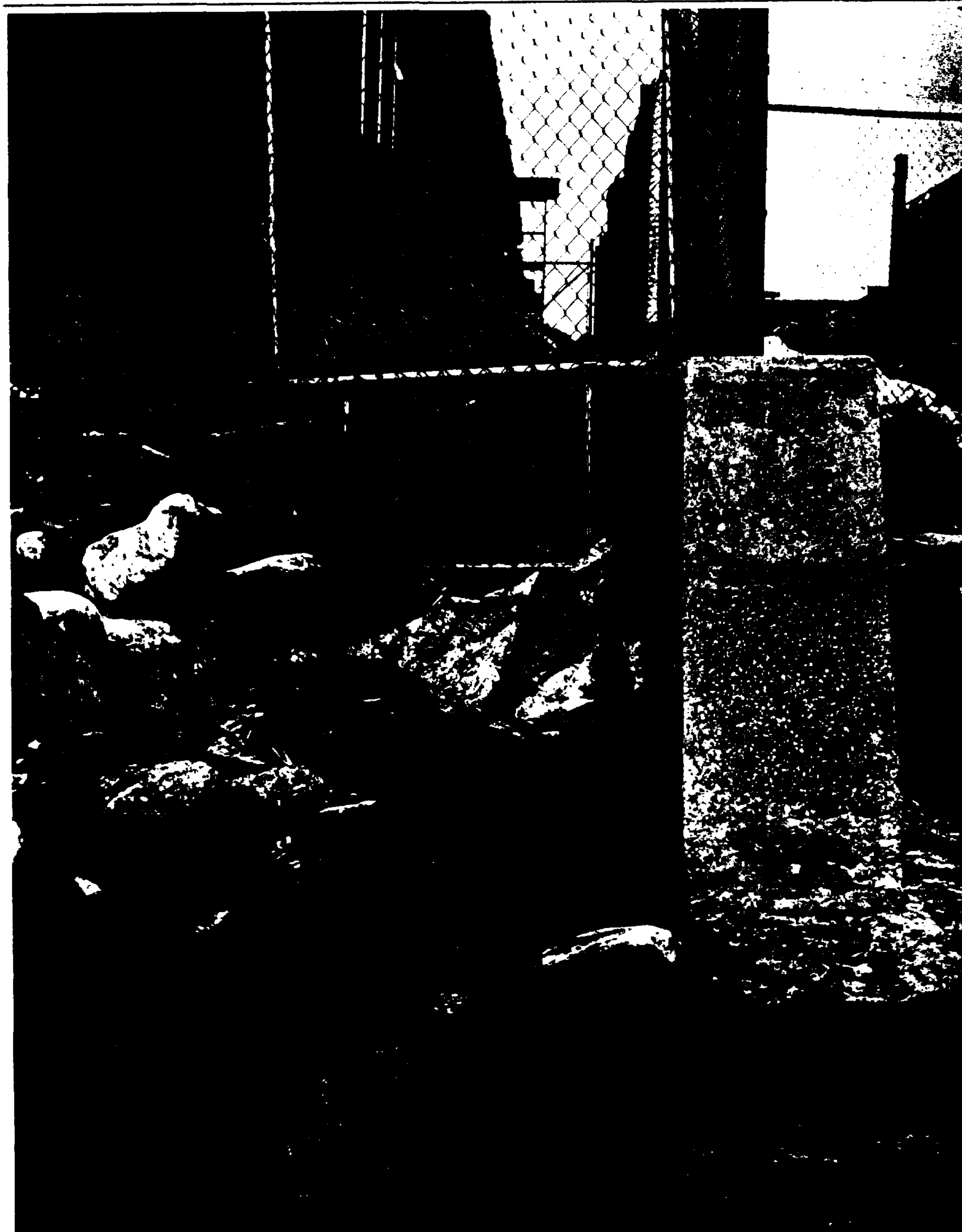
PCB Pollution in the New Bedford, Massachusetts Area:

A Status Report

June 1982



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PCB POLLUTION IN THE NEW BEDFORD, MASSACHUSETTS AREA

A STATUS REPORT

- June 1982 -

Second Printing, January 1983
(with minor revisions)

This reprint of the original report has minor corrections and clarification of some material that was subject to misinterpretation.

Commonwealth of Massachusetts
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Executive Office of Environmental Affairs
James T. Hoyte, Secretary

Office of Coastal Zone Management
Richard F. Delaney, Director

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ABSTRACT

A Summary of PCB Contamination in the New Bedford, Massachusetts Area

* The area of PCB contamination extends from the northernmost extreme of the Acushnet River Estuary to the sediments in the vicinity of the New Bedford municipal wastewater outfall, a distance of over six miles.

* Harbor sediments contain PCBs in levels up to 190,000 parts per million, or 19 percent. Concentrations in the thousands of ppm are common in the tidal flats near Aerovox Incorporated. These sediments exceed the federal hazardous waste criteria by several orders of magnitude.

* 18,000 acres of productive lobstering ground are closed to fishing. Lesser, yet significant, areas are closed to the taking of finfish and shellfish.

* Finfish have been found to contain PCBs at concentrations exceeding one hundred parts per million.

* Sampling at two industrial properties has documented the existence of high levels in upland sediments: 24,000 ppm (dry weight) at Aerovox and 99,000 ppm (dry weight) at Cornell Dubilier.

* The municipal wastewater treatment plant sludge, grit and effluent contain elevated levels of PCBs.

* The New Bedford municipal landfill is believed to contain one-half million pounds of PCBs.

* Other dump sites are suspect.

* Limited human blood analyses suggest that the blood of heavy fish eaters and industrially exposed individuals contain elevated levels of PCBs. No associated health effects have been documented.

INTRODUCTION

What is a PCB?

Polychlorinated biphenyls (PCBs) are industrial compounds which were commercially manufactured and marketed in the United States during the years 1929 to 1977. The Monsanto Corporation of St. Louis, Missouri, the United States' only industrial producer of PCBs, marketed PCB blends under the trade name "Aroclor". In recent years, all American-made PCBs were manufactured at the Sauget, Illinois factory (1). Chemically, some 210 different PCB molecules, or isomers, are possible; each Aroclor is composed of a complicated blend of these isomers. Only about ten Aroclors were widely marketed in the United States.

