DIAMOND ALKALI SUPERFUND SITE

NATURAL RESOURCE DAMAGE ASSESSMENT PLAN

PREPARED BY THE
FEDERAL NATURAL RESOURCE TRUSTEES

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

Public Review Draft
November 2007

This Draft Natural Resource Damage Assessment Plan was prepared by the Federal Natural Resource Trustees, consisting of the National Oceanic and Atmospheric Administration (part of the Department of Commerce) and the U.S. Fish and Wildlife Service (part of the Department of the Interior). These Federal Trustee agencies are working cooperatively to conduct a Natural Resource Damage Assessment for the Diamond Alkali Superfund Site. The Natural Resource Damage Assessment Plan is one step in the damage assessment process. It serves to document exposure of natural resources to hazardous substances and identify anticipated procedures for evaluating natural resource injuries potentially caused by such exposure.

Credits:
Cover Photos of Passaic River Courtesy USFWS.

Table of Contents

Exhibits

List of Acronyms and Abbreviations

BMF	Biomagnification factor
CBR	Critical body residue
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DDT	Dichloro diphenyl trichloroethane
DOI	United States Department of the Interior
ED	Effects dose
EFH	Essential fish habitat
EPA	United States Environmental Protection Agency
ER-M	Effects range-median
FTL	Field Team Leader
HEA	Habitat Equivalency Analysis
HMW	High molecular weight
HQ	Hazard quotient
LC_{50}	50% lethal concentration
LMW	Low molecular weight
LPR	Lower Passaic River
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPRSA	Marine Protection, Research and Sanctuaries Act
NA	Not available
NBSA	Newark Bay Study Area
NCP	National Contingency Plan
ND	Not detected
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzo-*para*-dioxin
PCDF	Polychlorinated dibenzofuran, or furan
PED	Preliminary Estimate of Damages
PI	Principal Investigators
ppb	Parts per billion
ppm	Parts per million
pptr	Parts per trillion
PQL	Practical Quantitation Limit
PRP	Potentially Responsible Party
PRSA	Passaic River Study Area
PSD	Preassessment Screen Determination
QA	Quality Assurance

QC	Quality Control
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedures
SWDA	Solid Waste Disposal Act
TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEF	Toxic equivalency factor
TEQ	Toxic equivalent
URRI	Urban River Restoration Initiative
USACE	U.S. Army Corps of Engineers
USFDA	United States Food and Drug Administration
USFWS	United States Fish and Wildlife Service
WHO	World Health Organization
%	Percent

Executive Summary

The Diamond Alkali Superfund Site

The Passaic River begins its journey in the hilly, wooded regions of northern New Jersey. From there it meanders through the swampy lowlands along the western edge of the Great Swamp, passes through the gorge at Great Falls, and flows over the Dundee Dam between the towns of Clifton and Garfield. Below the dam, the river enters more highly developed and industrialized areas as it travels generally south towards Newark Bay. The River empties into Newark Bay at the heavily industrialized port city of Newark. Newark Bay is a major commercial hub of the East coast and part of the New York Bight Watershed Estuary, which consists of a variety of interconnected rivers, channels, and bays including Upper and Lower New York/New Jersey Harbor (the Harbor), Raritan Bay, the Hudson, Raritan and East Rivers, and the Arthur Kill and Kill van Kull channels bordering Staten Island. Water flow throughout the Estuary is tidally influenced, with substantial mixing both within and among the various waterbodies.

The industrial history of the Passaic River dates back to the late 1700s, when the Society for Useful Engineers developed a plan to create the new industrial city of Patterson using energy generated by Great Falls. The establishment of various mills and factories followed, as did use of the River for commercial transportation and as a public sewer. Ultimately, heavy industrialization and use of the River led to severe impairments to water quality and natural habitats. The extent and severity of pollution resulted in the Passaic being listed as one of the twenty most endangered rivers in the country (American Rivers 1998).

Investigations to identify critical threats to the ecology of the River began in the 1980s. Those studies detected high levels of dioxin and polychlorinated biphenyls (PCBs) in the Passaic River adjacent to a former industrial facility, the Diamond Alkali Company pesticide manufacturing plant, located at 80 and 120 Lister Avenue in Newark. The severity of the contamination led to the institution of fish and seafood consumption advisories by the State of New Jersey as well as to the properties being listed on the National Priorities List as the Diamond Alkali Superfund Site (Site) by the Environmental Protection Agency (EPA). The EPA's Remedial Investigation of the properties, identified as Operable Unit (OU) 1 of the Site, detected a large number of hazardous substances in addition to dioxin and PCBs, including semi-volatile organic compounds, volatile organic compounds, herbicides, insecticides, polycyclic aromatic hydrocarbons (PAHs), and metals. Studies under OU2 of the Site were initially intended to guide remedial activities in the sediments of lower six miles of the Passaic River, in the vicinity of the Diamond Alkali plant, which were also found to be highly contaminated by a similar variety of hazardous substances. However, because of the tidally influenced movement of hazardous substances upstream and downstream, OU2 was expanded in 2003 to the current Lower Passaic River (LPR) study area, which includes the lower 17 miles of the Passaic River – the entire segment downstream of Dundee Dam. Downstream migration of hazardous substances also led the EPA to designate in 2004 another study area, the Newark Bay Study Area (NBSA), which includes Newark Bay, portions of the Hackensack River, and the Arthur Kill and Kill Van Kull channels, as OU3 of the Site.

The Role of the Trustees

Natural resources held in trust include fish, wildlife, and other biota, and the habitats that support them, as well as water, air, and protected lands. Natural resources may be injured by the release of hazardous substances. The ultimate objective of a Natural Resource Damage Assessment (NRDA) is to compensate the public through environmental restoration for injuries to natural resources caused by releases of hazardous substances into the environment. The Natural Resource Trustees (Trustees) are authorized to recover compensatory damages for natural resource injuries and losses that are not fully remediated by response actions and to use those damages to restore, rehabilitate, replace, or acquire the equivalent of natural resources injured by the release of hazardous substances. The Trustees may also recover reasonable costs of assessing natural resource damages and any prejudgment interest. The authority for restoring or replacing injured resources resides with federal, state, and tribal Trustees identified through federal and state statutes. For the Site, the Trustee agencies are the U.S. Department of Commerce, the U.S. Department of the Interior, and the State of New Jersey. Each agency has designated representatives that are responsible for evaluating injuries to trust resources and identifying appropriate restoration actions to compensate for the loss of those resources. The respective agency representatives for the Site are the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish and Wildlife Service (USFWS), and the New Jersey Department of Environmental Protection (NJDEP).

The Superfund law[1] assigns responsibility for the cost of cleaning up hazardous substances released into the environment and restoring natural resources injured by those releases. Under Superfund, the EPA is in charge of clean up (remediation) of contaminated sites; it is the Trustees' responsibility to restore or replace natural resources injured by hazardous substances. The Trustees have determined that remedial activities will not adequately compensate the public for losses associated with injuries to natural resources within the Site. Under Superfund law, parties liable for environmental cleanup are also responsible for natural resource damages and will be asked to compensate the public for such losses by funding assessment studies and restoring or acquiring equivalent resources.

The Natural Resource Damage Assessment Process

In performing a NRDA for the Site, the Trustees are guided by the NRDA Rule under the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA)[2] as well as by comparable regulations for NOAA under the Oil Pollution Act (OPA)[3]. Both sets of regulations outline the process for conducting a NRDA, including how to determine whether a damage assessment is warranted; how to determine that injuries to natural resources occurred; how to quantify injuries to natural resources; how to identify

[1] See 42 U.S.C. § 9601, *et seq.*
[2] See 43 C.F.R. Part 11, Subpart A.
[3] See 15 C.F.R. Part 990.

the type and quantity of restoration required to compensate the public for those injuries; and what procedures may be used for planning projects to accomplish restoration goals.

The first step in a NRDA is the development of a Preassessment Screen Determination (PSD). In the PSD, the Trustees evaluate the available information to determine whether sufficient evidence exists to indicate that a NRDA is appropriate. The Trustees approved the PSD for the Diamond Alkali Superfund Site in November 2005 (NJDEP, NOAA, and USFWS 2004).[4] The Trustees concluded in the PSD that all of the criteria required for proceeding with a NRDA for the Site are met.

Development of the Natural Resource Damage Assessment Plan

Following completion of the PSD, the next step in the NRDA process is the development of a NRDA Plan. The purpose of the NRDA Plan is to ensure that a NRDA is done in a systematic manner and at a reasonable cost, as well as to encourage the involvement of other interested parties, including potentially responsible parties (PRPs) and the general public. This document represents the Draft Federal NRDA Plan for the Site; at this time, the State of New Jersey has chosen not to participate as an active party in its development. However, the State of New Jersey shares Trusteeship of natural resources potentially injured at the Site. Therefore, while not formal partners in developing this Draft NRDA Plan, both State and Federal Trustees are working to ensure that the public is adequately and appropriately compensated for injuries to natural resources incurred by the release of hazardous substances at the Site.

Scientific research indicates that in addition to driving consumption advisories, hazardous substances can cause serious injuries to wildlife and other natural resources. Information in this plan confirms exposure of natural resources such as biota (fish, birds, and benthic invertebrates) and surface water (including sediments) to hazardous substances within the Site and potential investigations are described to identify the nature and extent of contamination. In addition, the NRDA Plan describes future studies that may be performed to determine whether other resources such as mammals, amphibians, groundwater, and air are exposed. The NRDA Plan also outlines potential activities for identifying and quantifying injuries to natural resources exposed to hazardous substances and addresses the major steps in the NRDA: 1) injury determination; 2) injury quantification; and 3) damage determination and restoration.

In the injury determination phase of a NRDA, the movement of hazardous substances through the environment is documented and the nature and extent of exposure and injury (including the reduction of associated services) to natural resources from hazardous substances are identified. The injury quantification phase of a damage assessment identifies the total amount of injured resources that must be restored or replaced, or for which the equivalent must be acquired. The Federal Trustees are considering conducting injury determination and quantification investigations for the following resources: fish, birds, surface water, groundwater, geologic, and air. The specific investigations proposed include the following:

---

[4] The PSD is available at: http://www.darrp.noaa.gov/northeast/passaic/injury.html.

- Fish and shellfish consumption advisories
- Biological injuries to fish and shellfish – preliminary evaluation, fish and shellfish community health, early life stage evaluation
- Exceedances of United States Food and Drug Administration (USFDA) thresholds for fish and shellfish
- Exceedances of USFDA thresholds for birds
- Biological injuries to birds – preliminary evaluation, breeding bird survey, avian developmental studies, floodplain exposure
- Consumption advisories for birds
- Water quality evaluation - surface water
- Sediment evaluation - sediments characteristic of solid waste
- Sediment evaluation - sediment injury - pathway and biota
- Groundwater evaluation
- Geologic resources evaluation
- Air resources evaluation
- Sources of hazardous substances within the Site
- Food web pathway evaluation

Using the results of the injury determination and quantification, the Federal Trustees will perform the damage determination, through which the Trustees evaluate the compensable value for injured natural resources and determine what compensation is appropriate to be sought as damages. The costs of restoring, rehabilitating, replacing, and/or acquiring the equivalent of the injured resources are the basic measure of damages. However, these costs are only one component of the damages that Trustees may assess; Trustees also have the discretion to assess the value of the services that the public lost from the date of the release or discharge until completion of restoration, rehabilitation, replacement, and/or acquisition of equivalent resources.

Potential investigations for the damage determination phase of the NRDA for the Site include the following:

- Recreational fishing lost use study
- Avian lost use study
- Habitat equivalency analysis
- Lost navigational services study

Many of the studies listed above are preliminary, and are designed to guide more in-depth studies to be undertaken in the future. If Federal Trustees conclude from a preliminary study that a more complete analysis is warranted, a study plan will be developed for each specific investigation. All study plans will be peer reviewed and released to the public for comment.

Once damages are assessed, Trustees identify and evaluate reasonable possible alternatives for restoring, rehabilitating, replacing, and/or acquiring the equivalent of the injured resources. Trustees then select one or several of the possible alternatives. Finally, the Trustees document their decisions in the Restoration and Compensation Determination Plan (Restoration Plan). The Restoration Plan is part of the overall NRDA and is therefore subject to public review and comment.

At the conclusion of the damage assessment, the Federal Trustees will issue a Report of Assessment documenting the studies undertaken as part of the NRDA, the conclusions of those studies, and the proposed restoration and compensation plan, along with public comments and responses to those comments for each document prepared during the damage assessment process. The Report of Assessment will be released to the public.

NRDA is an iterative process. This NRDA Plan represents an initial evaluation of the Site, and is designed to describe the overall landscape of what will be needed in the developing the injury and damage assessment. Subsequent detailed plans, which will be subject to public review, will be produced that will describe specific studies to be undertaken during the course of the damage assessment. Additionally, revisions or amendments to this Draft NRDA Plan may be implemented based on the need for additional studies or on additional evidence as it becomes available. While this document focuses primarily on natural resource injuries occurring within the LPR and NBSA resulting from the release or movement of hazardous substances into the lower Passaic River, additional evidence regarding contamination or likely injury, as well as risks associated with the nature and extent of contamination, may lead the EPA to expand the currently-delineated Site.

How You Can Help

The Federal Trustees are asking members of the public and parties potentially responsible for contamination within the Site to review the Draft NRDA Plan and provide feedback on the proposed assessment approach and studies. Comments on this document should be submitted to the contacts identified below within thirty days of the notice of availability in the Federal Register. Your comments will help the Federal Trustees conduct an assessment that is scientifically valid, cost effective, and incorporates a broad array of perspectives.

CONTACTS FOR PUBLIC INQUIRIES:

U.S. Fish and Wildlife Service
New Jersey Field Office
927 N. Main Street
Pleasantville, NJ 08232
Ph: 609-383-3938, ext 26 or 21
E-mail: tim_kubiak@fws.gov or melissa_foster@fws.gov

Chapter 1 : The Ecological, Cultural, and Economic Significance of the Site

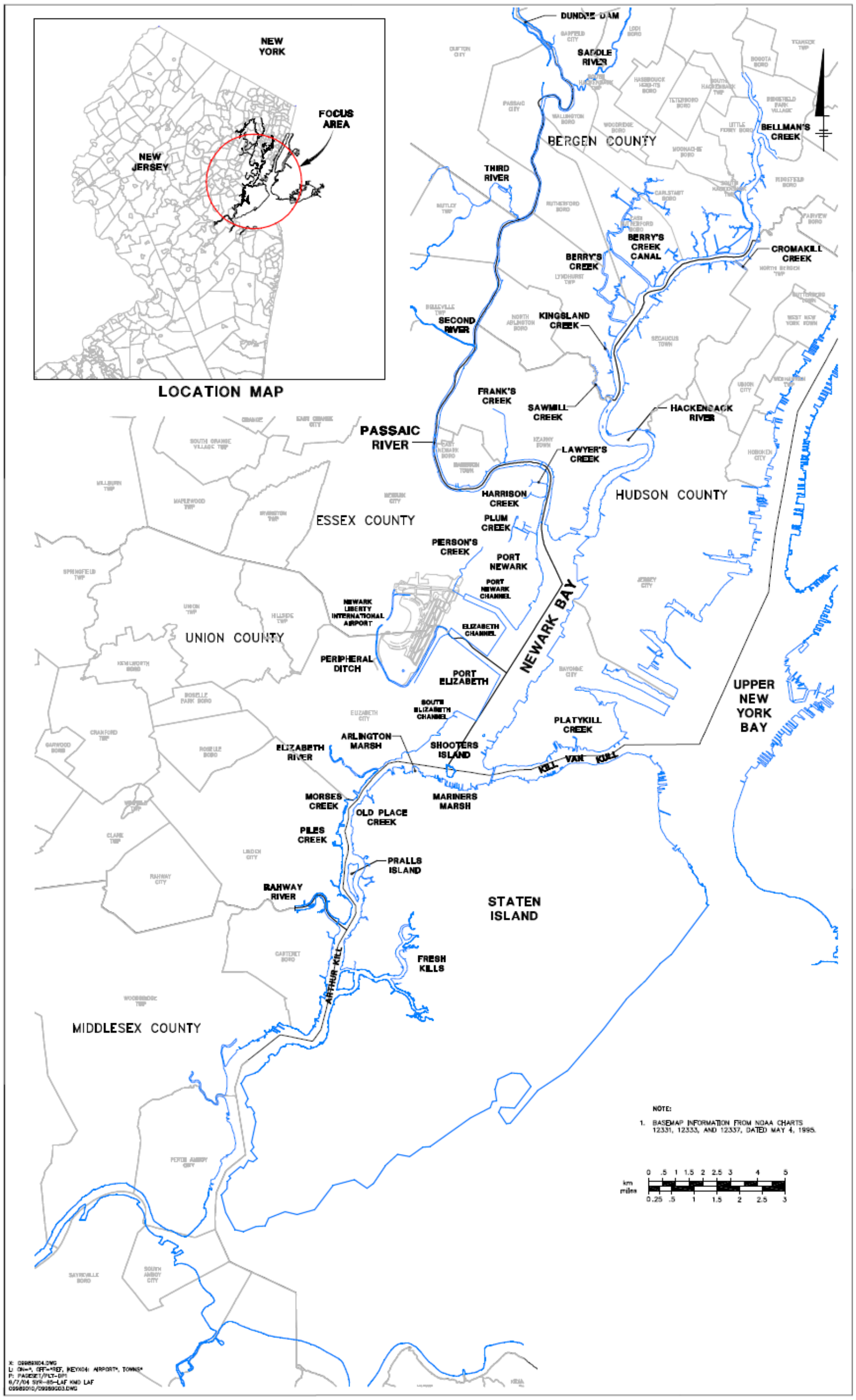
The Passaic River. Photos Courtesy Malcolm Pirnie, Inc. and EPA.

The Passaic River drains a watershed of 935 square miles. It begins in the hilly, wooded regions of northern New Jersey, flows through the meadows and bogs of the Central Basin, passes through the gorge at Little Falls, and finally enters the suburban and industrialized areas of the Lower Valley. At the port city of Newark, the Passaic empties into Newark Bay, one of the major water bodies of the New York/New Jersey Harbor area (Exhibit 1-1).

The Site includes the LPR, running south 17 miles from the Dundee Dam to the confluence with the Hackensack River, and the NBSA, including Newark Bay, the Arthur Kill, the Kill Van Kull, and tidal portions of the Hackensack River. However, these areas incorporate only a portion of the New York Bight Watershed Estuary, which through tidal action intricately connects the water bodies of the Site to both the upper and lower bays of the Harbor and the Hudson River. Therefore, this Draft NRDA Plan may be revised if the EPA-identified boundaries of the Site are modified.

The watershed of the 17-mile LPR includes the northeastern New Jersey counties of Bergen, Essex, Hudson, and Passaic. Most of the area is developed, with these counties having a combined population of 2.8 million people. Land use in the watershed is a mix of residential, commercial, and industrial. Intensive commercial and industrial uses occur near Newark Bay, which is in proximity to an extensive infrastructure of roadway, railway, and marine transportation services.

Exhibit 1-1: The Passaic River, Newark Bay, New York/New Jersey Harbor, And Environs



Other portions of the Site include a mixture of urbanized and semi-natural environments. The salt marshes of the New Jersey Meadowlands border the Hackensack River for about 7 miles from just north of Newark Bay up to the confluence with the Overpeck River. Further north, the Hackensack is surrounded by suburban developed land up to the Oradell Dam. The Arthur Kill and Kill Van Kull, important shipping channels in the New York/New Jersey Harbor, border Staten Island on the west and north, respectively, separating the island from mainland New Jersey. The channels are surrounded by a mixture of industrial facilities, urban parks, and residential neighborhoods. Newark Bay is an urban estuary about 6 miles long, fed by fresh water entering from the Passaic and Hackensack at the north end and by salt water entering from the Arthur Kill and Kill van Kull tidal straits to the south.

The Natural Environment of the Site

Despite significant urban development in the surrounding watershed, the Site supports an array of ecological resources that interact in myriad ways (Exhibit 1-2). While much of the shoreline habitats are degraded and vegetation is scarce, the Site still contains an estimated 45 acres of wetlands (USACE New York District, EPA Region II, and NJDOT Office of Maritime Resources 2003). These habitats are characterized primarily by emergent vegetation including common reed (*Phragmites australis*) and smooth cordgrass (*Spartina alterniflora*). Other important natural environments include benthic habitat and small areas of non-vegetated tidal mudflats. These habitats support a variety of benthic invertebrates and aquatic, semi-aquatic, and terrestrial vertebrates including clams, crabs, mussels, turtles, fish, birds, and mammals.

Historical Significance of the Site

Commerce and industry have a long history in the Passaic River region (Exhibit 1-3). In 1791, Alexander Hamilton founded the Society for Establishing Useful Manufactures at Passaic Falls, in what is now Paterson, New Jersey. It was the nation’s first effort to develop manufacturing capabilities to compete with Europe. When foreign supplies were interrupted during the War of 1812, manufacturing in the region grew. By the Civil War, an array of products, from locomotives to hats and shoes, were streaming out of the Passaic River valley. The Port of Newark opened in the early 20^{th} century and Newark Bay, together with the nearby ocean channels, became a major center of transportation and commerce.

Exhibit 1-2: Select Natural Resources Of The Site[1]

Natural Resource Category	Species – Common Names
Aquatic Invertebrates	• Blue crab, Atlantic rock crab, spider crab, lady crab, grass shrimp, mantis shrimp, horseshoe crab, softshell clam, hard clam, blue mussel, American oyster, longfin squid
Amphibians	• blue spotted salamander[3], four-toed salamander, Jefferson salamander, longtail salamander[2], marbled salamander, northern dusky salamander, northern red salamander, northern slimy salamander, northern two-lined salamander, redback salamander, red spotted newt, spotted salamander, American toad, ?bullfrog, green frog, New Jersey chorus frog, northern cricket frog, northern gray treefrog, northern spring peeper, pickerel frog, wood frog
Reptiles	• Common snapping turtle, diamondback terrapin, common musk turtle, eastern box turtle, eastern painted turtle, red-eared slider, spotted turtle, five-lined skink, black rat snake, eastern garter snake, eastern hognose snake, eastern milk snake, eastern ribbon snake, eastern smooth earth snake, eastern worm snake, northern black racer, northern brown snake, northern copperhead, northern redbelly snake, northern ringneck snake, northern water snake, smooth green snake, bog turtle[2,3]s, wood turtle[4]s, eastern mud turtles
Fish	• Anadromous and Catadromous Fish– alewife, blueback herring, American shad, American eel, striped bass • Estuarine and Marine Fish – bay anchovy, silver perch, Atlantic menhaden, weakfish, mummichog, striped bass, banded killifish, spot, Atlantic croaker, white perch, summer flounder[5], bluefish[5], winter flounder[5], gizzard shad, hogchoker, Atlantic sturgeon[6], conger eel, Atlantic herring[5], little skate, rainbow smelt[6], Atlantic tomcod, red hake[5], spotted hake, Atlantic silverside, inland silverside, tidewater silverside, three-spined stickleback, northern searobin, striped searobin, lined seahorse, northern pipefish, grubby, crevalle jack, scup[5], northern kingfish, tautog, rock gunnel, cunner, goby, butterfish[5], chub mackerel, striped mullet, white mullet, smallmouth flounder, fourspot flounder, windowpane flounder[5], oyster toadfish, planehead filefish, northern puffer, Atlantic needlefish, silver hake (whiting)[5], pPollock[5], black sea bass[5], smooth dogfish, lookdown, sheepshead, northern stargazer, American sand lance, white mullet, Atlantic moonfish, smooth trunkfish, striped burrfish, striped anchovy, longhorn sculpin, naked goby, seaboard goby, fourbeard rockling, striped cusk-eel, little skate, striped killifish, Atlantic croaker, planehead filefish, northern puffer, inland silverside, grubby sculpin, pollack, rough silverside • Freshwater Species – channel catfish, white catfish, goldfish, pumpkinseed, bluegill, largemouth bass, black crappie, red breasted sunfish, brown bullhead, golden shiner, carp, white sucker, northern pike
Birds	• Black-crowned night heron[4], American bittern[3], snowy egret[7], Canadian goose, great blue heron[8], green heron[7], little blue heron[7], great egret[7], wood duck[7], mallard, American black duck[7], belted kingfisher, osprey[4], laughing gull, mourning dove, eastern kingbird[7], blue jay, American crow, fish crow, gray catbird[7], northern mockingbird, northern cardinal, American tree sparrow, song sparrow, white-throated sparrow, red-winged blackbird, goldfinch, house finch, house sparrow, barn swallow, northern rough- winged swallow, great black-backed gull, herring gull, ring-billed gull, killdeer, least sandpiper, spotted sandpiper[8], greater yellowlegs[7], lesser yellowlegs, ring-billed gull, black scoter[7], white-winged scoter[7], common merganser, double-crested cormorant, peregrine falcon[3], red-tailed hawk, bald eagle[2,3,9], common loon, horned grebe[8], pied-billed grebe[3], great cormorant, cattle egret[7], tricolored heron[7], least bittern[8], yellow-crowned night heron[4], glossy ibis[7], brant[7], northern pintail[7], American wigeon, northern shoveler, green-winged teal, blue-winged teal, gadwall, canvasback, greater scaup[7], lesser scaup[7], goldeneye, hooded merganser, red-breasted merganser, ruddy duck, Cooper's hawk[4], sharp-shinned hawk[8], rough-legged hawk, broad-winged hawk[8], red-shouldered hawk[3], northern harrier[3], merlin, American coot, common moorhen, sora, Virginia rail[7], clapper rail, semipalmated plover, black-bellied plover, ruddy turnstone[7], sanderling[8], red knot[4], semipalmated sandpiper[7], willet[7], least tern[3], Forster's tern[7], gull-billed tern[7], short-eared owl[3], barred owl[4], pileated woodpecker, red-headed woodpecker[4], willow flycatcher[7], great crested flycatcher[7], brown creeper, marsh wren[7], hermit thrush, wood thrush[7], blue-gray gnatcatcher, yellow-throated vireo[7], Kentucky warbler[8], American redstart, scarlet tanager[7], rose-breasted grosbeak[7], sharp-tailed sparrow[7], seaside sparrow[7], dark-eyed junco, swamp sparrow, rufous-sided towhee, northern (Baltimore) oriole[7], pine siskin[10]
Mammals	• River otter, mink, muskrats, fox, raccoon, coyote, deer, opossum, eastern cottontail, Indiana bat[8,11]

[1]Species lists from NJDEP (2007); NOAA (1995); Papson *et al.* (1981); PSEG (1998); USFWS (1997a); Wilk *et al.* (1997)
[2] Federally listed as threatened (USFWS 2007).
[3] New Jersey State listed as endangered (NJDEP 2004a).
[4] New Jersey State listed as threatened (NJDEP 2004a).
[5] Federally managed species for which essential fish habitat (EFH) is designated pursuant to the Magnuson-Stevens Act (NMFS 2006a).
[6] NMFS-identified species of special concern (NMFS 2006b).
[7] Species in regional conservation plan (NJDEP 2005a).
[8] New Jersey State species of special concern (NJDEP 2005a).
[9] Within foraging range.
[10]In addition to the species listed here, approximately 30 additional bird species pass through the area during migration (USFWS 1997a).
[11] Federally listed as endangered (USFWS 2007).

Exhibit 1-3: Selected Events In The Recorded History Of The Site

1618	Dutch establish trading post in the area now known as Jersey City[1]
1666	British settlers colonize the area now known as Newark[2]
1679	Land tract known by Native Americans as Aquakanonk, which was to be divided later into Passaic and Clifton, purchased by English and Dutch colonists[1]
1792	Establishment of the Society of the Establishing Useful Manufacturers, whose funds would be used to establish Paterson, a planned industrial city powered by the Great Falls of the Passaic[3]
1825	Construction begins on Morris Canal, to run from Phillipsburg, on the Delaware River, to the Passaic River near Newark[1]
1836	Morris Canal extended to Jersey City[1]
1836	Newark Township given City status[4]
1845	Construction begins on Dundee dam[5]
1869	Front Street Gas Works, a manufactured gas plant, begins operation in Newark[6]
1873	Town of Passaic incorporated[1]
1889	Botany Mills factory built in Clifton; employs 6000 workers[1]
1894	Manhattan Rubber factory built in Clifton; employs 3000 workers[1]
1894	Acid fumes from Passaic River causes the paint on houses along the River to peel[7]
1896	State investigating commission created to undertake a comprehensive study of conditions in the Passaic River[7]
1897	Jersey City abandons use of Passaic River as a public water supply due to poor water quality[7]
1899	City of Newark abandons use of Passaic River as a public water supply[7]
1899	State Sewerage Commission established to protect all potable waters in the State of New Jersey[7]
1901	U.S. Quarantine Station built in Clifton[1]
1902	Passaic Valley Sewerage Commissioners created[8]
1908	Largest silk mill in U.S., the Henry Doherty Silk Company, built in Clifton; employs 1000 workers[1]
1912	Paterson Hydroelectric facility installed[5]
1915	Port Newark opens[4]
1922	Nearly 1,000 industrial firms are located in Newark; primary industries include clothing and jewelry manufacturers, printing and publishing, foundry products, and leather goods[9]
1924	Morris Canal drained after expanding railroad routes make it obsolete[1]
1924	Passaic Valley trunk sewer line completed; carried sewage directly from towns along the Passaic River to New York Harbor[7]
1928	Newark Airport opens[4]
1935	Subway opens in bed of former Morris Canal in Newark[4]
Mid 1940s	Manufacturing of pesticides and phenoxy herbicides begins at 80 Lister Avenue property[10]
1951	First leg of New Jersey Turnpike opens[6]
1951	Diamond Alkali Co. acquires plant at 80 Lister Avenue and begins production of 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) and other herbicides[11]
1960	Explosion at Diamond Alkali Plant releases hazardous substances into soils, sediments, and groundwater near the Site[11]
1965	Massive fish kill occurs, attributed to low dissolved oxygen concentrations[7]
1969	Passaic River Coalition is created[7]
1982	First fish consumption advisories for Passaic River issued by the State of New Jersey[12,13]
1983	Sampling at Diamond Alkali Plant and surrounding Passaic River shows high levels of dioxin[11]
1984	Diamond Alkali Superfund Site listed on the National Priorities List (NPL) [12]
1998	Passaic River named one of nation's Most Endangered Rivers[14]
2003	Passaic River among eight selected for a pilot project under the Urban River Restoration Initiative (URRI) [15]

Sources:
[1] City of Clifton and Passaic River Coalition (2003).
[2] Newark Water and Sewer (Not Dated).
[3] Walt (2002).
[4] City of Newark, New Jersey (2006).
[5] Passaic Valley Water Commission (2005).
[6] PSEG (2007).
[7] Brydon (1974).
[8] PVSC (2007).
[9] Merchants Association of Newark (1922).
[10] EPA (2006a).
[11] EPA (2006b).
[12] EPA (1987).
[13] Hauge *et al.* (1990).
[14] American Rivers (1998).
[15] Rothman (2003).

Due to urbanization and heavy industrial use in the area, the natural environment of the Site began to suffer as a toxic soup of sewage and hazardous substances was dumped into the waterway. Past studies of the lower Passaic River report the presence of fish and benthic organisms known to be highly tolerant of pollution or low dissolved oxygen conditions, implying the presence of a stressed aquatic system (Chang *et al.* 2000; Friedmann 1980; Santoro *et al.* 1980). Depressed levels of dissolved oxygen reflect a chronic problem in Newark York Harbor and its environs dating back to the early 1900s (Squires 1981). More recent studies of sediment and water quality indicate that pollution control measures and the reduction or control of other environmental stressors have improved ecosystem quality somewhat. However, water quality and natural resources continue to be significantly impaired. For example, dioxin concentrations in Passaic River fish and crabs are among the highest reported in the world (NJDEP 2005b). For this reason, American Rivers, a Washington, D.C.-based conservation group, listed the Passaic among America's twenty "Most Endangered Rivers" in 1998 (American Rivers 1998). The annual list designates rivers that are environmentally at risk from threats such as pollution, damming, draining, and toxic waste. The Passaic was selected based on its levels of hazardous substances, principally dioxin, which poses a risk to fish, wildlife, and human health (Traster 1998).

Commerce and Industry within the Site Today

The Harbor remains one of the major commercial hubs of the east coast. The waterways lie at the heart of an industrial region stretching from New York City to Plainfield, New Jersey and serve as a distribution and wholesale center for the mid-Atlantic region. Local industries include petroleum refining, tanneries, textiles, paints and dyes, pharmaceuticals, chemicals, and paper products. Today, the manufacturing sector is surpassed by services such as transportation, research and development, education, and health care.

The combined Port Newark/Elizabeth Marine Terminal forms the largest maritime cargo handling facility on the east coast of North America. Located on the western shore of Newark Bay and operated by the Port Authority of New York and New Jersey, the integrated complex covers 2,100 acres and includes major container handling terminals, automobile processing and storage facilities, warehousing and distribution buildings, trucking firms, and an on-dock rail terminal (National Museum of American History 2007). This port handles more than 85 million tons of bulk and general cargo and thousands of ships annually (The Port Authority of New York and New Jersey 2006, 2007). Dredging of navigation channels essential to the Port's operations is hindered by contamination of sediments in Newark Bay and associated restrictions regarding disposal of dredge materials. As part of the NRDA, the Federal Trustees may make a determination of the extent to which the marine transportation sector is adversely affected by chemical contamination.

Recreational Use within the Site

Urban waterways have the potential to support a variety of recreational activities that contribute to public value and enhance the civic environment. With its miles of channels and open waters in close proximity to large urban populations, the Site provides important resources for recreational enjoyment that may otherwise be lacking in such an industrialized region. The most significant recreational services include the provision of open space, recreational boating, and recreational fishing.

<u>Provision of open space</u>

While industrial development can diminish some of the amenities a public waterway can provide, the presence of an urban environment can also enhance resource services. For example, judicious urban planning can take advantage of a river's meandering channel or unobstructed view to mitigate the density of an urban setting. A number of public parks are located along the banks of Newark Bay and adjacent waterways, including the waterfront parks in Perth Amboy on the Arthur Kill, the 16th Street Park in Bayonne on Newark Bay, and public parks in Passaic, Wallington, Clifton, Rutherford, East Rutherford, Lyndenhurst, North Arlington, Kearny, and Newark along the Passaic River. Many of these parks are primarily ball fields and playgrounds, but some locations in the Newark Bay area, such as the Hackensack River County Park, offer a broad array of open space amenities including hiking trails and bird watching. Additionally, the town of Clifton recently purchased the eastern portion of Dundee Island, which will be maintained as a wildlife sanctuary, enhancing opportunities for viewing wildlife.

<u>Recreational Boating</u>

There is a long tradition of rowing on the Passaic River, beginning with regattas held annually in the late 1800s. That tradition survives in the form of the Passaic River Rowing Association and the Nereid Boat Club, along with several high school rowing programs, all based on the Passaic. These organizations sponsor regular rowing practice and events on the Passaic and elsewhere, and promote stewardship of the Passaic River environment. Other types of recreational boating occur throughout the Site. The Hackensack River provides access to areas of the New Jersey Meadowlands that are undeveloped and relatively pristine in appearance. Municipal marinas, boat ramps, or private yacht clubs are located on all five waterways of the Site, though in many areas there is demand for additional publicly available boating facilities.

<u>Recreational Fishing</u>

Consumption of fish is banned on the Passaic River due to contamination, but some recreational angling still occurs there. More significant fishing activity occurs in other areas of the Site, where fish consumption advisories are in place but regulations are less restrictive. The waters of the Site offer easy access to a large urban population, where inexpensive access to alternative options for outdoor activities can be limited. Fishing occurs at bridges, piers, and waterfront parks throughout the Site, such as at the pier at Veterans Stadium in Bayonne, New Jersey, New Bridge Landing in Bergen, New Jersey, and elsewhere.

As part of this Draft NRDA Plan, the Federal Trustees may make a determination of the extent to which the public's recreational use is and has been adversely affected by hazardous substance releases.

Fishing along the Passaic River. Photo Courtesy Baykeeper.

Chapter 2: Hazardous Substances in the Site

Along the Passaic. Photos Courtesy Malcolm Pirnie, Inc.

Types and Effects of Contamination

During the past two centuries, the lower Passaic River has suffered from rapidly expanding urban and industrial development. Hazardous substances released from multiple sources throughout the 1900s have had a substantial impact on the ecological conditions of the region (Esser 1982; Squires 1981). During the 1980s and 1990s, several investigations were conducted to evaluate the concentrations of various chemicals in sediments within the lower Passaic River. Those investigations indicated that river sediments contain elevated and potentially injurious concentrations of numerous hazardous substances, including dioxins (polychlorinated dibenzo-*para*-dioxins [PCDDs]) and furans (polychlorinated dibenzofurans [PCDFs]), polychlorinated biphenyls (PCBs), pesticides such as dichloro diphenyl trichloroethane (DDT), polycyclic aromatic hydrocarbons (PAHs), and metals (Exhibits 2-1 and 2-2). A brief description of the primary contaminants of concern within the Site, along with a summary of their toxic effects, is presented below.

Dioxin-Like Compounds

The term “dioxin” typically refers to one of the most toxic compounds known to humans, 2,3,7,8-tetrachlorodibenzo-*para*-dioxin (2,3,7,8-TCDD or simply TCDD). However, dioxins exist in a variety of forms, or isomers, which along with other “dioxin-like” compounds share many or all of the toxic characteristics of TCDD via a common receptor-mediated mechanism of action. Once absorbed into animal tissues, these compounds typically act in an additive fashion regardless of the exposure concentration and route of exposure.

