STATEMENT

OF

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CONCERNING THE

OCEAN DUMPING OF

CONTAMINATED DREDGED MATERIAL FROM

NEW YORK HARBOR

BEFORE THE

MERCHANT MARINE AND FISHERIES COMMITTEE

U.S. HOUSE OF REPRESENTATIVES

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I appreciate this opportunity to contribute with my distinguished fellow panelists in summarizing the ecosystem impacts of dredged materials from New York Harbor dumped in the New York Bight, and in suggesting possible strategies to reduce these impacts. As requested by the Committee, my initial comments will be brief; I will skip the managerial context of the problem, and address only the scientific and technical issues of ecosystem impact.

1. Environmental impact at the Mud Dump site compared to other areas of the New York Bight (including measurements indicative of environmental health).

For the sake of brevity, I will not repeat details already provided to this Committee on the consistent pollutant gradients in the waters, sediments and biota of the New York Bight. I will note that the sediments of the innermost Apex area of the Bight, embracing the inshore dump sites, typically contain at least 10 or 20 times as much toxic metal as do those of the outer continental shelf. The gradients of toxic metals concentrations in the water are less pronounced, but detectable. Even more pronounced gradients appear in sediment concentrations of certain synthetic organic compounds. PCBs in the most contaminated Apex sediments, for example, are over 100 times as concentrated as in offshore sediments.

Only a few of the observed ecological impacts at the Mud Dump site are attributable solely to dredged material dumping. The other impacts I will cite result from the combined influences of dredged contaminants which have escaped from the Mud Dump site together with those of contaminants from other sources (primarily those associated with sewage sludge dumping and with transport of materials from the Hudson-Raritan Estuary). The mixing of contaminants from three major sources, and numerous other sources, makes it difficult to determine how much of observed impacts can be attributed to specific toxicants from specific sources.

Discussions of ecological degradation often begin with the phytoplankton, appropriately because they produce the food for most of the ecosystem. Both the chemical composition and size of this phytoplankton food is of great importance to the organisms eating it. Most phytoplankton grazing organisms, for instance, have evolved mechanisms for eating particular sizes of food particles, and many animals cannot effectively use food particles of other sizes. So ecologists are often particularly concerned about these sorts of structural changes in the phytoplankton; they can have severe implications for food availability throughout the food web.

The species composition and standing crop of phytoplankton in the Apex of the Bight differ substantially from those in offshore waters. The summer phytoplankton of the Apex are dominated by very small green algae (primarily Nannochlorus atomus and Calycomonas gracilis) which are uncommon offshore. Laboratory studies have demonstrated that PCBs at concentrations of 1-10 μg/l, and other toxicants, modify the species compostion of phytoplankton leading to reductions in average cell size. While such experimental studies suggest that the Apex phytoplankton community structure is consistent with anticipated effects of dumped toxicants, other factors are probably more important. High concentrations of nutrients, also present, may also cause a reduction in average cell size. Whatever the forces responsible for small phytoplankton, the result is most evident in the Estuary, from which a large proportion of the "small forms" are subsequently transported to the Apex. I do not minimize the likelihood that toxicants from dumped dredged materials escape to the water column and exacerbate toxicant impacts upon phytoplankton, but the summer dominance of small phytoplanters is due primarily to estuarine influences.