The total production of PCBs by Monsanto during the approximately fifty years of manufacture is believed to have totaled approximately 1.4 billion pounds. In the years 1970 to 1977, 35 to 40 million pounds were produced annually (2,3). The usage of PCBs by New Bedford's industrial concerns peaked at about two million pounds per year during the years 1973, 1974 and 1975 (4).

The chemically stable, non-flammable nature of PCBs together with their high boiling point, low solubility and high dielectric constant make these chemical compounds nearly ideal for many industrial uses. Unfortunately, these same properties allow PCBs to persist in the environment and bioconcentrate, creating a potential hazard to the environment.

In New Bedford, PCBs have been used by Aerovox Incorporated and Cornell Dubilier Electronics Incorporated (and possibly Acushnet Capacitors, Inc.) in the production of electronic capacitors.

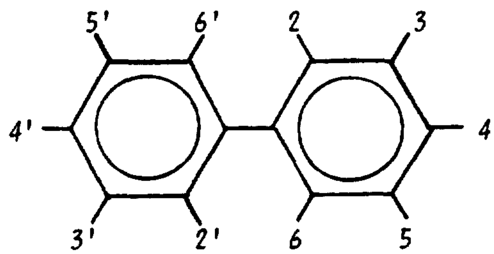
Nationally, PCBs have been used as liquid coolants in transformers, as flame retardants, lubricants, machine tool cutting oils and hydraulic fluids. PCBs at one time were used in the production of carbonless reproducing paper, food packaging materials, printers' ink, recycled paper, floor tiles, waxes and asphalt.

Aroclor 1242 was the primary PCB used in New Bedford until 1971 when Aroclor 1016 became available for use in the manufacture of electronic capacitors. Two other Aroclors, 1254 and 1252, were used in lesser quantities by Aerovox and Cornell Dubilier. All use of PCBs in New Bedford stopped by 1978 (4,80).

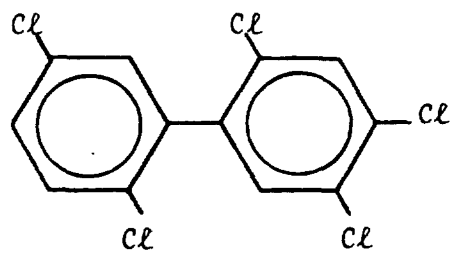
Aroclors are manufactured as mixtures of various PCBs. The four digit number which follows the trade name Aroclor characterizes the blend of polychlorinated biphenyls. Except for Aroclor 1016 which was not named according to protocol, the first two digits identify the product as a biphenyl. The final two digits express the approximate percentage of chlorine (by weight) in the

PCB blend. For example, Aroclor 1254 is a blend of biphenyls with an average chlorine content of fifty-four percent. Aroclor 1016, the exception to this rule, is a biphenyl blend containing 41 percent chlorine.

The physical characteristics of PCBs vary according to the mixture. As the chlorine content increases, the Aroclors change from a colorless oil to a sticky resin to a white powder and their persistence in the environment increases (5). The general chemical structure of a PCB molecule (1,6) is shown below. Chlorine atoms are substituted for hydrogen at any numbered location on either benzene ring.



As an example of a specific PCB isomer, the structure of 2,2',4,5,5' - Pentachlorobiphenyl is diagrammed below.



Although 2,2',4,5,5' - Pentachlorobiphenyl is 54 percent chlorine by weight, this molecule is not the sole constituent of Aroclor 1254, nor is Aroclor 1254 composed entirely of molecules with five chlorine atoms. Instead, as shown in Table 1, Aroclor 1254 is a blend of biphenyls containing three to seven chlorine atoms, and averages 54% chlorine by weight.

Table 1.
Typical Percentage Composition of
Polychlorinated Biphenyl Products*

Number of Chlorine Atoms per Molecule	Aroclor 1221 (21 % Cl)	Aroclor 1016 (41 % Cl)	Aroclor 1242 (42 % Cl)	Aroclor 1254 (54 % Cl)
0	11	LT. 0.1	LT. 0.1	LT. 0.1
1	51	1	1	LT. 0.1
2	32	20	16	LT. 0.5
3	4	57	49	1
4	2	21	25	21
5	LT. 0.5	1	8	48
6	ND	LT. 0.1	1	23
7	ND	ND	LT. 0.1	6
8	ND	ND	ND	ND

LT - less than
ND - none detected, i.e., less than 0.01 percent

* this table was taken from Tucker, et al. (7), page 707.

How are PCBs Measured?

Very small concentrations of polychlorinated biphenyls can be detrimental. Therefore it is important to use extremely sensitive analytic procedures in measuring PCBs. Precise measurements of PCBs in concentrations of parts per billion (ppb) are commonly required. In fact, the US Environmental Protection Agency (EPA) has recommended a water quality standard slightly below 1 part PCB per trillion parts of water to protect marine aquatic life (8).

PCB analyses are generally conducted utilizing a gas chromatograph (GC). A known standard is injected into the GC and a fingerprint of the standard is produced. A fingerprint chromatogram of Aroclor 1242 is shown in Figure 1. The sample to be analyzed is extracted with a solvent, cleaned on a column and is similarly injected into the gas chromatograph instrument to produce a chromatogram such as that shown in Figure 2.

Representative peaks from the standard chromatogram are matched with those from the sample chromatogram to determine the presence of the various Aroclors. The concentrations of the Aroclors are quantified by comparing the areas under the peaks of the sample with those of the standard. Figure 3 shows a chromatogram of herring gull eggs with Aroclor 1016/1242 and Aroclor 1254 representative peaks noted. The eggs from which this sample was taken contain approximately 5 parts per million (ppm) total PCBs. Note: Aroclors 1016 and 1242 are difficult to distinguish and are often reported together as Aroclor 1016/1242.

A more sensitive measurement of discreet PCB compounds (as opposed to blends) can be obtained by coupling a mass spectrometer (MS) with a conventional gas chromatograph instrument. When GC/MS is used, a vast amount of data is generated which when recorded, processed and displayed by a small or medium-sized laboratory computer produces a mass spectrum such as that shown in Figure 4. (It should be noted that the example shown in Figure 4 is not from a PCB but is from a pentachlorophenol and is used for illustrative purposes only. Techniques used in analysis are the same as would be used for a PCB.) As in conventional gas chromatography analyses, the product of GC/MS testing is a fingerprint which can be matched against a standard fingerprint to quantify the sample concentration. Through the use of computer analogs this process can be conducted accurately and automatically.

Gas chromatograph / mass spectrophotometer analyses are too expensive to allow for widespread use. It is not uncommon, however, to verify conventional gas chromatography results with occasional GC/MS measurements.