Exhibit 2-1: Occurrence And Distribution Of Selected Chemicals Of Potential Concern In Sediments Of The Lower Passaic River, Compared To Screening Criteria[1]

Chemical (units in dry weight)	Average Conc.	Maximum Conc.	Reach of Maximum Concentration	Detection Frequency	Criterion Value	Exceedance Frequency	Average HQ
TCDD (pptr)	546	13,500	Harrison Reach	234 / 239	NA	NA	NA
Total PCBs[2] (ppb)	1,746	17,506	Kearny Reach	252 / 255	180	252 / 255	9.7
PAHs (ppb)							
HMW PAHs (ppb)	29,886	1,400,000	Newark Reach	302 / 306	9,600	261 / 306	3.1
LMW PAHs (ppb)	9,796	1,410,000	Newark Reach	275 / 306	3,160	144 / 306	3.1
DDT, DDE, DDD (total DDT) (ppb)	236	5980	Point No Point Reach	197 / 206	46.1	177 / 206	5.1
Mercury (ppb)	2,697	10,700	Harrison Reach	229 / 252	710	217 / 252	3.8

Conc. = concentration
pptr = parts per trillion
ppb = parts per billion
NA = not available
PCBs = polychlorinated biphenyls
PAHs = polycyclic aromatic hydrocarbons
HMW = high molecular weight
LMW = low molecular weight
HQ = hazard quotient (= average concentration / criteria value)
[1]Sediment criteria are effects range medians (ER-Ms) from Long and Morgan (1995), representing the value above which biological effects would frequently occur. Data are for surficial sediments (depths to 0.5 feet). Sample concentrations for results qualified as non-detects assumed to be zero. Data accessed through on-line databases (Tierra Solutions, Inc. 2004; NOAA 2005). Study area reports and investigative programs through which data were obtained include the following:
Adams *et al.* (1998)
EPA (1993; 1995)
Long *et al.* (1993)
Maxus Energy Corporation (1993; 1994; 1995)
NOAA (1993)
Strobel *et al.* (1995)
Tierra Solutions Inc. (1990; 1993; 1995; 1997a; 1999a,b; 2000a,b)
USACE (1995)
[2]Total PCBs based on sum of aroclors.

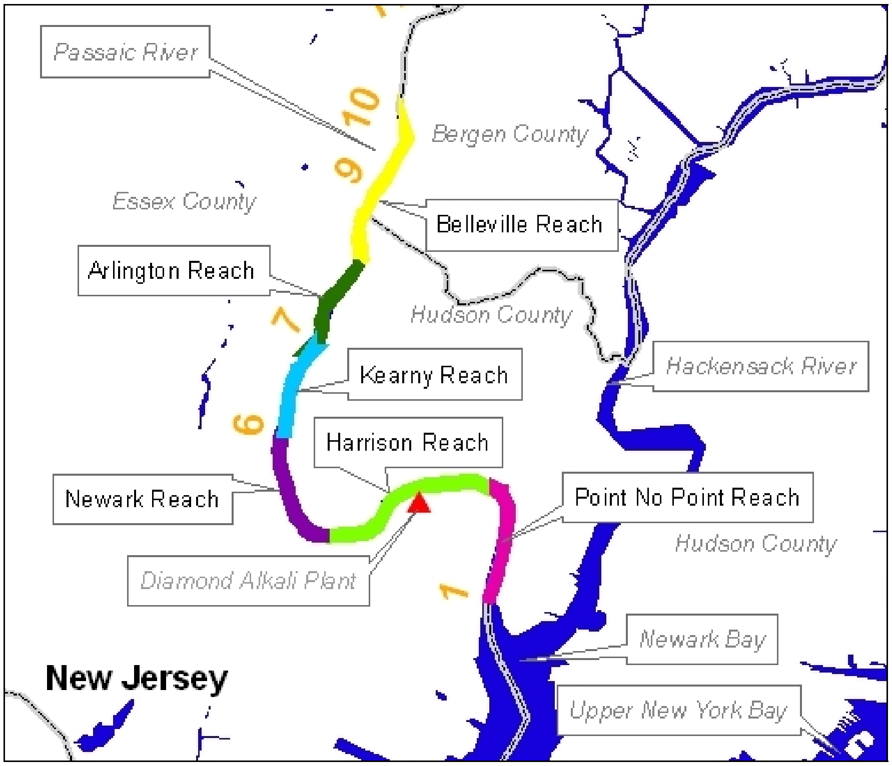
Dioxin-like compounds include the various isomers of dioxin, furans, and certain PCBs. These compounds are discussed in more detail below, as is the approach by which their additive effects are typically evaluated. In addition, information regarding toxicity of non-dioxin-like PCBs is presented as well.

Dioxins and Furans

Dioxins and furans have similar chemical and physical properties. They are both halogenated organic compounds, meaning that their chemical structure includes carbon, hydrogen, and halogen atoms (e.g., fluorine, chlorine, bromine). They exist in a variety of forms, known as congeners[5], which vary in the number and position of chlorine atoms.

[5] There are 75 chlorine-substituted dioxin and 135 chlorine-substituted furan congeners.

Exhibit 2-2: Reaches And River Mile Markers Of The Lower Passaic River In New Jersey. Data Courtesy Malcolm Pirnie, Inc.

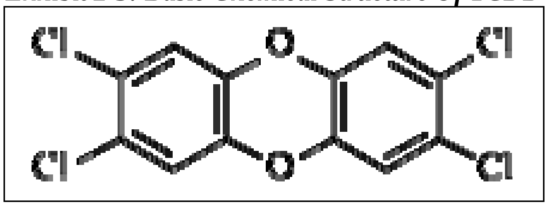


Dioxins and furans are not manufactured intentionally, but are formed as byproducts during the manufacture, pyrolysis, or combustion of certain chlorinated chemicals. Sources include chemical, herbicide, and pesticide manufacturing; industrial waste incineration; bleaching of textile and paper products; burning of coal, diesel fuel, chemically treated wood, or household trash; and forest fires. Dioxins and furans are slow to degrade and persist in the environment for a long time. In waterways, these compounds attach to suspended particles and settle to the bottom, where they can re-enter the water and food web through a variety of physical, chemical, and biological mechanisms. They are also capable of changing phase (e.g., from liquid to gas) and being transported many miles through both air and water.

Dioxins and furans enter the human food supply in the form of meats, dairy, fish, and shellfish. They accumulate particularly well in fat tissue; for example, fatty fish typically have higher concentrations of dioxins and furans than leaner fish. These compounds also biomagnify, meaning that tissue concentrations become progressively higher as the chemicals are transferred from one level of the food web to the next. Predatory organisms at the top of the food web may contain very high levels of dioxins and other hazardous compounds as a result of this biomagnification process.

Dioxin and furan toxicity and bioavailability in the environment are dependent upon the number and location of chlorine atoms in their molecular structure. Some congeners are extremely toxic, while others are believed to be relatively innocuous. Seven dioxin and ten furan congeners are considered hazardous to human, fish, and wildlife health. Among these is TCDD (Exhibit 2-3). TCDD may be best known as the toxic compound found in Agent Orange, at Love Canal, NY, and at Times Beach, Missouri. Toxic effects of dioxin include weight loss, abnormalities of the liver and other organs, impaired growth, edema, gastric ulcers, tumor production and carcinogenesis, immunosuppression, impaired endocrine function, embryo mortality, birth and developmental defects, and death.

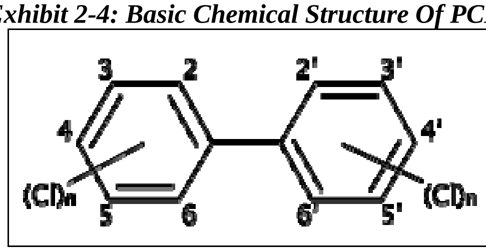
Exhibit 2-3: Basic Chemical Structure Of TCDD



PCBs

PCBs are a group of synthetic organic chemicals containing 209 possible congeners whose basic structure consists of chlorinated biphenyl rings (Exhibit 2-4). PCBs are very stable and inflammable, and were therefore used extensively as insulating or cooling agents in the electricity generating industry. However, the chemical characteristics that made PCBs useful to industry also make them extremely persistent in the environment. Thus, although PCBs have not been manufactured in the United States since 1977 and current use of PCBs is strictly regulated and severely restricted, PCBs continue to pose a serious environmental hazard.

Exhibit 2-4: Basic Chemical Structure Of PCBs



Some commercially-developed PCB mixtures are known in the United States by their industrial trade name, Aroclor, followed by a number indicating the number of carbon atoms and the chlorine content of the compound. For example, the trade name Aroclor 1254 refers to a mixture of PCBs containing twelve carbon atoms and approximately 54 percent (%) chlorine by mass. PCBs typically exist in the environment as mixtures of various congeners.

Environmental transport of PCBs is primarily determined by molecular weight. Heavier PCBs are more likely to associate with soils and sediments, while lighter PCBs are more likely to evaporate to air. Sediments that contain PCBs can also release the PCBs into the surrounding water. PCBs have a high affinity to fats and readily accumulate and biomagnify in the food web. Concentrations of PCBs in aquatic organisms may be up to a million times higher than the concentrations found in the surrounding water, with species at the top of the food web having the highest concentrations. Accumulation in biota varies by congener and generally increases with chlorine content until, in the most heavily chlorinated compounds, the size of the molecules hampers their accumulative properties.

The relative toxicity of different PCB congeners is influenced by fat solubility and the pattern of molecular chlorine substitution. Among the 209 congeners, 12 display dioxin-like toxicity as a result of their chemical and physical properties and modes of toxic action. Effects of non-dioxin like PCBs include neurotoxicity, endocrine disruption, and immunosuppression (EPA 2003).

While some of the dioxin-like PCBs may act through multiple toxicity pathways to cause a variety of effects, the most severe toxic responses are attributable to dioxin-like modes of action.

Evaluating Toxicity of Dioxin-Like Compounds

Dioxin-like compounds act through the same receptor mediated mechanism of action. For this reason, the cumulative toxicity of these compounds is generally additive. The total dioxin-like activity is therefore typically described using “toxic equivalency factors”, or TEFs (van den Berg *et al.* 1998; van den Berg *et al.* 2006). The TEF approach uses the potency of individual PCDD, PCDF, and PCB congeners, relative to TCDD, along with measured concentrations of these chemicals to calculate a toxic equivalent (TEQ) for each compound. The individual TEQs are then summed to derive a total TEQ, which gives an estimate of the total TCDD-like activity to which an organism is exposed. The World Health Organization (WHO) has used numerous toxicity studies of dioxins, furans, and PCBs to develop consensus-based TEFs for a variety of compounds for birds, fish, and mammals including humans (van den Berg *et al.* 1998; van den Berg *et al.* 2006) (Exhibit 2-5). TEFs are not presently available for invertebrates, reptiles, or amphibians.

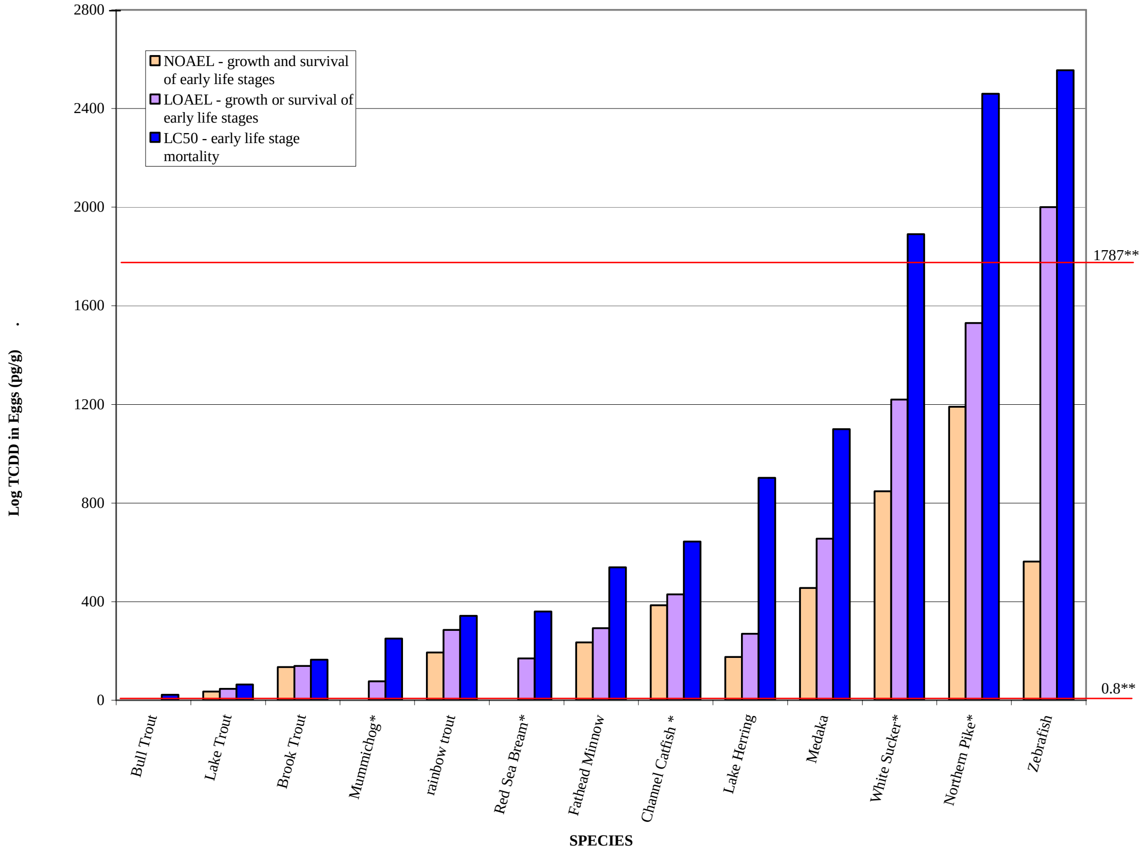
Different species vary in their sensitivity to dioxin-like compounds, although for all species, early life stages (including embryos) are typically the most sensitive. For example, among fish, trout are typically very sensitive to dioxin exposure; zebra fish are relatively insensitive (Exhibit 2-6). Notably, mummichog, which occur at the Site, are also relatively sensitive. Sensitivity also varies with the effect being measured; morphological or biochemical effects such as brain asymmetry and hormonal changes, respectively, or a functional effect such as a compromised immune response, are typically seen at lower concentrations than are effects on survival (Exhibit 2-7).

Exhibit 2-5: WHO Toxic Equivalency Factors For Dioxin, Furan, And PCB Congeners

Compound	**Fish TEF[1]**	**Avian TEF[1]**	**Mammalian TEF[2]**
*chlorinated dibenzo-*p*-dioxins*			
2,3,7,8-TCDD	1	1	1
1,2,3,7,8-pentaCDD	1	1	1
1,2,3,4,7,8-hexaCDD	0.5	0.05	0.1
1,2,3,6,7,8-hexaCDD	0.01	0.01	0.1
1,2,3,7,8,9-hexaCDD	0.01	0.1	0.1
1,2,3,4,6,7,8-heptaCDD	0.001	<0.001	0.01
OctaCDD	<0.0001	0.0001	0.0003
chlorinated dibenzofurans			
2,3,7,8-TCDF	0.05	1	0.1
1,2,3,7,8-pentaCDF	0.05	0.1	0.03
2,3,4,7,8-pentaCDF	0.5	1	0.3
1,2,3,4,7,8-hexaCDF	0.1	0.1	0.1
1,2,3,6,7,8-hexaCDF	0.1	0.1	0.1
1,2,3,7,8,9-hexaCDF	0.1	0.1	0.1
2,3,4,6,7,8-hexaCDF	0.1	0.1	0.1
1,2,3,4,6,7,8-heptaCDF	0.01	0.01	0.01
1,2,3,6,7,8,9-heptaCDF	0.01	0.01	0.01
OCDF	<0.0001	0.0001	0.0003
non-ortho substituted PCBs			
3,3',4,4'-tetraCB (PCB 77)	0.0005	0.1	0.0001
3,4,4',5-tetraCB (PCB 81)	0.0001	0.05	0.0003
3,3',4,4',5-pentaCB (PCB 126)	0.005	0.1	0.1
3,3',4,4',5,5'-hexaCB (PCB 169)	0.00005	0.001	0.03
mono-ortho substituted PCBs			
2,3,3',4,4'-pentaCB (PCB 105)	<0.000005	0.0001	0.00003
2,3,4,4',5-pentaCB (PCB 114)	<0.000005	0.0001	0.00003
2,3',4,4',5-pentaCB (PCB 118)	<0.000005	0.00001	0.00003
2',3,4,4',5-pentaCB (PCB 123)	<0.000005	0.00001	0.00003
2,3,3',4,4',5-hexaCB (PCB 156)	<0.000005	0.0001	0.00003
2,3,3',4,4',5'-hexaCB (PCB 157)	<0.000005	0.0001	0.00003
2,3',4,4',5,5'-hexaCB (PCB 167)	<0.000005	0.00001	0.00003
2,3,3',4,4',5,5'-heptaCB (PCB 189)	<0.000005	0.00001	0.00003

TEF = toxic equivalency factor
CDD = chlorinated dibenzodioxin
CDF = chlorinated dibenzofuran
PCBs = polychlorinated biphenyls
CB = chlorinated biphenyl.
[1]van den Berg *et al.* (1998).
[2] van den Berg *et al.* (2006).

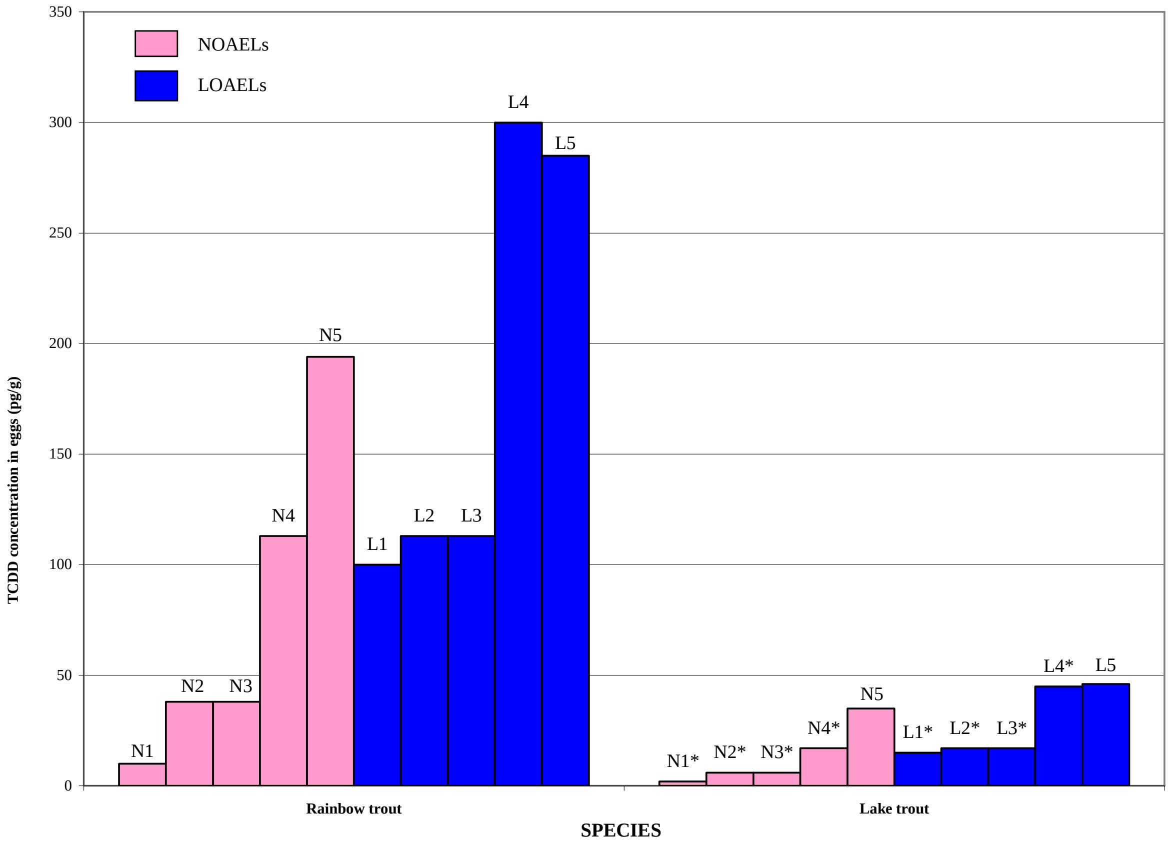
Exhibit 2-6: NOAELs, LOAELs, And LC50 Concentrations For Early Life Stages Of Various Fish Species Following Exposure To 2,3,7,8- TCDD.



NOAEL = no observable adverse effects level.
LOAEL = lowest observable adverse effects level.
LC 50 = concentration causing fifty percent mortality of the study population.
pg/g = picograms per gram.
Red lines indicate the range of tissue concentrations measured in fish from the Site.
*Species or closely related species found at the Site.
** Expected range of egg tissue concentrations for fish from the Site based on the relationship between site-specific fish lipid and TCDD concentrations and egg lipid concentrations in mummichog published in Bailey *et al.* (1973). Species-specific egg lipid concentrations could not be found in the literature for other species; the published egg lipid concentration for mummichog was used as a surrogate. Sexes of sampled fish were unknown; differences between lipid concentrations in female and male fish are assumed to be insignificant and data for all fish were used
Data from:

Carvalho *et al.* (2004)
Cook *et al.* (1991)
Cook *et al.* (2000)
Elonen *et al.* (1998)
Guiney *et al.* (1996)
Henry *et al.* (1997)
Johnson *et al.* (1998)
Spitsbergen *et al.* (1988)
Spitsbergen *et al.* (1991)
Toomey *et al.* (2001)
Walker and Peterson (1991, 1994)
Walker *et al.* (1991, 1992, 1994, 1996)
Yamauchi *et al.* (2006)
Zabel (1995).

Exhibit 2-7: NOAELs And LOAELs For Non-Mortality Endpoints In Early Life Stages Of Sensitive Fish Species Following Exposure To TCDD.



N1/L1 – NOAELs and LOAELs for proportion and severity of histopathological lesions in fry following a virus challenge (Spitsbergen *et al.* 1988).
N2/L2 - NOAELs and LOAELs for total length of fish at swim up (Carvalho *et al*. 2004).
N3/L3 - NOAELs and LOAELs for visual acuity in fish at swim up (Carvalho and Tillitt 2004).
N4/L4 - NOAELs and LOAELs for prey capture rate in fry (Carvalho *et al.* 2004).
N5/L5 - NOAELs and LOAELs for early life stage mortality in rainbow trout are from Walker *et al.* (1992); NOAELs and LOAELs for lake trout are the average of 1) the average of respective values for sac fry mortality from Walker *et al.* (1994), 2) respective values for growth and survival from Guiney *et al.* (1996), and 3) the average of respective values for sac fry mortality from Walker *et al.* (1992).
pg/g = picograms per gram.
NOAEL = no observable adverse effects level.
LOAEL = lowest observable adverse effects level.
Red lines indicate the range of tissue concentrations measured in fish from the Site.
*Values for lake trout are predicted based on the relationship between measured lethal effects dose for fifty percent of the study population (LD_{50}) for rainbow trout (333 pg/g; Walker *et al.* 1991) and lake trout (50 pg/g; Walker *et al.* 1994) and the relationship between measured LD_{50}s and LOAEL/NOAEL values presented in the studies listed above.

Extremely high concentrations of dioxins and PCBs within the Site led the New Jersey Department of Environmental Protection (NJDEP) to issue in 1983 an administrative order prohibiting the consumption and sale of all fish and shellfish from the Passaic River from its mouth to Dundee Dam and advising against consumption of any fish or shellfish from Newark Bay, the Hackensack River upstream to the Oradell Dam, the Arthur Kill, and the Kill Van Kull (NJ Administrative Order EO-40-17). In 1984, the sale or consumption of striped bass and blue crabs from Newark Bay, the Arthur Kill, the Kill van Kull, and the tidal Hackensack River were prohibited as well (NJ Administrative Order EO-40-19) (Hauge *et al.* 1990). In fact, the NJDEP stated that the calculated magnitude of cancer risk from consuming blue crabs from the Site was "one of the highest encountered by the NJDEP in any context" (NJDEP 2002a).

In addition to causing fish consumption advisories, concentrations of dioxin-like substances in biota from the lower Passaic River and Newark Bay have been measured at levels shown to produce harmful effects in biota (Belton *et al.* 1985; Hauge *et al.* 1990; Parsons 2003; Rappe *et al.* 1991; USFWS 2000a,b). Literature-based critical body residues (CBRs), which represent tissue concentrations at which toxic effects have been observed, for dioxin have been exceeded in most fish and birds thus far sampled at the Site (Exhibit 2-8). For example, projected dioxin levels in fish eggs, calculated based on the relationship between measured lipid and TCDD concentrations in fish from the Site and egg lipid concentrations in mummichog (Bailey *et al.* 1973), exceed no observable adverse effect levels (NOAELs) - the highest concentrations measured that do not produce measurable effects - for survival of early life stages in all species evaluated (lake trout, brook trout, rainbow trout, fathead minnow, channel catfish, lake herring, medaka, white sucker, northern pike, and zebrafish; Exhibit 2-6). Levels exceeded the lowest observable adverse effect levels (LOAELs) - those found to significantly affect survival – for early life stages for all species evaluated except zebrafish (lake trout, brook trout, mummichog, rainbow trout, red sea bream, fathead minnow, channel catfish, lake herring, medaka, white sucker, and northern pike; Exhibit 2-6). Finally, calculated egg concentrations exceeded LD_{50} values for early life stages – the exposure concentration causing fifty percent mortality in the study population – in 10 of the 13 species evaluated, (including bull trout, lake trout, brook trout, mummichog, rainbow trout, red sea bream, fathead minnow, channel catfish, lake herring, and medaka; Exhibit 2-6). Effects on more sensitive endpoints are likely to be even more severe. For example, egg tissue concentrations in fish at the Site are likely to be more than one to two orders of magnitude above those that significantly affect growth, increase the proportion and severity of histopathological lesions following a virus challenge, and decrease visual acuity and prey capture rate in trout species such as trout (Carvalho *et al.* 2004; Carvalho and Tillitt 2004; Spitsbergen *et al.* 1988) (Exhibit 2-7).

Exhibit 2-8: TCDD In Biotic Tissues From The Site In Comparison To Literature-Based Critical Body Residues (CBRs)

Species	**Tissue Analyzed**	**Sample Size**	**Source**	**Range (pptr)**	**Average (pptr)**	**Tissue Specific Type**	**Tissue specific range (pptr)**	**Tissue specific average (pptr)**	**CBR (pptr)**	**CBR - Species**	**CBR Tissue**	**Effect, reference**
Fish												
American eel	Whole body	6	1	4.5 - 20.6	9.7	egg[2]	3.9 - 20.0	9				
Atlantic menhaden	Whole body	6	1	25.0 - 79.1	45.5	egg[2]	5.6 - 1725	555				
Atlantic silverside	Whole body	9	1	21.4 - 59.5	40.5	egg[2]	442 - 1048	652				
Atlantic silverside	Whole body	6	4	8.8 - 24	22.35	egg[2]	28.2 - 417	190				
Mummichog	Whole body	57	1	3.7 - 828	76.3	egg[2]	53.0 - 1787	204				
Mummichog	Whole body	10	4	0.1 57	7.75	egg[2]	0.8 - 195	61	77	Mummichog	egg	LOAEL for apoptotic cell death[3]
Striped bass	Whole body	9	1	4.1 - 101	75.3	egg[2]	7.2 - 352	132				
Striped bass	Whole body	5	5	7.0 - 69	31.2	egg[2]	25.4 - 231	109				
White perch	Whole body	18	1	73.6 - 352	212	egg[2]	29.6 - 107	68				
White perch	Whole body	5	5	99.0 - 208	153	egg[2]	47.1 - 145	102				
Blue fish	Whole body	2	1	37.8 - 67	52.3	egg[2]	42.1 - 107	75				
Invertebrates												
Blue crab	Hepatopancreas	46	1	11.5 - 6238	522	Hepatopancreas[6]	11.5 - 6238	522				
Blue crab	Muscle	43	1	0.87 - 116	20.3	Muscle[6]	0.87 - 116	20.3				
Blue crab	Soft body tissue	19	1	28.1 - 141	75.1	Soft body tissue[6]	28.1 - 141	75.1				
Ribbed mussels	Soft body tissue	15	1	8.98 - 17.0	12.3	Soft body tissue[6]	8.98 - 17.0	12.3	2	American oyster	soft tissue	Altered gonadal and embryonic development[7]
Ribbed mussels	Soft body tissue	4	4	5.4 - 10.3	9.3	Soft body tissue[6]	5.4 - 10.3	9.3				
Softshell clams	Whole body	4	1	11.0 20.0	14.8	Whole body[6]	11.0 - 20.0	14.8				
Eastern mudsnail	Soft body tissue	2	4	5.5 - 7.2	6.4	Soft body tissue[6]	5.5 - 7.2	6.4				
Birds												
Black crowned night heron	egg	10	8	3.2 - 86.8	13.4 (g)	egg[6]	3.2 - 86.8	13.4 (g)	21	Great blue heron	egg	ED_{50} – brain asymmetry[9]
Double-crested cormorant	egg	8	8	44.1 - 161	83	egg[6]	44.1 - 161	83	34	Double-crested cormorant	egg	
Double-crested cormorant	egg	5	5	16 - 241	103	egg[6]	16.0 - 241	103				

[1]Data accessed through NOAA's (2005) on-line database. Sample concentrations for results qualified as non-detects assumed to be one-half the detection limit. Study area reports and investigative programs through which data were obtained include the following:
- Ashley and Horowitz (2002)
- Belton *et al.* (1985)
- Brown *et al.* (1994)
- Eckenfelder (1993)
- Gross and Cai (1992)
- Maxus Energy Corporation (1995)
- Rappe *et al.* (1991)
- Tierra Solutions Inc. (1999a).

[2]Calculated based on the relationship between measured lipid and TCDD concentrations in fish from the Site and egg lipid concentrations in mummichog published in Bailey *et al.* (1973). Species-specific egg lipid concentrations could not be found in the literature for other species; the published egg lipid concentration for mummichog was used as a surrogate. Sexes of sampled fish were unknown; differences between lipid concentrations in female and male fish are assumed to be insignificant and data for all fish were used. For mummichog, egg tissue concentrations of TCDD could only be calculated for 54 samples, because 3 samples did not have associated lipid values.
[3]Critical body residue for TCDD in egg tissue,based on Lowest Observed Adverse Effects Levels (LOAELs) for apoptotic cell death in embryos (Toomey *et al.* 2001).
[4]Data from USFWS (2000a).
[5]Data from USFWS (2000b).
[6]Measured.
[7]CBR from Wintermyer and Cooper (2003).
[8]Data from USFWS (1997b).
[9]CBR from Henshel (1998).
pptr = parts per trillion.
CBR = critical body residue.
g = geometric mean.
ED_{50} = concentration at which 50 % of the study population showed demonstrable effects.

Although no one has sampled birds at the Site to the extent of some other species, the likelihood for injury to birds from dioxins can be evaluated by using BMFs to estimate bird egg concentrations from fish (dietary) tissue concentrations (Hoffman *et al.* 1996). For example, using the alewife to herring gull egg BMF of 21 for TCDD, birds feeding exclusively on mummichogs or white perch from the lower Passaic River (containing average TCDD concentrations of 76 and 212 parts per trillion [pptr], respectively) may be expected to produce eggs containing approximately 1,600 to 4,400 pptr TCDD. These egg concentrations are expected to be toxic to many avian species endemic to the region, including herring gulls, Caspian terns, double-crested cormorants, bald eagles, black-crowned night herons, great blue herons, and Peregrine falcons (Hoffman *et al.* 1996). Other dioxin-like congeners would further elevate the risk of toxic effects to these species.

The likelihood of injury to mink exposed to dietary (fish) tissue concentrations of TCDD measured within the Site can also be assessed using dietary effects data. Mink consuming fish containing 12.6 pptr TCDD evidenced reproductive toxicity, as measured by reduced kit body weight (at 3 weeks of age) and survival (at 3 and 6 weeks of age) (Tillitt *et al.* 1996). Average concentrations of TCDD from fish in the Site were higher than 12.6 pptr for all species measured except the American eel (average = 9.7 pptr) (Exhibit 2-8).

It is important to note that Exhibit 2-8 gives only an idea of the potential for injury, by comparing measured tissue concentrations for each species evaluated to one or two literature-based effect levels. The Trustees intend to perform more in-depth evaluations of species sensitivities and potential effects from exposure to dioxin and other hazardous substances through detailed injury assessments for specific resources. These assessments will add to multiple lines of evidence that will be used to thoroughly evaluate injury to Trust resources from hazardous substances at the Site.

Pesticides

Pesticides include insecticides, fungicides, herbicides and other substances intended to control, destroy, repel, or mitigate pests. There are a wide variety of pesticides displaying a range of chemical structures and modes of toxicity. Major pesticide classes, grouped according to their mode of action, include the following:

- Organophosphate and carbamate pesticides, which are primarily insecticides and include such products as malathion, chlorpyrifos, and carbaryl;

- Pyrethroid pesticides, which are synthetic versions of the natural insecticide pyrethrin, found in chrysanthemums and which include such products as sumithrin and resmethrin; and

- Organochlorine pesticides that were widely used in the past and are now no longer in the marketplace, including such products as DDT, chlordane, and mirex.

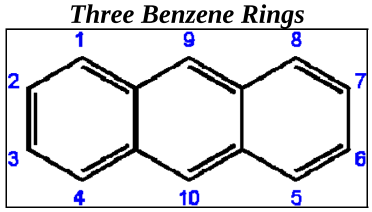
While these classes of pesticides have different structures and modes of action, most of the associated compounds are neurotoxins and work by disrupting the transmission of nerve impulses. The severity and symptoms of toxicity to non-target species, however, are wide-ranging, and vary with chemical and organism.

Widespread use of environmentally-persistent pesticides, along with the tendency of pesticides to accumulate in higher levels of the food web, can lead to unintended consequences in fish, wildlife, and humans and subsequent natural resource injuries. For example, pesticides often leach into aquatic environments, causing long-term, chronic effects in fish and other aquatic organisms and their predators. One of the best-known examples of unintended pesticide impact is the eggshell thinning and reduced reproductive success in birds of prey that ingested fish contaminated with the insecticide DDT.

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals containing hydrogen and carbon atoms arranged in the form of two or more benzene rings[6] (Exhibit 2-9). There are hundreds of PAH compounds that vary in molecular weight, depending upon the number of benzene rings in their structure.

Exhibit 2-9: Chemical Structure Of The Polycyclic Aromatic Hydrocarbon Anthracene, Which Contains Three Benzene Rings



PAHs are formed by the incomplete combustion of carbon-containing fuels. They may be created through natural processes, such as forest fires, microbial synthesis, and volcanic activity, but they may also be anthropogenic, produced as byproducts of automobile exhaust, power generation, incineration processes, and petroleum refining. Some PAHs are volatile and can be transported over long distances in air currents; others condense onto aerosol particles in the atmosphere. PAHs may be broken down by reacting with sunlight and other chemicals over a period of days to weeks; those that are not broken down may be scoured from the air by rain and deposited in soils and surface waters. Aquatic environments may also receive PAHs directly through oil spills and discharges from industrial and wastewater treatment plants.

PAHs are readily absorbed into fatty tissues, but do not accumulate in organisms to the extent of some other hazardous substances. In part, the less efficient accumulative nature of PAHs is because they are metabolized by many organisms. Due to their complex mixtures and chemical interactions, biological responses to PAHs are quite variable, making study of their fate, transport, and toxicity difficult. However, the ubiquity and potential toxicity of PAHs make such efforts a necessity.

[6] The benzene ring is a six-sided ring of carbon atoms with one hydrogen atom attached to each carbon. Its structure is written as C_6H_6. Benzene is the most basic form of aromatic hydrocarbons. Benzene is a colorless, toxic, and flammable liquid.

PAHs of primary toxicological concern include those with two to seven benzene rings. Lower molecular weight PAHs, containing 2-3 rings, cause significant acute (short-term, lethal) toxicity, but are non-carcinogenic (i.e., do not cause cancer). In contrast, heavier PAHs, with 4-7 rings, are less acutely toxic, but are instead carcinogenic to a wide variety of organisms. For instance, fish from areas with sediments heavily contaminated by certain PAHs have a greater incidence of liver tumors than do fish from less contaminated sites. In fact, some PAHs may be among the most highly carcinogenic compounds known to humans (Eisler 1987a).

Metals

Almost 75% of all elements are classified as metals, distinguished primarily by the arrangement of electrons in their atomic structure and their resulting physical and chemical properties. While some metals are essential for life, all metals are toxic above specific threshold concentrations.

Many metals have important industrial applications. Since the Industrial Revolution, the production of metals such as lead, copper, and zinc has increased exponentially (Nriagu 1996). Once released to the environment, either through mining, smelting, the burning of fossil fuels, or other waste releases, metals can reside in the environment for hundreds of years or more.

The degree of toxicity induced by different metals varies with organism and environmental conditions, which greatly impact metal bioavailability. Metals typically of greatest environmental concern include mercury, lead, cadmium, hexavalent chromium, copper, silver, arsenic, nickel, and zinc.

Based on measured concentrations of metals in sediments, mercury is the primary metal of concern at the Site (NOAA 2005; Tierra Solutions Inc. 2004). Mercury is used as a fungicide in agriculture, in the manufacture of chlorine, sodium hydroxide, electronics, and plastics, as a slime control agent in the pulp and paper industry, and in mining and smelting operations (Eisler 1987b). It is present in the environment in both inorganic and organic forms, although inorganic forms are readily converted to the more toxic organic forms by bacteria, particularly in anaerobic sediment. The organic mercury compound of greatest environmental concern is methylmercury, which is known to biomagnify in food webs. Mercury and methylmercury act as potent neurotoxins, resulting in impaired muscular coordination, vision, and hearing, with early developmental stages being the most sensitive (Eisler 1987b). Other effects include weight loss, changes in enzyme activity levels and histopathology, and depressed growth and reproduction.

