></td>
<td>Con: &lt;d.l. - 7.4 ppb (dry wt.) (Mytilus edulis) Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay Year: 1986-1988</td>
<td></td>
</tr>
<tr>
<td>Hexachlorobenzene (HCB)</td>
<td>I.B.</td>
<td>0.0064 ppm</td>
<td>EPA, 1989</td>
<td>1. NYS DEC (1987)</td>
<td>Con: &lt;0.01 - 0.04 ppm (striped bass, fillet) &lt;0.01 - 0.09 ppm (american eel) &lt;0.01 ppm (mummichog, fillet) &lt;0.01 ppm (winter flounder, fillet) &lt;0.01 ppm (white perch, fillet) &lt;0.01 ppm (carp, fillet) &lt;0.01 ppm (tautog, fillet) Location: Upper and Lower Bays, East River, Arthur Kill, Jamaica Bay Year: 1981 - 1985</td>
<td></td>
</tr>
<tr>
<td>2. McLeod et al. (1981)</td>
<td></td>
<td></td>
<td></td>
<td>Con: 3 ppb (dry wt.) (winter flounder, muscle) &lt;30 ppb (dry wt.) (winter flounder, liver) 2 ppb (dry wt.) (windowpane flounder, muscle) &lt;3 ppb (dry wt.) (striped bass, muscle) 2 - 5 ppb (dry wt.) (lobster, muscle) 200 - 500 ppb (dry wt.) (lobster, hepatopancreas) &lt;0.2 - 4 ppb (dry wt.) (blue mussel) 5.1 - 5.7 ppb (dry wt.) (grass shrimp) Location: Raritan Bay, Hudson River, Lower Bay Year: 1977-1980</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
gamma-Hexachlorocyclohexane (BHC) Category I.B. Criterion: 0.0081 ppm EPA, 1989

1. NYS DEC (1987)
   Conc: <0.01 - 0.05 ppm (striped bass, fillet)
   <0.01 - 0.02 ppm (american eel)
   <0.01 ppm (American shad, fillet)
   <0.01 ppm (winter flounder, fillet)
   <0.01 ppm (bluefish, fillet)
   <0.01 ppm (mummichog, fillet)
   <0.01 ppm (weakfish, fillet)
   <0.01 ppm (white perch, fillet)
   <0.01 ppm (carp, fillet)
   <0.01 ppm (tautog, fillet)

Location: Hudson River, Upper and Lower NY Bays, Arthur Kill, East River, Jamaica Bay
Year: 1980-1985

2. McLeod et al. (1981)
   Conc: <4 - 10 ppb (dry wt.) (winter flounder, muscle)
   <100 ppb (dry wt.) (winter flounder, liver)
   <2 - 4 ppb (dry wt.) (windowpane flounder, muscle)
   <20 ppb (dry wt.) (striped bass, muscle)
   <0.1 - 1 ppb (dry wt.) (lobster, muscle)
   <50 - 100 ppb (dry wt.) (lobster, hepatopancreas)
   <2 ppb (dry wt.) (blue mussel)
   <1.4 ppb (dry wt.) (grass shrimp)

Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

3. NOAA (1989)
   Conc: <0.59 - 25 ppb (dry wt.) (Mytilus edulis)

Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Methoxychlor Category I.E.

1. NYS DEC (1987)
   Conc: <0.01 ppm (striped bass, fillet)

Location: Upper and Lower Bays
Year: 1985

1-Methylnapthalene Category I.E.

1. McLeod et al. (1981)
   Conc: <4 ppb (dry wt.) (winter flounder, muscle)
   <5 - 700 ppb (dry wt.) (winter flounder, liver)
   <5 ppb (dry wt.) (windowpane flounder, muscle)
   <3 ppb (dry wt.) (striped bass, muscle)
   <3 - 40 ppb (dry wt.) (lobster, muscle)
   50 - 70 ppb (dry wt.) (lobster, hepatopancreas)
   <4 - 300 ppb (dry wt.) (blue mussel)
   <16 ppb (dry wt.) (grass shrimp)

Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

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2. NOAA (1989)
Conc: <d.l. - 170 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

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2-Methylnaphthalene Category I.E.