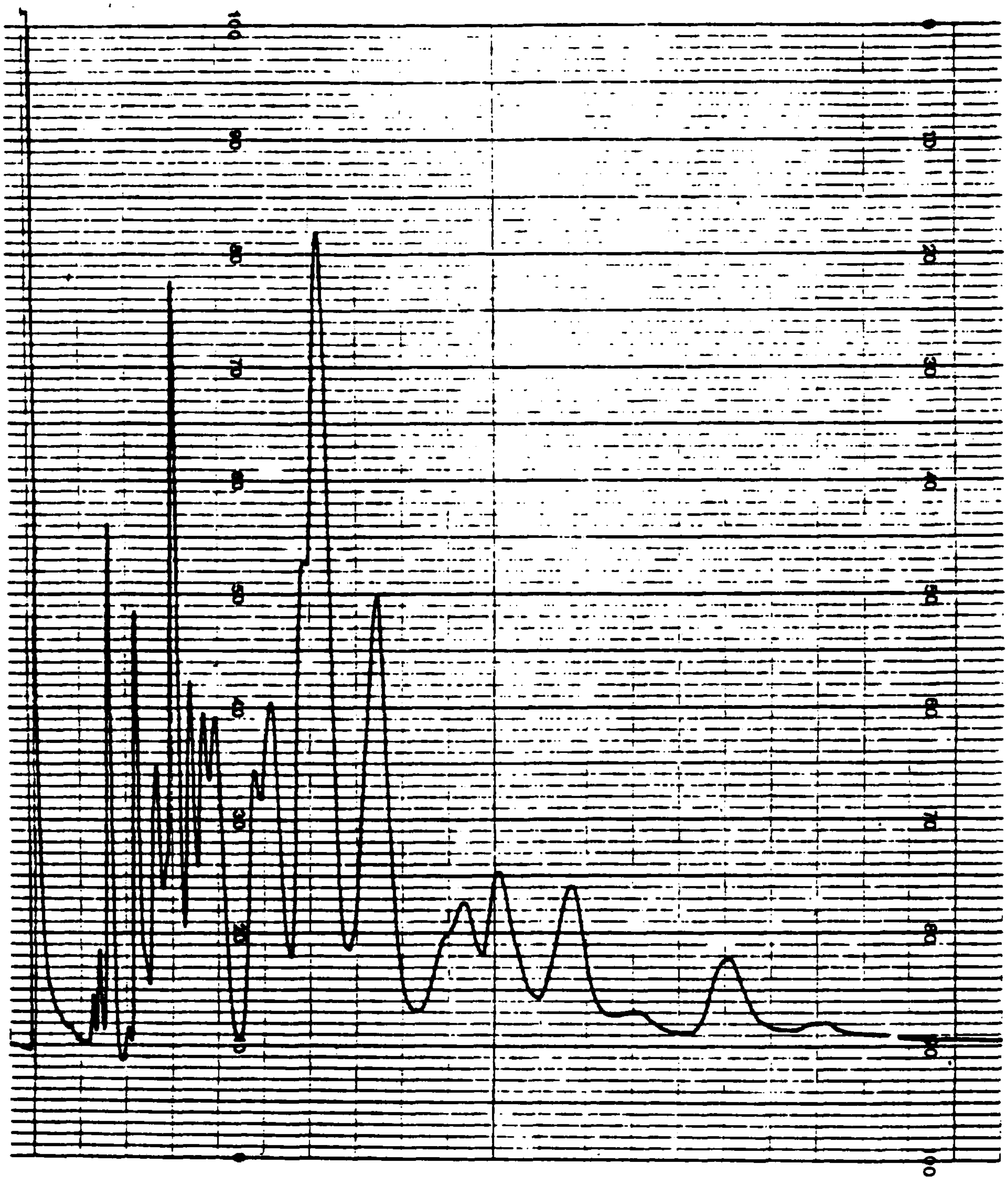


Figure 1. Chromatogram of an Aroclor 1242 standard.
from: Stratton, et al. (9), page 31.