Summary of Hazardous Substances of Concern

A summary of the hazardous substances of primary concern within the Site and their associated ecological effects is presented in Exhibit 2-10.

Exhibit 2-10: Potential Ecological Effects Of Hazardous Substances Within The Site

Chemical Categories	Primary Hazardous Substances	Selected Potential Ecological Effects
Dioxins & Furans	• Includes seven dioxin congeners of primary concern[1] • Includes ten furan congeners of primary concern[2]	• Mortality • Impaired growth • Liver failure • Chronic wasting • Reproductive and developmental impairment • Gastric ulcers • Carcinogenesis • Immunosuppression • Impaired endocrine function • Neurotoxicity • Dermal toxicity

PCBs	• Coplanar congeners – 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, 189
	• Aroclor mixtures – e.g., 1254, 1260
		• "Dioxin-like" PCBs have effects similar to dioxins, above
		• Effects of "Non-dioxin-like" PCBs include the following:
		  ◦ Mortality
		  ◦ Endocrine disruption
		  ◦ Decreased immune function
		  ◦ Reproductive and developmental impairment
		  ◦ Impaired behavioral responses
		  ◦ Carcinogenesis

Pesticides	• Organophosphate – malathion, chlorpyrifos • Carbamate – carbaryl • Pyrethroids – sumithrin, resmethrin • Organochlorine – DDT, chlordane	• Mortality • Reproductive and developmental impairment • Neurotoxicity
PAHs	• Anthracene • Benzo(a)pyrene • Chrysene • Fluorene • Pyrene	• Mortality • Leukemia • Decreased reproductive success • Stunted growth • Impaired behavioral responses
Metals	• Mercury and methylmercury	• Decreased growth and reproduction • Impaired coordination • Vision and hearing loss • Weight loss • Altered enzyme activity

[1]The 7 dioxin congeners include include 2,3,7,8- TCDD; 1,2,3,7,8-PentaCDD; 1,2,3,4,7,8-HexaCDD; 1,2,3,6,7,8-HexaCDD; 1,2,3,7,8,9-HexaCDD; 1,2,3,4,6,7,8-HeptaCDD; OCDD
[2]The 10 furan congeners include 2,3,7,8-TCDF; 1,2,3,7,8-PentaCDF; 2,3,4,7,8-PentaCDF; 1,2,3,4,7,8-HexaCDF; 1,2,3,6,7,8-HexaCDF; 1,2,3,7,8,9-HexaCDF; 2,3,4,6,7,8-HexaCDF; 1,2,3,4,6,7,8-HeptaCDF; 1,2,3,4,7,8,9-HeptaCDF; OCDF
PCBs = polychlorinated biphenyls
PAHs = polycyclic aromatic hydrocarbons

Sources of Contamination

Hazardous substances in the Site likely originate from numerous sources, both direct (point sources) and indirect (non-point sources). The impact of chemicals, human waste, and other human influences over the past two centuries has resulted in the United States Environmental Protection Agency (EPA) declaring the Passaic River in 1970 the "second most polluted river in America", behind only the Cuyahoga, which caught fire in 1969 (Nussbaum 2004).

One of the major sources of contamination to the lower Passaic River is the Diamond Alkali Plant, which operated at 80 and 120 Lister Ave., New Jersey, from 1951 until 1969 (Exhibit 2-11). The facility was used predominantly for making herbicides such as 2,4,5-T, a known source of dioxins. An explosion at the plant in 1960 released TCDD as a byproduct of chemicals burned during the fire. Additionally, direct intentional and unintentional releases of chemical wastes occurred repeatedly between 1951 and 1969 (Diamond Shamrock Chemicals Company v. Aetna Casualty and Surety Company *et al.* 1989), and inundation of the plant during tidal surges resulted in further chemical releases to the River (EPA 1987). Sampling of sediments in the vicinity of this plant during the 1980s and 1990s revealed high levels of dioxins (Battelle 2005; EPA 2004; USACE New York District, EPA Region II, and NJDOT Office of Maritime Resources 2003). The Diamond Alkali Plant was added to the NPL in 1984; a 1987 Record of Decision (ROD) for the Site indicated TCDD and DDT to be the primary contaminants of concern (EPA1987). The release of TCDD from the Diamond Alkali Plant is reflected by the concentration gradient of the chemical in sediment from the Passaic River, Newark Bay, and other parts of the Harbor (Exhibit 2-12).

The Diamond Alkali Plant is just one of approximately 120 New Jersey point source discharges into the lower Passaic River watershed; more than 50% of these are from industrial facilities (e.g., asphalt plants; plastic, metal, stone, clay, and glass manufacturers; sawmills; communications equipment; and various public utilities). In addition, non-point source discharges (e.g., landfill leachate; leaking storage tanks, chemical drums, container boxes; and stormwater runoff), along with illegal dumping, have contributed substantially to contamination along the river (NJDEP 2002b).

Cleanup of the LPR

The EPA undertakes cleanup actions at contaminated sites to reduce or eliminate risks to human health and the environment. EPA's activities are often directed at the hazardous substance itself – its physical removal from the environment or the creation of barriers between the contaminant and humans or wildlife. In most cases, cleanup actions will reduce future injury to natural resources within the Site. By contrast, the natural resource Trustees are responsible for implementing measures needed to compensate both for injury that occurred prior to completion of cleanup and future injury that is not prevented by EPA actions.

The EPA is investigating remedial cleanup in the LPR in conjunction with the U.S. Army Corps of Engineers (USACE). In July 2002, EPA and USACE entered into a Memorandum of Understanding (MOU) to facilitate cooperation between the two agencies to address a variety of contaminated sites involving issues of water quality, economic revitalization, and public use of urban rivers. The joint agreement was initiated under various statutory authorities including CERCLA, the Clean Water Act (CWA)[7], and the Water Resources Development Act (WRDA)[8]. The two agencies designated the

[7] See 33 U.S.C. § 1251 *et seq.*
[8] See 33 U.S.C. § 2201 *et seq.*

Exhibit 2-11: Location Of The Diamond Alkali Plant In Relation To The Passaic River And New York/New Jersey Harbor

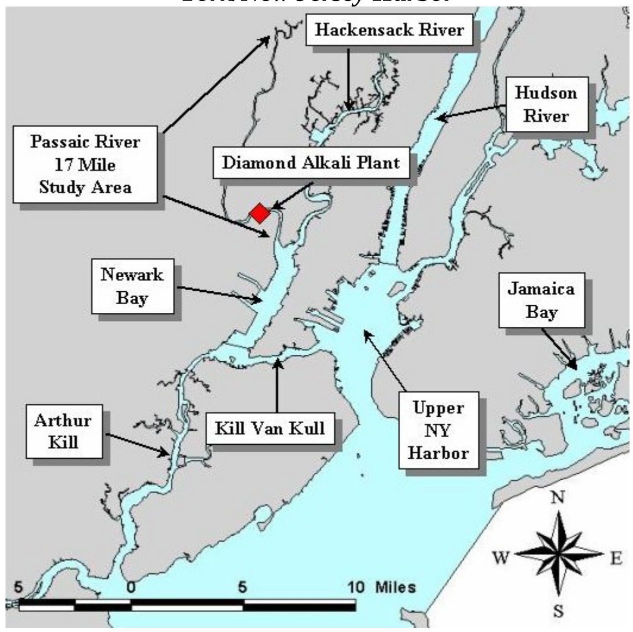


Exhibit 2-12: Concentrations Of TCDD In Surficial Sediments Of NY/NJ Harbor Waterways, 1990-2000[1]

Location	**Sample Size**	**Range (pptr)**	**Average ± 1 std. dev (pptr)**
Passaic River (North of Original PRSA[2])	23	2.4 - 970	277 ± 298
PRSA	194	2 - 13,500	61.5 ± 1470
Hackensack River	10	2.4 - 188	38 ± 43
Newark Bay	40	2.6 - 470	80 ± 83
Arthur Kill	14	7.3 - 55.8	28 ± 17
Kill van Kull	2	1.8 - 18	12 ± 9
Upper New York Bay	16	0.3 - 15	5 ± 5
Lower Bay/Raritan Bay	28	0.1 - 28	6 ± 8
Jamaica Bay	28	0.1 - 39	4 ± 8

[1]Surficial sediments considered those at depths from 0 to 0.5 feet below surface. Data accessed through NOAA's (2005) on-line database. Study area reports and investigative programs through which data were obtained include the following:

Adams *et al.* (1998)
EPA (1993; 1995)
Long *et al.* (1993)
Maxus Energy Corporation (1993; 1994; 1995)
Tierra Solutions Inc. (1995; 1996; 1997b; 1998; 1999a,b; 2000a,b)

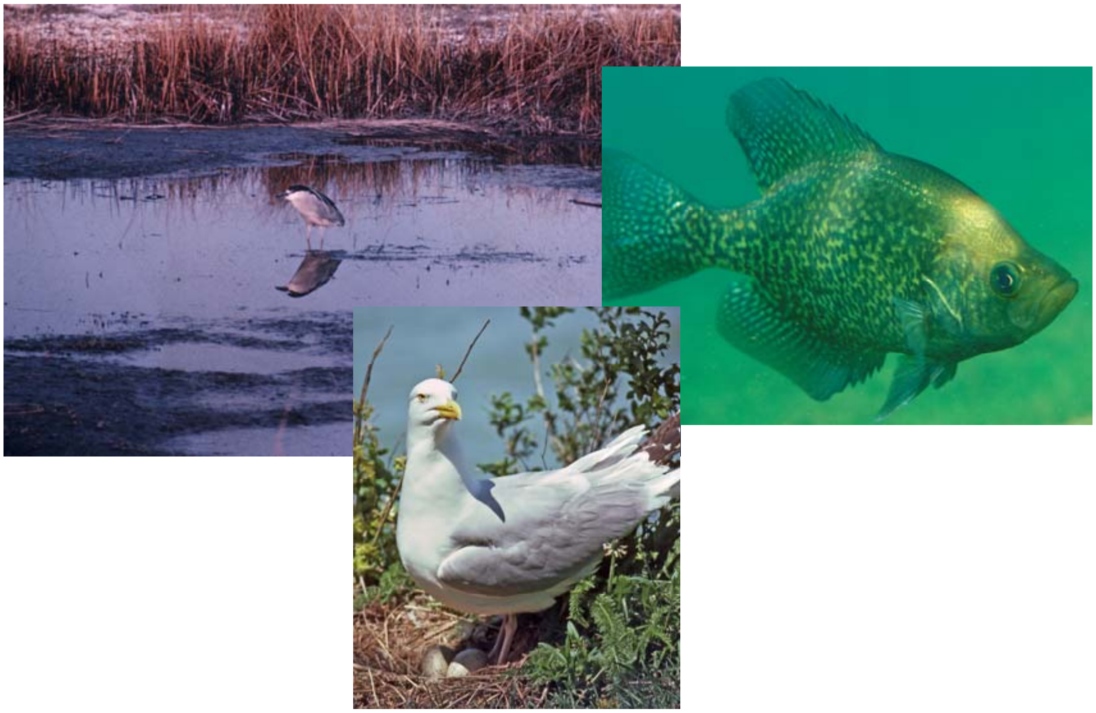
[2]PRSA = Passaic River Study Area: A 6-mile stretch of the Passaic River which includes Point-No-Point, Harrison, Newark, Kearny, and Arlington reaches.
pptr = parts per trillion
std. dev = standard deviation

LPR as one of eight demonstration projects for the coordinated cleanup and restoration of urban river systems.[9]

The outcome of the EPA/USACE cooperative process and the plan for addressing contamination in the LPR is not yet determined. Other government agencies, including natural resource Trustees, will also be involved in that process. Whatever cleanup actions are undertaken, it is unlikely that they will completely eliminate contaminated sediments in the affected areas. Natural resources within the Site will likely continue to be exposed to hazardous substances and adversely affected as a result of that exposure.

[9] For more information about the Urban Rivers Restoration Initiative, visit http://www.epa.gov/oswer/landrevitalization/urbanrivers/.

Chapter 3: The Role of the Trustees



Clockwise from Upper Left: Black-crowned night heron feeding in mudflats; black crappie (Eric Engbretson, photographer); herring gull (Donna Dewhurst, photographer) (Photos Courtesy USFWS).

The authority for restoring natural resources injured by hazardous substances lies with the government agencies and Indian tribes identified as Trustees.[10] The Trustees act as stewards of our natural resources and hold these resources in trust for the public and future generations. Each Trustee agency designates representatives to carry out natural resource damage assessments.

The Trustees for the Site are the State of New Jersey, the U.S. Department of Commerce and the U.S. Department of the Interior. The respective designated representatives of these agencies are the NJDEP, NOAA, and the USFWS. While the State of New Jersey has chosen not to be involved in developing this NRDA plan for the Site, both State and Federal Trustees intend to ensure that the public is adequately and appropriately compensated for injuries to trust resources incurred by releases of hazardous substances at the Site.

[10] The authority of the Passaic River Trustees is derived from CERCLA and the CWA. Based on CERCLA and the National Contingency Plan (NCP), the President has designated the Secretary of Commerce and the Secretary of the Interior to act as Trustees for particular natural resources managed or controlled by their agencies. In 1994, the Governor of New Jersey appointed the Commissioner of Environmental Protection as the Trustee for state natural resources. The Commissioner's natural resource damage responsibility under Federal law complements that authority under State law (the New Jersey Water Pollution Control Act and the New Jersey Spill Compensation and Control Act).

The NRDA Process

The NRDA process involves injury assessment, damage determination, and resource restoration. The objective of NRDA is to quantify the nature and extent of injuries to trust resources resulting from exposure to hazardous substances and to either restore the injured resources to conditions that would have existed if the hazardous substances were not released ("baseline" conditions), or replace them with / acquire the equivalent. In addition, Trustees may obtain compensation for interim resource losses that occur between the onset of injury and the full return to baseline conditions. The NRDA process includes the components described below.

Preassessment Phase

During the preassessment phase, the Trustees organize and assess available information about the area of concern and decide whether to proceed with a damage assessment. The findings of this evaluation for the Site are summarized in the PSD for the Diamond Alkali Superfund Site, Newark, Essex County, New Jersey (NJDEP, NOAA, and USFWS 2004). The Trustees determined through the PSD that a damage assessment is warranted for the Site because: (1) Hazardous substances were released to the River and Bay; (2) Natural resources within the jurisdiction of Trustee agencies have been or are likely to be adversely affected by the release; (3) The concentrations of hazardous substances released are sufficient to potentially injure natural resources; (4) The data necessary to conduct a NRDA are available or can be obtained at a reasonable cost; and (5) Completed or planned response actions will not completely remedy the injuries to natural resources.

Preliminary Estimate of Damages

As part of the planning process for a NRDA, the Trustees develop a Preliminary Estimate of Damages (PED). This PED is used "for reference in the scoping of the Assessment Plan to ensure that the choice of the scientific, cost estimating, and valuation methodologies expected to be used in the damage assessment fulfills the requirements of reasonable cost…" (43 C.F.R. §11.83, hereafter "CERCLA Rule"). The Trustees use readily available information to estimate damages and/or the cost of restoring injured natural resources and associated services. Different restoration and compensation scenarios, including an option allowing the environment to recover naturally without intervention from the Trustees, are evaluated. The PED also considers whether cleanup performed by non-Trustee agencies (e.g., the EPA or PRPs) will affect the scope of restoration required.

The Trustees completed a draft PED for the Site and concluded that the cost of the assessment will be less than anticipated damages. The Trustees will review and revise the PED at the end of the injury determination and quantification phases, or earlier, if appropriate. The PED and any significant modification of the PED will be discussed in the Report of Assessment, to be prepared by the Trustees at the conclusion of the NRDA.

Assessment Plan Phase

Once the decision to conduct a NRDA is made, the Trustees may develop a NRDA Plan. The purpose of the NRDA Plan is to ensure that the damage assessment is performed in a planned, systematic manner and that the studies proposed can be conducted for a reasonable cost. The NRDA Plan documents the exposure of natural resources to hazardous substance releases and identifies the anticipated procedures for evaluating the injuries caused by this exposure. The Trustees may then circulate the NRDA Plan for review and comment by the public and PRPs. The Trustees may modify the NRDA Plan at any stage of the assessment as new information becomes available.

This Draft NRDA Plan was prepared by the Federal Trustees for the Site. It demonstrates that natural resources are exposed to hazardous substances, makes a preliminary determination of the recovery period, and outlines the currently proposed approach for the NRDA, including studies that have been completed, are in progress, or may be proposed.

Injury Determination Phase

During this phase of the NRDA, the Trustees conduct investigations to determine whether natural resources have been injured by the release of hazardous substances. Injury is defined as “a measurable adverse change, either long-or short-term, in the chemical or physical quality or the viability of a natural resource” (43 CFR 11.14(v)), resulting either directly or indirectly, from exposure to a hazardous substance. Injury determination is based upon investigations of: (1) The nature of the injury; and (2) The exposure pathway. The nature of the injury includes physical deformities, reproductive impairment, increased incidence of cancer, or death. Other impacts, such as exceedances of regulatory standards or the institution of fish consumption advisories or regulatory fishing closures in the assessment area, may also constitute injury. The exposure pathway refers to the way in which injured natural resources come into contact with a hazardous substance. For example, investigations may establish that fish are exposed through contact with contaminated water, suspended solids, or bedded sediments, or that birds are exposed through the consumption of contaminated fish.

After injury determination is complete, the Federal Trustees will review the NRDA Plan to ensure that methods proposed for the next phases, injury quantification and subsequently damage determination, are consistent with the results of the injury determination. The review will also ensure that selection of proposed methodologies remains consistent with the requirements of reasonable cost.

Injury Quantification Phase

In the injury quantification phase, the Trustees use the information developed during injury determination to quantify both the amount of each resource or service injured and the period of time over which the injury will occur. This will establish the total quantity of injured natural resources that must be restored or replaced.

The current proposed approaches to the injury determination and quantification phases are described in Chapter 4. Existing information and data will be used when possible. Where existing information is insufficient to establish the extent of a particular injury, the Federal Trustees may undertake new data collection and analysis.

Damage Determination and Restoration Phases

Once the injuries to natural resources and services are quantified, the Trustees must determine how to restore or replace those resources and the services those resources would normally provide. This can be done either by estimating the value of the injured resources and lost services or by calculating the cost of the projects that will restore them. In some cases, it may be necessary for the Trustees to use elements of both approaches (while ensuring that there is no double-counting) to provide the most accurate account of injuries and ensure adequate restoration. For example, to address reproductive impairments in fish, the Trustees may design projects that provide fish access to new breeding habitat that is free of contamination. The damage determination for such a project would involve calculating the costs of making the required ecological improvements. Alternatively, the Trustees may undertake a study to calculate the value of the injuries in dollars.

The Federal Trustees will document their evaluation of restoration options in a Restoration and Compensation Determination Plan, which will evaluate several restoration alternatives, summarize the rationale behind the selection of the preferred alternative, and establish the cost of the restoration activities. The Restoration and Compensation Determination Plan will be distributed to the public and PRPs for review and comment. Such input facilitates the Federal Trustees' identification of restoration projects that focus on the natural resources injured and that provide the greatest benefits, while also taking cost into account.

At the conclusion of the NRDA, the Federal Trustees will prepare a Report of Assessment that includes the PSD, the PED, and the NRDA Plan. It will also include any comments on the Draft NRDA Plan and responses to those comments, comments on the individual study plans and responses to those comments, and all documentation supporting evaluations made during the injury determination, injury quantification, and damage determination phases. Finally, it will include the Restoration and Compensation Determination Plan, along with comments received during the public review of that plan and responses to those comments. The Report of Assessment will be released to the public.

Preliminary Determination of the Recovery Period

As part of the NRDA, the Trustees make a preliminary estimate of the time needed for the injured resources to recover. The recovery period is the length of time required to return the assessment area to baseline conditions. According to CERCLA, the recovery period may also refer to a lesser period of time (based on the facts of the case) selected by the authorized official (a federal or state official authorized to act on behalf of all affected federal or state agencies acting as Trustees) and documented in the NRDA Plan.

Estimates of the recovery period must be based on the best available knowledge. Where appropriate, the estimates may be based on cost-effective models. Information gathered to develop such models may come from published studies on the same or similar resources, the experience of resource specialists familiar with the injured resource or with restoration resulting from similar discharges elsewhere, or field and laboratory data acquired from assessment and reference areas. A number of factors are considered in estimating recovery times, including the ecological succession patterns in the area; the growth or reproductive patterns, life cycles, and ecological requirements of affected biological species, including their reaction or tolerance to the hazardous substances involved; the rate of bioaccumulation and the extent of hazardous substances in the food web; and the chemical, physical, and biological removal rates of those compounds from the exposed media.

The biological, surface water, groundwater, geologic, and air resources of the Site continue to be exposed to hazardous substances. These natural resources will remain exposed so long as environmental media such as soils, sediments, groundwater, and surface water remain contaminated and provide pathways for exposure. Based on existing literature documenting the persistence of various hazardous substances found within the Site, the evidence of continued toxicity and bioaccumulation of certain compounds, and the relatively long recovery periods estimated for other contaminated sites, the Trustees' preliminary determination is that it will be decades before natural recovery occurs. Well-planned remedial actions would likely shorten the recovery period.

Trustee Coordination with Other Government Agencies

Hazardous substances in the LPR are currently being addressed in an integrated effort among several federal and state agencies. The overall objectives are to characterize the nature and extent of contamination and harm to human health and the environment and to evaluate alternatives for comprehensive cleanup and restoration.

EPA has undertaken studies to examine contamination of the local environment and evaluate potential cleanup options. On September 1, 1984, the EPA placed a six-mile stretch of the Passaic River known as the Passaic River Study Area (PRSA) on the National Priorities List (NPL), thereby designating it as a Superfund site (EPA 2006a). This study area was expanded in 2003 to the current LPR study area, which includes the entire length of the Passaic River downstream of Dundee Dam, associated tributaries, and the surrounding watershed. In 2004, the NBSA, which includes Newark Bay, the Arthur Kill and Kill van Kull channels, and the tidal Hackensack River, was added to the Site. Under a 2007 EPA administrative order, a group of 73 companies known as the Cooperative Parties[11] entered into a settlement agreement with EPA to conduct (with EPA oversight) a Remedial Investigation/Feasibility Study (RI/FS) of the LPR. The RI/FS will provide information needed to evaluate potential cleanup actions.[12] The NJDEP, New Jersey Department of Transportation (NJDOT), USACE, NOAA, and USFWS are partnering with the EPA to ensure that the RI/FS is completed in a well-

[11] The Administrative Order on Consent and the list of Cooperative Parties can be found at: http://www.epa.gov/region2/passaicriver/Passaic%202007%20AOC.pdf.

[12] Information on cleanup activities can be found in site repositories at the following locations: Newark Public Library, 5 Washington Street, Newark, NJ 07102; Elizabeth Public library, 11 South Broad Street, Elizabeth, NJ 07202; and U.S. Environmental Protection Agency Records Center, 290 Broadway,18th Floor, NY, NY 10007.

planned, efficient manner and to promote sharing of data necessary for remedial, NRDA, and restoration activities. In addition, the USACE, with assistance from the Office of Maritime Resources within NJDOT and under the authority of WRDA, is evaluating restoration options within the LPR study area. This effort is being coordinated with EPA remedial actions and includes input from the Trustee agencies. The Federal Trustees may use information obtained through remedial and WRDA restoration studies where suitable to assess injuries to natural resources within the Site, with the ultimate objective of successfully restoring those injured resources.

Importance of Public Participation

The EPA, USACE, and NJDOT are providing opportunities for public participation that allow the public and PRPs to provide input on the decision-making process. The Federal Trustees will offer similar opportunities. The Federal Trustees will advertise those opportunities as they arise.

Several specific points in the NRDA process provide important opportunities for public involvement. The most significant include (1) Inviting comments on this Draft NRDA Plan as well as on forthcoming plans for injury determination/quantification studies, which Federal Trustees will make available for public review; and (2) Inviting participation in restoration planning. This Draft NRDA Plan presents a framework for the Federal Trustees' planned activities, and is viewed as a living document that will continue to be developed and refined as the damage assessment progresses. During restoration planning, restoration objectives and criteria are discussed and restoration projects are considered. Individuals interested in participating in this process should visit the Federal Trustees' internet sites for the Passaic River[13], or contact the Trustee representatives listed at the end of the Executive Summary.

Invitation for Cooperative Assessment

The Federal Trustees are interested in working with parties potentially responsible for the contamination of the Site and encourage their active participation in the damage assessment process. Such interactions provide for open dialog and identify common perspectives. The Federal Trustees believe that cooperative assessments enhance the quality and acceptability of scientific studies, reduce costs, and expedite restoration. Cooperative assessments also provide responsible parties the benefit of early involvement, the opportunity to participate in assessment and restoration, and an appreciation of the public's interest in restoring the resource.

At the option of the Federal Trustees, and with Trustee oversight, PRPs interested in the cooperative process may implement all or any part of the damage assessment. A Notice of Intent to Perform an Assessment, including an invitation to participate in the Assessment, were sent to multiple PRPs as described in the Federal Register (FR) Notice of August 8, 2007 (see Addendum). When parties express interest in a cooperative

[13] USFWS: http://www.fws.gov/northeast/njfieldoffice/NRDA/trustees.htm.
NOAA: http://www.darrp.noaa.gov/northeast/passaic/index.html.

.

assessment, the Federal Trustees may develop procedures and schedules for sharing data and collaborating on analysis, documentation, data dissemination, data interpretation, and dispute resolution. Information on any such decisions and procedures will be shared with the public.

Chapter 4: The Diamond Alkali Superfund Site NRDA: Assessment and Restoration

Exhibit 4-1: Restoration Opportunities (In Red) In The Vicinity Of The Diamond Alkali Superfund Site (Data Courtesy NOAA And Malcolm Pirnie, Inc.)

The Federal Trustees are conducting a NRDA to evaluate injuries to natural resources exposed to hazardous substances within the Site. In developing this Draft NRDA Plan, the Federal Trustees are guided by the Department of the Interior's (DOI) regulations for performing NRDA under CERCLA, as well as comparable regulations for NOAA under OPA. The Federal Trustees will follow the general process and standards of the CERCLA Rule while also drawing upon concepts under the OPA regulations.

Conducting a NRDA and restoring injured resources within the Site is a significant undertaking. The size and difficulty of the effort are directly related to the complicated nature of the estuary and the hazardous substances within the ecosystem. For example, chemical concentrations vary significantly depending on location and whether samples are collected from sediment, soil, water, or animal tissues. Similarly, some animals may be exposed to large quantities of a hazardous substance due to their feeding habits, while others may be exposed only on occasion. Also, different species exhibit a wide range of effects following exposure to hazardous substances. Where one animal may show plainly visible abnormalities, others may exhibit responses that are more subtle. Finally, some biological effects can be observed only at certain stages of development; for example, during sensitive early life stages.

As part of the assessment planning process, the Trustees decide whether to conduct a simplified ("type A") assessment or a comprehensive ("type B") assessment. In light of the complexities noted above and other considerations, the Federal Trustees have determined that the simplified procedures of the "type A" assessment provided for in the CERCLA Rule are inappropriate for this NRDA, and that a "type B" assessment should be conducted. The "type A" procedures use minimal field observations and computer models to generate a damage claim and are limited by the regulations to the assessment of relatively minor, short duration discharges. The Federal Trustees concluded that "type B" procedures are justified because: (1) The nature of the releases and exposures to hazardous substances in the Site are long-term and spatially and temporally complicated; (2) Substantial site-specific data already exist to support the assessment; and (3) Additional site-specific data can be collected at reasonable cost. As required for "type B" assessments, Quality Assurance (QA) Plans are developed for each investigative component; QA management is presented in the Appendix B.

The Federal Trustees intend to conduct the remaining components of the NRDA in two major phases: injury determination and quantification and damage determination and restoration. This framework is consistent with the CERCLA Rule and provides an effective means of evaluating hazardous substances within the Site.

The Federal Trustees' general approach to the assessment is to review the existing data, identify data gaps, and then undertake additional testing and sampling as needed. This minimizes the cost of the assessment and maximizes the use of existing information. Within each of the phases noted above, the Federal Trustees will, based on initial data review and additional preliminary investigations where necessary, develop individual in-depth investigations that together will define the nature and extent of injuries caused by hazardous substances within the Site. The remaining sections of this chapter provide overviews of each phase of the assessment and summarize the Federal Trustees' approach for each category of natural resource.

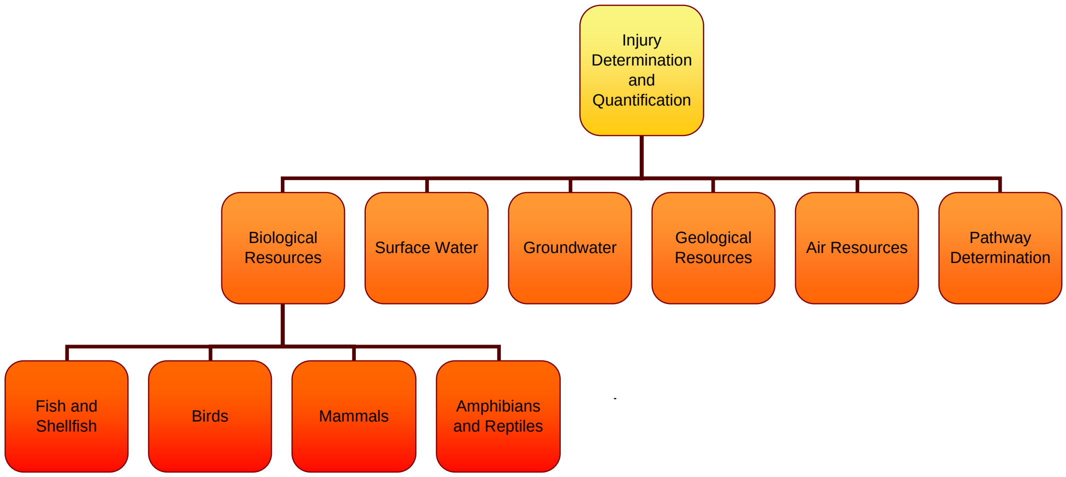
Injury Determination and Quantification

Injuries generally fall into two categories. The first category involves injury based on regulatory criteria, which may include violation of established standards for acceptable levels of contamination or the existence of state health advisories warning against the consumption of contaminated fish or wildlife. The second category establishes injury based on physical, chemical, or biological adverse changes in a resource resulting from exposure to hazardous substances. Examples of these injuries include changes in an organism's physical development, health, reproductive success, or behavior.

The injury to a resource can be quantified in terms of the loss of services that the resource would have provided had the contaminant release not occurred. Loss of services may include impairment of a habitat that supports a native species or diminished human use of a resource. Injury determination and quantification studies typically are performed by scientists who compare their observations regarding samples collected from the contaminated area to samples collected from appropriate reference locations. These studies may be performed in a laboratory, in the field, or in a combination of the two settings.

The Federal Trustees are considering conducting injury assessments for the following natural resources: biological resources (such as fish and birds), surface water (including sediments), groundwater, geologic resources, and air resources (Exhibit 4-2). The Federal Trustees intend to evaluate whether each resource should be included in the NRDA by using a phased approach. The components of this approach can be categorized as either preliminary investigations or injury determination studies. For each resource, the Federal Trustees will gather existing information about past, present, and predicted future concentrations of hazardous substances. The Federal Trustees intend to maximize the use of data assembled by the LPR Restoration Project. Where data are limited, the Federal Trustees may decide to conduct further preliminary exposure assessment studies. The compiled concentration and exposure data will be compared to known criteria, standards, guidance values, or other threshold values which, if exceeded, may indicate that injury to that resource exists or is likely to exist. Results will be assessed by the Federal Trustees to determine whether more thorough injury determination and quantification studies are warranted, or whether a particular resource should not be assessed further for injury. The Federal Trustees will also undertake studies to evaluate the sources and pathways of hazardous substances within the Site.

Exhibit 4-2: Categories Of Injury Determination And Quantification Studies Under Consideration



When the Federal Trustees determine, based on a preliminary investigation, that an injury study is warranted for a particular resource, the Trustees will develop a study plan. Study plans will include detailed information including, but not limited to: objectives to be achieved by testing and sampling, sampling locations, sampling and survey design, numbers and types of samples to be collected, analyses to be performed, and other information required to perform the selected methodologies. The Trustees expect that all plans for injury studies will be peer reviewed and released to the public for review and comment. Upon completion of the studies, the results will also be peer reviewed and released, as will a final study report that will include a description of the methods used.

The specific studies that the Federal Trustees have completed, currently have in progress, or intend to implement as preliminary investigations are described below.

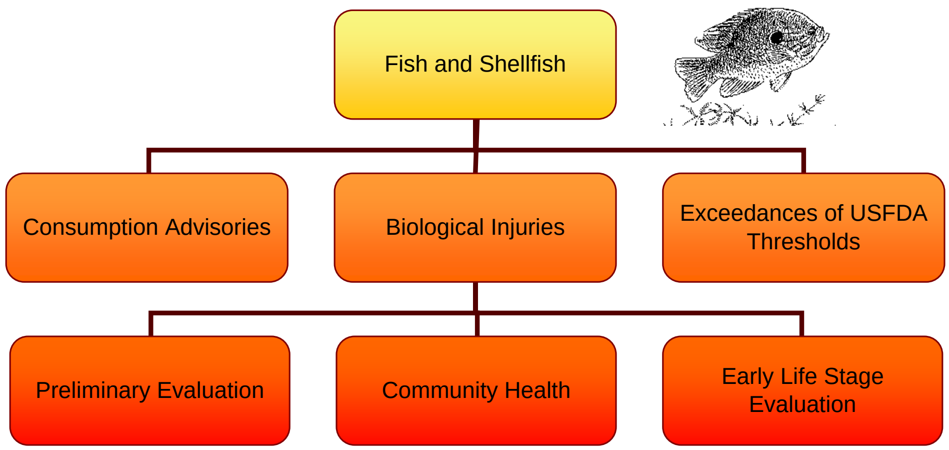
<u>Biological Resources</u>

Fish and Shellfish

Fish and shellfish are critical links in the food web of the Site. They serve as both predators and prey in the food web, where they consume plants, insects, shellfish, worms, and other organisms. In turn, fish and shellfish are consumed by amphibians, reptiles, birds, and mammals. The Site provides habitat to shellfish and resident and migratory fish, including several species of special concern (Exhibit 1-2). The resource is used by recreational and potentially subsistence anglers and historically supported a vibrant catch, including perch, herring, sturgeon, alewife, shad, oyster, and crabs (Holmes ca. 1895; Squires 1981). Because many of the fish and shellfish within the Site are in direct contact with contaminated sediment, water, and prey, they are an important indicator of the overall health of the ecosystem.

Injury to fish and shellfish will be based on the definitions contained in the CERCA Rule. Injuries may potentially include, but are not limited to: mortality, reduced growth, osmoregulatory impairment, lowered disease resistance, behavioral avoidance and other behavioral abnormalities, reproductive impairment, endocrine effects, developmental abnormalities, narcosis, lesions, cultural service losses, fish consumption restrictions, and other human use losses. The studies under consideration by Federal Trustees to evaluate injuries to fish within the Site are depicted in Exhibit 4-3 and are described below.

Exhibit 4-3: Potential Fish Injury Evaluations



Line Art Courtesy USFWS

Fish and Shellfish Consumption Advisories

Public use of the Site includes recreational and potentially subsistence angling, with fishery resources in close proximity to a large number of people. These estuarine waterways traditionally supported a variety of freshwater, anadromous, and marine fish species that are popular with recreational and subsistence anglers.

Both New Jersey and New York have issued advisories or restrictions to limit or prohibit the consumption of fish from the lower Passaic River and surrounding waterways due to toxic contamination. Many of the restrictions on fishing involve species frequently targeted by recreational and subsistence anglers. The current level of use of the resource by recreational and subsistence anglers may be considerably lower than would be the case without the fishing restrictions. It is the intention of the Federal Trustees to undertake an assessment of losses to recreational and potentially subsistence angling within the Site as part of the NRDA process.

A “do not eat” prohibition for all fish and shellfish species has been in place for the lower Passaic River since 1982 due to dioxin and PCB contamination. Additionally, a “no take” prohibition has applied to crabs in the lower Passaic River since 1994. New Jersey imposed a “do not eat” advisory to striped bass and blue crabs throughout the Site in 1983; a “no take” restriction was added for crabs in 1994. In 2003, advisories were modified to reflect the potential cancer risk and became more stringent for some species. New York has issued a series of similar advisories since 1985 for the Arthur Kill and Kill Van Kull. These have included “once a month” and “do not eat” advisories for up to fourteen species at various times. The current fish and shellfish consumption advisories for New York and New Jersey are shown in Exhibit 4-4.

The EPA also has developed guidance regarding fish consumption limits (EPA 2000). For unrestricted consumption (more than sixteen meals per month), the recommended maximum fish tissue concentrations of methylmercury, DDT, PAHs, PCBs, and dioxin/furan TEQs are 0.029 parts per million (ppm) (noncancer health endpoint), 0.0086 ppm (cancer health endpoint), 0.0004 ppm (cancer health endpoint), 0.00015 ppm (cancer health endpoint), and 0.019 pptr (cancer health endpoint), respectively. These numbers are risk-based default values, and are subject to change by the states; where states have not presented alternative values, or where states' numbers are considerably different from one another, EPA values may help reconcile those differences.

The CERCLA Rule defines the fish consumption advisories issued by New Jersey and New York as an injury. To document this injury, the Federal Trustees are evaluating the events that led to the imposition of fishing restrictions, the changing scope of restrictions over time, and the nature of restrictions that exist today. The Federal Trustees' intend to analyze the extent of injuries and the type and amount of restoration that may be necessary to compensate the public for such loss.