Among the potentially most significant ecological impacts of contaminants in the Bight are toxic stresses on hetrotrophic benthic bacteria, i.e., those nourished by organic substances in sediment. Just as the ecosystem relies fundamentally upon phytoplankton to produce organic matter, the entire system relies just as much upon the heterotrophic bacteria to break down organic matter quickly. Several studies conducted in the Bight provide a picture of benthic bacteria in the Apex which have developed genetic and physiological defenses against the contaminated environment in which they live. Many, perhaps most, bacteria could not live in such toxic sediments without first evolving these defense mechanisms against the toxicants (e.g., normal genetic resistance, transfer resistance, metabolism of the toxicant, and secretion of compounds which prevent the toxicant from entering the cell). All of these defense mechanisms are known to occur and at least three of them have been reported in the Bight. These defenses act against specific toxicants such as mercury, cadmium, copper, zinc, and several antibiotics such as ampicillin, penicillin, streptomycin, kanamycin, aureomycin, and triple sulfa. The bacterial mechanisms for avoiding toxicity from these metals and compounds have their limits; even these resistant bacteria die when exposed to higher toxicant concentrations than those in which they normally live. To my knowledge studies have not been undertaken in the Bight to document comparable defenses against petroleum hydrocarbons, PCBs, and other synthetic organic compounds. The benthic bacteria may also be stressed enough by some of these other toxicants to have developed comparable defense mechanisms.

In addition to such indications of toxicant stress on the bacteria, other recent measurements indicate even more directly the significance of the impacts. In sediments of the inner Bight much more than half of the bacterial flora has been found to be metabolically inactive. That is, perhaps as many as 90% of these sediment bacteria are in a resting state and therefore not performing their normal functions of degrading organic matter and recycling minerals.

A number of studies have noted major alterations in the total benthic communities of the New York Bight Apex. Extremely depauperate macrobenthic communities exist near the sewage sludge and dredged material disposal sites, with the most impacted zone typically in a 10-15 km^2 area east of the sewage sludge dump site. This area supports very few species in number but has dense populations of otherwise uncommon species of polychaete worms. Most of the adjacent Christiaensen Basin is characterized by low species diversity but high standing stocks of macrobenthos. Possible explanations for these observed alterations include (1) direct toxicity, (2) organic enrichment of sediments and low oxygen concentrations, and (3) exclusion of predators from the area by low oxygen levels or toxicants.

In fine sand habitats of the Apex, but not in mud, the diversity of nematodes (small benthic worms) is diminished in the presence of high toxic metal concentrations. These more toxic sediments are dominated by nematodes lacking "teeth", indicating an alteration of the trophic structure of this benthic group.

The observed modifications of benthic communities may have deleterious consequences for bottom feeding fishes. The benthic species which tend to be less abundant than normal, amphipods and the rock crab for example, are important prey for these fishes. Most of the benthic species which dominate the contaminated sediments are not important prey.

Declines or fluctuations in fish landings and estimates of stock abundance are primarily attributable to fishing pressure, climatic variations and modifications of critical coastal habitats. These influences apparently overwhelm any toxic effects upon fish stocks; such effects of toxicants on fish stocks directly, or indirectly through food chains, have not been observed in the Bight. There are, however, toxicant concentrations in surface waters that do contribute to mortality and genetic abnormalities of early life stages in Atlantic mackerel.

There is extensive evidence of pollution-associated disease of organisms in the Bight. Several diseases have an evident relationship with pollutant levels; particularly important are fin erosion and ulcers in fishes and gill fouling and shell erosion in crustacean shellfish.

2. Extent to which impacts are reversible.

Although some isomers of PCBs are metabolized by bacteria under laboratory conditions, the metabolism is selective for PCBs with few chlorine atoms. Further, I am aware of no evidence that PCBs are actually broken down in nature to any significant extent. PCBs must be considered to persist essentially undegraded in environments like the Bight over time periods of concern for management purposes. In this sense PCBs are comparable to several of the more persistent toxicants of concern such as metals and some other organics. Most of these metals and persistent compounds are also similar in their affinity for fine particles of silt, clay, and organic matter.

Assuming major reductions in the PCB loadings to the Bight, essentially all of the PCBs remaining would be in the sediments. The long-term tendency for cleansing of the region would then depend primarily upon how rapidly the PCB-contaminated fine sediments are resuspended and carried to other regions. Resuspension of these fine sediments is highly episodic; most resuspension is caused by wave energy during storms. Storms very effectively resuspend fine sediments throughout the entire Bight. These fines are then carried by currents, over distances up to hundreds of miles, before settling to the bottom again.