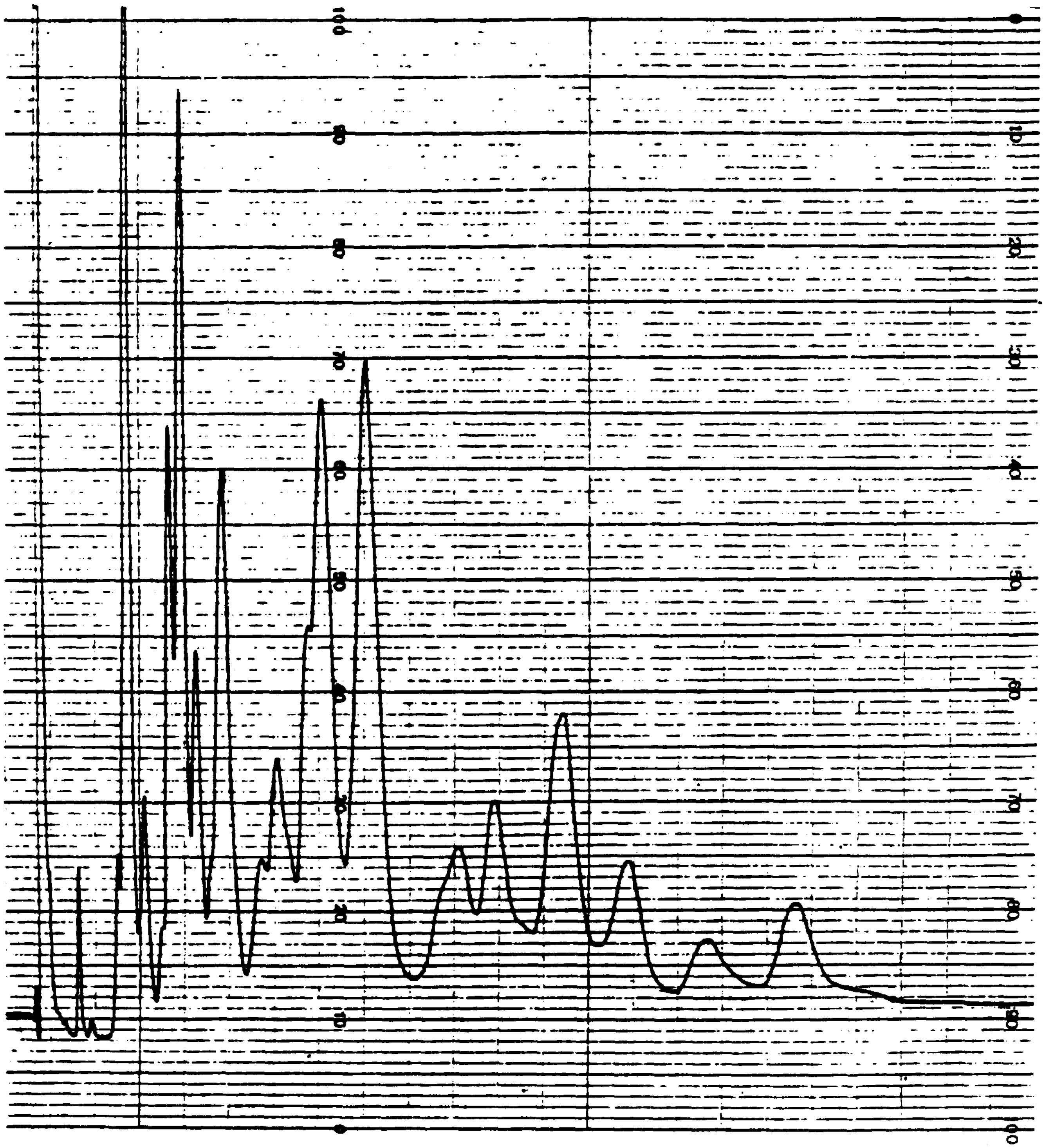


Figure 2. Chromatogram of a One Hour Ambient Air Sample Taken at the New Bedford Municipal Landfill.
from: Stratton, et al. (9), page 30.

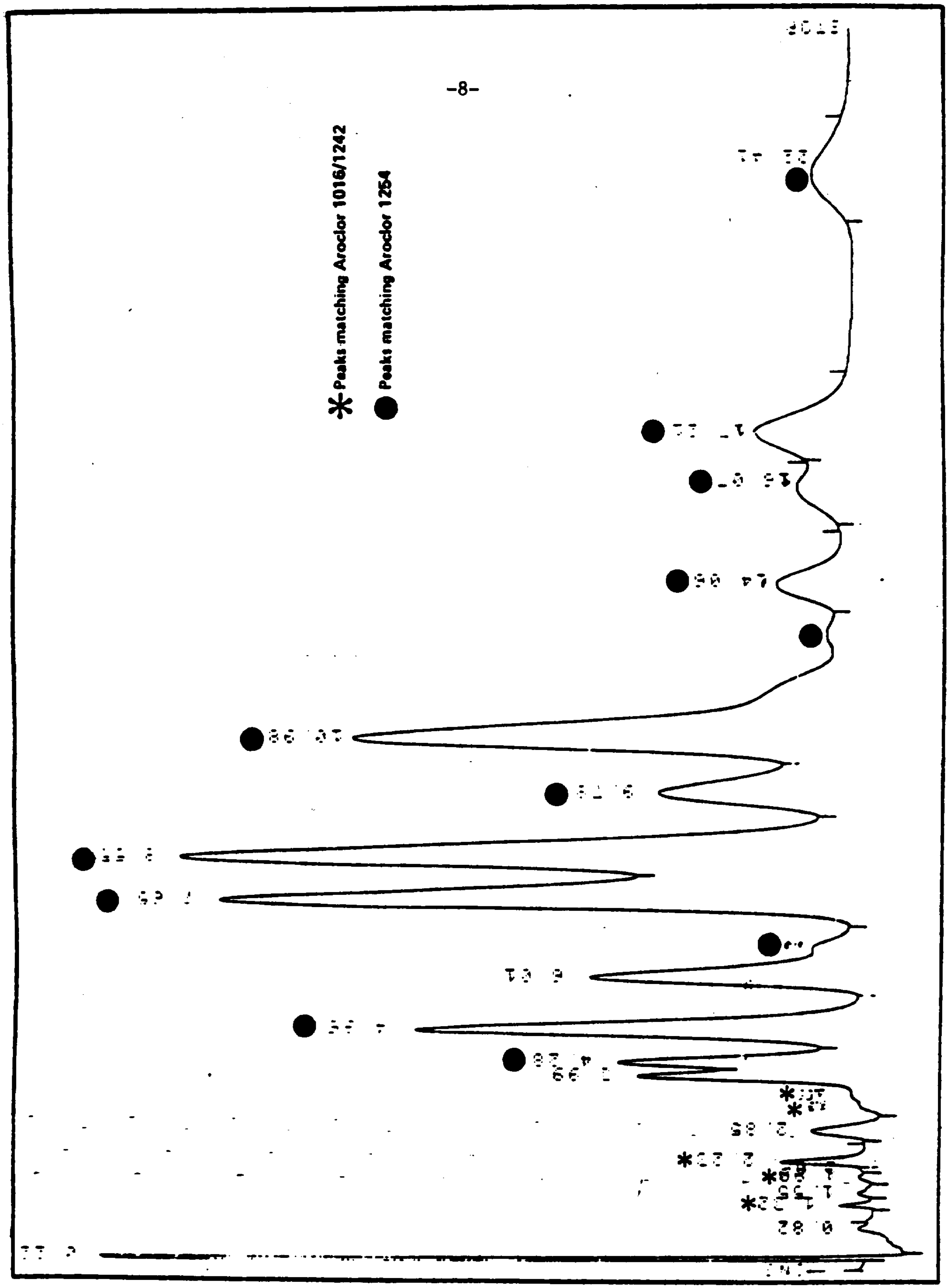


Figure 3. Chromatogram of a Herring Gull Egg.
from: Stratton, et al. (9), page 29.