Biological Injuries

Preliminary Evaluation of Fish and Shellfish

The CERCLA Rule states that a biological injury exists when the concentration of a hazardous substance is sufficient to cause a variety of adverse health effects in fish, such as death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical deformations, in fish or other biota. A variety of hazardous substances are found in tissues of fish and shellfish from the Site; preliminary summaries of measured values for some chemicals are presented in Exhibits 2-8, 4-5, and 4-6.

As a first step in evaluating the potential presence and severity of such effects, the Trustees will identify tissue-based thresholds in the literature associated with adverse impacts to fish and shellfish (i.e., CBRs). Potentially appropriate thresholds have been published for at least some hazardous substances of concern (e.g., Beckvar *et al.* 2005, Spitsbergen *et al.* 1991, Toomey *et al.* 2001, Wintermyer and Cooper 2003). The Trustees will review these and other potentially relevant CBRs for applicability to the Site. The Trustees may also develop additional CBRs based on available ecotoxicological literature.

When temporal, spatial, and species data gaps are found, the Trustees may determine that additional sampling is necessary to better characterize the extent of contamination in fish and shellfish. In that event, the Trustees may engage in additional data collection activities to provide a better understanding of potential injury to the Site's fish and shellfish resources.

Exhibit 4-4: Fish And Shellfish Consumption Advisories In The Site And Surrounding Waters

Area	**Species**	**New Jersey Advisory**	**Chemical of Concern**	**New York Advisory**	**Chemical of Concern**
Passaic River downstream of Dundee Dam and tributaries	All species of fish and shellfish	Do not eat	PCBs/Dioxin	NA	NA
	Blue crab	Do not harvest, do not eat	PCBs/Dioxin	NA	NA
Newark Bay and tributaries	Blue crab	Do not harvest, do not eat	PCBs/Dioxin	Eat no more than 6 crabs per week; do not eat hepatopancreas; discard cooking liquid	PCBs, Cadmium, Dioxin
	Striped bass	Eat no more than four meals* per year	PCBs/Dioxin	Do not eat	Dioxin and PCBs
	American eel, white perch	Do not eat	PCBs/Dioxin	Do not eat	Dioxin and PCBs
	Atlantic needlefish, rainbow smelt	Not specified	NA	Eat no more than one meal per month	PCBs
	White catfish	Eat no more than one meal* per year	PCBs/Dioxin	Not specified	NA
	Bluefish	fish > 6 lbs.: Eat no more than four meals* per year fish < 6 lbs.: Eat no more than one meal* per month	PCBs/Dioxin	Eat no more than one meal per month	PCBs
	Gizzard shad	Not specified	NA	Do not eat	Dioxin and PCBs
Arthur Kill, Kill van Krull	Bluefish	fish > 6 lbs.: Eat no more than four meals* per year fish < 6 lbs.: Eat no more than one meal* per month	PCBs/Dioxin	Eat no more than one meal per month	PCBs
	Atlantic needlefish, rainbow smelt	Not specified	NA	Eat no more than one meal per month	PCBs
	Striped bass	Eat no more than four meals* per year	PCBs/Dioxin	Do not eat	Dioxin and PCBs
	Blue crab	Do not harvest, do not eat	PCBs/Dioxin	Eat no more than 6 crabs per week; do not eat hepatopancreas; discard cooking liquid	PCBs, Cadmium, Dioxin
	American eel, white perch	Do not eat	PCBs/Dioxin	Do not eat	Dioxin and PCBs
	White catfish	Eat no more than one meal* per year	PCBs/Dioxin	Not specified	NA
	Gizzard shad	Not specified	NA	Do not eat	Dioxin and PCBs
Upper Bay	Atlantic needlefish, rainbow smelt	Not specified	NA	Eat no more than one meal per month	PCBs
	Bluefish	fish > 6 lbs.: Eat no more than four meals* per year fish < 6 lbs.: Eat no more than one meal* per month	PCBs/Dioxin	Eat no more than one meal per month	PCBs
	Striped bass	Eat no more than four meals* per year	PCBs/Dioxin	Eat no more than one meal per month	PCBs
	White perch	Eat no more than one meal* per year	PCBs/Dioxin	Do not eat	PCBs
	Blue crab	Eat no more than one meal of 7 crabs per week; do not eat hepatopancreas; discard cooking liquid	PCBs/Dioxin	Eat no more than 6 crabs per week; do not eat hepatopancreas; discard cooking liquid	PCBs, Cadmium, Dioxin
	Winter flounder	Eat no more than one meal* per month	PCBs	Not specified	NA
	American eel	Eat no more than one meal* per year	PCBs/Dioxin	Eat no more than one meal per month	PCBs
	White catfish	Do not eat	PCBs/Dioxin	Not specified	NA
	rainbow smelt	Not specified	NA	Eat no more than one meal per month	PCBs
	Gizzard shad	Not specified	NA	Do not eat	PCBs
Lower Bay	Bluefish	fish > 6 lbs.: Eat no more than four meals* per year fish < 6 lbs.: Eat no more than one meal* per month	PCBs/Dioxin	Eat no more than one meal per week	PCBs
	American eel	Eat no more than one meal* per year	PCBs/Dioxin	Eat no more than one meal per week	PCBs
	Striped bass	Eat no more than one meal* per month	PCBs/Dioxin	Eat no more than one meal per month	PCBs
	Weakfish, porgy	Eat no more than one meal* per month	PCBs/Dioxin	Not specified	NA
	Winter flounder	Eat no more than one meal* per month	PCBs	Not specified	NA
	American lobster	Eat no more than one meal* per week; do not eat hepatopancreas; discard cooking liquid	PCBs/Dioxin	Do not eat hepatopancreas; discard cooking liquid	PCBs, Cadmium, Dioxin
	White catfish	Eat no more than four meals per year	PCBs/Dioxin	Not specified	NA
	White perch	Eat no more than one meal per year	PCBs/Dioxin	Not specified	NA
	Blue crab	Eat no more than one meal of 7 crabs per month; do not eat hepatopancreas; discard cooking liquid	PCBs/Dioxin	Do not eat hepatopancreas; discard cooking liquid	PCBs, Cadmium, Dioxin
Raritan Bay (west of Wolfe's Pond Park in New York; New Jersey portions of Raritan Bay, Sandy Hook Bay and Lower New York Harbor)	Bluefish	fish > 6 lbs.: Eat no more than four meals per year fish < 6 lbs.: Eat no more than one meal per month	PCBs/Dioxin	Not specified	NA
	Striped bass	Eat no more than one meal per month	PCBs/Dioxin	Eat no more than one meal per month	PCBs
	Weakfish, porgy	Eat no more than one meal per month	PCBs/Dioxin	NA	NA
	Winter flounder	Eat no more than one meal per month	PCBs	NA	NA
	White perch	Eat no more than one meal per year	PCBs/Dioxin	Do not eat	PCBs, Dioxin
	American eel	Eat no more than one meal per year	PCBs/Dioxin	NA	NA
	White catfish	Eat no more than four meals per year	PCBs/Dioxin	NA	NA
	Blue crab	Eat no more than one meal of 7 crabs per month; do not eat hepatopancreas; discard cooking liquid	PCBs/Dioxin	Eat no more than 6 crabs per week; do not eat hepatopancreas; discard cooking liquid	PCBs, Cadmium, Dioxin
	American lobster	Eat no more than one meal per week; do not eat hepatopancreas; discard cooking liquid	PCBs/Dioxin	NA	NA
Raritan Bay (east of Wolfe's Pond Park in New York)	Striped bass	NA	NA	Eat no more than one meal per month	PCBs
	American eel, bluefish	NA	NA	Eat no more than one meal per week	PCBs
	Blue crab	NA	NA	Do not eat hepatopancreas; discard cooking liquid	PCBs, Cadmium, Dioxin

lbs. = pounds
NA = not applicable
PCBs = polychlorinated biphenyls
Note: More conservative consumption advisories may be in effect for high-risk individuals including pregnant women and children.
Sources:
Diskin (2006)
NJDEP (2006a)
NJDEP (2006b)
NJDEP (2006c)
NJDEP (2004b)
NYSDOH (2006)

Exhibit 4-5: Concentrations Of Selected Hazardous Substances Measured In Fish From New York Harbor[1]

Chemical	Location	Organism	Tissue	Sample Size	Range	Average
2,3,7,8-TCDD (pptr)	LPR	American eel	standard fillet	2	20.0 - 31.0	25.5
			whole body	3	5.03 - 20.60	12.24
		Atlantic menhaden	whole body	6	25.00 - 79.10	45.45
		Atlantic silverside	whole body	6	21.40 - 59.50	40.65
		Bluefish	whole body	2	37.80 - 66.70	52.25
			skinless fillet	1	7.54 - 7.54	7.54
		Mummichog	whole body	47	18.50 - 828.0	82.09
		Striped bass	whole body	6	4.14 - 101.0	70.22
			skinless fillet	9	1.63 - 49.20	24.21
			standard fillet	2	26.00 - 26.00	26.00
		White perch	whole body	10	73.60 - 352.0	206.7
			skinless fillet	4	34.40 - 88.90	68.15
	PRSA	American eel	standard fillet	9	10.00 - 80.00	27.39
		Atlantic silverside	whole body	6	4.53 - 46.30	23.64
		Brown bullhead	skinless fillet	6	70.00 - 220.0	111.7
			standard fillet	1	110.00 - 110.0	110.0
		Carp	standard fillet	2	100.00 - 210.0	155.0
		Mummichog	whole body	7	43.20 - 79.50	67.30
		Striped bass	whole body	7	7.00 - 95.90	57.47
		White perch	skinless fillet	2	43.10 - 73.50	58.30
			standard fillet	1	38.00 - 38.00	38.00
			whole body	8	90.40 - 297.0	218.7
	NB, AK, KVK	Striped bass	standard fillet	8	19.5 - 733.9	127.6
		American eel	standard fillet	2	4.0 - 4.3	4.15
	NB[2]	Atlantic silverside	whole body	6	8.8 - 23.9	22.35
		Striped bass	whole body	5	7.0 - 69	31.2
		White perch	whole body	5	99.0 - 208	153
		Mummichog	whole body	10	0.1 - 57	7.75
	HR	Mummichog	whole body	3	3.69 - 12.5	6.80
		Striped bass[3]	skinless fillet	1	NA - NA	16.90
		White perch[3]	skinless fillet	3	NA - NA	17.60
Total PCBs (calculated) (ppb)	LPR	American eel	whole body	4	856.0 - 2460	1667
		Atlantic menhaden	whole body	6	430.2 - 1727	902.3
		Atlantic silverside	whole body	6	278.4 - 580.9	418.4
		Bluefish	whole body	2	1090 - 1098	1094
			skinless fillet	1	440.1 - 440.1	440.1
		Carp	whole body	1	2990 - 2990	2990
			standard fillet	1	5830 - 5830	5830
		Mummichog	whole body	47	0.03320 - 938.5	605.5
		Striped bass	whole body	6	371.0 - 2099	1391
			skinless fillet	9	188.2 - 964.8	511.2
			standard fillet	2	33.5 - 33.6	33.5
		White perch	whole body	10	1324 - 3756	2371
			skinless fillet	4	767.4 - 1040	897.7
	PRSA	American eel	whole body	3	750.7 - 1342	991.3
			standard fillet	7	1080 - 4776	2335
		Atlantic silverside	whole body	3	385.9 - 525.4	444.7
		Brown bullhead	skinless fillet	6	564.6 - 1278	875.1
		Mummichog	whole body	7	499.2 - 585.8	552.9
		Striped bass	whole body	3	1088 - 2049	1461
			skinless fillet	1	346.8 - 346.8	346.8
		White perch	whole body	8	1343 - 2890	2134
			skinless fillet	2	1283 - 1333	1308
	HR	American eel	whole body	1	3740 - 3740	3740
			standard fillet	1	4810 - 4810	4810
		Striped bass[3]	skinless fillet	1	1465 - 1465	1465
		White perch[3]	skinless fillet	3	1299 - 1720	1449
PCBs (sum of congeners) (ppb)	PRSA	American eel	whole body	7	1950 - 8360	4149
		Brown bullhead	skinless fillet	6	990.0 - 2210	1527
	NB, AK, KVK	American eel	whole body	1	2530 - 2530	2530
			standard fillet	3	650 - 3490	2183
		Bluefish	standard fillet	1	3800 - 3800	3800
		Striped bass	whole body	4	1390 - 2480	1870
			standard fillet	5	820 - 6650	3208
PCBs (sum of homologues) (ppb)	PRSA	American eel	whole body	7	1660 - 5560	3243
		Brown bullhead	skinless fillet	6	1090 - 2490	1727
Total DDTs (sum of 6 isomers) (ppb)	LPR	American eel	skinless fillet	1	250.4 - 250.4	250.4
		Striped bass	standard fillet	4	122.1 - 158.4	131.8
	PRSA	American eel	skinless fillet	8	254.2 - 254.2	254.2
			standard fillet	7	120.0 - 1030	335.7
		Brown bullhead	skinless fillet	6	11.0 - 60.0	30.8
		Carp	standard fillet	2	284.0 - 805.1	544.5
	NB, AK, KVK	American eel	skinless fillet	5	173.1 - 1238	550.2
		Bluefish	standard fillet	1	458.7 - 458.7	458.7
		Striped bass	standard fillet	6	12.50 - 166.4	95.4
		White perch	standard fillet	1	128.8 - 128.8	128.8
	HR	American eel	skinless fillet	2	512.0 - 573.7	542.9
		Striped bass[3]	skinless fillet	1	125.9 - 125.9	125.9
		White perch[3]	skinless fillet	3	71.6 - 113.5	89.4
Total DDT (o,p'-DDT + p,p'-DDT) (ppb)	LPR	American eel	skinless fillet	1	18.38 - 18.38	18.4
		Striped bass	standard fillet	4	5 - 26.12	10.3
	PRSA	American eel	skinless fillet	1	29.17 - 29.17	29.2
		Carp	standard fillet	2	5 - 13.3	9.2
	NB, AK, KVK	American eel	skinless fillet	5	11.79 - 89.29	30.8
		Bluefish	standard fillet	1	31.25 - 31.25	31.3
		Striped bass	standard fillet	11	5 - 30.44	11.2
		White perch	standard fillet	1	12.5 - 12.5	12.5
	HR	American eel	skinless fillet	2	34.34 - 38	36.2
Total DDD (o,p'-DDD + p,p'-DDD) (ppb)	LPR	American eel	skinless fillet	1	115.7 - 115.7	115.7
		Striped bass	standard fillet	4	15.12 - 56.73	45.2
	PRSA	American eel	skinless fillet	1	104.2 - 104.2	104.2
		Carp	standard fillet	2	154.0 - 390.6	272.3
	KVK, AK, NB	American eel	skinless fillet	5	76.5 - 737.2	296.2
		Striped bass	standard fillet	11	5 - 312.5	76.2
		Bluefish	standard fillet	1	210.0 - 210.0	210.0
		White perch	standard fillet	1	56.82 - 56.82	56.8
	HR	American eel	skinless fillet	2	228.0 - 243.1	235.6
Total DDE (o,p'-DDE + p,p'-DDE) (ppb)	LPR	American eel	skinless fillet	1	116.3 - 116.3	116.3
		Striped bass	standard fillet	4	60.3 - 104.2	76.3
	PRSA	American eel	skinless fillet	1	120.9 - 120.9	120.9
		Carp	standard fillet	2	125 - 401.2	263.1
	KVK, AK, NB	American eel	skinless fillet	5	84.82 - 411.5	223.2
		Bluefish	standard fillet	1	217.5 - 217.5	217.5
		Striped bass	STandard fillet	11	2.5 - 292.6	100.4
		White perch	standard fillet	1	59.52 - 59.52	59.5
	HR	American eel	skinless fillet	2	246.0 - 296.3	271.1

Exhibit 4-5: Concentrations Of Selected Hazardous Substances Measured In Fish From New York Harbor, Continued[1]

Chemical	Location	Organism	Tissue	Sample Size	Range	Average
p,p' - DDD (ppb)	LPR	American eel	whole body	3	35.00 - 70.00	58.3
		Atlantic menhaden	whole body	6	14.00 - 460.0	116.0
		Atlantic silverside	whole body	6	3.50 - 8.60	4.4
		Bluefish	whole body	2	28.00 - 60.00	44.0
			skinless fillet	1	3.50 - 3.50	3.5
		Mummichog	whole body	47	3.50 - 47.60	16.0
		Striped bass	whole body	6	3.50 - 110.0	51.4
			skinless fillet	9	3.50 - 32.00	15.5
			standard fillet	2	1.05 - 1.05	1.1
		White perch	whole body	10	35.00 - 150.0	66.2
			skinless fillet	4	14.00 - 27.00	20.5
	PRSA	American eel	whole body	3	5.00 - 70.00	31.3
			standard fillet	7	22.0 - 500.0	144.6
		Atlantic silverside	whole body	3	13.00 - 15.00	13.7
		Brown bullhead	skinless fillet	6	3.5 - 17.5	13.0
		Mummichog	whole body	7	10.00 - 35.00	23.0
		Striped bass	whole body	3	21.00 - 50.00	34.0
			skinless fillet	1	11.00 - 11.00	11.0
		White perch	whole body	8	35.00 - 83.00	61.1
			skinless fillet	2	20.00 - 27.00	23.5
	HR	Mummichog	whole body	3	110.0 - 150.0	126.7
p,p'-DDE (ppb)	LPR	American eel	whole body	3	90.0 - 250.0	176.7
		Atlantic menhaden	whole body	6	45.0 - 370.0	148.3
		Atlantic silverside	whole body	6	15.0 - 25.0	19.7
		Bluefish	whole body	2	130.0 - 150.0	140.0
			skinless fillet	1	25.0 - 25.0	25.0
		Mummichog	whole body	47	7.5 - 94.1	35.3
		Striped bass	whole body	6	39.0 - 300.0	153.0
			skinless fillet	9	14.0 - 110.0	43.0
			standard fillet	2	6.8 - 8.3	7.6
		White perch	whole body	10	66.0 - 430.0	176.8
			skinless fillet	4	39.0 - 61.0	50.3
	PRSA	American eel	whole body	3	36.0 - 140.0	89.7
			standard fillet	7	120.0 - 530.0	264.3
		Atlantic silverside	whole body	3	35.0 - 40.0	38.0
		Brown bullhead	skinless fillet	6	11.0 - 60.0	30.8
		Mummichog	whole body	7	20.0 - 44.0	33.0
		Striped bass	whole body	3	73.0 - 260.0	154.3
			skinless fillet	1	23.0 - 23.0	23.0
		White perch	whole body	8	120.0 - 210.0	167.5
			skinless fillet	2	47.0 - 61.0	54.0
	HR	Mummichog	whole body	3	70.00 - 96.00	83.3
p,p'-DDT (ppb)	LPR	American eel	whole body	3	67.0 - 180.0	132.3
		Atlantic menhaden	whole body	6	25.0 - 140.0	73.7
		Atlantic silverside	whole body	6	5.5 - 13.0	8.8
		Bluefish	whole body	2	96.0 - 100.0	98.0
			skinless fillet	1	21.0 - 21.0	21.0
		Mummichog	whole body	47	0.9 - 120.0	21.8
		Striped bass	whole body	6	39.0 - 210.0	110.5
			skinless fillet	9	5.0 - 81.0	22.3
			standard fillet	2	0.91 - 0.91	0.9
		White perch	whole body	10	51.0 - 380.0	149.9
			skinless fillet	4	5.0 - 43.0	22.8
	PRSA	American eel	whole body	3	37.0 - 130.0	83.3
			standard fillet	7	25.0 - 50.0	46.4
		Atlantic silverside	whole body	3	31.0 - 35.0	33.0
		Brown bullhead	skinless fillet	6	5.0 - 25.0	18.3
		Mummichog	whole body	7	14.0 - 36.0	21.4
		Striped bass	whole body	3	60.0 - 170.0	110.0
			skinless fillet	1	7.0 - 7.0	7.0
		White perch	whole body	8	89.0 - 230.0	157.9
			skinless fillet	2	5.0 - 37.0	21.0
Mercury (ppb)	LPR	American eel	whole body	3	0.110 - 0.710	0.373
		Atlantic menhaden	whole body	6	0.040 - 0.084	0.060
		Atlantic silverside	whole body	6	0.053 - 0.077	0.063
		Bluefish	whole body	2	0.073 - 0.097	0.085
			skinless fillet	1	0.320 - 0.320	0.320
		Mummichog	whole body	47	0.021 - 0.150	0.038
		Striped bass	whole body	6	0.081 - 0.270	0.189
			skinless fillet	8	0.190 - 0.690	0.295
			standard fillet	2	0.670 - 0.700	0.685
		White perch	whole body	10	0.130 - 0.570	0.265
			skinless fillet	4	0.350 - 0.360	0.355
	PRSA	American eel	whole body	3	0.150 - 0.240	0.197
			standard fillet	7	0.2 - 0.6	0.4
		Atlantic silverside	whole body	3	0.049 - 0.062	0.058
		Brown bullhead	skinless fillet	6	0.1 - 0.2	0.1
		Mummichog	whole body	7	0.020 - 0.042	0.028
		Striped bass	whole body	3	0.100 - 0.270	0.160
			skinless fillet	1	0.170 - 0.170	0.170
		White perch	whole body	8	0.130 - 0.160	0.145
			skinless fillet	2	0.330 - 0.430	0.380
	HR	American eel	whole body	1	0.440 - 0.440	0.440
		Alewife	whole body	2	0.240 - 0.240	0.240
		Atlantic silverside	whole body	1	0.210 - 0.210	0.210
		Atlantic tomcod	whole body	1	0.140 - 0.140	0.140
		Brown bullhead	whole body	1	0.240 - 0.240	0.240
		Bluegill	whole body	1	0.120 - 0.120	0.120
		Carp	whole body	2	0.100 - 0.110	0.105
		Mummichog	whole body	2	0.110 - 0.290	0.200
		Pumpkinseed	whole body	1	0.110 - 0.110	0.110
		Sunfish	whole body	1	0.240 - 0.240	0.240
		Weakfish	whole body	2	0.230 - 0.260	0.245
		White perch	whole body	2	0.240 - 0.380	0.310
		Striped bass[3]	skinless fillet	1	0.200 - 0.200	0.200
		White perch[3]	skinless fillet	3	0.100 - 0.400	0.270
Methylmercury (ppb)	LPR	Mummichog	whole body	5	39.60 - 76.80	58.48
		Striped bass	whole body	2	429.0 - 464.0	446.5

[1] Data accessed through NOAA's (2005) on-line database except as indicated below. Sample concentrations for results qualified as non-detects assumed to be one-half the detection limit. Units are in wet weight. Study area reports and investigative programs through which data were obtained include the following:

Eckenfelder (1993)
Hauge *et al.* (1990)
Hauge *et al.* (1993)
Maxus Energy Corporation (1995)
Santoro and Koepp (1986)
Tierra Solutions Inc. (1999a; 2000a,b; 2001)

LPR = Lower Passaic River
PRSA = Passaic River Study Area
KVK, AK, NB = Kill Van Kull, Arthur Kill, and Newark Bay
HR = Hackensack River
TEQ = toxic equivalent
pptr = parts per trillion
ppb = parts per billion
PCBs = polychlorinated biphenyls
[2]Data from USFWS 2000a,b. Data for striped bass are for whole body minus liver.
[3]Data from Horowitz *et al.* (2006).

Exhibit 4-6: Concentrations Of Selected Hazardous Substances Measured In Shellfish From New York Harbor[1]

Chemical	Location	Organism	Tissue	Sample size	Range	Average
2,3,7,8-TCDD (pptr)	NB	Blue crab	hepatopancreas	11	320 - 940	564
			muscle	9	4.8 - 45	22.2
			hepatopancreas[2]	6	NA - NA	189
			muscle[2]	6	NA - NA	3.2
		Ribbed mussels	soft tissue[3]	4	5.40 - 10.30	9.25
		Eastern mudsnails	soft tissue[3]	2	5.50 - 7.20	6.35
		Softshell clams	whole body	4	11.0 - 20.0	14.8
		Eastern oyster	soft tissue[4]	1	NA - NA	3.2
	Lower PR	Blue crab	hepatopancreas	15	195 - 6238	894
			muscle	21	6.6 - 116	25.10
			soft tissue	16	28.1 - 141	74.8
			hepatopancreas[2]	5	NA - NA	288
			muscle[2]	5	NA - NA	9.0
		Ribbed mussels	soft tissue	13	8.98 - 17.0	12.4
	PRSA	Blue crab	hepatopancreas	2	205 - 228	217
			hepatopancreas + muscle	1	54 - 54	54
			muscle	3	14.8 - 21.5	18.7
			soft tissue	3	32.6 - 99	76.8
			hepatopancreas[2]	5	NA - NA	221
			muscle[2]	5	NA - NA	3.40
		Ribbed mussels	soft tissue	2	11.5 - 12	11.75
	HR	Blue crab	hepatopancreas	9	30.1 - 1063	422
			muscle	9	0.87 - 23.1	9.83
			hepatopancreas[2]	3	NA - NA	188
			muscle[2]	3	NA - NA	3.20
	Raritan River/Raritan Bay	Blue crab	hepatopancreas	9	11.5 - 33.5	18.60
			muscle	1	1.43 - 1.43	1.43
	Arthur Kill	Blue crab	hepatopancreas[2]	3	NA - NA	48.6
			muscle[2]	3	NA - NA	0.8
		Eastern oyster	soft tissue[4]	1	NA - NA	1.3
	Upper NY Bay	Blue crab	hepatopancreas[2]	3	NA - NA	2.40
			muscle[2]	3	NA - NA	0.60
	Raritan Bay	Blue crab	hepatopancreas[2]	12	NA - NA	2.35
			muscle[2]	12	NA - NA	0.175
		American lobster	hepatopancreas + muscle[5]	19	ND - 100.0	34.4
			hepatopancreas + muscle[6]	9	10 - 62.0	32.3
			hepatopancreas[2]	5	NA - NA	13.80
			muscle[2]	5	NA - NA	0.00
Total PCBs (calculated) (ppb)	Lower PR	Blue crab	hepatopancreas	13	1383 - 55720	6010
			muscle	17	33.5 - 127	69.9
			soft tissue	16	349 - 897	532
			hepatopancreas[2]	5	1668 - 7020	3597
			muscle[2]	5	48.7 - 97.3	70.3
		Ribbed mussel	soft tissue	13	50.9 - 84.0	67.8
	PRSA	Blue crab	hepatopancreas	2	1349 - 1971	1660
			muscle	3	43.0 - 125	78.9
			soft tissue	3	431 - 611	521
			hepatopancreas[2]	5	1540 - 5976	3190
			muscle[2]	5	22.1 - 72.3	42.1
		Ribbed mussel	soft tissue	2	46.0 - 58.2	52.1
	HR	Blue crab	hepatopancreas	5	130 - 5600	3200
			hepatopancreas + muscle	5	590 - 2240	1482
			muscle	1	240 - 240	240
			hepatopancreas[2]	3	2574 - 7865	5223
			muscle[2]	3	21.5 - 81.10	47.0
	NB	Blue crab	hepatopancreas	4	3510 - 8270	5440
			hepatopancreas + muscle	11	900 - 3340	1735
			muscle	4	360 - 440	393
			hepatopancreas[2]	6	822 - 5187	3656
			muscle[2]	6	3.2 - 69.3	34
		Eastern oyster	soft tissue[4]	1	NA - NA	68.6
	Arthur Kill	Blue crab	hepatopancreas[2]	3	2648 - 4378	3464
			muscle[2]	3	13.70 - 21.40	17.7
		Eastern oyster	soft tissue[4]	1	NA - NA	64.5
		American lobster	hepatopancreas + muscle[6]	2	650 - 790	720
	Raritan Bay	Blue crab	hepatopancreas[2]	12	642 - 3740	1511
			muscle[2]	12	10.40 - 42.60	19.90
		American lobster	hepatopancreas[2]	5	319 - 4058	1740
			muscle[2]	5	3.30 - 9.80	19.90
	Upper NY Bay	Blue crab	hepatopancreas[2]	3	1540 - 3933	2874
			muscle[2]	3	17.4 - 42.20	27.60

Exhibit 4-6: Concentrations Of Selected Hazardous Substances Measured In Shellfish From New York Harbor[1], Continued

Chemical	Location	Organism	Tissue	Sample size	Range	Average
DDTs						
p,p' - DDD (ppb)	Lower PR	Blue crab	hepatopancreas	13	67.0 - 480	153
			muscle	19	1.05 - 3.50	2.98
			soft tissue	16	3.50 - 29.0	12.9
		Ribbed mussel	soft tissue	13	3.50 - 11.0	4.08
	PRSA	Blue crab	hepatopancreas	2	85.0 - 110	97.5
			muscle	3	3.50 - 3.50	3.50
			soft tissue	3	3.50 - 14.0	9.8
		Ribbed mussel	soft tissue	2	3.50 - 3.50	3.50
	HR	Blue crab	hepatopancreas	5	12.0 - 1200	586
			muscle	3	22.0 - 38.0	28.0
p,p'-DDE (ppb)	Lower PR	Blue crab	hepatopancreas	13	240 - 670	405
			muscle	19	1.45 - 8.10	6.45
			soft tissue	16	21.0 - 120	59.6
		Ribbed mussel	soft tissue	13	3.90 - 11.00	7.12
	PRSA	Blue crab	hepatopancreas	2	340 - 430	385
			muscle	3	4.00 - 7.50	5.37
			soft tissue	3	41.0 - 54.00	46.7
		Ribbed mussel	soft tissue	2	7.20 - 7.50	7.35
	HR	Blue crab	hepatopancreas	5	10.0 - 2100	978
			muscle	4	24.0 - 98.0	48.0
p,p'-DDT (ppb)	Lower PR	Blue crab	hepatopancreas	13	190 - 440	324
			muscle	19	0.910 - 5.00	4.14
			soft tissue	16	5.00 - 79.0	31.3
		Ribbed mussel	soft tissue	13	5.00 - 5.00	5.00
	PRSA	Blue crab	hepatopancreas	2	320 - 480	400
			muscle	3	5.00 - 5.00	5.00
			soft tissue	3	5.00 - 31.0	17.7
		Ribbed mussel	soft tissue	2	5.00 - 5.00	5.00
DDT (p,p' + o,p') (ppb)	Upper NY Bay	Blue crab	hepatopancreas	3	5.00 - 21.3	12.6
			hepatopancreas + muscle	5	5.00 - 12.3	6.45
			muscle	3	5.00 - 5.00	5.00
	HR	Blue crab	hepatopancreas	1	12.3 - 12.3	12.3
			hepatopancreas + muscle	5	5.00 - 18.4	7.68
			muscle	1	5.00 - 5.00	5
	Lower PR	Blue crab	hepatopancreas	2	27.6 - 30.8	29.2
			hepatopancreas + muscle	6	5.00 - 10.7	6.91
			muscle	2	5.00 - 5.00	5.00
	NB	Blue crab	hepatopancreas	2	17.1 - 46.0	31.5
			hepatopancreas + muscle	5	5.00 - 61.1	20.7
			muscle	2	5.00 - 5.00	5.00
DDD (o,p' + p,p') (ppb)	Upper NY Bay	Blue crab	hepatopancreas	3	83.2 - 128	101
			hepatopancreas + muscle	5	26.6 - 75.2	55.0
			muscle	3	5.00 - 21.5	10.5
	HR	Blue crab	hepatopancreas	1	77.1 - 77.1	77.1
			hepatopancreas + muscle	5	5.00 - 127.31	46.30
			muscle	1	5.00 - 5.00	5.00
	Lower PR	Blue crab	hepatopancreas	2	154 - 202	178
			hepatopancreas + muscle	6	24.8 - 139	68.9
			muscle	2	16.3 - 19.7	18.0
	NB	Blue crab	hepatopancreas	2	222 - 353	287
			hepatopancreas + muscle	5	58.0 - 120	78.9
			muscle	2	15.4 - 18.2	16.8
DDE (o,p' + p,p') (ppb)	Upper NY Bay	Blue crab	hepatopancreas	3	63.6 - 160	115
			hepatopancreas + muscle	5	45.8 - 108	79.1
			muscle	3	2.50 - 29.33	16.01
	HR	Blue crab	hepatopancreas	1	108 - 108	108
			hepatopancreas + muscle	5	32.3 - 166	78.7
			muscle	1	14.5 - 14.5	14.5
	Lower PR	Blue crab	hepatopancreas	2	184 - 285	235
			hepatopancreas + muscle	6	47.2 - 228	115
			muscle	2	22.6 - 32.8	27.7
	NB	Blue crab	hepatopancreas	2	353 - 490	422
			hepatopancreas + muscle	5	85.1 - 138	108
			muscle	2	23.0 - 26.7	24.9
DDT (total of 6 isomers) (ppb)	Upper NY Bay	Blue crab	hepatopancreas	3	161 - 310	229
			hepatopancreas + muscle	5	77.4 - 195	141
			muscle	3	12.5 - 55.8	31.5
			hepatopancreas[2]	3	208 - 426	314
			muscle[2]	3	1.60 - 5.30	3.00
	HR	Blue crab	hepatopancreas	1	197 - 197	197
			hepatopancreas + muscle	5	42.3 - 311	133
			muscle	1	24.5 - 24.5	24.5
			hepatopancreas[2]	3	453 - 857	714
			muscle[2]	3	4.10 - 14.90	7.90
	Lower PR	Blue crab	hepatopancreas	2	369 - 514	442
			hepatopancreas + muscle	6	77.0 - 372	191
			muscle	2	43.8 - 57.4	50.6
			hepatopancreas[2]	5	263 - 1182	596
			muscle[2]	5	14.5 - 22.9	18.1
	PRSA	Blue crab	hepatopancreas[2]	5	224 - 788	421
			muscle[2]	5	8.50 - 14.1	11.9
	NB	Blue crab	hepatopancreas	2	592 - 889	741
			hepatopancreas + muscle	5	157 - 319	207
			muscle	2	46.2 - 47.1	46.6
			hepatopancreas[2]	6	175 - 1991	1024
			muscle[2]	6	1.50 - 28.2	10.9
		American lobster	hepatopancreas + muscle[6]	2	25.6 - 27.8	26.7
	Arthur Kill	Blue crab	hepatopancreas[2]	3	1152 - 1787	1538
			muscle[2]	3	7.80 - 16.6	12.8
	Raritan Bay	Blue crab	hepatopancreas[2]	12	118 - 1183	363
			muscle[2]	12	2.9 - 20.6	7.53
		American lobster	hepatopancreas[2]	5	45.0 - 391.2	181
			muscle[2]	5	0.30 - 1.40	0.70

Exhibit 4-6: Concentrations Of Selected Hazardous Substances Measured In Shellfish From New York Harbor[1], Continued

Chemical	Location	Organism	Tissue	Sample size	Range	Average
PAHs						
Total PAHs (ppb)	Lower PR	Blue crab	hepatopancreas	26	125 - 1022	279
			muscle	34	15.0 - 870	134
			soft tissue	32	15.0 - 848	240
		Ribbed mussel	soft tissue	13	36.1 - 148	94.9
	PRSA	Blue crab	hepatopancreas	4	125 - 1013	500
			muscle	6	15.0 - 125	107
			soft tissue	6	125 - 882	430
		Ribbed mussel	soft tissue	1	312 - 312	312
HMW PAHs (ppb)	Lower PR	Blue crab	hepatopancreas	26	125 - 486	178
			muscle	34	7.50 - 443	116
			soft tissue	32	15.0 - 518	184
		Ribbed mussel	soft tissue	13	36.1 - 120	79.2
	PRSA	Blue crab	hepatopancreas	4	125 - 512	316
			muscle	6	7.50 - 125	105
			soft tissue	6	89.4 - 600	321
		Ribbed mussel	soft tissue	1	269 - 269	269
LMW PAHs (ppb)	Lower PR	Blue crab	hepatopancreas	26	55.0 - 536	189
			muscle	34	13.5 - 427	66.6
			soft tissue	32	15.0 - 333	121
		Ribbed mussel	soft tissue	13	15.0 - 39.5	22.6
	PRSA	Blue crab	hepatopancreas	4	55.0 - 501	211
			muscle	6	15.0 - 55.0	48.3
			soft tissue	6	54.6 - 378	171
		Ribbed mussel	soft tissue	1	43.2 - 43.2	43.2
Mercury (ppm)	Lower PR	Blue crab	hepatopancreas	13	0.029 - 0.073	0.0429
			muscle	9	0.050 - 0.280	0.1111
			hepatopancreas[2]	5	0.10 - 0.10	0.10
			muscle[2]	5	0.10 - 0.20	0.18
			soft tissue	16	0.034 - 0.088	0.0581
		Ribbed mussel	soft tissue	13	0.002 - 0.025	0.0176
	PRSA	Blue crab	hepatopancreas	2	0.037 - 0.053	0.0450
			muscle	3	0.090 - 0.140	0.1133
			soft tissue	3	0.032 - 0.099	0.0620
			hepatopancreas[2]	5	0.10 - 0.10	0.10
			muscle[2]	5	0.10 - 0.20	0.16
		Ribbed mussel	soft tissue	2	0.017 - 0.021	0.0190
	HR	Blue crab	whole body	2	0.17 - 0.26	0.215
			hepatopancreas	1	0.39 - 0.39	0.39
			muscle	2	1.00 - 1.40	1.20
			hepatopancreas[2]	3	0.10 - 0.20	0.13
			muscle[2]	3	0.30 - 0.40	0.33
		Mud crab	whole body	1	0.47 - 0.47	0.47
		Fiddler crab (*Uca minax*)	whole body	2	0.13 - 0.18	0.16
		Fiddler crab (*Uca pugnax*)	whole body	2	0.11 - 0.12	0.12
		Grass shrimp	whole body	2	0.11 - 0.26	0.19
	Arthur Kill	Blue crab	hepatopancreas[2]	3	0.10 - 0.10	0.10
			muscle[2]	3	0.20 - 0.20	0.20
	Newark Bay	Blue crab	hepatopancreas[2]	6	0.10 - 0.10	0.10
			muscle[2]	6	0.20 - 0.30	0.24
	Upper NY Bay	Blue crab	hepatopancreas[2]	3	0.10 - 0.10	0.10
			muscle[2]	3	0.20 - 0.20	0.20
	Raritan Bay	Blue crab	hepatopancreas[2]	12	0.00 - 0.1	0.09
			muscle[2]	12	0.10 - 0.1	0.10
Methylmercury (ppb)	Lower PR	Blue crab	muscle	4	152 - 235	197

[1]Data accessed through NOAA's (2005) on-line database except as indicated below. Sample concentrations for results qualified as non-detects assumed to be one-half the detection limit. Units are in wet weight. Study area reports and investigative programs through which data were obtained include the following:
- Brown *et al.* (1994)
- Eckenfelder (1993)
- Gross and Cai (1992)
- Hauge *et al.* (1990; 1993)
- Maxus Energy Corporation (1995)
- Rappe *et al.* (1991)
- Santoro and Koepp (1986)
- Tierra Solutions Inc. (1999a; 2000b)

[2]Data from Horowitz *et al.* (2006).
[3]Data from USFWS (2000a).
[4]Data for oysters following 10-month accumulation study (Wintermyer and Cooper 2003).
[5]Data for lobsters in the Ambrose Fishery, which includes Raritan and Sandy Hook Bays, extending to a hypothetical 7 nautical mile radius on the Ambrose Light leading into New York Harbor (Hauge *et al.* 1994).
[6]Data from Belton (1985).
pptr = parts per trillion
ppm = parts per million
ppb = parts per billion
NA = not available
ND = non detect
PCBs = polychlorinated biphenyls
PAHs = polycyclic aromatic hydrocarbons
HMW = high molecular weight
LMW = low molecular weight

Fish and Shellfish Community Health

Available literature suggests causal linkages between some hazardous substances and fish and shellfish health impacts. For instance, PAHs have been linked to a wide range of adverse effects in fish including deformities, lesions, and tumors (Logan 2007, Pinkney *et al.* 2004).