1. McLeod et al. (1981)
Conc: <3 - 10 ppb (dry wt.) (winter flounder, muscle)
<5 - 1000 ppb (dry wt.) (winter flounder, liver)
<6 ppb (dry wt.) (windowpane flounder, muscle)
<3 ppb (dry wt.) (striped bass, muscle)
<5 ppb (dry wt.) (lobster, muscle)
60 - 100 ppb (dry wt.) (lobster, hepatopancreas)
<5 - 600 ppb (dry wt.) (blue mussel)
<19 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

2. NOAA (1989)
Conc: <d.l. - 390 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

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1-Methylophanthrene Category I.E.

1. McLeod et al. (1981)
Conc: <5 ppb (dry wt.) (winter flounder, muscle)
<7 ppb (dry wt.) (winter flounder, liver)
<6 ppb (dry wt.) (windowpane flounder, muscle)
<4 ppb (dry wt.) (striped bass, muscle)
<5 ppb (dry wt.) (lobster, muscle)
<15 - 60 ppb (dry wt.) (lobster, hepatopancreas)
<7 - 400 ppb (dry wt.) (blue mussel)
<23 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

2. NOAA (1989)
Conc: <d.l. - 730 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988
Mirex

Category I.C.

1. NYS DEC (1987)
   Conc: <0.01 ppm (striped bass, fillet)
   <0.01 ppm (american eel)
   <0.01 ppm (american shad, fillet)
   <0.01 ppm (winter flounder, fillet)
   <0.01 ppm (bluefish, fillet)
   <0.01 ppm (mummichog, fillet)
   <0.01 ppm (weakfish, fillet)
   <0.01 ppm (white perch, fillet)
   <0.01 ppm (carp, fillet)

   Location: Hudson River, Upper and Lower NY Bays, Arthur Kill, East River, Jamaica Bay

   Year: 1980-1985

2. McLeod et al. (1981)
   Conc: <10 ppb (dry wt.) (winter flounder, muscle)
   <3 - 70 ppb (dry wt.) (winter flounder, liver)
   <10 ppb (dry wt.) (windowpane flounder, muscle)
   <9 ppb (dry wt.) (striped bass, muscle)
   <1 ppb (dry wt.) (lobster, muscle)
   <50 ppb (dry wt.) (lobster, hepatopancreas)
   <2 ppb (dry wt.) (blue mussel)
   <4.7 ppb (dry wt.) (grass shrimp)

   Location: Raritan Bay, Hudson River, Lower Bay

   Year: 1977-1980

3. NOAA (1989)
   Conc: <0.64 - 11 ppb (dry wt.) (Mytilus edulis)

   Location: Upper and Lower NY Bays, Jamaica Bay, Raritan Bay

   Year: 1986-1988

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Naphthalene

Category I.E.

1. McLeod et al. (1981)
   Conc: 10 - 30 ppb (dry wt) (winter flounder, flesh)
   40 - 500 ppb (dry wt) (winter flounder, liver)
   10 - 40 ppb (dry wt) (windowpane flounder)
   4 - 30 ppb (dry wt) (striped bass)
   4 - 40 ppb (dry wt) (lobster, flesh)
   60 - 70 ppb (dry wt) (lobster, digestive gland)
   <6 - 100 ppb (dry wt) (blue mussel)
   <18 ppb (dry wt) (grass shrimp)

   Location: Raritan Bay, Hudson River, Lower Bay

   Year: 1977 - 1980

   Conc: <1.1 - 0.07 ppm (blue crab, hepatopancreas)

   Location: Hudson River, Upper and Lower Bays, Newark Bay, Arthur Kill, Raritan Bay

   Year: 1982

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trans-Nonaclor  

Category I.E.