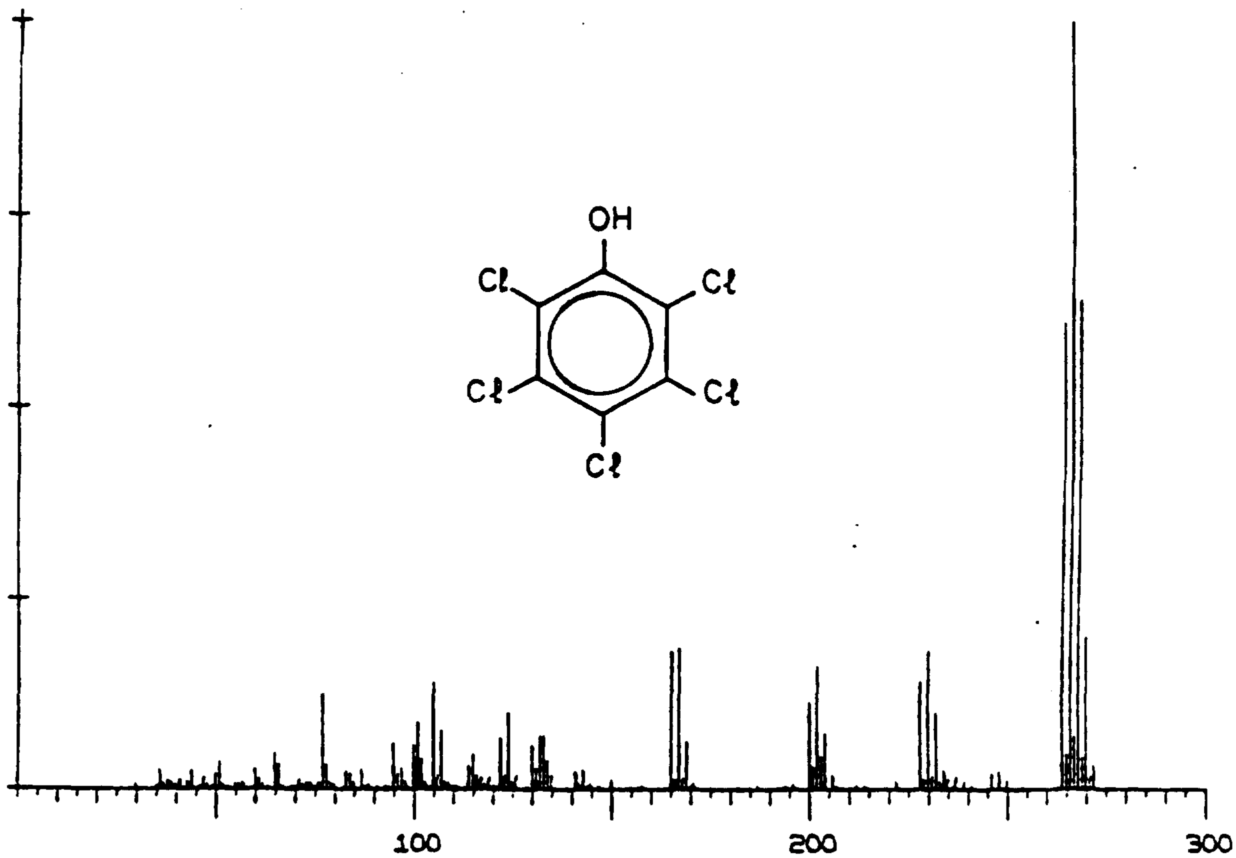


Figure 4. Gas Chromatograph / Mass Spectrophotometer Analysis of Pentachlorophenol. from: Biemann (10).

HEALTH AND ENVIRONMENTAL EFFECTS OF PCBs

PCBs are the only class of chemical compounds whose manufacture has been banned by the U.S. Environmental Protection Agency (11). Scientific studies have documented the toxicity and biological hazard of PCBs to many organisms. Several studies are referenced in this section.

First recognized as a problem by scientists in 1954 (12), PCBs came to world-wide attention in 1968 when over 1,000 individuals in Yusho, Japan became ill after consuming rice bran oil which had been contaminated with Kanechlor 400, a Japanese brand of PCB containing 48 percent chlorine (by weight). The average amount of PCB consumed by affected individuals was 2 grams (2,000 milligrams), with symptoms appearing at doses as low as 500 milligrams. As a result of this incident Japan subsequently banned import and production of PCBs (2).

PCBs made big news in this country when it was discovered that high levels of these compounds were present in Lake Michigan salmon. Today these compounds are found all over the globe in such diverse locations as Arctic polar bears, New York State chickens, England's rainfall, the world's oceans and human milk (2).

Serious adverse health effects from a single, short-term exposure to PCBs are unlikely, however scientists are concerned about the effects caused by long-term, low level exposure to these compounds.

PCBs have a low solubility in water and do not volitilize easily into air. They are not normally found in these media at concentrations greater than one part per billion (water) or nanograms per cubic meter (air). Thus, even though PCBs may be present at levels too small to be detected without sophisticated laboratory equipment, small concentrations can cause concern.

PCBs tend to be adsorbed onto sediment particles and not be available for direct biotic uptake. However, in areas where sediments are sufficiently contaminated, some will be released into water or air. Their subsequent movement into the food chain follows various pathways.

In the primary pathway of terrestrial PCB pollution, the chemical enters the atmosphere, attaches to fine particles, and is deposited on vegetation. The material is then available to the food chain through ingestion by herbivores. In aquatic environments, PCBs in the water may be taken up by organisms via two principal routes; direct absorbtion through gill membranes and other exposed tissues, or from the food chain via ingestion. Which of these pathways contributes more to the body burden of the organism depends directly on PCB concentrations. In areas where the water is highly contaminated, most uptake is through the gills. So much water, and dissolved contaminant, are passed over these tissues that invariably some PCBs are taken up. In areas of lesser contamination, most PCBs originally enter the food chain through ingestion of single-celled organisms to which PCBs have adsorbed.

The few reported measurements of PCB concentrations in ambient air from the U.S. have shown wide variations in levels. Results available from oceanic and rural continental areas indicate atmospheric PCB levels in the range between 0.002 and approximately 2 ng/m3 (1). Test results from suburban and urban sites have shown most values in the 1 to 10 ng/m3 range (1). One report, covering three urban areas, found levels averaging approximately 100 ng/m3 (83).

The concentration of PCBs in fresh water is generally in the range of 1-3 ng/l (parts per trillion). The waters of Lake Michigan are believe to contain an average PCB level of 31 ng/l (1).

There is great regional variation in the degree of PCB contamination in freshwater sediments throughout the U.S. The highest PCB levels are in industrial areas, particularly in the eastern part of the country. The area from the Pacific coast to the Continental Divide has the lowest PCB level in sediments ranging from 2-20 ppb. The highest "background" values reported are in the Appalachian Mountain-Atlantic coast region where sediments with values ranging from 100-500 ppb have been found (1).