In light of the potential for such impacts, the Trustees may evaluate fish and shellfish health as indicated by the presence of abnormalities (such as deformities, eroded fins, lesions, and tumors), as well as the incidence of diseases, parasitic infections, or other health metrics in one or more species. This information, combined with data on Site contaminant levels, will help the Trustees better understand the incidence, severity, and potential extent of injuries to the fish and shellfish communities. The Trustees may also evaluate the overall status of the fish and shellfish communities through studies designed to assess community composition, species abundance, distribution patterns, or other similar metrics. As part of such studies, the Trustees would identify and characterize appropriate reference areas to understand the likely baseline condition.

The Trustees may supplement these assessments of the impact of Site contaminants on fish and shellfish community health with a literature review. The review would compare the results of previous studies of fish and shellfish at the Site to current studies performed as part of the damage assessment, as well as to studies from other locations (particularly those subject to similar degrees of contamination, to the extent available).

Fish and Shellfish Early Life Stages

Fish and oysters are among the most sensitive species to the effects of dioxins, and early life stages are the most vulnerable (Boening 1998, Elonen *et al.* 1998, Tietge *et al.* 1998, Hahn 2001; Wintermyer and Cooper 2003). Young fish exposed to sufficiently high concentrations of TCDD exhibit symptoms resembling blue-sac disease, including edema, hemorrhaging, craniofacial deformity, and death (Elonen *et al.* 1998, Cook *et al.* 2003), while oysters show altered embryonic development (Wintermyer and Cooper 2003). Other Site contaminants, including PAHs and PCBs, are also particularly toxic to early life stages, adversely affecting the development of fish eggs and/or young of the year (EPA 2003, Barron *et al.* 2005).

To better understand the impacts that these or other hazardous substances may have on fish and shellfish at the Site, the Trustees may conduct studies on the effects of these substances on the early life stages of relevant species. The specifics of any such studies are yet to be determined, but could potentially include laboratory toxicity evaluations and/or *in situ* investigations. Results would be interpreted in the context of site-specific conditions as well as prior research on the contaminant(s) and species of interest.

USFDA Evaluation

To protect human health, the United States Food and Drug Administration (USFDA) requires that fishery products containing certain hazardous substances in excess of safe levels be removed from commerce. Based on the CERCLA Rule, fishery resources are injured if they contain concentrations of a hazardous substance sufficient to exceed action levels or tolerances established by the USFDA. Current USFDA tolerances, action levels, or guidance values for PCBs, DDTs, and methylmercury are 2.0, 5.0, and 1.0 ppm, respectively, in edible fish tissue (USFDA 2001). The USFDA does not have a uniform guidance value for dioxin or dioxin TEQs. However, in response to an incident involving contamination of animal feed by dioxin, USFDA scientists established a "level of concern" of 1 pptr in edible tissues of fish, eggs, meat, poultry, and other food products (FSIS 1997). Tissues containing higher concentrations were deemed adulterated and unfit as food (General Accounting Office 1998). In another incident, egg and egg-containing products from Belgium, France, and the Netherlands and animal feed containing products from Europe were prohibited from importation unless demonstrated to contain less than 1 pptr dioxins (USFDA 1999).

The Federal Trustees will compare the available fish and shellfish tissue data from the Site with USFDA tolerances and action levels. This injury determination is in progress and, upon completion, will be made available to the public.

Striped Bass Illustration by Timothy Knepp (Courtesy USFWS).

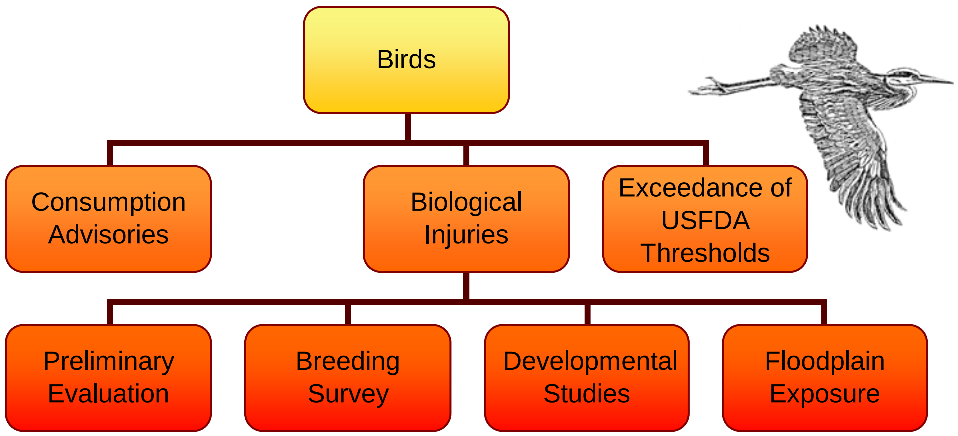
Birds

Birds are an integral part of the ecosystem and provide a number of important ecosystem services such as seed distribution, plant pollination, and insect control. Birds are also an important source of prey to other species. Birds are valued by the public through participation in activities such as bird watching, nature study, and bird feeding.

Birds may be exposed to hazardous substances through the direct ingestion of contaminated water, sediment, or soil. However, a more important pathway is likely through consumption of food items. Carnivorous and piscivorous (fish-eating) birds are particularly susceptible to chemicals that biomagnify, including dioxins, PCBs, methylmercury, and pesticides. Food items contaminated by chemical releases to the estuary may include fish, benthic invertebrates, amphibians, aquatic insects, adult insects that develop from aquatic larvae, plants growing in or near the river, or mammals that forage in the floodplains. The Federal Trustees intend to assess the potential injuries to birds from exposure to hazardous substances in the Site based on definitions of injury contained in the CERCLA Rule. Potential injuries may include, but are not limited to:

reproductive impairment, chronic toxicity from dietary exposure, and acute/chronic toxicity from direct contact with and/or ingestion of sediments. The studies the Federal Trustees are considering to determine potential injuries to birds are depicted in Exhibit 4-7 and described below.

Exhibit 4-7: Potential Avian Injury Evaluations For The Site



Line Art by Tom Kelley (Courtesy USFWS)

Waterfowl Consumption Advisory

The State of New York has in place statewide waterfowl and snapping turtle consumption advisories due to contamination by PCBs, mirex, chlordane, and DDT (NYSDOH 2006). Specifically, the State recommends that mergansers should not be eaten, and that other waterfowl should not be eaten more than two times per month. While the State of New Jersey does not currently have advisories for species other than fish or shellfish, the Federal Trustees may evaluate concentrations of hazardous substances in tissues of waterfowl in relation to waterfowl and snapping turtle advisories in the future.

Biological Injuries

Preliminary Avian Evaluation

Estuaries, when healthy, provide a rich source of food in the form of fish and benthic invertebrates, thereby supporting a diverse array of avian species. The Site and surrounding New York and New Jersey Harbor Estuary support over 70 species of birds, including waterfowl, wading birds, shorebirds, songbirds, and birds of prey. Some species live in and around the river throughout the year, while others use the river only for breeding, feeding, as an over-wintering area, or as a stopover during long migrations.

Hazardous substances adversely affect reproduction, growth, health, and survival of numerous bird species. A limited number of studies document the presence of hazardous substances in birds from the Site; concentrations of TCDD and dioxin-like compounds, PCBs, mercury, and PAHs were found to be elevated in blood, feathers, and/or eggs of double-crested cormorants and black-crowned night herons from in the Kill van Kull and Arthur Kill, respectively (Map in Exhibit 1-1) (Parsons 2003; USFWS 1997b; USFWS 2000b) (Exhibits 2-8 and 4-8).

Exhibit 4-8: Concentrations Of Selected Hazardous Substances Measured In Birds From New York Harbor

Chemical	Location	Species	Source	Tissue	Sample Size	Range	Mean
2,3,7,8-TCDD (pg/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	8.59 - 201	59.8
				Plasma	11	1.13 - 10.1	3.14
	Swinburne Island	DCC	a	Eggs	13	7.76 - 48.1	28.2
				Plasma	13	0.581 - 1.63	1.03
	Shooter's Island	DCC	b	Eggs	8	44.1 - 161	83
	Isle of Meadows	BCNH	b	Eggs	10	3.2 - 86.8	13.41 (g)
	Shooter's Island	DCC	c	Eggs	5	16 - 241	103
Total dioxins and furans[1] (pg/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	44.2 - 440	191
				Plasma	11	6.23 - 18.0	11.2
	Swinburne Island	DCC	a	Eggs	13	70.7 - 186.0	121
				Plasma	13	6.46 - 58.6	12.4
Total dioxins and furans (total homologues)[2] (pg/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	23 - 393	155
				Plasma	11	0 - 10.1	3.93
	Swinburne Island	DCC	a	Eggs	13	47.1 - 143	96.9
				Plasma	13	0 - 10.7	2.94
Dioxin and Furan TEQs[3] (pg/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	NA	92
				Plasma	11	NA	3.99
	Swinburne Island	DCC	a	Eggs	13	NA	55.8
				Plasma	13	NA	2.00
	Shooter's Island	DCC	c	Eggs	5	34 - 289	138
Dioxin, Furan, and PCB TEQs[4] (pg/g wet wt.)	Shooter's Island	DCC	c	Eggs	5	254 - 767.0	604
Total PCBs (Total Aroclors) (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	3380 - 69200	24700
				Plasma	11	158 - 544	323
	Swinburne Island	DCC	a	Eggs	13	3208 - 20300	12700
				Plasma	13	39.2 - 145	107
Total PCBs (Total Congeners) (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	1980 - 40400	13900
				Plasma	11	105 - 331	209
	Swinburne Island	DCC	a	Eggs	13	1930 - 13200	8000
				Plasma	13	30.3 - 108	77.5
PCB TEQs[5] (pg/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	NA	322
				Plasma	11	NA	8.48
	Swinburne Island	DCC	a	Eggs	13	NA	249
Total DDTs (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	NA	3870
				Plasma	11	NA	48
	Swinburne Island	DCC	a	Eggs	13	NA	1790
				Plasma	13	NA	9.7
2,4'-DDT (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	0.254 13.9	2.60
				Plasma	11	0 0.31	0.0788
	Swinburne Island	DCC	a	Eggs	13	0 - 0.44	0.252
				Plasma	13	NA	NA
4,4'-DDT (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	3.19 50.2	18.8
				Plasma	11	0.128 2.24	1.02
	Swinburne Island	DCC	a	Eggs	13	0.995 16.7	7.28
				Plasma	13	0 0.31	0.129
2,4'-DDD (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	0.12 60.5	6.44
				Plasma	11	0 0.42	0.126
	Swinburne Island	DCC	a	Eggs	13	0 0.52	0.164
				Plasma	13	NA	NA
4,4'-DDD (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	2.59 2150	181
				Plasma	11	0.168 8.00	2.54
	Swinburne Island	DCC	a	Eggs	13	0.433 6.82	2.93
				Plasma	13	0 0.11	0.062
2,4'-DDE (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	0 28.9	2.64
				Plasma	11	0 0.18	0.0622
	Swinburne Island	DCC	a	Eggs	13	0 0.98	0
				Plasma	13	NA	NA
4,4'-DDE (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	487 12100	3660
				Plasma	11	12.8 88.9	44.1
	Swinburne Island	DCC	a	Eggs	13	300 5700	1780
				Plasma	13	3.40 16.8	9.49

Exhibit 4-8: Concentrations Of Selected Hazardous Substances Measured In Birds From New York Harbor, Continued

Chemical	**Location**	**Species**	**Source**	**Tissue**	**Sample Size**	**Range**			**Mean**
PAHs (ng/g wet wt.) (Naphthalene[6])	Shooter's Island	DCC	a	Eggs	14	2.63	-	9.6	4.605
				Plasma	10	5.52	-	11	7.28
	Swinburne Island	DCC	a	Eggs	13	2.07	-	3	2.53
				Plasma	12	5.99	-	15	8.01
Total mercury (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	14	85.4	-	1130	338
				Down	10	2540	-	5560	3672
				Feathers	11	2310	-	13800	5630
				Blood	11	65.9	-	401	195
	Swinburne Island	DCC	a	Eggs	13	154	-	673	342
				Down	12	2390	-	5060	3600
				Feathers	12	3350	-	5840	4590
				Blood	14	99.7	-	198	168.3
Methylmercury (ng/g wet wt.)	Shooter's Island	DCC	a	Eggs	3	175	-	320	230
				Down	2	3160	-	5900	4530
				Feathers	2	2750	-	3310	3030
				Blood	2	160	-	167	163.5
	Swinburne Island	DCC	a	Eggs	3	146	-	525	282
				Down	2	2890	-	4330	3610
				Feathers	2	3260	-	4400	3830
				Blood	2	169	-	204	186.5

[1]Total dioxins and furans include 1,2,3,4,6,7,8-HpCDD; 1,2,3,4,6,7,8-HpCDF; 1,2,3,4,7,8,9-HpCDF; 1,2,3,4,7,8-HxCDD; 1,2,3,4,7,8-HxCDF; 1,2,3,6,7,8-HxCDD; 1,2,3,6,7,8-HxCDF; 1,2,3,7,8,9-HxCDD; 1,2,3,7,8,9-HxCDF; 1,2,3,7,8-PeCDD; 1,2,3,7,8-PeCDF; 2,3,4,6,7,8-HxCDF; 2,3,4,7,8-PeCDF; 2,3,7,8-TCDD; 2,3,7,8-TCDF; OCDD; OCDF.
[2]Total dioxins and furans (total homologues) includes homologue groups HPCDD, HPCDF, HXCDD, HXCDF, PECDD, PECDF, TCDD and TCDF.
[3]Predicted toxic equivalents of Ah receptor-active dioxins and furans based on WHO avian toxic equivalent factors from van den Berg *et al.* (1998).
[4]Predicted toxic equivalents of Ah receptor-active dioxins, furans, and PCBs based on WHO avian toxic equivalent factors from van den Berg *et al.* (1998).
[5]Predicted toxic equivalents of Ah receptor-active PCB congeners (77,81,105,114,118,123,126, 156, 157, 167, 169, 189) based on WHO avian toxic equivalent factors from van den Berg *et al*. (1998).
[6]Data for total PAHs, high molecular weight PAHs, and low molecular weight PAHs are not available. Only data for naphthalene, the PAH analyte contributing the greatest concentration to total are presented.
pg/g = picograms per gram
ng/g = nanograms per gram
wt. = weight
DCC = double crested cormorant
BCNH = black crowned night heron
(g) = geometric mean
PCBs = polychlorinated biphenyls
PAHs = polycyclic aromatic hydrocarbons
HMW = high molecular weight
LMW = low molecular weight
NA = not available
Sources:
a Data from Parsons (2003). Values for non-detects assumed to be zero.
b Data from USFWS (1997b). Values for non-detects assumed to be one-half detection limit.
c Data from USFWS (2000b). Values for non-detects assumed to be one-half detection limit.

The Federal Trustees intend to conduct a screening-level evaluation of the effects of hazardous substances within the Site on birds. This work will involve reviewing existing scientific studies, evaluating exposure and tissue concentrations associated with avian injury, and summarizing bird exposure data. Based on the results of this work, the Federal Trustees may undertake additional studies to provide a better understanding of exposure and potential injury of avian resources in the area.

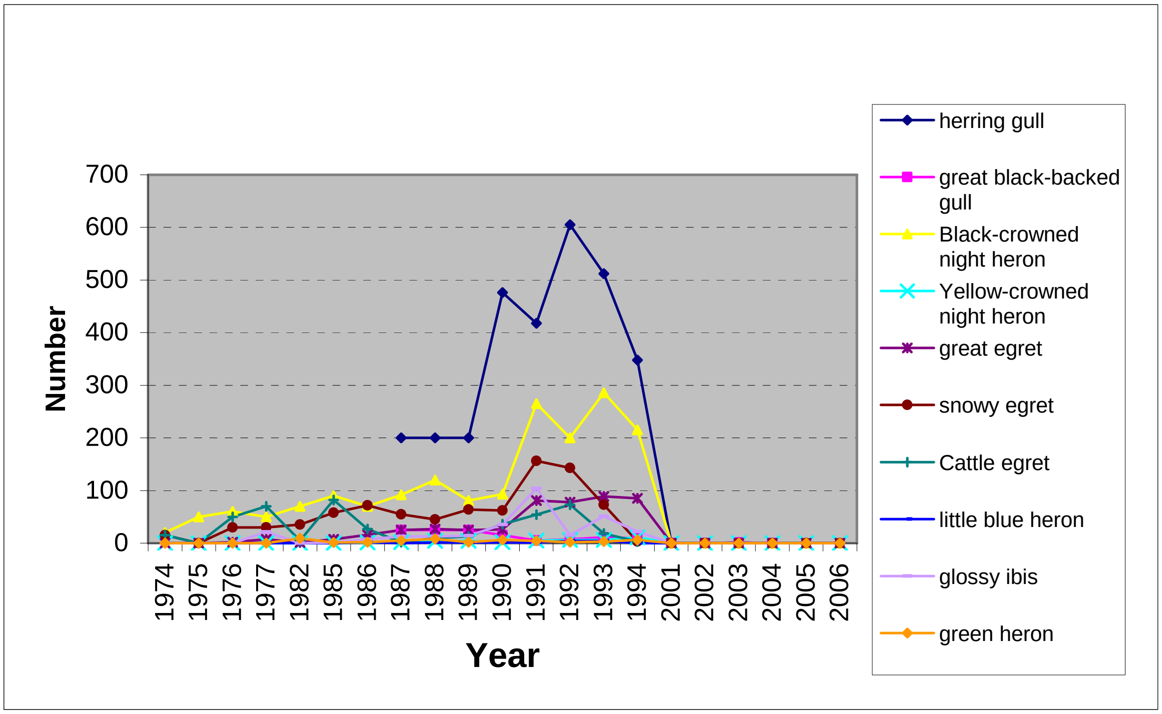
Breeding Bird Survey

Each bird species found within the Site uses specific types of habitats for feeding, breeding, and nesting. To perform injury studies involving birds, it is important that the Federal Trustees understand the relationship between the Site and each species' particular habitat and foraging preferences. Such relationships help define the likelihood that a given species is at risk for adverse impacts from hazardous substances. To confirm the presence, relative abundance, and breeding and foraging habitat requirements of bird species across the Site, the Federal Trustees will review information available from previous breeding bird surveys of the area. For example, the Harbor Heron Project of the New York City Audubon Society has performed surveys of colonial wading birds in New York/New Jersey Harbor for the past 30 years. Those surveys show that the breeding activity of colonial wading birds on Shooter's Island was low during the 1970s and 1980s, began increasing in the 1990s, and has declined to nearly zero since 2001 (Exhibit 4-9). As part of the screening-level evaluation, the Federal Trustees will review the temporal and spatial trends of breeding birds within the Site in relation to chemical distributions. Further surveys may be undertaken if needed. The results of these investigations could provide information useful in planning future avian injury determination studies, as well as help the Federal Trustees decide which species to include in the damage determination. Additionally, these studies could help the Federal Trustees design studies to characterize the effects of hazardous substances on local bird populations.

Avian Developmental Studies

The Federal Trustees have done limited studies in and around the Site to evaluate the exposure of birds to some hazardous substances at sensitive early life stages. Measured concentrations of several hazardous substances occur in bird eggs of a variety of species that inhabit the Site at levels found in other studies to be associated with harmful effects. For example, studies by Parsons 2003 and the USFWS (USFWS 1997b; 2000b) show that eggs from black-crowned night herons and double-crested cormorants in the Harbor contain concentrations of dioxins and PCBs at levels that induced brain asymmetries in great blue herons (Henshel 1998), correlate with reduced embryo weight in black-crowned night herons (Hoffman *et al.* 1986), correlate with vitamin A depletion and porphyria in herring gulls (Fox *et al.* 1988; Spear *et al.* 1990), and reduce hatching success and cause developmental abnormalities in common terns (Hoffman *et al.* 1993).

Exhibit 4-9: Wading Bird Populations On Shooter's Island, 1976 to 2006



Data from Bernick (2005, 2006); Kerlinger(2004);and Parsons (1994).

Further, these levels increase the frequency of beak and foot abnormalities, reduce egg hatchability, and decrease weight of embryos and hatchlings in Forster's terns (Hoffman *et al.* 1987; Kubiak *et al.* 1989); correlate negatively with reproductive success in bald eagles (Bowerman *et al.* 1994; Kubiak and Best 1991); and induce beak deformities in double-crested cormorants (Yamashita *et al.* 1993) (Exhibits 2-8 and 4-8). Additionally, concentrations of PCBs in blood plasma of double-crested cormorants in the Harbor occur at levels associated with reduced reproductive success of bald eagles (Bowerman *et al.* 1994). Finally, DDE concentrations in blood plasma and eggs of double-crested cormorants in the Harbor occur at levels that correlate with egg abnormalities and death in double-crested cormorants (Yamashita *et al.* 1993) and reduce reproductive success of bald eagles (Bowerman *et al.* 1994; Kubiak and Best 1991; Wiermeyer *et al.* 1984). Studies of herring gulls in the Great Lakes, for which long-term monitoring efforts provide a wealth of information regarding exposure to and effects of a variety of hazardous substances (for example, Fox *et al.* 2002; Herbert *et al.* 1999), may also be used to evaluate injury to birds in the Site.

To provide further insight into the effects of hazardous substances on sensitive life stages in birds, the Federal Trustees may implement additional studies that evaluate chemical concentrations in eggs from other species and areas within and near the Site. Such studies may help determine whether further avian injury determination and quantification studies are warranted.

Evaluation of Avian Exposure from Feeding on Floodplain Organisms

Some bird species use floodplains extensively for feeding. For example, American robins forage on the ground or in low vegetation by probing with their beaks or by gleaning. They may also forage along the edge of streams. American robins feed heavily on ground-dwelling invertebrates, particularly during the months before and during the breeding season, during which time they feed their young such items as earthworms and grubs obtained in moist forests and open woodlands. Other avian species occurring in the Site that frequently feed in floodplains include red-winged blackbird, eastern meadowlark, mourning dove, northern oriole, thrushes, woodpeckers, wrens, goldfinch, catbird, rose-breasted grosbeak, rufous-sided towhee, blue jay, cardinal, scarlet tanager, flycatchers, yellow-throated vireo, and Kentucky warbler.

Relatively few soil screening benchmarks are available that are based on potential risk to wildlife from the bioaccumulation of hazardous substances. Available values include Preliminary Remediation Goals (PRGs) for Ecological Endpoints developed by the U.S. Department of Energy (Efroymson *et al.* 1997), Ecological Screening Levels developed by EPA Region 5 (EPA Region 5 2003), and a set of risk-based guidance values for TCDD, intended to protect wildlife, developed by the Health Council of the Netherlands (Health Council of the Netherlands 1996). These values and the endpoints on which they are based are shown in Exhibit 4-10. Other screening numbers could potentially be derived from loading rates developed for land application of sewage sludge containing TCDD or other compounds, such as those found in Thiel *et al.* (1995). This methodology may have advantages over soil concentration-based criteria in situations where hazardous substances are deposited in a relatively thin layer on the surface, as might occur through flooding during storm events.

Exhibit 4-10: Soil Screening Values Based On Risk To Wildlife For Some Hazardous Substances Found Within The Site

Hazardous Substance(s)	**Soil Concentration**	**Units**	**Endpoint**	**Source**
TCDD	0.199 2 3.15	pptr pptr pptr	Shrew Wildlife Shrew	EPA 2003 Health Council of the Netherlands 1996 DOE 1997
TCDF	0.84	ppb	Hawk	DOE 1997
PCDDs	0.199	pptr	Shrew	EPA 2003
PCDFs	0.0386	ppb	Shrew	EPA 2003
PCBs	371 0.332	ppb ppb	Shrew Shrew	DOE 1997 EPA 2003
DDD	4.88	ppb	Shrew	EPA 2003
DDE	3.16	ppb	Shrew	EPA 2003
DDT	4.15	ppb	Shrew	EPA 2003
Mercury	0.51	ppb	Woodcock	DOE 1997

PCBs = polychlorinated biphenyls
pptr = parts per trillion
ppb = parts per billion

Little information is available regarding the concentrations of hazardous substances in floodplain soils within the Site. The Federal Trustees may undertake studies to determine whether those concentrations are sufficiently high to cause injury to avian species feeding on floodplains in the study area. Such an evaluation may potentially involve measuring concentrations of hazardous substances in soils from the Site and comparing those concentrations to screening values, determining concentrations of hazardous substances in dietary items of birds within the Site and comparing those concentrations to toxicity reference values from the scientific literature, and evaluating tissue concentrations and resulting health effects of hazardous substances in floodplain-dependent bird species, including sensitive life stages, within the Site. Additionally, a risk-based approach developed for sewage-sludge applications could be applied to floodplain soils contaminated by hazardous substances carried in sediments and deposited during flood events (Meyn *et al.* 1997). This approach incorporates information including application (i.e., flooding) rate, incorporation depth, soil bulk density, percent solids, application (flooding) frequency, and contaminant half-life into a model that evaluates risk through dietary exposure to contaminated soil.

USFDA Evaluation

Natural resources are injured when concentrations of PCBs in wild waterfowl exceed the USFDA's tolerance for poultry. To protect human health, the USFDA requires that poultry containing PCB concentrations in excess of safe levels be removed from commerce. For PCBs, this tolerance level is currently 3 ppm in the fat tissue, or 5 ppm in the muscle tissue (USFDA 1987). While there are no federal tolerances for dioxin in food or feed, the USFDA restricts the importation of bird eggs for consumption to those with a maximum of 1 pptr PCBs or dioxins as TCDD TEQs (USFDA 1999). To evaluate bird injuries based on USFDA requirements, the Federal Trustees may assess concentrations of hazardous substances such as PCBs and dioxins in waterfowl and compare those concentrations with USFDA actions.

Photos (left to right): Belted kingfisher (C. Schlawe), great egret (Lee Karney), and green heron (Lee Karney) (Courtesy USFWS).

Mammals

While available habitat along the lower portion of the Site is limited for mammalian species, some may rely on the Site for food and as a breeding ground. Mammals that may depend heavily on the river resources for food and habitat include muskrats, raccoons, bats, mice, shrews, squirrels, opossums, chipmunks, white-tailed deer, and rabbits and, although less likely, foxes, otters, mink, bobcats, and beavers. Additionally, there have been occasional sightings of marine mammals such as dolphins and seals in New York Harbor, including harbor seals basking on Hoffman and Swinburne Islands located in the Lower Bay off the southeast coast of Staten Island (Wildlife Conservation Society 2006) and a harbor porpoise in Upper New York Bay (McFadden 1995).

The potential exists for mammals that feed in or around contaminated waters to accumulate harmful levels of hazardous substances. Mammals may accumulate chemicals by consuming fish, insects, and other river-dependent species. They also may be directly exposed to hazardous substances in water, sediment, soil, and plants as they physically manipulate their environment by building dens, foraging for food, and marking territory. Potential injury to mammals will be based on definitions of injury to biological resources contained in the CERCLA Rule. Potential injuries may include, but are not limited to, acute and chronic toxicity, reproductive impairment, immunosuppression, and endocrine effects.

At present, no data are available to evaluate concentrations of hazardous substances in mammals at the Site. The Federal Trustees are contemplating potential studies to evaluate exposure or injury to mammals; however, no studies are identified at this time. The Federal Trustees may in the future decide that further investigation into mammalian resource injuries is warranted.

Raccoon Photo by Dave Menke, (Courtesy USFWS).

Amphibians and Reptiles

The Site and its surrounding habitats support a variety of species of amphibians and reptiles (Exhibit 1-2). These species spend a large part of their lives in contact with potentially contaminated water, sediment, and /or soil, and consume potentially contaminated prey. As essential components of the food web, amphibians and reptiles prey on insects, worms, and other invertebrates, and are in turn consumed by larger animals such as hawks, owls, and raccoons. In addition to providing nutrients for their predators, amphibians and reptiles also pass on accumulated hazardous substances.

The Federal Trustees are contemplating potential investigations to confirm exposure of or injury to amphibians and reptiles. Injury to amphibians and reptiles would be based on the definitions contained in the CERCLA Rule. However, no studies are identified at this time. As mentioned above, the State of New York has issued statewide consumption advisories for snapping turtles. The Federal Trustees may further evaluate this and identify other evidence of injury that would justify additional investigation in the future.

Diamondback Terrapin Photo by Jeff Lovich (Courtesy USGS).

<u>Surface Water</u>

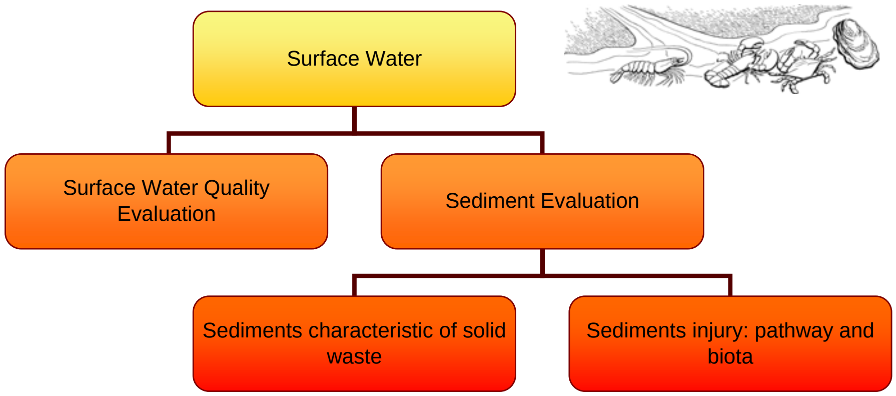
The waters of the Site represent critical habitat for many plants and animals. The River and Bay provide food and shelter for adults, as well as critical nursery habitat for many species. The Site also provides recreational opportunities for people to boat, swim, fish, and observe wildlife.

The specific studies that the Federal Trustees have in progress to determine injuries to surface water resources of the Site are described below and shown in Exhibit 4-11. The categories of surface water investigations include both water quality and sediment. River sediments are included within the regulatory definition of surface waters for NRDA purposes, due in part to the close association between contamination in sediment and water.

Surface Water Quality Evaluation

The CERCLA Rule states that when hazardous substances are present in waterways at levels that exceed a standard set by a state or the federal government, the surface water resource is injured. For this provision to apply, the surface water must have met the standard before the release and must be a “committed use” as a habitat for aquatic life, water supply, or recreation. The CERCLA Rule stipulates that when the surface water is used for multiple uses, the most stringent criterion applies.

Exhibit 4-11: Potential Surface Water Injury Evaluations



Line Art by Bob Hines (Courtesy USFWS)

According to NJDEP (2002b; 2006d), the freshwater section of the Passaic River south of Dundee Dam is classified by the State of New Jersey as "FW2-NT", meaning that designated uses are:

1. Maintenance, migration, and propagation of the natural and established biota;
2. Primary and secondary contact recreation;
3. Industrial and agricultural water supply;
4. Public potable water supply after conventional filtration treatment (a series of processes including filtration, flocculation, coagulation, and sedimentation, resulting in substantial particulate removal but no consistent removal of chemical constituents) and disinfection; and
5. Any other reasonable uses.

The waters of the saltwater section of the Site are classified as "SE2" or "SE3", meaning that designated uses are:

1. Maintenance, migration, and propagation of the natural and established biota;
2. Maintenance of diadromous fish;
3. Maintenance of wildlife;
4. Secondary contact recreation; and
5. Any other reasonable uses.

Thus, the New Jersey waters of the Site fit the definition of the committed use provision. The NJDEP also identified use impairments including aquatic life support and fish consumption for the lower Passaic River and Newark Bay (NJDEP and the Administrator of the New Jersey Spill Compensation Fund vs. Occidental Chemical Corporation, Tierra Solutions, Inc., Maxus Energy Corporation, *et al.* 2005.).

Surface waters of the Site located in New York State are subject to New York State Water Quality Standards. Designated uses of such waters vary by area, but include classifications that have standards for protection for:

1. Human health through consumption of fish;
2. Fish propagation;
3. Fish survival; and

4. Wildlife protection (NYDEC 1998).

Additional applicable water quality criteria include EPA National Recommended Water Quality Criteria for human health through the consumption of fish tissue and for the protection of aquatic life, and New Jersey-specific wildlife values derived to protect the peregrine falcon, bald eagle, and dwarf wedgemussel, but which are considered protective of other species as well (NJDEP, USFWS, and EPA 2001).

Applicable New Jersey, New York, and EPA water quality criteria and standards and New Jersey-specific wildlife values are shown in Exhibit 4-12. The Federal Trustees intend to evaluate existing water quality data in comparison to established water quality standards to document where and when the surface waters of the Site exceeded these standards, thus documenting injury to surface water resources.

Photo of Passaic River, Courtesy Malcolm Pirnie, Inc.

Sediment Evaluation

The Federal Trustees are evaluating whether contamination of river sediments constitutes a natural resource injury. Two potential investigations, supported by specific injury provisions in the CERCLA Rule, are described below.

Exhibit 4-12: New Jersey, New York, And EPA Aquatic Water Quality Criteria For Primary Contaminants Of Concern In The Site

	Freshwater				**Saltwater**				**Saltwater and Freshwater**		
Contaminant of Concern	**New Jersey State FW2 Aquatic WQC[1] (µg/L)**	**New Jersey State Human Health WQC[2] (µg/L)**	**EPA Chronic WQC[3] (µg/L)**	**EPA Human Health WQC[4] (µg/L)**	**New Jersey State SE Aquatic WQC[5] (µg/L)**	**New Jersey State Human Health WQC[2] (µg/L)**	**EPA Chronic WQC[3] (µg/L)**	**EPA Human Health WQC[4]**	**New York State Ecological WQS (µg/L)[6]**	**New York State Human Health WQS (µg/L)[7]**	**New Jersey Specific WQC for Wildlife (µg/L)[8]**
2,3,7,8-TCDD	NA	0.000000005	NA	0.000000005	NA	0.0000000051	NA	0.0000000051	0.0000000031 [9]	0.0000000006 [10]	NA
Total PCBs	0.014	0.000064	0.014	0.000064	0.03	0.000064	0.03	0.000064	0.00012 [9]	0.000001	0.000072
4,4'-DDD	NA	0.00031	NA	0.00031	NA	0.00022	NA	0.00022	NA	0.00008	NA
4,4'-DDE	NA	0.00022	NA	0.00022	NA	0.00022	NA	0.00022	NA	0.00007	NA
4,4'-DDT	0.001	0.00022	0.001	0.00022	0.001	0.00022	0.001	0.00022	0.000011 [9,11]	0.00001	0.000004 [11]
PAHs											
High molecular weight PAHs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Low molecular weight PAHs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals											
Mercury[12]	0.77	0.05	0.77	0.3	0.94	0.051	0.94	0.3	0.0026 [9]	0.0007	0.00053

[1] Chronic WQC for aquatic life, for water bodies designated FW2 (see text) (NJDEP 2006d).
[2] WQC for human health due to the consumption of organism and water (NJDEP 2006d).
[3] Chronic WQC from EPA (2006c).
[4] Chronic WQC for human health due to the consumption of organism only (EPA 2006c).
[5] Chronic WQC for aquatic life, for waterbodies designated SE (see text) (NJDEP 2006d).
[6] According to the Clean Water Act, waters must be protected for the most stringent of their applicable uses. Therefore, when more than one type of value is available (i.e., fish propagation, fish survival, or wildlife), the lowest water quality standard is presented. Standards apply to all designated classes of surface water as identified under 6 NYCRR §890 (NYDEC 1998).
[7] WQS is for the protection of human health through fish consumption (NYDEC 1998).
[8] WQC derived to minimize adverse effects on the bald eagle, peregrine falcon, and dwarf wedgemussel. These maximum allowable surface water concentrations should adequately protect at-risk wildlife species in the State of New Jersey (NJDEP, USFWS, and EPA 2001).
[9] WQS for the protection of wildlife (NYDEC 1998).
[10] Applies to the sum of chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans. The TCDD equivalent for a congener for the standard for human consumption of fish is obtained by multiplying the concentration of that congener by its TEF and its Bioaccumulation Equivalency Factor (BEF) listed in NYDEC (1998).
[11] WQS is for the sum of DDD,DDE, and DDT (NYDEC 1998).
[12] New Jersey WQC for aquatic life, New York WQS, and EPA chronic WQC based on dissolved, inorganic form. New Jersey WQC, EPA WQC for human health, and New Jersey-specific WQC for wildlife are based on total recoverable mercury (EPA 2006c; NJDEP 2006d; NJDEP, USFWS, and EPA 2001; NYDEC 1998).
WQC = Water quality criteria
µg/L = micrograms per liter
WQS = Water quality standard
NA = Not applicable
PCB = Polychlorinated biphenyls
PAHs = Polycyclic aromatic hydrocarbons
TEF = toxic equivalency factor

Sediments Characteristic of Solid Waste

When concentrations of hazardous substances on bed, bank, or shoreline sediments are sufficient to characterize the sediment as hazardous under the Solid Waste Disposal Act (SWDA; also known as the Resource Conservation and Recovery Act, or RCRA)[14], the resource is injured. For example, sediments containing chemicals tied to specific industries, included in lists of hazardous waste, or that have measurable properties indicating they pose enough of a threat to be regulated are defined as hazardous waste. EPA policy states that environmental media containing hazardous waste must be managed as hazardous waste until they no longer contain the waste. The Federal Trustees may investigate whether, when, and to what extent the sediments of the Site are adversely affected such that they exhibit contamination characteristics defined in the SWDA. Available data indicate that some areas of the Site are contaminated to such a degree that they show such characteristics. The results of such an investigation may serve to document injury to surface water resources under the CERCLA Rule.