1. **NYS DEC (1988)**
   Conc: <0.01 - 0.75 ppm (striped bass, fillet)
   Location: Upper and Lower NY Bays
   Year: 1985, 1987

2. **McLeod et al. (1981)**
   Conc: 20 - 30 ppb (dry wt.) (winter flounder, muscle)
   70 - 1500 ppb (dry wt.) (winter flounder, liver)
   10 - 20 ppb (dry wt.) (windowpane flounder, muscle)
   600 - 800 ppb (dry wt.) (striped bass, muscle)
   10 - 20 ppb (dry wt.) (lobster, muscle)
   2200 - 2900 ppb (dry wt.) (lobster, hepatopancreas)
   <30 - 56 ppb (dry wt.) (blue mussel)
   34 - 40 ppb (dry wt.) (grass shrimp)
   Location: Raritan Bay, Hudson River, Lower Bay
   Year: 1977 - 1980

3. **NOAA (1989)**
   Conc: 17 - 85 ppb (dry wt.) (Mytilus edulis)
   Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

Octachlorostyrene  

Category I.E.

1. **NYS DEC (1987)**
   Conc: <0.01 ppm (striped bass, fillet)
   Location: Upper and Lower Bays
   Year: 1985

Perylene  

Category I.E.

1. **O'Connor and Moese (1984)**
   Conc: <d.l. - 1.92 ppm (blue crab, muscle)
   <d.l. - 3.04 ppm (blue crab, hepatopancreas)
   <d.l. - 0.97 ppm (lobster, muscle)
   <d.l. - 7.07 ppm (lobster, hepatopancreas)
   <d.l. - 0.09 ppm (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay, Arthur Kill, Raritan Bay
   Year: 1982
2. McLeod et al. (1981)
Conc: <20 ppb (dry wt.) (winter flounder, muscle)
<10 ppb (dry wt.) (winter flounder, liver)
<20 ppb (dry wt.) (windowpane flounder, muscle)
<7 ppb (dry wt.) (striped bass, muscle)
<8 ppb (dry wt.) (lobster, muscle)
100 ppb (dry wt.) (lobster, hepatopancreas)
<10 ppb (dry wt.) (blue mussel)
<35 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

3. NOAA (1989)
Conc: <d.l. - 310 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988

Phenanthrene
Category I.B.
Criterion: 0.00093 ppm
EPA, 1989

Conc: <d.l. - 0.08 ppm (blue crab, muscle)
<d.l. - 1.10 ppm (blue crab, hepatopancreas)
<d.l. - 0.06 ppm (lobster, muscle)
<d.l. - 2.55 ppm (lobster, hepatopancreas)
<d.l. (winter flounder, muscle)
Location: Hudson River, Upper and Lower Bays, Newark Bay,
Arthur Kill, Raritan Bay
Year: 1982

2. McLeod et al. (1981)
Conc: <4 - 5 ppb (dry wt.) (winter flounder, muscle)
<6 ppb (dry wt.) (winter flounder, liver)
<6 - 9 ppb (dry wt.) (windowpane flounder, muscle)
<3 ppb (dry wt.) (striped bass, muscle)
<3 - 30 ppb (dry wt.) (lobster, muscle)
50 - 200 ppb (dry wt.) (lobster, hepatopancreas)
20 - 80 ppb (dry wt.) (blue mussel)
<16 - 77 ppb (dry wt.) (grass shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

3. NOAA (1989)
Conc: <d.l. - 2,400 ppb (dry wt.) (Mytilus edulis)
Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
Year: 1986-1988
   Conc: <d.1. - 0.27 ppm (blue crab, muscle)
   <d.1. - 3.58 ppm (blue crab, hepatopancreas)
   <d.1. - 0.05 ppm (lobster, muscle)
   <d.1. - 0.74 ppm (lobster, hepatopancreas)
   <d.1. (winter flounder, muscle)
   Location: Hudson River, Upper and Lower Bays, Newark Bay, Arthur Kill, Raritan Bay
   Year: 1982