Data on PCB levels in oceans are very limited. Existing data indicate generally higher PCB levels in the waters of the North Atlantic than in the Pacific Ocean and Gulf of Mexico. Surface water values in the New England coastal region range from 0.8 to 8 ng/l (parts per trillion) (1). Surveys of marine sediments in the North Atlantic Ocean vary considerably. For example, off Nova Scotia values were undetectable; off Long Island and New Jersey, PCB levels were 10 and 40 ug/kg (or ppb) respectively (1); and in an area of the Acushnet River estuary in New Bedford, Massachusetts, samples measured several thousands of parts per million PCBs (14,15).

PCBs are not generally detected in agricultural soils. The estimated average soil concentration for metropolitan areas in the U.S. is about 2 ug/kg (ppb) (1).

The extent of PCB contamination in foods has been monitored by the U.S. Food and Drug Administration and the U.S. Department of Agriculture since 1969. Their surveys indicate that the incidence and levels of PCBs have dropped in nearly all food classes. By 1975, the only significant sources were fish, meat, and dairy products; and fish were by far the most significant source. Comprehensive fish surveys conducted by the USFDA in 1973 and 1974 indicated a drop in the incidence of PCB detection in fish from less than 30 percent in 1973 to less than 20 percent in 1974. Even though the incidence dropped, however, the fraction of fish found to contain PCBs at levels exceeding 5 ppm increased. These surveys provided no information about sport fish per se, yet indicated that high levels of PCBs do not generally occur in saltwater fish (16).

The Environmental Protection Agency has estimated that half of the U.S. population contains 1-2 ppm of PCBs in their adipose (fat) tissue (8). Human PCB exposure generally occurs through environmental exposure. PCBs are commonly found in the fat of people who have not been occupationally exposed. PCBs concentrate mainly in fat, although they have also been found in the kidney, liver, brain, muscle, skin, and blood.

Because human milk is largely fat, compared to other body fluids it contains relatively high levels of PCBs. The average PCB concentration found in a 1977-78 study of human milk in Michigan women was 1.5 ppm, measured as a fat basis (17). Breast fed infants may receive more than 50 times the concentration of PCBs that is in the food eaten by their mothers (2). By 3-4 months, the blood levels in nursing infants may exceed that in their mothers (85) and levels will continue to rise as nursing continues. Although some PCBs may be passed through the placenta, the principal pathway into infants is through mother's milk.

Human Health Effects

Human exposure to PCBs can occur through a number of different routes: occupational exposure, ingestion of contaminated foods or water, exposure to contaminated air, soil or water, as well as transmission from mother to child through breast feeding. Because of the low concentrations and the subtle nature of the toxic effects, it is extremely difficult to correlate changes in the health of human and animal populations with environmental exposure to PCBs.

Although a large percentage of the human population has been exposed to PCBs, there are only a few well documented cases of health problems associated with such environmental exposures. Therefore, a detailed evaluation of the effects on human health in the general population is not currently available.

The largest recorded case of "PCB poisoning", which occured in Yusho, Japan in 1968, serves as a good example of the complications encountered when attempting to correlate cause and effect. The typical clinical findings of "Yusho" disease included chloracne with increased pigmentation of the skin, increased eye discharge, transient visual disturbances, feeling of weakness, numbness in limbs, headaches, and disturbances in liver function (2,16). Follow-up research revealed that infants born to women exposed were born with brown pigmentation of the skin and were smaller than normal. These health effects slowly regressed as the infants aged.

Because PCBs are slowly excreted in breast milk, infants born up to 3 years after the mother's exposure had abnormal skin pigmentation, presumably caused by suckling on contaminated breast milk. While many of the clinical effects of PCBs are reversible, it may take several years for the symptoms to disappear. This phenomenon is probably a result of the long biological half-life of the contaminant (1,18).

Originally, the effects seen in the Yusho incident were attributed to PCBs. However, subsequent measurement by gas chromatography of samples of the contaminated rice oil indicated that it contained not only PCBs (150-1,000 ppm) (19,82), but also polychlorinated dibenzofurans (PCDFs, 2-8 ppm) (82), and polychlorinated quaterphenyls (PCQs, 490-866 ppm) (82). The latter two contaminants amounted to .9 to 3.5 times the concentration of PCBs in the oil, depending on the sample (20,21,82).

Uncertainty about the confounding effects of PCBs, PCDFs and PCQs make it difficult to determine from the Yusho data exactly what effect, or effects, exposure to PCBs alone could have on humans. The toxicity of PCDFs are considered to range from 200 to 500 times that of PCBs (22) and PCDFs have been associated with embryonic mortality and birth defects observed in experiments conducted on birds. There is presently little information available on PCQ toxicity. However, fat and blood samples taken from Yusho patients demonstrated that PCQs were elevated in the tissues of the exposed individuals.

PCBs have been found to be easily absorbed through the gastrointestinal tract, respiratory tract and skin. They are initially stored in liver and muscle tissues and then redistributed primarily to fat tissues. The degree to which PCBs are stored in the body or excreted depends upon the degree of chlorination of the PCB isomers. PCB isomers having a higher number of chlorine atoms are metabolized and excreted more slowly and accumulate to a higher extent in fat tissue. It is likely that metabolized PCBs are excreted in bile, urine and milk. Unmetabolized PCBs may be excreted in the feces, milk, hair and urine. Excretion in the urine is most prominent for the least chlorinated, while the bile becomes the more significant route of excretion for more highly chlorinated isomers. PCBs can be transferred to the fetus transplacentally and to infants by breast feeding (1,23).

Events such as that of Yusho, and preliminary laboratory results, suggest that PCBs may have profound toxic effects on human health, particularly when repeated exposures occur. PCBs are accumulated in the body and metabolized for long periods of time, resulting in the induction of liver microsomal enzymes (23). Some of the effects on health that may be attributed to low-level exposure to PCBs are abnormal fatigue, abdominal pain, numbness of limbs, swelling of joints, chronic cough, menstrual irregularity, and headaches. Abnormal tooth development, hyperpigmentation, and low weight in newborn children may also be complications resulting from PCB exposure. Abnormalities in blood lipids, anemia, lymphocytosis and adrenocortical hypofunction have been recorded in a number of chronic diseases associated with PCB intoxication. In addition to dermatological abnormalities, such as acne and hyperpigmentation, there have been suggestions of increased incidence of cancer in some of the Japanese who were exposed to PCB through contamination of cooking oil (16,24).