Sediments Injury: Pathway and Biota

Sediments are also injured when they contain hazardous substances of sufficient concentration and duration to cause injury to other natural resources (e.g., groundwater, air, geologic, or biological resources) when such resources are exposed to surface water, suspended sediments, or bed, bank, or shoreline sediments.

The Federal Trustees may perform an investigation to determine whether the concentrations of hazardous substances in sediments of the Site are sufficient to cause injury to other natural resources, such as biota, that are exposed to those sediments. This evaluation could be primarily focused on evaluating injury to sediment-dwelling biota due to exposure to contaminated sediments and associated water.

A variety of studies have evaluated the effects of contaminated sediments on biota. These studies led to the establishment of various sediment quality criteria and sediment quality guidelines, as well as suggested values for clean-up that would be protective for species that come into contact with hazardous substances in sediment. The Federal Trustees may compare existing sediment data with thresholds, effect levels, and clean-up values identified in the literature to determine where, when, and for how long sediments in the Site exceeded those criteria. Data collected thus far indicate that sediments in some areas of the Site exceed such thresholds and effect levels; i.e., that the concentrations of some hazardous substances may be sufficiently high to cause injury to other natural resources, particularly sediment-dwelling biota (Exhibit 4-6). This condition would constitute a surface water injury under the CERCLA Rule.

[14] See 42 U.S.C.§ 6901 *et seq.*

Passaic River sediments exposed at low tide. Photo Courtesy EPA.

Groundwater

Groundwater is the water beneath the earth's surface in what is called the "saturated zone". It may flow naturally to the earth's surface through seeps or springs.

Groundwater resources may be injured in several ways. First, injury occurs if concentrations of hazardous substances in the groundwater exceed standards established in the Safe Drinking Water Act (SDWA)[15], so long as the groundwater satisfied certain requirements prior to the release. Those requirements include either evidence of potability or evidence that the groundwater met applicable standards at the time of chemical release and is a "committed use" as a public water supply. Second, injury occurs if concentrations of hazardous substances in the groundwater exceed criteria established in the CWA, so long as the groundwater satisfied certain requirements prior to the release. Those requirements include that the groundwater met the criteria for a domestic water supply before the release, and is a committed use as a domestic water supply. Third, injury may occur due to violations of certain other state or Federal standards or criteria for groundwater designated as a drinking water supply, public water supply, or domestic water supply prior to the release. Finally, contaminated groundwater resources can also be injured by, and can injure, other resources by serving as a source and pathway for hazardous substances. For example, seepage of contaminated groundwater into a river may be an exposure pathway for fish. If concentrations of hazardous substances in groundwater are sufficiently high to cause injury to fish exposed to groundwater, injuries have occurred to both groundwater and fish.

While the groundwater of the Site is not currently used as a drinking water supply, most groundwater in the State of New Jersey, including that in the vicinity of the lower Passaic River and Newark Bay, is required by the State to adhere to Class II-A criteria (Exhibit 4-13). The primary designated use for Class II-A groundwater is for potable water and

[15] See 42 U.S.C. § 300f *et seq*.

conversion (through conventional water supply treatment, mixing, or other similar technique) to potable water[16]. Class II-A secondary designated uses include agricultural water and industrial water.

Exhibit 4-13: Groundwater Quality Criteria For Primary Contaminants Of Concern Within The Site

Constituent	**Groundwater Quality Criterion (μg/L)**	**PQL (μg/L)**	**Higher of PQL and Groundwater Quality Criterion (μg/L)***
2,3,7,8-TCDD	0.0000002	0.00001	0.00001
Total PCBs	0.02	0.5	0.5
4,4'-DDD	0.1	0.02	0.1
4,4'-DDE	0.1	0.01	0.1
4,4'-DDT	0.1	0.1	0.1
Total PAHs	NA	NA	NA
Mercury (total)	2	0.05	2

*"Where a constituent standard...is of a lower concentration than the relevant PQL..., the Department shall not (in the context of an applicable regulatory program) consider the discharge to be causing a contravention of that constituent standard so long as the concentration of the constituent in the affected ground water is less than the relevant PQL." (Title 7 NJAC, Chapter 7:9C).
μg/L = Micrograms per liter
PQL = practical quantitation limit
PCBs = polychlorinated biphenyls

The extent of groundwater contamination by hazardous substances released into the Site is not known. The Federal Trustees may compile the available information regarding the presence of hazardous substances in groundwater in and around the Site, and compare that information to relevant standards and criteria. Based on the results of this preliminary analysis, a determination will be made regarding the need for further study.

<u>Geologic Resources</u>

Geologic resources include elements of the Earth's crust, such as soils, sediments, rocks, and minerals. A geologic resource may be injured by the release of a hazardous substance when, among other things, one or more of the following changes in the physical or chemical quality of the resource is measured as a result of concentrations of hazardous substances sufficient to have: (1) Caused the materials in the geologic resource to exhibit characteristics identified under the SWDA; (2) Caused injury to groundwater from physical or chemical changes in gases or water from the unsaturated zone; (3) Caused a toxic response in soil invertebrates; (4) Caused a phytotoxic response such as retardation of plant growth; (5) Impeded soil microbial respiration to an extent that plant and microbial growth are inhibited; or (6) Caused injury to other resources including surface water, air, groundwater, or biological resources. Thus, as for groundwater, contaminated geologic resources can also be injured by, and can injure, other resources by serving as a source and pathway for hazardous substances.

The Federal Trustees may evaluate injuries to geologic resources by compiling existing information regarding the presence of hazardous substances in those resources, such as floodplains, in and around the Site. The results may be compared to relevant standards and thresholds to evaluate the possibility of injury. The Federal Trustees may also

[16] Title 7 of the New Jersey Administrative Code, Chapter 7:9C.

undertake additional investigations to help determine the extent of injury to geologic resources, and prepare a report documenting the extent of the injury. Such injuries would be distinct from any injuries to biological resources of the floodplains, such as birds and mammals, and may be treated separately in damage quantification. The Federal Trustees may alternatively make a determination that removes this resource from the assessment and provide the basis for doing so in a report available to the public.

Air Resources

Air may be injured when a hazardous substance is present at concentrations that exceed air quality standards established under the Clean Air Act[17], or other standards issued by a state or the federal government to protect public welfare or natural resources. Like groundwater and geologic resources, contaminated air resources can be injured by other resources, and can injure other resources by serving as a source and pathway for hazardous substances.

Some hazardous substances, for example, mercury, dioxins, PAHs, and PCBs, are known to enter the atmosphere from water or wet sediments through volatilization. The Federal Trustees may investigate existing information regarding the presence of these substances in the air in and around the Site, and compare that information to relevant standards and injury thresholds. Following that review, the Federal Trustees may undertake additional investigations, potentially including an injury determination study, and prepare a report documenting the extent of the injury. Federal Trustees may alternatively make a determination that removes this resource from the assessment and provide the basis for doing so in a report available to the public.

Pathway Determination

Through pathway determination, the Federal Trustees will document how hazardous substances enter and move through the environment, including how they move among species in the food web. Pathway studies are frequently very technical, focusing on the chemical composition of the hazardous substances and how they interact with the physical environment and the biological processes they encounter. Pathway determination usually relies on a combination of empirical data and modeling assumptions. The interpretation of these data helps the Federal Trustees determine whether a link exists between the release of hazardous substances and the injured natural resource.

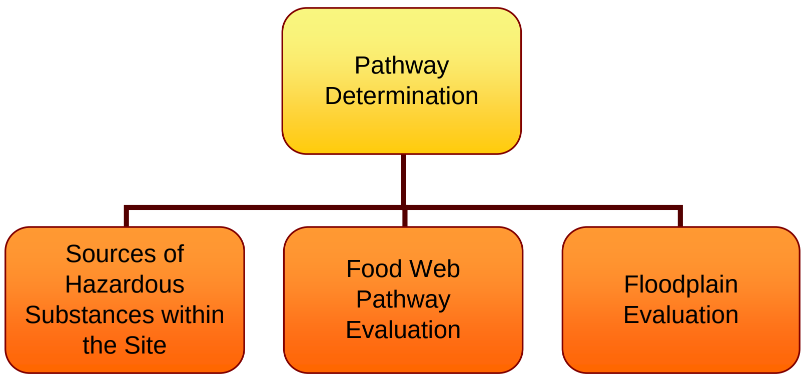
The contaminant pathways for the Site include soil, sediment, and water, which are important habitats for species at the base of the food web. For example, the sediment in the Site provides habitat for a wide range of invertebrates such as shellfish, worms, and insects. These organisms are key components of the ecosystem, providing food for other animals, cycling nutrients, and constantly modifying the river bottom. Because sediment may contain large quantities of organic matter, to which hazardous substances often bind, exposure of sediment-dwelling organisms to contaminated sediments provides a route for entry of those compounds into the food web. Organisms that live in direct contact with

[17] 42 U.S.C. 7401 *et seq*.

the sediment may accumulate substantial amounts of hazardous substances and pass them on to other organisms.

The Federal Trustees will implement preliminary investigations to determine which hazardous substances and pathways in the Site are most significant for the purposes of the damage assessment. The investigations will consider information from other injury determination studies as it becomes available. The components of the preliminary investigations are shown in Exhibit 4-14 and described below.

Exhibit 4-14: Potential Pathway Determination Investigations For The Site



Sources of Hazardous Substances within the Site

Existing data show that a variety of hazardous substances are present in the sediment and water of the Site. Analytical results from over a thousand sediment, water, soil, and tissue samples document elevated concentrations of substances including dioxins, furans, PCBs, DDTs, PAHs, and metals (Exhibits 2-1, 2-8, 2-10, 4-5, 4-6, and 4-8). EPA notified dozens of PRPs of their potential liability for hazardous material releases under CERCLA. The Federal Trustee's investigation will assess evidence regarding the sources of various hazardous substances in the Site and evaluate available data on sediment chemistry, deposition/erosion, and transport. Should the Federal Trustees conclude from the preliminary investigation that a more detailed pathway determination study is warranted, a study plan will be developed and released for public review and comment.

Food Web Pathway Evaluation

Several of the hazardous substances found in the Site have chemical properties that cause them to accumulate in biota. Such compounds, including dioxins, PCBs, and methylmercury, tend to accumulate to the highest levels in long-lived, upper trophic level organisms, such as predatory fish and wildlife that feed on fish. The State of New Jersey and the EPA conducted a series of studies that indicate that sediment-dwelling organisms in the Site are exposed to hazardous substances and that such substances reside in their tissues (Exhibit 4-6). Sediment-dwelling organisms provide one of the primary means of transfer of hazardous substances from the sediment into the food web.

The Federal Trustees may develop studies to explore more completely how hazardous substances move through the food web based on ecological, biological, and chemical principles. This effort may provide insight into restoration options for those resources that are injured by hazardous substances in the Site. It may also help identify the need for future studies.

Floodplain Evaluation

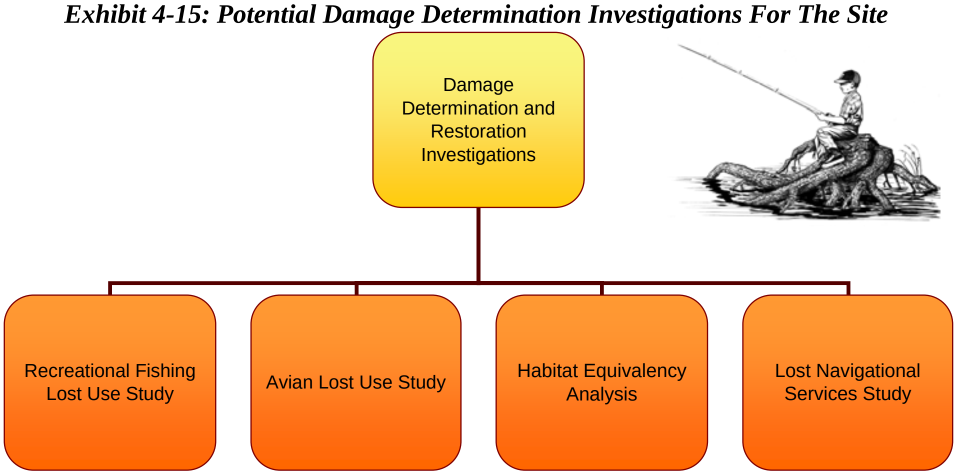
Although limited in scope, floodplains within the Site provide habitat to a range of wildlife including soil invertebrates, amphibians, reptiles, birds, and mammals. These organisms often are important parts of the diet for predators such as shrews, hawks, falcons, and owls. If floodplain soils contain hazardous substances, they may provide a source of contaminants for floodplain biota. Additionally, the floodplain may be a source of aquatic contamination through runoff and flooding, and may in turn be contaminated by floodwaters carrying contaminated sediment overflowing river banks and depositing sediment on the floodplain.

Few data are available regarding the concentrations of hazardous substances in floodplain soils within the Site, and no studies on floodplain soils are identified at this time. However, the Federal Trustees may decide to acquire or evaluate evidence of hazardous substances that may justify further investigation into the extent to which floodplains should be considered an exposure pathway within the damage assessment.

Damage Determination

Exhibit 4-15 illustrates the studies the Federal Trustees are considering within the damage determination and restoration phases of the assessment. The specific studies are described below. The studies will guide the Federal Trustees in development of the Restoration and Compensation Determination Plan. The results of studies undertaken by the Federal Trustees will be contained within the Report of Assessment.

Exhibit 4-15: Potential Damage Determination Investigations For The Site



Line Art by Paul Kerris (Courtesy USFWS)

Recreational Fishing Lost Use Study

The Federal Trustees intend to assess the value of lost use of the recreational fishery as part of the damage determination. Public use of the Site includes recreational angling, and the resource is in close proximity to a large number of people. The estuary's waters support a variety of freshwater, marine, and anadromous fish species that are popular with anglers. However, hazardous substances in the Site have likely changed the way that anglers view the river and its fishery. In particular, fishing bans and consumption restrictions issued by the State of New Jersey may affect anglers' choices about whether to fish in the affected waterbodies and may reduce the enjoyment of those who do. Common responses of anglers faced with resource contamination and associated fish consumption advisories include reducing their total number of fishing trips, taking fewer or no trips to the affected areas, and frequenting less desirable alternative sites. They may also travel further to reach uncontaminated sites, convert to catch-and-release angling, or pursue a different activity altogether. These behavioral impacts are associated with a loss in recreational value. The Federal Trustees are considering studies that will examine past, present, and future fishing restrictions within the Site, evaluate the effect of those restrictions on recreational activity, quantify the resulting lost value to the public, and identify appropriate restoration projects. Subsistence fishing may also occur at the Site. If warranted, lost use of subsistence angling may be evaluated in the future.

Based on the results of monitoring and research undertaken since the mid-1970s, the State of New Jersey has taken a number of steps, in the form of consumption advisories, closures, and sales bans, to limit the public's exposure to contaminated fish in this region. In 1982, an emergency order was introduced prohibiting the sale, and advising against the consumption, of several species of fish and eel. This initial measure was based on the presence of PCB contamination in fish. The discovery of widespread TCDD contamination within the Site led the State of New Jersey to issue a number of additional Administrative Orders in 1983 and 1984, which prohibited the sale or consumption of all fish, shellfish, and crustaceans from portions of the lower Passaic River. Additional advisories and restrictions were subsequently instituted throughout the Site, including advisories introduced by the State of New York in 1985 for the Arthur Kill and Kill Van Kull. New York and New Jersey advisories and restrictions currently in effect in the area are detailed in Exhibit 4-4.

Avian Lost Use Study

The Federal Trustees may assess the lost use of avian resources, specifically waterfowl, within the Site. The State of New York has issued waterfowl consumption advisories based on PCB levels in avian tissues. While the State of New Jersey does not have consumption advisories in effect for waterfowl, it may institute such an advisory in the future. The Federal Trustees are considering studies that would determine the degree to which hazardous substance releases have or are likely to impact hunting and consumption of waterfowl within the Site, quantify the resulting loss in recreational value to the public, and identify appropriate restoration projects.

Habitat Equivalency Analysis

As described in this report, the Federal Trustees are engaged in a process of assessing exposure of natural resources to various hazardous substances and determining whether the exposure resulted in injuries resources including surface water, sediment, and biota. In addition to restoring resource services to baseline levels, the Federal Trustees may determine the amount of restoration needed to compensate the public for losses occurring during the period between the onset of injury and the resource's return to baseline. One way to do this is to use a method called Habitat Equivalency Analysis (HEA). This method is based on the principle that the public can be compensated for past and future losses of natural resources by providing additional resources of the same type and quality (NOAA 2006; United States of America, Internal Improvement Trust Fund, *et al.*, v. Great Lakes Dredge and Dock Company 2001; Unsworth and Bishop 1994). HEA determines compensation by establishing the equivalence between the quantity of injured resources or services and the quantity of restoration. The Federal Trustees will evaluate the appropriateness of using this or other methods to derive compensation following completion of the injury determination.

Assessment of Lost Navigational Services

The Site is a vital economic resource both regionally and nationally. It is a major part of the largest port on the East Coast, which incorporates a system of waterways that directly and indirectly supports more than 230,000 jobs, generates over $15 billion in gross domestic product, and serves 18 million consumers in the region (New York City Council 2006; Port Authority of New York and New Jersey 2003). In 2005, the Port generated 58.4% of the total North Atlantic market share, handling more than 85 million metric tons of cargo and thousands of ships annually (Port Authority of New York and New Jersey 2005; 2006). Current expansion of the port's container facilities will lead to further demands on Newark Bay commercial shipping channels.

Periodic dredging is required to maintain channel depth in the Site. In many locations, Newark Bay and surrounding ocean channels are naturally shallower than the currently maintained channel depth of 40 feet. Safe navigation channels for many modern oil tankers, bulk vessels, and container ships require depths exceeding 45 feet. Economic analyses performed by the USACE demonstrated a need for dredging not only to maintain existing channel depths but also to deepen certain channels to better accommodate present and projected future shipping needs (USACE 1999).

Some environmental benefits may also result from dredging. Removal of contaminated sediments can prevent uptake of hazardous substances by aquatic organisms and their subsequent incorporation into the ecological food web. If dredge material can be suitably cleaned, it may be used to remediate and restore degraded upland areas, potentially providing substantial environmental benefits.

Historically, depositing of dredge spoils took place at specific sites in the New York Harbor area or further out to sea off the New York and New Jersey coasts. Regulation of contaminated spoil dumping in the ocean began in 1972 with the implementation of the

Marine Protection, Research, and Sanctuaries Act (MPRSA) (EPA 1977). Beginning in 1977, spoils were classified into three categories based upon their degree of contamination, with material suitable for unrestricted ocean disposal classified Category I, material suitable for ocean disposal if capped with Category I material classified Category II, and material unsuitable for ocean disposal classified Category III (McLaughlin *et al.* 1999). Under 1984 criteria, 95% of the dredged material the Port of New York and New Jersey was classified Category I and about 5% was classified Category II. However, criteria were made increasingly more stringent over the years; a 1992 revision resulted in approximately 66% of the dredge spoils in the Port of New York and New Jersey being classified as Category III and 9% being classified Category II. This change greatly increased dredging and disposal costs. Further, ocean disposal of Category II material was halted by executive order in 1996, and in 2000, the criteria were yet again revised, becoming even more stringent (Litten 2003).

Certain losses that result from reduced ability to maintain authorized federal shipping channels and an increase in dredging costs resulting from contamination due to problems with disposal of contaminated dredge material are compensable damages under NRDA laws and regulations. As part of this assessment, the Federal Trustees will determine whether injuries to surface water resources led to a loss or impairment of navigational services provided by the Site. The Federal Trustees will also evaluate whether proposed remedial actions by the EPA will adequately restore potential navigational use of this waterway to its baseline condition. Based on these evaluations, the Federal Trustees may institute additional studies of the potential loss of navigational services within the Site and investigate potential restoration options.

Restoration

The Federal Trustees will consider the issue of restoration throughout damage assessment. Restoration is designed to return injured resources to their baseline condition and to compensate for the resources that were lost during the period of injury. To accomplish this objective, the Federal Trustees may use one or both of the following approaches depending on the circumstances of the case: (1) Calculate the cost of restoring, replacing, or acquiring the equivalent of the injured resources and the services they provide; or (2) Determine the value of the losses due to the resource injuries and apply that amount to resource restoration. The Federal Trustees will develop a Restoration and Compensation Determination Plan that establishes the procedures for determining the appropriate restoration.

Restoration is the goal of a NRDA. It is an active component of damage assessment that can be seen and enjoyed for generations. For example, restoration projects may improve or create aquatic habitats, thereby providing fish with clean spawning habitat and anglers with opportunities to catch fish with reduced levels of hazardous substances. Similarly, restoration may involve creating conservation areas and nesting locations that are attractive to waterfowl or other birds. Restoration also may include increasing the viability and abundance of threatened or rare species.

The restoration planning process is initiated and managed by the Trustees. The Trustees identify (1) Restoration goals; (2) Restoration projects; and (3) The type and amount of restoration that is necessary to effectively compensate the public for the injured natural resources and the loss of the services those resources provide. The Federal Trustees will consider a number of restoration alternatives, including taking no action and estimating the time required for natural recovery. The Federal Trustees will then select the most appropriate alternative. Ultimately, the Federal Trustees will develop and issue a Restoration and Compensation Determination Plan that documents the restoration process. This plan will be distributed to the public and potentially responsible party or parties for review and comment.

Throughout the restoration planning process, the Federal Trustees will seek assistance and input from individuals who are interested in the future of the Site. The Federal Trustees may periodically advertise opportunities for public involvement, develop fact sheets or information packets that explain the restoration process and avenues for public participation, hold public meetings, and seek comments on potential restoration goals and projects. Ideas for restoration projects may be solicited through internet sites maintained by the Federal Trustee agencies and through public contacts at the agencies. Through these avenues, the Federal Trustees intend to keep the public apprised of the ongoing restoration program and facilitate the exchange of information among interested parties. By actively involving people with different perspectives, it is hoped the Site will be restored with a rich range of projects that will fulfill the needs of the surrounding communities.

Literature Cited

Adams, D.A., J.S. O'Connor, and S.B. Weisberg. 1998. Sediment Quality of the NY/NJ Harbor System. Final Report. An Investigation under the Regional Environmental Monitoring and Assessment Program (REMAP). Environmental Protection Agency. EPA/902/R-98/001. Edison, NJ. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

American Rivers. 1998. America's Most Endangered Rivers of 1998. Washington, D.C. April.

Ashley, J.R. and J. Horowitz. 2002. A Supplemental Study to Assessment of PCBs, Selected Organic Pesticides and Mercury in Fishes from New Jersey: 1998-1999 Monitoring Program. Academy of Natural Sciences Report No. 00-20F. 112 pp. Data Accessed through Query Manager V. 2.61 Database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Bailey, C.F. 1973. Lipids of the fertilized egg and adult brain of *Funduls heterclitus*. Journal of Experimental Zoology 185:265-276.

Barron, M.G., M.G. Carls, R. Heintz, and S.D. Rice. 2004. Evaluation of fish early life-stage toxicity modes of chronic embryonic exposures to complex polycyclic aromatic hydrocarbon mixtures. Toxicological Sciences 78:60-67.

Battelle. 2005. Pathways Analysis Report: Lower Passaic River Restoration Project. Duxberry, MA. July.

Beckvar, N., T.M. Dillon, and L.B. Read. 2005. Approaches for linking whole-body fish tissue residues of mercury or DDT to biological effects thresholds. Environmental Toxicology and Chemistry 24(8):2094-2105.

Belton, T.J., R. Hazen, B.E. Rupel, K. Lockwood, R. Mueller, E. Stevenson, and J.J. Post. 1985. A Study of Dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin) Contamination in Select Finfish, Crustaceans, and Sediments of New Jersey Waterways. New Jersey Department of Environmental Protection, Office of Science and Research, Trenton, New Jersey. Data accessed through Query Manager V. 2.61 Database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Bernick, A.J. 2006. New York City Audubon's Harbor Herons Project: 2006 Interim Nesting Survey. New York City Audubon. New York, NY. September 28.

Bernick, A.J. 2005. New York City Audubon's Harbor Herons Project: 2005 Interim Nesting Survey. New York City Audubon. New York, NY. August 27.

Boening, D.W. 1998. Toxicity of 2,3,7,8-tetrachlordibenzo-*p*-dioxin to several ecological receptor groups: A short review. Ecotoxicology and Environmental Safety 39:155-163.

Bowerman, W.W. IV., D.A. Best, J.P.J. Giesy, T.J. Kubiak, and J.G. Sikarskie. 1994. The influence of environmental contaminants on bald eagle *Haliaeetus leucocephalus* populations in the Laurentian Great Lakes, North America. Pp. 703-707 in Meyburg B.J.andR.D. Chancellor, eds. Raptor Conservation Today. World Working Group on Birds of Prey and Pica Press, East Sussex, Great Britain.

Brown, R.P., K.R. Cooper, A. Cristini, C. Rappe, and P.A. Bergqvist. 1994. Polychlorinated dibenzo-*p*-dioxins and dibenzofurans in *Mya arenaria* in the Newark/Raritan Bay estuary. Environmental Toxicology and Chemistry 13(3):523-528.

Brydon, N.F. 1974. The Passaic River: Past, Present, Future. Rutgers University Press, New Brunswick, New Jersey.

Carvalho, P.S.M., Noltie, D.B., and Tillitt, D.E. 2004. Intra-strain dioxin sensitivity and morphometric effects in swim-up rainbow trout (Oncorhynchus mykiss). Comparative Biochemistry and Physiology Part C 137:133-142.

Carvalho, P.S.M. and Tillitt, D.E. 2004. 2,3,7,8-TCDD effects on visual structure and function in swim-up rainbow trout. Environmental Science and Technology 38:6300-6306.

Chang, M., J.G. Kennan, and E.D. Corso. 2000. Evaluating temporal changes in stream condition in three New Jersey river basins by using an index of biotic integrity. NJAS. March 22. Available at: http://www.accessmylibrary.com/coms2/summary_0286-28751522_ITM.

City of Clifton and Passaic River Coalition. 2003. Natural Resources Inventory: City of Clifton, Passaic County, New Jersey.

City of Newark, New Jersey. 2006. A Brief History of Newark. Available at: http://www.ci.newark.nj.us/About_Newark/About_Newark.htm.

Cook, P., J.A. Robbins, D.D. Endicott, K.B. Lodge, P.D. Guiney, M.K. Walker, E.W. Zael, and R.E. Peterson. 2003. Effects of aryl hydrocarbon receptor-mediated early life stage toxicity on lake trout populations in Lake Ontario during the 20th century. Environmental Science and Technology 37:3864-3877.

Cook, P.M., M.W. Hornung, W. Fredenberg, M.J. Lawonn, I.K. Loeffler, R.E. Peterson. 2000. Vulnerability of bull trout to early life stage toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and other AhR agonists. 21st Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville TN, November 12 - 16, 2000.

Cook, P., D, Kuehl, M. Walker, and R. Peterson. 1991. Bioaccumulation and toxicity of TCDD and related compounds in aquatic ecosystems. Pp. 143-165 in: Biological Basis for Risk Assessment of Dioxins and Related Compounds (Gallo, M.A., R.J. Scheuplein, and K.A. van der Heijden, eds). Banbury Report 35. Cold Spring Harbor Press, Cold Spring Harbor, NY.

Diamond Shamrock Chemicals Company v. Aetna Casualty and Surety Company *et al.* 1989. Superior Court of New Jersey Chancery Division, Morris County. Docket No. C-3939-84. Corrected 4-12-89. April 12.

Diskin, C. 2006. NJ Tightens Warnings on Fish, Shellfish. The Record. Hackensack, NJ, March 31. Available at: http://www.redorbit.com/news/science/452806/nj_tightens_warnings_on_tidal_fish_shellfish/index.html. Accessed January 31, 2007.

Eckenfelder, I. 1993. An Evaluation of Tissue and Sediment Concentrations of Selected Compounds in the Hackensack Meadowlands. Eckenfelder, Inc. Nashville, TN. Data accessed through Query Manager V. 2.61 Database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Efroymson, R.A., G.W. Suter, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints. Prepared for the U.S. Department of Energy. ES/ER/TM-162/R2. Oak Ridge, TN. August. Available at: http://www.esd.ornl.gov/programs/ecorisk/documents/tm162r2.pdf.

Eisler, R. 1987a. Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review. Contaminant Hazard Review Report 11, USFWS. Laurel, MD. May.

Eisler, R. 1987b. Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Review Report No. 10, USFWS. Laurel, MD. April.

Elonen, G.E., R.L. Spehar, G.W. Holcombe, R.D. Johnson, J.D. Fernandez, R.J. Erickson, J.E. Tietge, and P.M. Cook. 1998. Comparative toxicity of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin to seven freshwater fish species during early life-stage development. Environmental Toxicology and Chemistry 17(3):472-483.

EPA. 2006a. NPL Fact Sheet for Diamond Alkali Co. Available at: http://www.epa.gov/Region2/superfund/npl/0200613c.pdf. Accessed January 17, 2007.

EPA. 2006b. Five Year Review Report: Second Five Year Review Report for Diamond Alkali Superfund Site, City of Newark, Essex County, New Jersey. Available at: http://www.epa.gov/superfund/sites/fiveyear/f0602022.pdf. Accessed August 1, 2007.

EPA. 2006c. National Recommended Water Quality Criteria. Office of Water, Office of Science and Technology. Washington, D.C. Available at: http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf.

EPA. 2004. Administrative Order on Consent for Remedial Investigation and Feasibility Study in the Matter of the Diamond Alkali Superfund Site (Newark Bay Study Area). Index No. CERCLA-02-2004-2010. February.

EPA. 2003. Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans and Biphenyls in Ecological Risk Assessment. External Review Draft. Risk Assessment Forum. 630/P-03/002A. Washington, D.C. June.

EPA. 2002a. Guidance for Quality Assurance Project Plans, EPA QA/G-5. Office of Environmental Information. EPA/240/R-02/009. Washington, DC. December. Available at: http://www.epa.gov/quality/qs-docs/g5-final.pdf.

EPA. 2002b. Guidance on Environmental Data Verification and Data Validation, EPA QA/G-8. Office of Environmental Information. EPA/240/R-02/004. Washington, DC. November. Available at: http://www.epa.gov/quality/qs-docs/g8-final.pdf.

EPA. 2001. EPA Requirements for Quality Assurance Project Plans (QA/R-5). Office of Environmental Information. EPA/240/B-01/003. Washington, DC. March. Available at: http://www.epa.gov/quality/qs-docs/r5-final.pdf.

EPA. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2. Risk Assessment and Fish Consumption Limits, Third Edition. Office of Science and Technology, Office of Water. U.S. Environmental Protection Agency. 823-B-00-008. Washington, DC.

EPA. 1995. Remedial Investigation Sampling Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

EPA. 1993. Surficial Sediment Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

EPA. 1987. Record of Decision for Diamond Shamrock Superfund Site, Essex County, New Jersey.

EPA. 1977. Ocean Dumping in the United States. Sixth Annual Report of the Environmental Protection Agency on Administration of Title 1, Marine Protection and Sanctuaries Act of 1972, As Ammended. Washington, D.C. January - December. Available at: http://www.epa.gov/history/topics/mprsa/Fifth%20Annual%20Report%20on%20Ocean%20Dumping%20Permit%20Program%201977.pdf.

EPA Region 5. 2003. Ecological Screening Levels. August 22. Available at: http://www.epa.gov/RCRIS-Region-5/ca/ESL.pdf.

Esser, S.C. 1982. Long-term changes in some finfishes of the Hudson-Raritan estuary. Pp. 299-314 in Mayer G.F., ed. Ecological Stress and the New York Bight: Science and Management. Estuarine Research Federation, Columbia, SC.

FSIS. 1997. News and Information: Advisory to Owners and Custodians of Poultry, Livestock, and Eggs. Available at: http://www.fsis.usda.gov/OA/topics/dioxinlt.htm. Accessed March 13, 2007.

Fox, G.A., K.A. Grassman, K.A. Hobson, K. Williams, D. Jeffry, and B. Hanbridge. 2002. Contaminant residues in tissues of adult and prefledged herring gulls from the Great Lakes in relation to diet in the early 1990s. Journal of Great Lakes Research 28(4):643-663.

Fox, G.A., S.W. Kennedy, R.J. Norstrom, and D.C. Wigfield. 1988. Porphyria in herring gulls: A biochemical response to chemical contamination of Great Lakes food chains. Environmental Toxicology and Chemistry 7:831-839.

General Accounting Office. 1998. Food Safety: Agencies Handling of a Dioxin Incident Caused Hardships for Some Producers and Processors. United States General Accounting Office. GAO/RCED-98-104. Washington, D.C. April. Available at: http://www.gao.gov/archive/1998/rc98104.pdf.

Gross, M.L. and Z. Cai. 1992. Dioxins in tissues from crabs and lobsters from the Raritan/Newark Bay system. Data accessed through Query Manager V. 2.61 database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Guiney, P.D., P.M. Cook, J.M. Casselman, J.D. Fitzsimmons, H.A. Simonin, E.W. Zabel, and R.E. Peterson. 1996. Assessment of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin induced sac fry mortality in lake trout (*Salvelinus namaycush*) from different regions of the Great Lakes. Canadian Journal of Fisheries and Aquatic Science 53:2080-2092.

Hahn, M. 2001. Dioxin toxicology and the aryl hydrocarbon receptor: Insights from fish and other non-traditional models. Marine Biotechnology 3:S224-S238.

Hauge, P., A. Baldwin-Brown, and B. Ruppel. 1993. PCB, Chlordane, and DDT in Selected Fish and Shellfish from New Jersey Waters 1988-91. New Jersey Department of Environmental Protection and Energy, Division of Science and Research. Trenton, NJ. July.

Hauge, P.M., T.J. Belton, B.E. Ruppel, K. Lockwood, and R.T. Mueller. 1994. 2,3,7,8-TCDD and 2,3,7,8-TCDF in blue crabs and American lobsters from the Hudson-Raritan Estuary and the New York Bight. Bulletin of Environmental Contamination and Toxicology 52:734-741.

Hauge, P., J. Bukowski, P. Morton, M. Boriek, J. McClain, and G. Casey. 1990. Polychlorinated Biphenyls (PCBs), Chlordane, and DDTs in Selected Fish and Shellfish from New Jersey Waters, 1986-1987: Results from New Jersey's Toxics in Biota Monitoring Program. NJDEP, Trenton, NJ.

Health Council of the Netherlands. 1996. Polychlorinated dibenzo-*p*-dioxins, dibenzofurans and dioxin-like polychlorinated biphenyls. Prepared by the Committee on Risk Evaluation of Substances/Dioxins. 1996/10E.

Henry, T.R., J.M. Spitsbergen, M.W. Hornung, C.C. Abnet, and R.E. Peterson. 1997. Early life stage toxicity of 2,3,7,8,-tetrachlorodibenzo-*p*-dioxin in zebrafish (*Danio rerio*). Toxicology and Applied Pharmacology 142:56-68.

Henshel, D.S. 1998. Developmental neurotoxic effects of dioxin and dioxin-like compounds on domestic and wild avian species. Environmental Toxicology and Chemistry 17(1):88-98.

Herbert, C.E., R.J. Nortstrom, and D.V.C. Weselow. 1999. A quarter century of environmental surveillance: The Canadian Wildlife Service's Great Lakes Herring Gull Monitoring Program. Environmental Reviews 7:147-166.

Hoffman, D.J., B.A. Rattner, C.M. Bunck, and A. Krynitsky. 1986. Association between PCBs and lower embryonic weight in black-crowned night herons in San Francisco Bay. Journal of Toxicology and Environmental Health 19:383-391.

Hoffman, D.J., B.A. Rattner, L. Sileo, D. Docherty, and T.J. Kubiak. 1987. Embryotoxicity, teratogenicity, and aryl hydrocarbon hydroxylase activity in Forster's terns on Green Bay, Lake Michigan. Environmental Research 42:176-184.