A quantitative estimate is not yet available for the rate at which contaminated fine sediments are exported from the Bight. A reliable estimate of the time required to disperse the existing persistent contaminants such as PCBs from inner Bight sediments depends upon such knowledge of fine particle transport. Assuming that contaminant loadings to the Bight were greatly reduced, sediment resuspension and transport would take much longer to disperse existing contaminants from the Bight than the time involved for subsequent recovery of the ecosystem.

An obvious consequence of such dispersal of persistent contaminants from the Bight is contamination of adjacent regions; not an optimal solution obviously.

3. Environmental processes affecting impact and implications for mitigating environmental effects.

There are three possible fates for the toxicants dumped as part of contaminated dredged materials:

a. burial and effective removal from the ecosystem,

b. uptake by organisms at the dump site, and

c. immediate or subsequent transport from the dump site.

It appears that much of the toxic materials dumped are buried at the Mud Dump site, at least initially. The quantity of contaminant uptake by biota, relative to the total amounts dumped, is quite small through highly significant ecologically.

A number of investigations have been directed towards processes which have the potential to disperse contaminants from the dredged material mound. Measurements of metals concentrations in pore waters of the mound indicate some flow of dissolved iron and manganese to overlying waters, while the corresponding benthic flux of mercury and cadmium is below detection limits. Sediment resuspension is probably a more significant process. Sediment transport in the Bight is dominated by episodic, storm-driven events. During a 135-day observation of near bottom-flow off Long Island, over 95% of the computed transport occurred during a flow off Long Island, over 95% of the computed transport occurred during a single winter storm. Some degree of post-depositional dispersion near the dump site itself is suggested by the presence of considerably more fine-grained sediment at the fringes of the mound than at its top (although this pattern could also result from a sorting effect during deposition).

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Most of the toxicants at the Mud Dump are strongly attracted to particulate material. This is true of PCBs, petroleum hydrocarbons and most toxic metals. The management implications of this strong adsorption is that most toxicants would be expected to remain sequestered if they could be effectively "capped" by non-toxic sediment. The long-term efficacy of such "capping" at the Mud Dump site cannot be estimated at present. There are also practical difficulties; by no means yet solved, in accurately positioning such a cap in the first place.

4. Risk posed by PCB contamination to the marine environment.

PCBs have been shown to have deleterious effects upon marine biota in several ways other than by causing direct mortality:

a. additive or synergistic effects with other chemical and physical stresses which together cause mortality or sublethal effects at lower PCB concentrations than might otherwise be expected,
b. greater susceptibility to disease,
c. impaired reproductive success,
d. lowered photosynthetic rates,
e. developmental abnormalities, and
f. inhibition of shell growth in molluscs and inhibition of moulting in crustacea.

PCBs act not alone, but together with the many other toxicants present in the Bight. I emphasize that, because of these additive and synergistic effects with other toxicants, PCBs probably pose ecological risks at concentrations lower than would be expected from laboratory PCB bioassays.

Significant quantities of PCBs accumulate in organisms such as plankton, polychaetes, the rock crab and the blue mussel. These groups are important elements of the marine food web. Probable widespread distribution of PCBs through the ecosystem poses corresponding risks of the various impacts enumerated above. Certain toxicant effects on biota of the Bight may be partially due to PCBs even when no solid evidence implicates PCBs directly. Such effects are fin erosion in fishes, skeletal erosion in crustacea, genetic damage to and mortality of Atlantic mackerel eggs and larvae.