Follow-up studies of the Japanese who suffered "Yusho" disease noted that of the deaths that occurred up to five and one-half years after the first exposure to PCBs and other contaminants, nine of 22 (41 percent) were due to malignant neoplasms. Three of the tumors occurred in the stomach, one in the liver (with cirrhosis), two in the lungs and one in the breast, and two were malignant lymphomas. An additional liver cancer was mentioned in connection with one of the stomach cancers, but it is not clear whether this was an additional primary cancer or a metastasis from the stomach. Whether these cancer deaths represent an elevated incidence rate is uncertain because no baseline estimate of the numbers or types of tumors that could be expected in this group has been established (24).

Studies of individuals in other situations support the notion that PCBs are human carcinogens. These results are, however, inconclusive. In a study of chemical workers, two malignant melanomas were diagnosed in thirty-one workers exposed heavily to Aroclor 1254 (and also exposed to other chemicals). Among forty-one other workers less heavily exposed to Aroclor 1254, one additional melanoma was diagnosed. Among the 31 heavily exposed workers, three other individuals developed four cancers at other locations in their bodies, including two pancreatic cancer cases (24).

There is experimental evidence of a carcinogenic effect of certain PCBs in rodents (i.e., Aroclor 1260, 1254 and 1242) (24). Although no epidemeological studies have conclusively linked PCBs with cancer in humans, the body of research done in animals has made these compounds suspect human carcinogens.

The International Agency for Research on Cancer (IARC), an agency within the World Health Organization, reviewed the animal and human findings and concluded that the data provide "suggestive evidence" of a relationship between PCBs and the development of malignant melanomas. Thus, until confirmatory evidence is produced the IARC believes that PCBs should, for practical purposes, be regarded as carcinogenic to humans (24).

The potential for reproductive abnormalities occurring as a result of chronic exposure of PCBs has been suggested by the results of controlled experiments using various species, such as fish (84), birds (86), and particularly in mammals including nonhuman primates. In addition to alterations in the menstrual cycle and births of abnormally small infants, experimental monkeys experienced a greater frequency of early abortions following low-level exposure to PCBs (5 ppm Aroclor 1248 in the diet for six months). Infants born to mothers exposed to PCBs during gestation and lactation also showed some loss of immunological competence as well as learning and behavioral deficiencies. These abnormalities persisted indefinitely (2,25).

Research sponsored by the Wisconsin Sea Grant program and conducted by James Allen, a pathologist with the University of Wisconsin - Madison Medical School and the Regional Primate Research Center, involved the feeding of PCBs to monkeys and subsequent monitoring of reproductive effects. The results of these experiments possess implications for humans since humans have metabolic pathways similar to those of monkeys.

Allen fed eight female Rhesus monkeys 2.5 and 5 ppm Aroclor 1248 in their diet for six months during which time they were mated to unexposed males (i.e. males maintained on a PCB-free diet). Six of the eight females fed at 5.0 ppm conceived but only one carried to term. All of the eight animals fed at 2.5 ppm conceived and five gave birth. PCB levels in milk during nursing ranged from 3.85 - 9.9 ppm on a fat basis. Within two months following birth, the infants experienced loss of facial hair, acne, swelling of the eyelids and pigmentation of the skin. Three of the six infants died during their first year of life.

To evaluate any potential prolonged effects on female primates, the same females were again mated to unexposed males one year after the females had been taken off the PCB diet. The resultant offspring showed considerable weight variation and the infants from the 5 ppm group were generally smaller than historical control infants. The infant monkeys were exposed to PCB levels of from 0.9 to 1.25 ppm (on a fat basis) in milk and showed signs of PCB poisoning (25,27).

Allen's findings demonstrate that PCBs may be toxic to primates over a wide dose range. This is particularly important in that the metabolic system of the monkeys is comparable to that of humans. Although the possibility of man consuming a steady diet containing these concentrations of PCBs is remote, these findings point out that small amounts of PCBs can be toxic and that a safe level of consumption has not yet been established.

Environmental Effects / Findings

A study from the National Academy of Science reports: "In early 1960, mink ranchers began noticing reproductive complications and excessive kit mortality among their stock. An acute problem was evident by 1967, resulting in an unprecedented 80 percent increase in newborn mortality. Subsequent investigation indicated a strong relationship between kit mortality and the percentage of coho salmon in the mother's diet, as well as the duration of feeding with a salmon diet. Factors such as rancidity, pesticide contamination and mercury poisoning were suspected but were shown not to contribute to the problem. Experiments with the mink diet were conducted, and the results indicated that diets of 30 percent salmon produced the reproductive problems." (1, page 119.)

The coho salmon were found to contain elevated levels of PCBs and the kit mortality was attributed to the ingestion of PCBs. Later studies showed that mink fed a diet containing 5 ppm Aroclor 1242 suffered complete reproductive failure. Aroclor 1016 was also found to impair reproduction, but not as dramatically as 1242 (28).

"In 1977, a poultry firm began noticing high chemical levels in tissue samples taken from their chickens. The feed supplier was asked to help in pinpointing the cause, and the culprit was found to be fish meal contaminated by PCBs that had been used in formulating the chicken feed. The fish meal had been prepared and stored in Puerto Rico at a Ralston Purina plant warehouse where two electrical transformers containing PCBs were stored also. Contamination of the meal occurred during a fire in April 1977, which damaged the electrical equipment and allowed PCBs to leak out. Water from fire hoses evidently mixed with the PCB fluid and soaked into the stored fish meal. The contamination was not detected and the fish meal was subsequently sold. As a consequence, 400,000 chickens and 15,000 dozen eggs were destroyed. Some of the contaminated feed did not actually contain the PCB fish meal, but the feed had been processed with the same machinery as the fish meal." From: NAS (1), page 121.

PCB levels in wildlife may be increasing. First noticed in birds in 1966, PCBs have subsequently been detected in all organisms examined in the North and South Atlantic (2). Elevated levels of PCBs have been observed in New York State snapping turtles (29), bald eagle eggs collected in Alaska and several continental U.S.A. locations (30), game birds (31) and Ascension Island green turtles (32).

"The effects of PCBs are more severe in birds and higher mammals than they are in lower vertebrates and invertebrates. The most serious consequence in birds is reproductive failure, although other symptoms such as kidney, heart and liver damage can also occur. Fish take in PCBs both through the food chain and directly from the surrounding water through gills and skin. Fish can contain very high concentrations of PCBs without being severly affected although it may affect their reproduction. Shellfish, oysters and shrimp, on the other hand, are highly sensitive to PCBs - only very small concentrations in the water can kill them.