2. McLeod et al. (1981)
   Conc: <5 - 5 ppb (dry wt.) (winter flounder, muscle)
   <7 ppb (dry wt.) (winter flounder, liver)
   <5 - 5 ppb (dry wt.) (windowpane flounder, muscle)
   <4 ppb (dry wt.) (striped bass, muscle)
   <5 - 200 ppb (dry wt.) (lobster, muscle)
   1400 - 1500 ppb (dry wt.) (lobster, hepatopancreas)
   10 - 1100 ppb (dry wt.) (blue mussel)
   200 - 280 ppb (dry wt.) (grass shrimp)
   Location: Raritan Bay, Hudson River, Lower Bay
   Year: 1977-1980

3. NOAA (1989)
   Conc: 460 - 4,600 ppb (dry wt.) (Mytilus edulis)
   Location: Upper and Lower Bays, Jamaica Bay, Raritan Bay
   Year: 1986-1988

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Polychlorinated Biphenyls (PCBs) (Total)

1. NYS DEC (1988)
   Conc: 0.40 - 21.63 ppm (striped bass)
   Location: Hudson River (FM 12), Upper and Lower NY Bays
   Year: 1987

2. NYS DEC (1987)
   Conc: 0.11 - 32.91 ppm (striped bass)
   0.95 - 24.69 ppm (american eel)
   1.44 - 22.15 ppm (white perch)
   2.64 - 25.46 ppm (white catfish)
   <0.59 - 2.66 ppm (american shad)
   0.32 - 1.21 ppm (bluefish)
   0.19 - 2.43 ppm (mummichog)
   0.87 - 2.92 ppm (common carp)
   0.11 - 0.62 ppm (winter flounder)
   0.55 - 0.62 ppm (tautog)
   1.15 ppm (weakfish)
   Location: 15 locations throughout the Harbor
   Year: 1982-1986
3. NYS DEC (1986)
Conc: 0.65 - 31.15 ppm (striped bass)
Location: Hudson River (RM 27) and Upper NY Bay (RM 12)
Year: 1985

4. NYS DEC (1981)
Conc: <0.37 - 14.79 ppm (striped bass)
2.65 - 32.00 ppm (white catfish)
0.83 - 25.69 ppm (american eel)
<0.83 - 2.15 ppm (american shad)
Location: Hudson River (RM 27 and 12), Harlem River
         Jones Beach
Year: 1978-1981

5. NYS DEC (1978)
Conc: <0.87 - 24.40 ppm (striped bass)
<0.05 - 11.20 ppm (american shad)
Location: Hudson River (RM 27)
Year: 1976-1977

6. Haugse et al. (1990)
Conc: <0.2 - 6.65 ppm (striped bass, fillet)
1.43 - 7.12 ppm (white perch, fillet)
0.65 - 4.81 ppm (american eel)
<0.2 - 3.80 ppm (bluefish, fillet)
0.42 - 0.67 ppm (weakfish, fillet)
0.59 - 3.86 ppm (blue crab, muscle + hepatopancreas)
<0.24 - 0.39 ppm (blue crab, muscle)
4.18 - 8.27 ppm (blue crab, hepatopancreas)
Location: Hudson River, Upper NYBay, Hackensack, Passaic
         and Raritan Rivers, Newark Bay and Raritan Bay
Year: 1986-1987

7. Belton et al. (1983)
Conc: 0.16 - 5.03 ppm (striped bass, fillet)
0.90 - 12.6 ppm (white perch, fillet)
1.25 - 10.5 ppm (white catfish, fillet)
0.9 - 7.86 ppm (american eel)
0.32 - 3.44 ppm (bluefish, fillet)
1.49 - 3.37 ppm (atlantic sturgeon, fillet)
0.14 - 1.47 ppm (summer flounder, fillet)
0.24 - 1.24 ppm (weakfish, fillet)
0.3 - 3.44 ppm (atlantic menhaden, fillet)
0.16 - 1.07 ppm (blue crab)
0.4 ppm (winter flounder, fillet)
0
Location: Hudson River, Hackensack River, Passaic River,
         Raritan River, Newark Bay, Raritan/Sandy Hook
         Bay, Arthur Kill
Year: 1975-1982

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5. NYS DEC (unpublished data)
Conc: < d.l. - 0.1 ppm (mya)
Location: Navesink, Shrewesbery River, Sandy Hook
Little Egg Harbor
Year: 1982-1983