Hoffman, D.J., C.P. Rice, and T.J. Kubiak. 1996. PCBs and dioxins in birds. Pp. 165-207 in Beyer, W.N., G.H. Heinz, and A.W. Redmon-Norwood, eds. Environmental Contaminants in Wildlife - Interpreting Tissue Concentrations. SETAC Special Publication Series, CRC Press, Boca Raton, FL.

Hoffman, D.J., G.J. Smith, and B.A. Rattner. 1993. Biomarkers of contaminant exposure in common terns and black-crowned night herons in the Great Lakes. Environmental Toxicology and Chemistry 12:1095-1103.

Holmes, H. ca. 1895. Brief History of Belleville: Reminiscences of 75 Years of Belleville, Franklin and Newark. 2nd Edition. Publisher not known.

Horowitz, R.J., P.F. Overbeck, J. Ashley, D. Velinsky, and L. Zadoudeh. 2006. 2004 Monitoring Program for Chemical Contaminants in Fish from the State of New Jersey: Second Year of Routine Monitoring Program. Final Report. Patrick Center for Environmental Research, Academy of Natural Sciences. Report No. 06-04F. December 14.

Johnson, R.D., J.E. Tietge, K.M. Jensen, J.D. Fernandez, A.L. Linnum, D.B. Lothenbach, G.W. Holcombe, P.M. Cook, S.A. Christ, D.L. Lattier, and D.A. Gordon. 1998. Toxicity of 2,3,7,8,-tetrachlorodibenzo-*p*-dioxin to early life stage brook trout (*Salvelinus fontinalis*) following parental dietary exposure. Environmental Toxicology and Chemistry 17(12):2408-2421.

Kerlinger, P. 2004. Harbor Herons Project: 2004 Nesting Survey. New York City Audubon. New York, NY. August 25.

Kubiak, T.J. and D.A. Best. 1991. Wildlife risks associated with passage of contaminated anadromous fish at federal energy regulatory commission licensed dams in Michigan. Contaminants Program, Ecological Services, East Lansing Field Office, U.S. Fish and Wildlife Service. East Lansing, Michigan.

Kubiak, T.J., H.J. Harris, L.M. Smith, T.R. Schwartz, D.I. Stalling, J.A. Trick, L. Sileo, D.E. Docherty, and T.C. Erdman. 1989. Microcontaminants and reproductive impairment of the Forster's tern on Green Bay, Lake Michigan - 1983. Archives of Environmental Contamination and Toxicology 18:706-727.

Litten, S. 2003. Contaminant Assessment and Reduction Project Final Report. Bureau of Water Assessment and Management, Division of Water, New York State Department of Environmental Conservation. August 14.

Logan, D.T. 2007. Perspective on ecotoxicology of PAHs to fish. Human and Ecological Risk Assessment 13:302-316.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Long, E.R., K.J. Scott, G.B. Tursby, E. Stern, C. Peven, and T. Schwartz. 1993. Magnitude and Extent of Sediment Toxicity in the Hudson-Raritan Estuary. NOAA Technical Memorandum. Data accessed through Query Manager V. 2.61 database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Maxus Energy Corporation. 1995. Analytical Data Summary Tables Related to Passaic River Study. Environmental Protection Agency and New Jersey Department of Environmental Protection. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Maxus Energy Corporation. 1994. Maxus Passaic River Combined Sewer Outfall Study. Analytical Data Summary Tables Related to Passaic River Study. Environmental Protection Agency and New Jersey Department of Environmental Protection. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Maxus Energy Corporation. 1993. Passaic River Sediment Study 1991-1993. Analytical Data Summary Tables Related to Passaic River Study. Environmental Protection Agency and New Jersey Department of Environmental Protection. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

McFadden, R.D. 1995. Ailing Porpoise Eludes Rescuers in Murky Canal. New York Times, March 18. Available at: http://select.nytimes.com/gst/abstract.html?res=F6061FF83A5D0C7B8DDDAA0894DD494D81. Accessed January 17, 2006.

McLaughlin, D.F., S.V. Dighe, D.L. Keairns, N.H. Ulerich. 1999. Decontamination and beneficial reuse of dredged estuarine sediment: The Westinghouse plasma vitrification process. 19th Western Dredging Association (WEDA XIX) Annual Meeting and Conference and 31st Texas A&M University Dredging Seminar (TAMU 31), May 15-20, Louisville, Kentucky. Available at:http://www.bnl.gov/wrdadcon/publications/articles/article.htm. Accessed December 21, 2006.

Merchants Association of Newark. 1922. Newark Industrial Exposition, First Regiment Armory, May 20-27.

Meyn, O., M. Zeeman, M. Wise, and S.E. Keane. 1997. Terrestrial wildlife risk assessment for TCDD in land-applied pulp and paper mill sludge. Environmental Toxicology and Chemistry 16(9):1789-1801.

National Museum of American History. 2007. America on the Move Exhibition: Port Newark/Port Elizabeth, New Jersey. Available at: http://americanhistory.si.edu/ONTHEMOVE/collection/object_465.html. Accessed June 19, 2007.

Newark Water and Sewer. Not Dated. History of the Newark Sewer System. Available at: http://www.ci.newark.nj.us/Water/sewerhistory.htm. Accessed January 17, 2007.

New York City Council. 2006. Oversight: Port Security in New York City. Briefing Paper of the Governmental Affairs and Infrastructure Divisions. March 30. Available at: http://webdocs.nyccouncil.info/attachments/71982.htm?CFID=1660761&CFTOKEN=68170831.

NJDEP. 2007. Online Field Guide for Reptiles and Amphibians. Available at: http://www.state.nj.us/dep/fgw/ensp/fieldguide_herps.htm#turtles. Accessed February 4, 2007.

NJDEP. 2006a. Fish Smart, Eat Smart. A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters. New Jersey Department of Environmental Protection and New Jersey Department of Health and Senior Services. Trenton, NJ. Available at: http://www.state.nj.us/dep/dsr/njmainfish.htm.

NJDEP. 2006b. New Jersey Updates Fish Consumption Advisories. Press Release, March 30. Available at: http://www.nj.gov/dep/newsrel/2006/06_0021.htm. Accessed January 31, 2007.

NJDEP. 2006c. New Jersey Issues Winter Flounder Consumption Advisories. Press Release, March 23. Available at: http://www.state.nj.us/dep/newsrel/2006/06_0018.htm. Accessed January 31, 2007.

NJDEP. 2006d. New Jersey Surface Water Quality Standards. NJAC 7:9B. Trenton, NJ. Available at: http://www.state.nj.us/dep/wms/bwqsa/swqshome.html.

NJDEP. 2005a. New Jersey Sues Three Companies for Discharging and Delaying Cleanup of Highly Toxic Dioxin in the Lower Passaic River. Press Release. Available at: http://www.state.nj.us/dep/newsrel/2005/05_0134.htm. Accessed December 14, 2006.

NJDEP. 2005b. Birds of New Jersey. Available at: http://www.state.nj.us/dep/fgw/chkbirds.htm. Accessed February 14, 2007.

NJDEP and the Administrator of the New Jersey Spill Compensation Fund vs. Occidental Chemical Corporation, Tierra Solutions, Inc., Maxus Energy Corporation, *et al.* 2005. Superior Court of New Jersey Law Division, Essex County.

NJDEP. 2004a. New Jersey's Endangered and Threatened Wildlife. Division of Fish and Wildlife. Trenton, NJ. Available at: http://www.state.nj.us/dep/fgw/tandespp.htm#pdf.

NJDEP. 2004b. A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters. New Jersey Department of Environmental Protection and New Jersey Department of Health and Senior Services. Trenton, NJ.

NJDEP. 2002a. DEP Commissioner Warns Urban Anglers About Health Risks of Eating Contaminated Crabs. Press Release, May 24. Available at: http://www.state.nj.us/dep/newsrel/releases/02_0038.htm. Accessed January 17, 2007.

NJDEP. 2002b. Watershed Characterization and Assessment: A Technical report for the Passaic River Basin Watershed Management Project, Watershed Management Area 4, Lower Passaic River & Saddle River Watersheds. Division of Watershed Management. Available at: http://www.state.nj.us/dep/watershedmgt/publications.htm. Accessed January 17, 2007.

NJDEP, NOAA, and USFWS. 2004. Preassessment Screen and Determination for the Diamond Alkali Superfund Site, Newark, Essex County, New Jersey. Available at: http://www.darrp.noaa.gov/northeast/passaic/injury.html.

NJDEP, USFWS, and EPA. 2001. Derivation of New Jersey-specific Wildlife Values as Surface-Water Quality Criteria for: PCBs, DDT, Mercury. New Jersey Department of Environmental Protection. Trenton, New Jersey.

NYDEC. 1998. Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. Division of Water. June. Available at: http://www.dec.ny.gov/docs/water_pdf/togs111.pdf.

NMFS. 2006a. Guide to Essential Fish Habitat Descriptions. Available at: http://www.nero.noaa.gov/hcd/list.htm. Accessed January 17, 2007.

NMFS. 2006b. Proactive Conservation Program: Species of Concern & Candidate Species. Available at: http://www.nmfs.noaa.gov/pr/species/concern/. Accessed January 17, 2007.

NOAA. 2006. Habitat Equivalency Analysis: An Overview. NOAA Technical Papers, Damage Assessment and Restoration Program.

NOAA. 2005. Query Manager V. 2.61 database for Newark Bay. Available at: http://response.restoration.noaa.gov/resource_catalog.php.

NOAA. 1995. Results of a Biological and Hydrographical Characterization of Newark Bay, New Jersey: May 1993-April 1994. National Marine Fisheries Service, Northeast Fisheries Science Center. Highlands, NJ.

NOAA. 1993. Implementation Plan for the Toxic Chemical Contaminants Theme Area, FY93. Coastal Monitoring and Bioeffects Division. Data accessed through Query Manager V. 2.61 database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Nriagu, J.O. 1996. A history of global metal pollution. Science 272(5259):223-224.

Nussbaum, A. 2004. Passaic Full of Hazards to Health, Study Finds. The Record, August 25. Available at: http://northjersey.com/page.php?qstr=eXJpcnk3ZjcxN2Y3dnFlZUVFeXkyJmZnYmVsN2Y3dnFlZUVFeXk2NTc0MjE5. Accessed January 26, 2007.

NYSDOH. 2006. Chemicals in Sportfish and Game 2006-2007 Health Advisories. New York State Department of Health. Albany, NY. Available at: http://www.health.state.ny.us/nysdoh/fish/fish.htm.

Papson, R.G., W.S. Murawski, A.B. Pyle, and P.A. Cookingham. 1981. Anadromous Fish Study of the Passaic River Basin, New Jersey. Prepared for U.S. Fish and Wildlife Service. Washington, D.C.

Parsons, K.C. 2003. Chemical Residues in Cormorants from New York Harbor and Control Location. Manomet Center for Conservation Sciences, Manomet, MA. Final report under contract C003858. New York State Department of Environmental Conservation, Division of Fish, Wildlife and Marine Resources, Albany, NY.

Parsons, K. 1994. Wildlife Habitats on Shooters Island, New York Harbor: Characterization Study and Management Recommendations. Draft. U.S. Army Corps of Engineers, New York District.

PVSC. 2007. Overview Tour of the Passaic Valley Sewerage Commissioners. Available at: http://www.pvsc.com/about/about.htm. Accessed August 2, 2007.

Passaic Valley Water Commission. 2005. History. Available at: http://www.pvwc.com/about/history.html. Accessed January 17, 2007.

Pinkney, A.E., J.C Harshbarger, E.B. May, and M.J. Melancon. 2004. Tumor prevalence and biomarkers of exposure in brown bullhead (*Ameiurus nebulosus*) from Back River, Furnace Creek, and Tuckahoe River, Maryland. Archives of Environmental Contamination and Toxicology 46:492-501.

Port Authority of New York and New Jersey. 2007. Port of New York and New Jersey Sets Cargo Record in 2006. Press Release. Available at: http://www.panynj.gov/AboutthePortAuthority/PressCenter/PressReleases/PressRelease/index.php?id=924. Accessed June 19, 2007.

Port Authority of New York and New Jersey. 2006. Port Authority Police. Available at: http://www.panynj.gov/AboutthePortAuthority/PortAuthorityPolice. Accessed January 17, 2007.

Port Authority of New York and New Jersey. 2005. 2005 Year-End Statistics. Available at: http://www.panynj.gov/2005tradestats/YearendStats05.pdf. Accessed January 17, 2007.

Port Authority of New York and New Jersey. 2003. Port Authority and Panama Canal Authority Sign Historic Agreement to Boost NY-NJ Port Business with Asia. Press Release. Available at: http://www.panynj.gov/AboutthePortAuthority/PressCenter/PressReleases/PressRelease/index.php?id=366. Accessed January 17, 2007.

PSEG. 2007. The Urban Environment: Remediation, Then Redevelopment. Available at: http://www.pseg.com/environment/urban/remedia.jsp. Accessed August 2, 2007.

PSEG. 1998. Hudson Generating Station Supplemental 316(b) Report. Prepared for Public Service Electric and Gas Company. Newark, NJ.

Rappe, C., P.A. Bergqvist, L.O. Kjeller, S. Swanson, T. Belton, B. Ruppel, K. Lockwood, and P.C. Kahn. 1991. Levels and patterns of PCDD and PCDF contamination in fish, crabs, and lobsters from Newark Bay and the New York Bight. Chemosphere 22(3-4):239-266.

Rothman, S., Congressman. 2003. Rothman Helps Announce Plan To Clean & Restore Passaic River. Press Release, October 20. Available at: http://www.house.gov/rothman/news_releases/rel_102003.htm. Accessed January 17, 2007.

Santoro, E.D., N.A. Funicelli, and S.J. Koepp. 1980. Fishes of Newark Bay, N.J. Bulletin of the American Littoral Society 12(2):22.

Santoro, E.D. and S.J. Koepp. 1986. Mercury levels in organisms in proximity to an old chemical site (Berry's Creek, Hackensack Meadowlands, New Jersey, USA). Marine Pollution Bulletin 17(5):219-224. Data accessed through Query Manager V. 2.61 database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Spear, P.A., D.H. Bourbonnais, R.J. Norstrom, and T.W. Moon. 1990. Yolk retinoids (vitamin A) in eggs of the herring gull and correlations with polychlorinated dibenzo-*p*-dioxins and dibenzofurans. Environmental Toxicology and Chemistry 9:1053-1061.

Spitsbergen, J.M., K.A. Schat, J.M. Kleeman, and R.E. Peterson. 1988. Effects of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) or Aroclor 1254 on the resistance of rainbow trout, *Salmo gairdneri* Richardson, to infectious haematopoietic necrosis virus. Journal of Fish Diseases 11:73-83.

Spitsbergen, J.M., M.K. Walker, J.R. Olson, and R.E. Peterson. 1991. Pathologic Alterations in Early Life Stages of Lake Trout, *Salvelinus namaycush*, Exposed to 2,3,7 ,8-Tetrachlorodibenzo-*p*-dioxin as Fertilized Eggs. Aquatic Toxicology 19:41-72.

Squires, D.F. 1981. The Bight of the Big Apple. The New York Sea Grant Institute of the State University of New York and Cornell University. NYSG-RS-81-00. Albany, NY.

Strobel, C.J., H.W. Buffum, S.J. Benyi, E.A. Petrocelli, D.R. Reifsteck, and D.J. Keith. 1995. Statistical Summary. EMAP-Estuaries. Virginian Province 1990 to 1993. Environmental Protection Agency. EPA/620-R-026. Narragansett, R.I. Data accessed through Query Manager V. 2.61 database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Thiel, D.A., S.G. Martin, B.B. Goodman, and J.R. Sullivan. 1995. Use of loading rates to establish dioxin criteria for land application of sludge. Environmental Toxicology and Chemistry 14(8):1443-1450.

Tierra Solutions Inc. 2004. Passaic River Study Area Database, Version 4. Tierra Solutions Inc., East Brunswick, NJ. Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 2001. 2001 Supplemental ESP Sampling Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc. East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 2000a. 1999/2000 Minish Park Monitoring Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 2000b. 2000 Spring ESP Sampling Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc. East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 1999a. 1999 Late Summer/Early Fall ESP Sampling Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 1999b. 1999 Sediment Sampling Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 1998. 1998 Newark Bay Elizabeth Channel Sampling Program. Tierra Solutions, Inc. East Brunswick, NJ. Data accessed through Query Manager V. 2.61 database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Tierra Solutions Inc. 1997a. 1997 Outfall Sampling Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 1997b. 1997 Newark Bay Reach B, C, and D Sediment Sampling Program. Tierra Solutions, Inc. East Brunswick, NJ. Data accessed through Query Manager V. 2.61 database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Tierra Solutions Inc. 1996. 1996 Newark Bay Reach A Sediment Sampling Program. Tierra Solutions, Inc. East Brunswick, NJ. Data accessed through Query Manager V. 2.61 database for Newark Bay (NOAA 2005). Available at: http://response.restoration.noaa.gov/resource_catalog.php.

Tierra Solutions Inc. 1995. 1995 Sediment Grab Sampling Program. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 1993. 1991, 1992, and March and July 1993 Core Sediment Investigations. Data accessed through Passaic River Study Area Database, Version 4. (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tierra Solutions Inc. 1990. Surficial Sediment Investigation. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

Tietge, J.E., R.D. Johnson, K.M. Jensen, P.M. Cook, G.E. Elonen, J.D. Fernandez, G.W. Holcombe, D.B. Lothenbach, and J.W. Nichols. 1998. Reproductive toxicity and disposition of 2,3,7,8-tetrachlordibenzo-*p*-dioxin in adult brook trout (*Salvelinus fontinalis*) following a dietary exposure. 1998. Environmental Toxicology and Chemistry 17(12):2395-2407.

Tillitt, D.E., R.W. Gale, J.C. Meadow, J.L. Zajicek, P.H. Peterman, S.N. Heaton, P.D. Jones, S.J. Bursian, T.J. Kubiak, J.P. Giesy, and R.J. Aulerich. 1996. Dietary exposure of mink to carp from Saginaw Bay. 3. Characterization of dietary exposure to planar halogenated hydrocarbons, dioxin equivalents, and biomagnification. Environmental Science and Technology 30:283-291.

Toomey, B.H., S. Bello, M.E. Hahn, S. Cantrell, P. Wright, D.E. Tillett, and R.T. DiGiulio. 2001. 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin induces apoptotic cell death and cytochrome P4501A expression in developing *Fundulus heteroclitus* embryos. Aquatic Toxicology 53:127-138.

Traster, T. 1998. Passaic River Listed as 'Endangered'. The Bergen Record, April 7. Available at: http://wildnj.com/br5.htm. Accessed January 17, 2007.

United States of America, Internal Improvement Trust Fund, *et al.*, v. Great Lakes Dredge and Dock Company. 2001. United States Court of Appeals, Eleventh Circuit. Case No. 00-12002. July 30.

Unsworth, R.E. and R.C. Bishop. 1994. Assessing natural resource damages using environmental annuities. Ecological Economics 11:35-41.

USACE. 1999. Dredged Material Management Plan for the Port of New York and New Jersey. Implementation Report. Draft. New York District. New York, NY. September.

USACE. 1995. 1995 Minish Park Investigation. Data accessed through Passaic River Study Area Database, Version 4 (Tierra Solutions, Inc., East Brunswick, NJ). Available at: http://www.ourpassaic.org/.

USACE New York District, EPA Region II, and NJDOT Office of Maritime Resources. 2003. Draft Project Management Plan, Lower Passaic River, New Jersey. Investigation and Feasibility Study for Remediation and Ecosystem Restoration.

USFDA. 2001. Fish and Fisheries Products Hazards and Controls Guidance, Third Edition. Center for Food Safety & Applied Nutrition. June. Available at: http://www.cfsan.fda.gov/~comm/haccp4i.html.

USFDA. 1999. FDA Talk Paper: All Egg and Egg-containing Products from Belgium, France and the Netherlands and Animal Feed from European Countries to be Detained at Ports of Entry. U.S. Department of Health and Human Services. Rockville, MD. June 11.

USFDA. 1987. Sec. 565.200 Red Meat Adulterated with PCB's (CPG 7111.03). Available at: http://www.fda.gov/ora/compliance_ref/cpg/cpgfod/cpg565-200.html. Accessed January 17, 2007.

USFWS. 2007. USFWS Threatened and Endangered Species System (TESS). Available at: http://ecos.fws.gov/tess_public/SpeciesReport.do?kingdom=V&listingType=L&mapstatus=1. Accessed January 23, 2007.

USFWS. 2000a. Assessing Dietary Transfer of Dioxins, Furans, and Dioxin-like Toxicants from Sediments in the Passaic River-Newark Bay-Arthur Kill Ecosystem: Preassessment Study for the Diamond Alkali Superfund Site, Newark, Essex County, New Jersey. Part Two Interim Report. Pleasantville, New Jersey.

USFWS. 2000b. Impacts of Dioxins, Furans, and Polychlorinated Biphenyls on Anadromous Fish and Piscivorous Birds in Newark Bay. Pleasantville, New Jersey.

USFWS. 1997a. Significant Habitats and Habitat Complexes of the New York Bight Watershed. Southern New England-New York Bight Coastal Ecosystems Program. Charlestown, RI. November. Available at: http://training.fws.gov/library/pubs5/web_link/text/ec_app1.htm.

USFWS. 1997b. 2,3,7,8-Tetrachlorodibenzo-p-dioxin Concentrations in Double-crested Cormorant and Black-Crowned Night Heron Eggs of Shooters Island and Isle of Meadows, New York. Cortland, NY.

van den Berg, M., L.S. Birnbaum, M. Denison, M. De Vito, W. Farland, M. Feeley, H. Fiedler, H. Hakansson, A. Hanberg, L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama, A. Tritscher, J. Tuomisto, M. Tysklind, N. Walker, and R.E. Peterson. 2006. The 2005 World Health Organization re-evaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Toxicological Sciences 93(2):223-241.

van den Berg, M., L. Birnbaum, A.T.C. Bosveld, B. Brunstrom, P. Cook, M. Feeley, J.P. Giesy, A. Hanberg, R. Hasegawa, S.W. Kennedy, T. Kubiak, J.C. Larsen, F.X.R. van Leeuwen, A.K.D. Liem, C. Nolt, R.E. Peterson, L. Poellinger, S. Safe, D. Schrenk, D. Tillitt, M. Tysklind, M. Younes, F. Waern, and T. Zacharewski. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environmental Health Perspectives 106(12):775-792.

Walker, M.K., P.M. Cook, A.R. Batterman, B.C. Butterworth, C. Berini, J.J. Libal, L.C. Hufnagle, and R.E. Peterson. 1994. Translocation of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin from adult female lake trout (*Salvelinus namaycush*) to oocytes: effects on early life stage development and sac fry survival. Canadian Journal of Fisheries and Aquatic Science 51:1410-1419.

Walker, M.K., P.M. Cook, B.C. Butterworth, E.W. Zabel, and R.E. Peterson. 1996. Potency of a complex mixture of polychlorinated dibenzo-*p*-dioxin, dibenzofuran, and biphenyl congeners compared to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin in causing fish early life stage mortality. Fundamental and Applied Toxicology 30:178-186.

Walker, M.K., L.C. Hufnagle, M.K. Clayton, and R.E. Peterson. 1992. An egg injection method for assessing early life stage mortality of polychlorinated dibenzo-*p*-dioxins, dibenzofurans, and biphenyls in rainbow trout, (*Oncorhynchus mykiss*). Aquatic Toxicology 22:15-38.

Walker, M.K. and R.E. Peterson. 1991. Potencies of polychlorinated dibenzo-*p*-dioxin, dibenzofuran, and biphenyl congeners, relative to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, for producing early life stage mortality in rainbow trout (*Oncorhynchus mykiss*). Aquatic Toxicology 21:219-238.

Walker, M.K. and R.E. Peterson. 1994. Toxicity of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin to brook trout (*Salvelinus fontinalis*) during early development. Environmental Toxicology and Chemistry 13(5):817-820.

Walker, M.K., J.M. Spitsbergen, J.R. Olson, and R.E. Peterson. 1991. 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) toxicity during early life stage development of lake trout (*Salvelinus namaycush*). Canadian Journal of Fisheries and Aquatic Science 48:875-883.

Walt, R. 2002. Patterson, New Jersey: A History. Available at: http://www.patersonhistory.com/. Accessed January 17, 2007.

Wiermeyer, S.N., T.G. Lamont, C.M. Bunck, C.R. Sindelar, F.J. Gramlich, J.D. Fraser, and M.A. Byrd. 1984. Organochlorine pesticide, polychlorobiphenyl, and mercury residues in bald eagle eggs - 1969-79 - and their relationships to shell thinning and reproduction. Archives of Environmental Contamination and Toxicology 13:529-549.

Wildlife Conservation Society. 2006. New York Aquarium News: A Seal in Your Backyard? Available at: New York Aquarium Website: http://nyaquarium.com/287230/10320211. Accessed January 17, 2007.

Wilk, S.J., D.G. McMillan, R.A. Pikanowski, E.M. MacHaffie, A.L. Pacheco, and L.L. Stehlik. 1997. Fish, Megainvertebrates, and Associated Hydrographic Observations Collected in Newark Bay, New Jersey, During May 1993-April 1994. Northeast Fisheries Science Center 97(10).

Wintermyer, M.L. and K.R. Cooper. 2003. Dioxin/furan and polychlorinated biphenyl concentrations in eastern oyster (*Crassostrea virginica*, Gmelin) tissues and the effects on egg fertilization and development. Journal of Shellfish Research 22(2):737-746.

Yamashita, N., S. Tanabe, J.P. Ludwig, H. Kurita, M.E. Ludwig, and R. Tatsukawa. 1993. Embryonic abnormalities and organochlorine contamination in double-crested cormorants (*Phalacrocorax auritus*) and Caspian terns (*Hydroprogne caspia*) from the Upper Great Lakes in 1988. Environmental Pollution 79:163-173.

Yamauchi, M., E.Y. Kim, H. Iwata, Y. Shima, and S. Tanabe. 2006. Toxic effects of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) in developing red seabream (*Pagrus major*) embryo: An association of morphological deformities with AHR1, AHR2, and CYP1A expressions. Aquatic Toxicology 80:166-179.

Zabel, E.W., P.M. Cook, and R.E. Peterson. 1995. Toxic equivalency factors of polychlorinated dibenzo-*p*-dioxin, dibenzofuran, and biphenyl congeners based on early life stage mortality in rainbow trout (*Oncorhynchus mykiss*). Aquatic Toxicology 31:315-328.

Glossary

Acute toxicity - immediate or short-term health effects occurring after exposure to a hazardous substance.

Advisory - state-generated health warning regarding the consumption of contaminated animals (e.g., fish and waterfowl). These advisories include advice on how to reduce exposures to hazardous substances in fish and game by avoiding or reducing consumption and by the use of filleting/trimming and cooking techniques to further reduce contaminant levels.

Air resources – naturally-occurring gas constituents of the atmosphere, including those essential for human, plant, and animal life

Anadromous - reproducing in freshwater and then living as adults in marine waters. Generally the term is used to describe fish species that ascend rivers and streams from saltwater habitat for the purpose of spawning.

Anthropogenic - caused by humans**;** relating to or resulting from the influence that humans have on the natural world.

Aroclor - commercially prepared PCB mixture, consisting of individual PCB compounds (congeners) differing in position and degrees of chlorination, that was manufactured by the Monsanto Chemical Company.

Authorized official - a federal, or state, or tribal official authorized to act on behalf of all affected federal or state agencies or Indian tribes acting as Trustees.

Baseline - the condition or conditions that would have existed at the assessment area had the discharge of oil or release of the hazardous substance under investigation not occurred.

Behavioral avoidance - avoidance of potentially harmful conditions, which reduces contact with or exposure to hazardous substances.

Benthic - relating to the ocean bottom.

Bioaccumulation - the accumulation of substances from the environment in the tissues of exposed organisms.

Bioavailability - a measure of the physicochemical access that a toxicant has to the biological processes of an organism. The less bioavailable a toxicant, the less its toxic effect on an organism.

Biological resources - plants and animals; those natural resources referred to in section 101(16) of CERCLA as fish and wildlife and other biota. Fish and wildlife include marine and freshwater aquatic and terrestrial species; game, non-game, and commercial species; and threatened, endangered, and state sensitive species. Other biota include shellfish, terrestrial and aquatic plants, and other living organisms not otherwise listed in this definition.

Biomagnification - the sequence of processes resulting in higher concentrations of hazardous substances in organisms at higher trophic levels in the food web.

Biomagnification factor - a number that relates the concentration of a hazardous substance in the lipids of animals at a certain level in the food web to the concentration in the lipids of its prey. The higher the number, the greater the degree of biomagnification.

Birds of prey - a bird that captures its food using its beak and talons.

Carcinogenic - capable of causing cancer.

Carcinogenesis - the process by which normal cells are transformed into cancer cells.

Catadromous - reproducing in marine waters and then migrating as adults to freshwater.

Chronic toxicity - effects of repeated or long-term exposure to a substance.

Clean Water Act - Public Law 95-217 as amended, 33 U.S.C. 1251 *et seq.*; designed to restore and maintain the chemical, physical, and biological integrity of the nation's waters by achieving a level of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and for recreation on the water, to eliminate the discharge of pollutants into surface waters, and to promote a policy that the discharge of toxic pollutants in toxic amounts be prohibited.

Code of Federal Regulations - the general and permanent rules published in the Federal Register by the Executive departments and agencies of the Federal Government.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) - Public Law 95- 510 as amended, 42 U.S.C. Sec. 9601 *et seq.*; designed to respond to situations involving the past disposal of hazardous substances; regulates the cleanup of sites where hazardous substances are located and the distribution of cleanup costs among the parties who generated and handled hazardous substances at these sites.

Committed use - either a current public use; or a planned public use of a natural resource for which there is a documented legal, administrative, budgetary, or financial commitment established before the discharge of oil or release of a hazardous substance is detected.

Congener - with respect to PCBs (polychlorinated biphenyls), a compound with a specific number and position of chlorine atoms attached to a biphenyl; a member of the group of compounds known as PCBs.

Criterion - the level of a compound or material set by a governmental agency to be protective of human health, wildlife health, and/or the environment.

Critical Body Residue - the concentration of a hazardous substance in tissue(s) of an organism at which harmful effects occur.

Damages - the amount of money sought by the natural resource Trustees as compensation for injury, destruction, or loss of natural resources as set forth in section 107(a) or 111(b) of CERCLA.

Damage determination - establishment of the amount of restoration or money to be sought in compensation for injuries to natural resources resulting from a discharge of oil or release of a hazardous substance.

Degradation - decomposition of a compound or material.

Deposition - setting down of particles on a surface.

Diadromous - organisms that migrate between fresh and salt water, including anadromous and catadromous species

Dredged material or dredge spoils - naturally accumulated sediment (or existing rock) that is excavated, or dredged, from the bottom of channels, berthing areas, and other navigation facilities to create or maintain sufficient depth for safe and efficient vessel operation.

Drinking water supply - any raw or unfinished water source that is or may be used by a public water system, as defined by the Safe Water Drinking Act, or as drinking water by one or more individuals.

Ecological succession - a gradual process of change in the number of individuals of each species of a community and through the establishment of new species that may gradually replace the original inhabitants.

Ecosystem - the complex of a community and its environment functioning as an ecological unit in nature.

Effects Dose$_{50}$ - the dose of a hazardous substance found to cause a measurable physiological or biological effect in 50% of the study population.

Endocrine - the secretion of substances, such as hormones, internally, most commonly into the systemic circulation.

Endangered species - any species that is in danger of extinction throughout all or a significant portion of its range.

Emergent vegetation - plants that are rooted underwater in sediment but that grow above the water's surface.

Essential Fish Habitat - those waters and substrate necessary for fish to spawn, breed, feed, and grow to maturity (NMFS 2006a).

Exposure pathway - the course a hazardous substance takes from its source to an exposed organism.

Floodplain - low-lying lands near a river that are submerged when the river overflows its banks.

Food web - complex of interacting organisms, accounting for feeding relations, production, consumption, decomposition, and energy flow.

Foraging - to search for or collect food.

Fungicide - a chemical substance that destroys or inhibits the growth of fungi**.**

Geologic resources - those elements of the earth's crust such as soils, sediments, rocks, and minerals, including petroleum and natural gas, that are not included in the definitions of ground and surface water resources.

Gleaning - gathering of food from widely scattered places; to collect food bit by bit.

Groundwater - the water beneath the Earth's surface.

Groundwater resources - water in a saturated zone or stratum beneath the surface of land or water and the rocks or sediments through which groundwater moves.

Guidance value - ambient water quality value set to protect water quality. A guidance value may be used where a standard does not exist for a particular water class and type of value.

Habitat - place where a plant or animal species naturally exists.

Habitat Equivalency Analysis - a method for determining compensation by establishing the equivalence between the quantity of injured resources or services and the quantity of restoration to be undertaken. This method is founded on the principle that the public can be compensated for past and future losses of natural resources by providing additional resources of the same type and quality.

Hazardous substance - substances designated in sections 311(b)(2)(A) or 307 (a) of the Federal Water Pollution Control Act; any element, compound, mixture, solution, or substance as defined in section 102 of CERCLA; any hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act; any hazardous air pollutant listed under section 112 of the Clean Air Act; and any imminently hazardous chemical substance or mixture with respect to which the Administrator has taken action pursuant to section 7 of the Toxic Substances Control Act (does not include petroleum, natural gas, or synthetic gas).

Hazardous waste - waste containing substances designated as hazardous as described in section 3001 of the Solid Waste Disposal Act (see "hazardous substance").

Histopathology - microscopic changes in diseased tissues.

Immunosuppression - a decrease in the ability of the body's immune system to respond to disease.

Injury - a measurable adverse change, either long- or short-term, in a chemical or physical quality affecting the viability of a natural resource and resulting either directly or indirectly from exposure to a discharge of oil or release of a hazardous substance, or exposure to a product of reactions resulting from the discharge of oil or release of a hazardous substance.

Inorganic - relating to the class of compounds not having a carbon basis.

LC_{50} - 50% lethal concentration; the concentration of a substance that is expected to cause death in 50% of an experimental test population when administered over a specified period of time.

Lesion - abnormal change in the structure of an organ or tissue due to injury or disease.

Lower Passaic River (LPR) - the area of the Diamond Alkali Superfund Site that incorporates the 17-mile stretch of the Passaic River from Dundee Dam to the mouth at Newark Bay.

Magnuson-Stevens Act - Public Law 94-265, the Fishery Conservation and Management Act. An act providing for the conservation and management of fisheries, and for other purposes.

Migratory - groups of animals (especially birds or fishes) that periodically move from one region to another for feeding or breeding.

Narcosis - a state of stupor brought on by a substance that depresses nerve excitability.

National Priorities List (NPL) - a list of sites prepared according to the statutory criteria of the hazard ranking system that evaluates the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States; Appendix B of the National Contingency Plan.

Natural resources - land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the fishery conservation zone established by the Magnuson Fishery Conservation and Management Act of 1976), any state or local government, any foreign government, any Indian tribe, or, if such resources are subject to a trust restriction or alienation, any member of an Indian tribe. These natural resources are categorized into the following five groups: surface water resources, groundwater resources, air resources, geologic resources, and biological resources.

Natural Resource Damage Assessment (NRDA) - the process of collecting, compiling, and analyzing information, statistics, or data to determine damages for injuries to natural resources.

Natural Resource Damage Assessment Plan (NRDA Plan) - a plan created by the Trustees and reviewed by the public that serves as a means of evaluating whether the approach used for assessing damages is likely to be cost-effective and meets the definition of reasonable cost; includes descriptions of the natural resources and geographical areas involved, the methodologies proposed for injury assessment, and a statement of Trusteeship.

Newark Bay Study Area (NBSA) – The area of the Diamond Alkali Superfund Site that incorporates Newark Bay, portions of the Hackensack River, and the Arthur Kill and Kill Van Kull channels.

Non-point source - diffuse pollution sources (i.e., those without a single point of origin).

Nursery habitat - portions of an estuary used by early life stages of marine species.

Organic - relating to the class of compounds having a carbon basis.

Osmoregulatory - any physiological mechanism involved in the maintenance of an optimal level of osmotic activity of the fluid in and around the cells of a living organism.

Passaic River Study Area (PRSA) – The lower six miles of the Passaic River, in the vicinity of the Diamond Alkali Company manufacturing plant downstream to Newark Bay.

Pathway - the route or medium through which oil or a hazardous substance is or was transported from the source of the discharge or release to the injured resource.

Phytotoxic response - the response of plants to toxic substances.

Piscivorous - fish eating.

Point source - a pollution source occupying a small area and having a concentrated output.

Polychlorinated biphenyls (PCBs) - a group of 209 congeners consisting of a biphenyl ring with between 1 and 10 chlorine atoms attached, known to be persistent in the environment and to cause adverse effects in organisms.

Porphyria - overproduction of porphyrin, which is a foundation structure for heme (an iron-containing blood pigment) and certain enzymes, creating various physical symptoms.

Practical Quantitation Limit - the lowest concentration that can be reliably measured within specified limits of precision and accuracy for a specific laboratory analytical method during routine laboratory operating conditions.

Predator - an animal with a mode of life in which food is primarily obtained by the killing and consuming of animals.

Prey - an animal taken by a predator as food.

Pyrolysis - decomposition or transformation of a compound by heat.

Quality Assurance Project Plan - a document outlining procedures that those who conduct a monitoring project will take to ensure that the data they collect and analyze meets project requirements.

Reasonable cost - the amount that may be recovered for the cost of performing a damage assessment.

Record of Decision - a signed federal document representing the culmination of the federal environmental document review and approval process, and documenting federal project environmental approval.

Recovery period - the amount of time it takes for an injured resource to return to baseline conditions.