5. Specific research needs relating to improved measurement of marine environmental impact.

A thorough evaluation is needed of the technology and environmental effects of conventional ocean dumping alternatives. It appears that one such alternative, at least in the short-term is "capping" of contaminated sediments by clean sediments. This approach is being evaluated in the Long Island Sound and other areas. A similar "capping" procedure is being explored in New York Harbor, placing toxic spoils in sand borrow pits and covering with clean sediments. Several questions should be studied however: Does the capping material effectively cover the toxic material? Does the capping material waft fines away from the earlier dumped material? Does the cap stay on top; will we have to recap? Can toxicants, or even fine particulates, escape from capped sediments? Do we want to use a scarce, valuable resource such as clean sand for this capping purpose?... How much sand?

NOAA has designed a monitoring strategy for the New York Bight which does address the trends in PCB concentrations (and of other toxicants) both in the environment and in biota. Some important research questions are related to this monitoring. What are the additive and synergistic effects of PCBs and other contaminants? What are the conditions necessary for release of PCBs from particulate materials; in sediments, in the water column, and within the digestive tracts of animals?

6. Biological availability of contaminants associated with dredged materials.

The complex mixture of contaminants associated with dredged materials is potentially available to the ecosystem if contaminated particles or organisms are eaten, or if contaminants in the water column pass through gill or body surfaces. Most of the organic and inorganic contaminants associated with dredged materials are bound rather tightly to fine particles (with important exceptions such as cadmium and plant nutrients), and are therefore directly available only to particle feeders.

Despite this typical pattern of contaminant binding, the dissolved concentrations of several contaminants are concentrated enough to pose bioaccumulation risks to some segments of the ecosystem. Among the toxicants with dissolved concentrations high enough to be of concern are cadmium, mercury, lead, and PCBs. The dissolved fraction of PCBs is particularly important because existing evidence indicates that most organisms take up PCBs primarily from the water.

7. Field observations in marine ecosystems of bioaccumulation and biomagnification of contaminants.

Most of the contaminants of principal concern in the Bight are known to enter organisms directly through the gills, epithelial tissue or other surfaces. This "bioconcentration" mechanism appears to be the principal route of biotic contamination by PCBs, arsenic, cadmium, copper and other toxicants. Laboratory studies, however, indicate that in several groups contaminant-laden foods do significantly add to the body burdens accumulated from water.

There are few clear instances of marked toxicant biomagnification through the food chain; DDT and its derivatives are perhaps the best known examples of the process.

NOAA, the Mussel Watch program, and other groups have accumulated extensive field observations on bioaccumulation and biomagnification which are being used in determining the most appropriate strategies for dredged material disposal.

8. Adequacy of the COE-EPA ocean dumping regulations in addressing risk to the marine environment and recommendations for improvement.

My individual comments on the recent "matrix" relaxation of the ocean dumping regulations were presented in recent NOAA testimony before your Committee.

Improvemnets should be made in the bioassay and bioaccumulation tests used as indicators of environmental risk. Some assurance should be required that the tests are carried out uniformly by knowledgeable individuals. Care must also be taken to ensure that the test organisms are as sensitive to toxicants as their counterparts in nature. Exposures of organisms for only ten days may seriously underestimate actual toxicant bioaccumulation. Either assays should be run for longer periods, or reliable determinations should be made of the proportion of potential toxicant burden actually accumulated within the 10-day test period.

The ocean dumping regulations emphasize the concentration of toxicants in dredged material without adequate consideration of the amounts of material involved. Large volumes of dredged materials with relatively low toxicant concentrations may introduce larger quantities of toxicants than small dumping actions even if the latter are highly contaminated.

I would also like to stress that in the long-term, ocean dumping regulations _per se_ cannot resolve dredged material disposal contamination. This central consideration in arriving at appropriate, long-term solutions of the contaminated dredged materials' problem is often overlooked. These dredged materials become toxic, carcinogenic, teratogenic, etc., because of massive toxicant loads to the Estuary contributed by industry, by government, and by individuals; much of these toxicant loadings are in violation of existing laws and regulations. The enforcement of existing regulation on pollutant discharges would significantly reduce the volume of toxicity, however defined, of toxic dredged materials.

This concludes my formal remarks, Mr. Chairman. I will be happy to answer any questions.