Conc: < d.l. (Mercenaria mercenaria)
Location: Raritan Bay, Jamaica Bay
Year: 1983, 1988

7. McLeod et al. (1981)
Conc: 0.08 - 0.10 ppm (winter flounder, flesh)
0.4 - 7.3 ppm (winter flounder, liver)
0.08-0.2 ppm (windowpane flounder)
3.0-8.0 ppm (striped bass)
0.1-0.4 ppm (lobster, flesh)
4.0-9.0 ppm (lobster, digestive gland)
0.09-0.32 ppm (blue mussel)
0.19 ppm (grays shrimp)
Location: Raritan Bay, Hudson River, Lower Bay
Year: 1977-1980

8. NOAA (1989)
Conc: 0.37 - 4.3 ppm (dry wt) (Mytilus edulis)
0.06 - 0.64 ppm (wet wt) (conversion factor: 15%)
Location: Upper and Lower NY Bays, Jamaica Bay,
Raritan Bay
Year: 1985-1988

9. Stainken and Rollwagen (1979)
Conc: 0.041-0.360 ppm (M. mercenaria)
0.048-0.112 ppm (C. virginica)
0.031-0.263 ppm (M. arenaria)
Location: Raritan Bay, Arthur Kill, East Shore of Staten Island
Year: 1979

10. Belton et al. (1985)
Conc: 0.65 - 0.79 ppm (american lobster; muscle+hepatopancreas)
Location: Raritan Bay
Year: 1984

11. Roberts et al. (1982)
Conc: 0.16-0.41 ppm (american lobster)
Location: NY Harbor (Gravesend Bay)

10. Donn (1986)
Conc: 0.09-0.18 ppm (blue crab, muscle)
5.6-13.0 ppm (blue crab, hepatopancreas)
Location: Hudson River (Tappen Zee)
Year: 1985

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2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) Category I.A. Criterion: 25 ppt
FDA action level

1. NYS DEC (1987)
   Conc: 16-60 ppt (striped bass, fillets)
   Location: Newark Bay
   Year: 1983
   Conc: <9 - 120 ppt (striped bass, fillets)
   Location: Hudson River
   Year: 1981-1983

2. Belton et al. (1985)
   Conc: 25 - 480 ppt (blue crab, muscle + hepatopancreas)
   <42 - 1063 ppt (blue crab, hepatopancreas)
   <35 ppt (blue crab, muscle)
   <20 - 62 ppt (American lobster, muscle + hepatopancreas)
   <6 - 58 ppt (striped bass, fillet)
   <5 - 61 ppt (american eel)
   73 - 110 ppt (brown bullhead, fillet)
   114 ppt (mummichog, fillet)
   <76 ppt (white perch, fillet)
   <6 ppt (largemouth bass, fillet)
   <34 ppt (bluefish, fillet)
   <25 ppt (weakfish, fillet)
   <4 - 155 ppt (carp, fillet)
   <8 - 50 ppt (channel catfish, fillet)
   Location: Passaic River, Hackensack River, Newark Bay, Hudson River, Raritan River, Raritan Bay
   Year: 1982-1984

Tetrachlorodibenzoofurans (TCDF) Category I.B. Criterion: 0.7 ppt
based on a TEF of 0.1
EPA, 1989

1. NYS DEC (1987)
   Conc: 20 - 32 ppt (striped bass, fillet)
   Location: Newark Bay
   Year: 1983
   Conc: 16 - 76 ppt (striped bass, fillet)
   Location: Hudson River
   Year: 1981, 1983

2. Belton et al. (1985)
   Conc: <16 - 42 ppt (striped bass, fillet)
   Location: Passaic River/Newark Bay confluence
   Year: 1983
1. NYS DEC (1987)
   Conc: <0.05 ppm (striped bass, fillet)
   Location: Upper and Lower NY Bays
   Year: 1985


NJ DEP (New Jersey Department of Environmental Protection). 1985. Report. Special Investigation Heavy Metals – Shellfish, Chemical Investigation of Shellfish from Northern Monmouth County Waters, Phase II.