Reference Area - A study population or area expected to be relatively unaffected by contamination that is evaluated for comparative purposes.

Remediation - an action that alleviates contamination or injury.

Resource - see “Natural Resource”.

Restoration - actions undertaken to return an injured resource to its baseline condition, as measured in terms of the injured resource’s physical, chemical, or biological properties, or the services it previously provided, when such actions are in addition to response actions completed or anticipated, and when such actions exceed the level of response actions determined appropriate to the site pursuant to the National Contingency Plan.

Safe Drinking Water Act - Public Law 93-523 as amended, 42 U.S.C. 300f *et seq.*; designed to ensure that the water that comes from the tap in the United States is fit to drink (according to EPA national drinking water standards) and prevent contamination of groundwater.

Services - physical and biological functions performed by a resource including the human uses of those functions. These services are the result of the physical, chemical, or biological quality of the resource.

Solid Waste Disposal Act - Public Law 94-580; an act providing for comprehensive cradle-to-grave regulation of hazardous waste and authorizing environmental agencies to order the cleanup of contaminated sites.

Spawning - the production of eggs in large numbers, usually in reference to aquatic animals (e.g., fish and frogs).

Species of special concern - species of fish and wildlife found to be at risk of becoming either endangered or threatened.

Standard - see criterion.

Superfund - see CERCLA.

Surface water resources - the waters of the United States, including the sediments suspended in water or lying on the bank, bed, or shoreline and sediments in or transported through coastal and marine areas. This term does not include groundwater or water or sediments in ponds, lakes, or reservoirs designated for water treatment under the Resource Conservation and Recovery Act of 1976 or the Clean Water Act and applicable regulations.

Threatened species - any species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Tolerance - the USFDA-established maximum amount of a hazardous substance that may be legally in or on a raw agricultural commodity.

Toxic - poisonous.

Toxic Equivalent - the potency or toxicity of one substance in comparison to another.

Trophic level - position of an organism in a food web in terms of what it eats and what eats it.

Trustee - any federal natural resource management agency designated in the NCP [National Contingency Plan] and any state agency designated by the governor of each state, pursuant to section 107(f)(2)(B) of CERCLA, that may prosecute claims for damages under section 107(f) or 111(b) of CERCLA; or an Indian tribe, that may commence an action under section 126(d) of CERCLA.

Trust Resource - resources (see "Natural Resources") in the possession or care of a Trustee; for the purposes of NRDA, Trustees are any federal natural resources management agency designated in the NCP, any state agency designated by the governor of each state, or an Indian tribe, that may prosecute claims for damages under section 107(f) or 111(b) of CERCLA.

Unsaturated zone - the area below the land surface and above the water table where soil pores are not fully saturated, although some water may be present.

Volatile - evaporating readily at normal temperatures and pressures.

Watershed - the total land area from which water drains into a particular stream or river.

Appendix: Quality Assurance Management

The Federal Trustees will collect and analyze chemical, biological, and physical data as part of the NRDA for the Site. For the Federal Trustees to have confidence in the data developed during the damage assessment, a structured process for ensuring quality must exist. Therefore, QA Plans will be developed for each data collection effort that is part of the NRDA and is identified in the NRDA Plan. The QA Plans may be independent documents or be incorporated into project-specific work plans.

The purpose of each QA Plan will be to assist the Federal Trustees in developing defensible data that will provide a solid foundation for their decisions. The QA Plans developed for this damage assessment will be based on EPA requirements for QA Project Plans (EPA 2001) and EPA Guidance for QA Project Plans (EPA 2002a). In general, each QA Plan should provide sufficient detail to demonstrate that:

- The project's technical and quality objectives (i.e., data quality objectives) are identified;
- The intended measurements or data acquisition methods are appropriate for achieving project objectives;
- Assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and
- Any limitations on the use of the data can be identified and documented.

Accordingly, the plans developed for this assessment will address the four general elements identified by EPA guidance as described below:

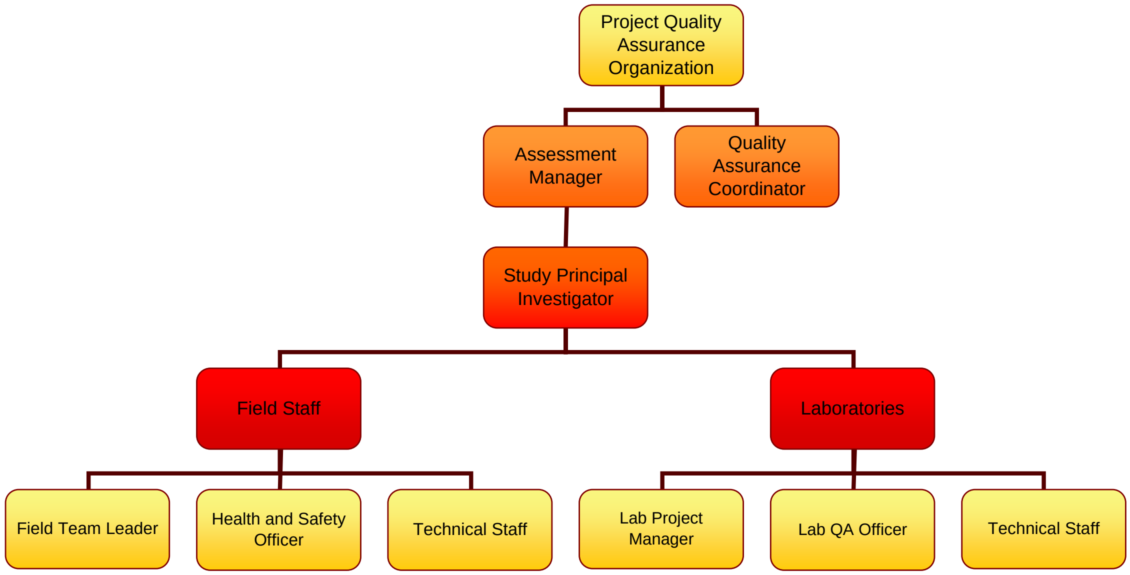
1) Project Management - documents that the project has a defined goal(s), that the participants understand the goal(s) and the approach to be used, and that the planning outputs are documented;
2) Data Generation and Acquisition - ensures that all aspects of project design and implementation including methods for sampling, measurement and analysis, data collection or generation, data handling, and Quality Control (QC) activities are identified and documented;
3) Assessment and Oversight - assesses the effectiveness of the implementation of the project and associated QA and QC activities; and
4) Data Validation and Usability - addresses the QA activities that occur after the data collection or generation phase of the project is completed.

Each of these elements is discussed briefly below.

Project Management

Project organization, roles, and responsibilities help ensure that individuals are aware of specific areas of responsibility for QA, as well as internal lines of communication and authority. Organizational roles and responsibilities may vary by study or task, depending on the lead agency and project team performing the investigation, and should be described in the project-specific QA Plan (Exhibit A-1).

Exhibit A-1: Project QA Organization



The Assessment Manager is the designated Trustee representative responsible for the review and acceptance of each QA Plan and ensuring that Trustee agency efforts are in accordance with requirements of the damage assessment.

The overall conduct of the quality system for the damage assessment is the responsibility of the QA Coordinator appointed by the Trustees. The responsibilities of this individual include, but are not limited to: development of an analytical QA Plan; reviewing/assisting project leaders with the development of QA Plans; conducting audits and ensuring implementation of both the project and the relevant QA Plans; archiving samples, data, and all documentation supporting the data in a secure and accessible form; and reporting to the Trustees.

Study-specific Principal Investigators (PIs) ensure that QA guidance and requirements are followed. The PI or the designee will note significant deviations from the QA Plan for the study, and report the deviations to the Assessment Manager and the QA Coordinator.

The Field Team Leader (FTL) supervises day-to-day field investigations, including sample collection, field observations, and field measurements. The FTL generally is responsible for all field QA procedures defined in the QA Plan. The Laboratory Project Manager is responsible for monitoring and documenting the quality of laboratory work.

Data Generation and Acquisition

Studies identified in the NRDA Plan that will either generate or acquire data to be used in the damage assessment will include a study plan that will be submitted to and approved by the QA Coordinator or designee. Each study plan should include, at a minimum:

- Rationale for generating or acquiring the data;

- Proposed method(s) for generating or acquiring the data;
- Data quality requirements for the study or project and the types of quality control materials and procedures to be used in determining if the data meet these requirements;
- In-house quality assessment procedures to be used in evaluating the outcome; and
- Description of the interpretation, including statistical analyses, of the data.

The QA Plan for each study may be based on EPA guidance, such as EPA Guidance for QA Project Plans (EPA 2002a) or some other model, and will describe the experimental data generation or data collection design for the project, including the types and number of samples required, the design of the sampling network, sampling locations and frequencies, and the rationale for the design.

In addition, QA Plans will describe or reference (and include as appendices) Standard Operating Procedures (SOPs) for all sampling or data-generating and analytical methods, including sample handling and custody in the field, in the laboratory, and during transport. Documentation to be included with the final report(s) from each study will include field logs for the collection or generation of the samples, chain of custody records, and QA/QC documentation. Documentation will be specific for each study, but each QA Plan will identify the appropriate documentation and provide for retention. All studies are required to comply with Good Laboratory Practice Standards for facilities, apparatus, and physical/chemical and biological test systems. These standards include descriptions of maintenance, inspections of instruments, and acceptance testing of instruments, equipment, and their components, as well as the calibration of such equipment and the maintenance of all records relating to these exercises.

Assessment and Oversight

All studies that include the generation or acquisition of data will be audited by the QA Coordinator or designee. These audits will include both technical system audits (i.e., qualitative evaluations of operational details) and data and report audits (i.e., evaluations of data quality, adequacy of documentation, and technical performance characteristics). The purpose of these audits is to ensure that QA Plans are being implemented as described.

If, in the professional opinion of the QA Coordinator, the results of an audit indicate a compromise in the quality of the data, the QA Coordinator has the authority to stop work by oral direction. The QA Coordinator will submit to the Federal Trustees a written report describing the necessity for this direction.

Data Validation and Usability

All study plans, work plans, and final reports will be reviewed for adequacy of design and appropriateness of methodology. Analytical data will be validated by an independent third party. Prompt validation of analytical data will assist the analyst or analytical facility in developing data that meet the requirements for precision and accuracy. It is expected that data validation will use the QA Plans and EPA Guidance on Environmental Verification and Validation (EPA 2002b).

Addendum: Notice of Intent to Perform an Assessment

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Office of Response and Restoration
Silver Spring, Maryland 20910

August 2, 2007

Re: Diamond Alkali Superfund Site
Natural Resource Damage Assessment
Notice of Intent to Perform a Natural Resource Damage Assessment

TO: Attached Companies

Please be advised that the National Oceanic and Atmospheric Administration, acting as the lead administrative trustee on behalf of itself and the U. S. Department of the Interior, collectively acting as Federal natural resource trustees (Federal Trustees), have concluded their preliminary investigation of potential injuries to natural resources under their trusteeship that may have occurred as the result of releases of hazardous substances at or from the Diamond Alkali Superfund Site ("Site"). Pursuant to 43 CFR 11, the Federal Trustees have completed a Preassessment Screen ("PAS"). The complete PAS may be found at http://www.darrp.noaa/gov/northeast/passaic/injury.html.

The two agencies cited serve as Federal Trustees under authority of Subpart G of the National Contingency Plan, 40 CFR Sections 300.600(b)(1-3), and 300.605.

Information gathered and presented in the PAS forms the basis of the Federal Trustees' conclusion that the following criteria are met:

1. A release of a hazardous substance has occurred.
2. Natural resources for which the Federal Trustees may assert trusteeship under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) are or are likely to be adversely affected by the release.
3. The quantity and concentration of the released hazardous substances are sufficient to potentially cause injury to natural resources for which the Trustees may assert trusteeship under CERCLA.
4. Data sufficient to pursue a natural resource damage assessment are available or likely to be obtained at a reasonable cost.
5. Currently implemented and planned response actions will not sufficiently remedy the injury to natural resources without further action.

Based upon the above findings, the Federal Trustees made the determination to perform a natural resource damage assessment for the Site, and by this letter provide you with Notice of Intent to Perform an Assessment (Notice). This Notice is provided pursuant to 43 CFR 11.32(a)(2)(iii)(A). Your company is identified as a potentially responsible party (PRP) in connection with the release of hazardous substances and the subsequent damages resulting from natural resource injury. Accordingly, you are invited to participate in the development and performance of this assessment, and in its funding. You should be aware that other PRPs are being noticed at this time (see attachment), and the Federal Trustees may in the future also provide Notices to additional PRPs as may be deemed appropriate.

Please provide a response to this Notice within 30 calendar days of your receipt of this letter, stating whether you wish to participate in this process. Please send responses to:

Eli Reinharz
NOAA Assessment and Restoration Division
1305 East-West Highway, N/ORR3, SSMC#4, Room 10342
Silver Spring, Maryland
20910-3281

If you have any questions, please feel free to contact Eli Reinharz (NOAA) at (301) 713-4248 ext.193, eli.reinharz@noaa.gov, or Tim Kubiak (FWS) at (609) 646-9310, tim_kubiak@fws.gov. Legal questions should be addressed to Linda Burlington (NOAA) at (301) 713-1332, linda.b.burlington@noaa.gov, or Mark Barash (DOI) at (617) 527-2103, r5mbarash@gmail.com.

Sincerely,

Captain Ken Barton, Acting Director
Office of Response and Restoration
National Ocean Service
NOAA

cc: Brian Donohue, Esq. DOJ
Mark Barash, Esq. DOI
Linda Burlington, Esq. NOAA

Attachment: Mailing List

DISTRIBUTION LIST:

A.E. Staley Manufacturing Co., Inc.
2200 E. Eldorado Street
Decatur, IL 62521-1578

John R. Holsinger, Esq., for
A.E. Staley Manufacturing Co., Inc.
Two University Plaza, Suite 300
Hackensack, NJ 07601

Alcan Corporation
6060 Parkland Blvd.
Cleveland, OH 44101

Elisa Pizzino, Esq.
Alcan Corp.
6060 Parkland Blvd.
Cleveland, OH 44101

Alden Leeds Inc.
55 Jacobus Ave.
Kearny, NJ 07032

Joseph Fiorenzo, Esq.
Sokol, Behot & Fiorenzo
Continental Plaza
433 Hackensack Ave.
Hackensack, NJ 07601

Alliance Chemical, Inc., on behalf of itself
and Pfister Chemical, Inc.
James N. Bendelius, Ph.D., President
P.O. Box 237
Ridgefield, NJ 07657

American Ref-Fuel Co.
155 Chestnut Ridge Road
Montvale, NJ 07645

Kirk Bily, Esq., for
American Ref-Fuel Co.
40 Lane Road
Fairfield, NJ 07004

American Modern Metals Co.
44 Passaic Street
Kearny, NJ 07032

Alexa Richman-LaLonde, Esq., for
American Modern Metals Co.
Riker, Danzig, Scherer, Hyland, Perretti
LLP
Headquarters Plaza
One Speedwell Avenue
Morristown, NJ 07962

Arkema Inc.
Richard L. Charter II, President
Legacy Site Services LLC, exclusive agent
for Arkema, Inc.
Legacy Site Services LLC
1201 Lousiana Street
Houston, TX 77002

Ashland Inc.
Michael S. Roe, Senior Counsel
5200 Blazer Parkway
Dublin, Ohio 43017

Atlas Refining, Inc.
142 Lockwood Street
Newark, NJ 07105

Thomas Ryan, Esq., for
Atlas Refining, Inc.
Laddey, Clark & Ryan LLP
60 Blue Heron Road, Suite 300
Sparta, NJ 07871

Donna M. Russo, Esq.
Automatic Electro Plating Corp.
185 Foundry Street, Suite 3
Newark, NJ 07105

BASF Corp. on its own behalf and on behalf of BASF Catalysts LLC
Nan Bernardo, Environmental Counsel
100 Campus Drive
Florham Park, NJ 07932

Belleville Industrial Center
Carol Shapiro, President
681 Main Street, Building 43
Belleville, NJ 07109

Benjamin Moore & Co.
James L. Megin, VP Finance, Chief Information Officer and Treasurer
101 Paragon Drive
Montvale, NJ 07645

Bristol-Myers Squibb Company
Joseph Tarnowski, Ph.D., Senior Vice President,
Biologics Manufacturing & Process Development
345 Park Avenue
New York, NY 10154

Campbell Foundry Company
800 Bergen Street
Harrison, NJ 07029

Michael V. Calabro, Esq., for Campbell Foundry Company
466 Bloomfield Avenue, Suite 200
Newark, NJ 07107

CBS Corporation
Eric J. Sobczak, Esquire, Vice President, Associate General Counsel
11 Stanwix Street, Rm. 336
Pittsburgh, PA 15222

Celanese Ltd
James Shields, Vice President & Treasurer of Celanese,
International Corporation,
General Partner of Celanese Ltd.
1601 West LBJ Freeway
Dallas, Texas 75234

Chargeurs
38, Rue Marbeuf
75008 Paris, France

James. R. Brendel, Esq., for Chargeurs
Thorp Reed & Armstrong, LLP
One Oxford Centre
301 Grant Street, 14th floor
Pittsburgh, PA 15219-1425

Chemical Compounds Inc.
10 Baldwin Court
Roseland, NJ 07086

Stephen Geller, Esq., for Chemical Compounds Inc.
Himelman, Werthheim & Geller
1405 Route 18 South, Suite 201
Old Bridge, NJ 08857

Chemtura Corporation and Raclaur, LLC
as current and former owner of the property f/k/a
Atlantic Industries
Philip Tinkler, VP
c/o Mark C. Furse
1025 Ashland Ave.
Wilmette, IL 60091

Chevron Environmental Management Company,
for itself and on behalf of Texaco Inc.
Robert R. John, Assistant Secretary
c/o Mark Stella
4800 Fournace Place, E530C
Bellaire, TX 77401

Coltec Industries Inc.
John R. Mayo, Assistant Secretary/Deputy Gen. Counsel
5605 Carnegie Blvd.
Charlotte, NC 28209

Congoleum Corp.
3705 Quakerbridge Road
Mercerville, NJ 08619

Russell Hewit, Esq., for
Congoleum Corp.
Dughi, Hewit & Palatucci, P.C.
340 North Avenue
Cranford, NJ 07016

Conopco, Inc. d/b/a Unilever (as successor to CPC/Bestfoods, former parent of Penick Corporation (facility located at 540 New York Avenue, Lyndhurst, New Jersey))
Andrew Shakalis, Associate General Counsel, Environmental & Safety, as in-house counsel, acting on behalf of Conopco, Inc.
700 Sylvan Avenue
Englewood Cliffs, NJ 07632

Cooper Industries, Ltd.
600 Travis, Suite 5800
Houston, TX 77002

Christopher Marraro, Esq., for
Cooper Industries, Ltd.
Howry, LLP
1299 Pennsylvania Ave., N.W.
Washington, DC 20004

Covanta Essex Company
Seth Myones, Senior Vice President
Attn: General Counsel
40 Lane Road
Fairfield, NJ 07004

Croda Inc.
Norman W. Spindel, Attorney and Authorized Agent for Croda Inc.
c/o Lowenstein Sandler PC
65 Livingston Avenue
Roseland, NJ 07068

Curtiss-Wright Corp.
4 Becker Farm Road
Roseland, NJ 07068

James Maher, Esq.
Curtiss-Wright Corp.
4 Becker Farm Road
Roseland, NJ 07068

Degussa Building Systems, Inc.
889 Valley Park Drive South
Shakopee, MN 55379

Todd Wiener, Esq., for
Degussa Building Systems, Inc.
McDermott Will & Emery
227 West Monroe Street
Chicago, IL 60606

DiLorenzo Properties Company on behalf of itself and the Goldman/Goldman/DiLorenzo partnerships
Waters, McPherson, McNeill, P.C.
Steven R. Gray, Esq., Counsel for DiLorenzo Properties Company and Goldman/Goldman/DiLorenzo Properties Partnerships
300 Lighting Way, 7th Floor
Secaucus, NJ 07096

Drum Service of Newark, Inc.
38 Laurel Drive
Wayne, NJ 07470

Du Pont Company
Bernard J. Rielly, Corporate Counsel
1007 Market Street
Wilmington, DE 19898

Eden Wood Corporation
Herbert B. Bennett
Attorney for Eden Wood Corporation
Sokol Behot & Fiorenzo
229 Nassau Street
Princeton, NJ 08542

Elan Chemical Co. Inc
Jocelyn Manship, President
268 Doremus Ave.
Newark, NJ 07105

El Paso Tennessee Pipeline Co.
1001 Louisiana Street
Houston, TX 77002

Kimberly Lesniak, Esq.
El Paso Corporation
1001 Louisiana Street
Houston, TX 77002

EM Sergeant Pulp & Chemical Co.
6 Chelsea Road
Clifton, NJ 07012

Michael G. Stingone, Esq., for
EM Sergeant Pulp & Chemical Co.
Winne, Banta, Hetherington, Basralian & Kahn, P.C.
Court Plaza South- East Wing
21 Main Street
Hackensack, NJ 07602

EPEC Polymers, Inc. on behalf of itself and EPEC Oil Company Liquidating Trust
Robert W. Baker, Executive Vice President & General Counsel
1001 Louisiana
Houston, TX 77002

Essex Chemical Corp.
2030 WMDC
Midland, MI 48674

Fairmount Chemical Co.
117 Blanchard St.
Newark, NJ 07105

William D. Wallach, Esq., for
Fairmount Chemical Co.
McCarter & English, LLP
Four Gateway Center
100 Mulberry Street
Newark, NJ 07102

Flexon Industries Corp.
Thomas Spiesman, Counsel
Porzio Bromberg & Newman, P.C.
100 Southgate Parkway
Morristown, NJ 07962

Donna M. Russo, Esq
Foundry Street Corporation
260 Knoll Drive
Park Ridge, NJ 07656

Fragrances North America
1775 Windsor Road
Teaneck, NJ 07666

Gail Allyn, Esq.
Pitney Hardin, LLP
P.O. Box 1945
Morristown, NJ 07962-1945

Franklin-Burlington Plastics, Inc.
Norman W. Spindel, Attorney
and Authorized Agent for Franklin-
Burlington Plastics, Inc.
c/o Lowenstein Sandler PC
65 Livingston Avenue
Roseland, NJ 07068

Garfield Molding Co. Inc.
Charles Murray, President
10 Midland Ave.
Wallington, NJ 07057

General Electric Company
Jane Gardner, Manager - Counsel
3135 Easton Turnpike
Fairfield, CT 06828-0001

General Motors Corporation
James P. Walle
Attorney, GM Legal Staff
300 Renaissance Ctr.
Mail Code 482-C24-D24
P.O. Box 300
Detroit, MI 48265

Givaudan Fragrances Corp.
John Colin O'Neill, President
1775 Windsor Road
Teaneck, NJ 07666

Goodrich Corporation on behalf of itself and
Kalama Specialty Chemicals, Inc.
Bruce C. Amig, Director Global
Remediation Services
Four Coliseum Centre
2730 West Tyvola Road
Charlotte, NC 28217-4578

Goody Products, Inc.
400 Galleria Parkway, Suite 1100
Atlanta, GA 30339

Andrew Sawula, Esq., for
Goody Products, Inc
Schiff Hardin & Waite
6600 Sears Tower
Chicago, IL 60606

Harrison Supply Company
800 Passaic Avenue
East Newark, NJ 07029

Timothy J. Corriston, Esq., for
Harrison Supply Company
Connell Foley LLP
85 Livingston Avenue
Roseland, NJ 07068

Hercules Chemical Company, Inc.
James A. Kosch, Attorney for Hercules
Chemical Company, Inc.
Reed Smith LLP
136 Main St. Suite 250
Princeton, NJ 08543-7839

Hess Corporation, on its own behalf and on behalf of Atlantic Richfield Company
Dr. Gerald Bresnick, Vice President, Environmental Health & Safety
c/o Bonnie Allyn Barnett, Esquire
Drinker Biddle & Reath LLP
One Logan Square, 18th & Cherry Streets
Philadelphia, PA 19103-6996

Christopher Colman, Esq.
Amerada Hess Corp.
1 Hess Plaza
Woodbridge, NJ 07095

Todd Normane, Esq.
BP America, Inc.
6 Centerpointe Drive,
LPR 6-552
5th Floor
La Palma, CA 90623

Hexcel Corporation
Rodney P. Jenks, Asst Secretary
281 Tresser Blvd
Stamford, CT 06901

Hoffmann-La Roche Inc. on its own behalf and on behalf of its affiliate, Roche Diagnostics
Frederick C. Kentz III, Vice President
Hoffmann-La Roche Inc.
340 Kingsland Street
Nutley, New Jersey 07110

Honeywell International Inc.
John J. Morris, Remediation Portfolio Director
101 Columbia Road
Morristown, NJ 07962

ISP Chemicals LLC
Steven E. Post, Sr. Vice President-Operations
1361 Alps Road
Wayne, NJ 07470

ITT Corporation
Kathleen S. Stolan, VP, Secretary & Assoc. General Counsel
Attn: F. Daves, Legal Dept.
4 West Red Oak Lane
White Plains, NY 10604

Kearny Industrial Associates
25 Belgrove Drive
Kearny, NJ 07032

David Reger, Esq., for Kearny Industrial Associates
Bressler, Amery & Ross
325 Columbia Turnpike
Florham Park, NJ 07932

Kearny Smelting & Refining
936 Harrison Ave #5
Kearny, NJ 07032

David DeClement, Esq.,
Kearny Smelting & Refining
P.O. Box 217
55 Simpson Ave.
Pitman, NJ 08071

Kao Brands Company
Stephen C. Cagle, Vice President, Product Supply
2535 Spring Grove Avenue
Cincinnati, Ohio 45214

Leemilt's Petroleum, Inc. (successor to Power Test of New Jersey, Inc.), on its behalf and on behalf of Power Test Realty Company Limited Partnership and Getty Properties Corp., the General Partner of Power Test Realty Company Limited Partnership
Andrew M. Smith, President, Leemilt's Petroleum, Inc., and President, Getty Properties Corp.
125 Jericho Turnpike, Suite 103
Jericho, NY 11753

Lucent Technologies Inc.
Roy J. Femenella, EH&S Vice President
600 Mountain Avenue
P.O.Box 636 Room 7B-520
Murray Hill, NJ 07974

Lyondell Chemical Company
c/o MHC, Inc.
1221 McKinney Street,
Suite 700
Houston, TX 77010

Steven Cook, Esq.
MHC, Inc.
One Houston Center, Suite 700
1221 McKinney Street
Houston, TX 77010

Mallinckrodt Inc., a Delaware Corp.
Patricia Hitt Duft, Vice President
675 McDonnell Blvd.
St. Louis, MO 63042

Marcal Paper Mills, Inc.
William Reilly,
Director of Environmental Affairs
1 Market Street
Elmwood Park, NJ 07407-1451

Marshall Clark Manufacturing Corp.
20-40 Marshall Street
Kearny, NJ 07032

Maxus Energy Corporation
Wendy Weber-Frances, Vice President
1330 Lake Robbins Drive, Suite 400
The Woodlands, Texas 77380

Millennium Chemicals, Inc. affiliated entities MHC, Inc. (on behalf of itself and Walter Kidde & Company, Inc.), Millennium Petrochemicals, Inc. (f/k/a Quantum Chemical Corporation) and Equistar Chemicals LP
Deborah Kryak,
Director, Retained Liabilities and Remediation
One Houston Center, Suite 700
1221 McKinney Street
Houston, TX 77010

Monsanto Co.
800 North Lindbergh Blvd.
St. Louis, Missouri 63167

John McGahren, Esq., for Monsanto Co.
Latham & Watkins
One Newark Center, 16th floor
Newark, NJ 07101

National-Standard, LLC
E. A. Roskovensky, President/CEO
1631 Lake Street
Niles, MI 49120

Nell-Joy Industries, Inc.
8 Reith St.
Copiague, NY 11726

Gary P. Field, Esq., for
Nell-Joy Industries, Inc.
425 New York Avenue, Suite 204
Huntington, NY 11743

Newell Rubbermaid Inc., on behalf of itself and its wholly-owned
subsidiaries Goody Products, Inc. and Berol Corporation (as successor by merger to Faber-Castell Corporation)
Lori A. Prokes, Vice President, Assistant General Counsel
2707 Butterfield Road, Suite 100
Oak Brook, IL 60523

News Publishing Australia Ltd. (successor to Chris Craft Industries)
Peter Simshauser, Attorney
Skadden, Arps, Slate, Meagher & Flom LLP
One Beacon Street, 31st Floor
Boston, MA 02108

News America Inc.
767 Fifth Ave., 46th Floor
New York, NY 10153

Brian Kelly, Esq.
News America Inc.
767 Fifth Ave., 46th Floor
New York, NY 10153

Peter Simshauer, Esq.
Skadden Arps
300 South Grand Avenue
Los Angeles, CA 90071

Novelis Corporation (f/k/a Alcan Aluminum Corporation)
Charles R. Aley, Esq., Vice President, General Counsel & Secretary
Novelis Corporation
6060 Parkland Blvd.
Cleveland, Ohio 44124
NPEC, Inc.

Joseph G. Gabriel, President NPEC Inc.
3400 Ridge Road West
Suite #5-341
Rochester, NY 14626

Occidental Chemical Corporation
Dennis F. Blake, Senior Vice President-Business Analysis
5005 LBJ Freeway
Suite 2400
Dallas, Texas 75244-6119

Otis Elevator Company
Dennis M. Mayer, Vice President & Counsel
One Farm Springs Road
Farmington, CT 06032

Passaic Pioneer Properties
PO Box 327
35 Eighth Street
Passaic, NJ 07055

Pfizer, Inc.
Carol A. Casazza Herman, VP and Assistant General Counsel
235 E. 42nd St.
New York, NY 10017

Pharmacia Corporation (f/k/a Monsanto Company)
Jeffrey R. Klieve, Director, Environmental Affairs,
Monsanto Company (Pharmacia Corporation's attorney-in-fact)
800 North Lindbergh Blvd.
St. Louis, MO 63167

Power Test of New Jersey, Inc.
125 Jericho Turnpike
Jericho, NY 11753

Andrew M. Smith, Esq.
General Counsel and Corporate Secretary
Getty Realty Corp.
125 Jericho Turnpike, Suite 103
Jericho, NY 11753

PPG Industries, Inc.
J. Richard Alexander, Senior Vice President, Coatings
One PPG Place
Pittsburgh, PA 15272

Public Service Electric and Gas Company
R. Edwin Selover, Executive Vice President and General Counsel
80 Park Plaza
Newark, NJ 07102

Purdue Pharma Technologies, Inc.
James Stewart, Attorney and Authorized Agent for Purdue Pharma Technologies, Inc.
Lowenstein Sandler, P.C.
65 Livingston Avenue
Roseland, NJ 07068

Quality Carriers, Inc. as successor to Chemical Leaman Tank Lines, Inc. its affiliates and parents, and Quality Distribution, Inc.
Timothy B. Page, Senior VP & CFO
3802 Corporex Drive
Tampa, Florida 33619

Reichhold Inc. (f/k/a Reichhold Chemicals, Inc.)
Scott R. Phillips, Assistant General Counsel
P.O.Box 13582
Research Triangle Park, NC 27709-3582

Reilly Industries, Inc.
1510 Market Square Center
151 North Delaware St.
Indianapolis, IN 46204

Anne Frye, Esq.
Reilly Industries, Inc.
300 N. Meridan Street
Suite 1500
Indianapolis, IN 46204

Revere Smelting & Refining Corporation
John A. De Paul, Vice President
2777 N. Stemmons Freeway
Suite 1800, Dallas Tx 75207

Roman Asphalt Corporation
14 Ogden Street
Newark, NJ 07104

Royce Associates
366 N. Broadway, Ste. 400
Jericho, NJ 11753

Ronald Bluestein, Esq., for Royce Associates
Dilworth Paxson LLP
3200 Mellon Bank Center
1735 Market Street
Philadelphia, PA 19103-7595

RTC Properties, Inc.
79 Fifth Avenue
New York, NY 10003

Michael L. Rodburg, Esq., for RTC Properties, Inc
Lowenstein Sandler, PC
65 Livingston Manor
Roseland, NJ 07068

S&A Realty Corp.
55 Passaic Avenue
Kearny, NJ 07032

Jeffrey Pollock, Esq., for
S&A Realty Corp.
Fox Rothschild
P.O. Box 5231
Princeton, NJ 08543

Safety-Kleen Envirosystems Company by
McKesson, and McKesson
Corporation for itself
Nicholas A. Loiacono, Treasurer
McKesson Corporation
One Post Street
San Francisco, CA 94104

Sequa Corporation
Stephen R. Lowson, Vice President
200 Park Avenue, 44th Floor
New York, NY 10166

Seton Company, Inc.
1000 Madison Avenue
Norristown, PA 19403

John Wittenborn, Esq., for
Seton Company, Inc.
Kelley Drye Collier & Shannon
Washington Harbour, Suite 400
3050 K Street, N.W.
Washington, D.C. 20007-5108

David Acquesta, Esq.
General Counsel, Asst Secretary
Seton Company
Valley Forge Corporate Center
1000 Madison Avenue
Norristown, PA 19403

SpectraServ, Inc.
75 Jacobus Avenue
Kearny, NJ 07032

Thomas Sabino, Esq., for
SpectraServ, Inc.
Wolff & Samson
One Boland Drive
West Orange, NJ 07052

Sun Chemical Corporation
Melvin M. Cox, Sr. Vice President and
General Counsel
35 Waterview Boulevard
Parsippany, New Jersey 07054

Tate & Lyle Ingredients Americas, Inc.
(f/k/a A.E. Staley Manufacturing
Company, including its former division
Staley Chemical Company)
John R. Holsinger, Attorney at Law
2200 East Eldorado Street
Decatur, IL 62525

Teval Corporation
M.J. O'Driscoll-Levy, President
c/o Crowell & Moring
Att. Ridgeway Hall or Kirsten Nathanson
1001 Pennsylvania Ave. N.W.
Washington D.C. 20004

Teva Pharmaceuticals USA, Inc. (f/k/a
Biocraft Laboratories, Inc.)
Kirsten E. Bauer, Senior Associate General
Counsel
1090 Horsham Road
North Wales, PA 19454

Textron Inc.
Jamieson Schiff, Assistant General Counsel
40 Westminster Street
Providence, RI 02903

The Andrew Jergens Co.
2535 Spring Grove Ave.
Cincinnati, OH 45214

A. Christian Worrell, Esq., for
The Andrew Jergens Co.
Graydon, Head & Ritchey, LLP
1900 Fifth Third Center
511 Walnut Street
Cincinnati, OH 45202

The BOC Group, Inc.
James Stewart, Attorney and Authorized
Agent for the BOC Group, Inc.
Lowenstein Sandler, P.C.
65 Livingston Avenue
Roseland, NJ 07068

The Hartz Consumer Group, Inc. on behalf
of The Hartz Mountain
Corporation
Curtis B. Schwartz, Vice Chairman
The Newark Group, Inc.
James Stewart, Attorney and Authorized
Agent for the BOC Group, Inc.
400 Plaza Drive, P.O.Box 1515
Secaucus, NJ 07096-1515

Lowenstein Sandler, P.C.
65 Livingston Avenue
Roseland, NJ 07068

The Newark Group, Inc.
20 Jackson Drive
Cranford, NJ 07016

James Stewart, Esq.
Lowenstein Sandler PC
65 Livingston Avenue
Roseland, NJ 07068

The Okonite Company, Inc.
102 Hilltop Road
Ramsey, New Jersey 07446

James Groome, Director
Safety and Environmental Programs
The Okonite Company, Inc.
102 Hilltop Road
Ramsey, NJ 07446

The Sherwin-Williams Company
Louise E. Stellato, Vice President, General
Counsel and Secretary
contact Donald J. McConnell
101 Prospect Ave., N.W.
Cleveland, OH 44115

The Stanley Works
Theodore C. Morris, Assistant Secretary
1000 Stanley Drive
New Britain, CT 06053

Three County Volkswagen Corp.
Scott R. Senior, President
701 Riverside Ave
Lyndhurst, NJ 07071

Tierra Solutions, Inc.
David Rabbe, President
2 Tower Center Blvd, 10th Fl,
East Brunswick, New Jersey 08816

Tiffany and Company (New York
Corporation)
Patrick B. Dorsey, Senior Vice President,
Secretary and General Counsel
600 Madison Ave.
New York, NY 10022

US Filter/ Wallace & Tiernan
1901 West Garden Road
Vineland, NJ 08360

Unilever Bestfoods
International Plaza
Sylvan Avenue
Englewood Cliffs, NJ 07632

Andrew Shakalis, Esq.
Associate General Counsel – Environmental & Safety
Unilever
700 Sylvan Avenue
Englewood Cliffs, NJ 07632

Universal International Industries, Inc.
17 Academy Street, Room 717
Newark, NJ 07102

Viacom Inc.
11 Stanwix St.
Pittsburgh, PA 15222

Linda Kelley, Esq.
Viacom Inc.
11 Stanwix St.
Pittsburgh, PA 15222

Vertellus Specialties Inc., f/k/a Reilly Industries, Inc.
Anne M. Frye, Vice President, General Counsel & Secretary
300 N. Meridian St.
Ste. 1500
Indianapolis, IN 46204

Vulcan Materials Company
William F. Denson III, Senior Vice President, General Counsel and Secretary
1200 Urban Center Drive
Birmingham, Alabama 35242

Wiggins Plastics Inc.
186 Kingsland Road
Clifton, NJ 07014

Glenn Tucker, Esq., for
Wiggins Plastics Inc.
Greenberg Dauber
One Gateway Center, Suite 600
Newark, NJ 07102

Wyeth, on behalf of Shulton, Inc.
Steven A. Tasher, Vice President
Wyeth
5 Giralda Farms
Madison, NJ 07940