..."Fish can take up PCBs through their gills, fins and skin. PCBs also adhere to small particles in the water and thus are taken in by lower forms of aquatic life and passed up through the food chain to the top predators, fish and fish-eating birds and mammals. Scientists have found that some fish contain concentrations of PCBs that are 100,000 to a million times greater than the concentrations in surrounding waters.

"Scientists are not yet sure whether PCBs are significantly reducing wildlife populations, but there are indications that they may be. As is the case with DDT, birds and mammals high on the food chain, especially those consuming fish, are hard-hit. High PCB concentrations have been found in herons and scaups in New York, petrels and peregrine falcons in California, eagles in Sweden and the U.S., terns in Florida and gulls on the Great Lakes, to mention a few. Like DDT, PCBs degrade Vitamin D and estrogen in birds, resulting in eggshell-thinning and reproductive failure." From: Wisconsin Sea Grant (2), pages 2,4.

A summary of the chronic toxic effects of PCBs is presented in Table 2.

Table 2. Summary of Chronic Toxic Effects of PCBs*

TEST	EFFECTS
Chronic Feeding	
Aquatic Species	Threshold effects in egg hatchibility of vertebrates and invertebrates at levels of 2 to 5 mg/l
	Embryo toxicity evident at 50 mg/l
Terrestrial Species	Mouse - some liver change with exposure to highly chlorinated products; 300-500 mg/g
	Rat - some liver changes, minimal reproductive effects; 100-500 mg/g
	Monkey - Yusho symptoms, altered reproduction cycles, hyperplastic gastritis and ulceration; 2.5-5 mg/g
	Chicken - some morphologic deformity, reproduction decline, subcutaneous edema; 20-50 mg/g
	Mink - dose response relationship in growth and reproduction; 10 mg/g
	Dogs - reduced growth, some liver changes; 100 mg
	Pelican - some hepatocellular changes; 100 mg
	Wildfowl - some reproduction changes, varies with species; 50-200 mg/g
Teratogenicity (birth defects)	Effects seen in avian species; 50-200 mg/g
Mutagenicity (genetic alterations)	Chromosomal abnormalities - negative results
	Dominant lethal mutations - negative results
	Ames test - Aroclor 1221; significantly mutagenic
Oncogenicity (tumor causing)	Highly chlorinated compounds produced tumors in rats and mice, relationship with PCB not always clear

*taken from: NAS (1), page 123.

PCB LIMITS AND STANDARDS

To protect American consumers from PCB-related illnesses, the U.S. Food and Drug administration has established limits for various foods. The limit for fish and shellfish is 5 parts per million (wet weight) of total PCBs in the edible portion of the foodstuff. Canada has established a fisheries limit of 2 ppm (also wet weight), and this level was proposed as the United States standard in 1977 (16). In 1979 the 2 ppm level was promulgated for fisheries in the U.S. (26) but has since been stayed by legal action. All of the U.S. FDA limits on PCBs currently in effect are presented in Table 3 below.

Table 3. U.S. FDA Limits on PCB Concentration in Foodstuffs.*

FOOD	CONCENTRATION (wet weight)
Fish and Shellfish	5.0 ppm (edible portion)**
Milk and manufactured dairy products	1.5 ppm (fat basis)
Poultry	3.0 ppm (fat basis)
Red meat	3.0 ppm - action level (fat basis)
Eggs	0.3 ppm
Infant and Junior foods	0.2 ppm
Paper food package in direct contact with foodstuff	10.0 ppm - action level
Animal feed components of animal origin	2.0 ppm
Feed for food-producing animals	0.2 ppm (except concentrates, supplements and pre-mixes)

* source: Federal Register (26)

** USFDA lowered this standard to 2 ppm in 1979, however challenges by the seafood industry have resulted in the courts ordering a temporary stay (87).

The 1973 USFDA tolerance level of 5 ppm in fish and shellfish was based on an evaluation of all available animal and human toxicological data. The key human study used to determine an acceptable daily PCB intake was the incident in Japan where over 1,000 persons consumed rice bran oil contaminated with PCBs (Kanechlor 400). The average dosage of PCBs that caused overt health effects was 2,000 milligrams. Although this dosage was received in approximately fifty days, 2,000 mg was divided into a 1,000 day exposure period. A safety margin of 10 was applied to this value to determine that 200 ug/day would be an acceptable PCB intake (26).

Considering average fish consumption, the FDA calculated that a 5 ppm PCB level in fish, in addition to all other dietary sources of PCBs, would not exceed the 200 ug/day intake. Nonetheless, when this tolerance level was established by the FDA in 1973, it was termed "temporary" because: (a) it was calculated as a 1,000 day, not a lifetime, exposure and (b) it was assumed that PCB levels would decrease with time. This standard, was based on average fish consumption and did not take into account unusually high levels of fish consumption as might be found along the coast. Thus, when the temporary tolerance level of 5 ppm was set, the FDA planned to reevaluate the standard during the next few years.

In 1977, the U.S. FDA proposed that the tolerance level for fish be reduced from 5 ppm to 2 ppm when it was found that the PCB levels in fish had not decreased since 1973. The FDA proposed to reduce the tolerance level to more adequately protect the public health after further toxicological testing demonstrated potential mutagenic, carcinogenic and reproductive effects at low levels. The FDA concluded that a no-effects threshold, and thus an allowable PCB intake, could not be conclusively determined.

Since a zero tolerance level would be impractical, the FDA evaluated the possibility of lowering the guidelines by taking into account economic factors. A 1 ppm guideline was considered, but was not proposed because the FDA decided that the public health protection afforded, at least theoretically, did not justify the greater loss of food that would result. It was calculated that there would be an economic loss of $16 million per year in landings associated with this standard. Instead, the FDA chose 2 ppm as the tolerance level necessary to protect public health even though this guideline would cause an estimated economic loss of about $5.7 million per year (26).

Following the announcement of the 2 ppm PCB tolerance level, implementation of the new regulation was stayed in 1979 as a result of objections by the National Fisheries Institute (NFI). A final rule establishing this level, promulgated in 1979, was also stayed. A hearing is scheduled for 1982 and will consider only the magnitude of human food loss from reducing the tolerance level from 5 ppm to 2 ppm. The 5 ppm concentration will remain as the enforceable tolerance level for total PCBs in fish until the courts settle this matter.

At this time, there are no federal standards for PCB concentrations in ambient air or drinking water.

In 1977, the National Institute for Occuational Safety and Health (NIOSH) recommended a 1 ug/m3 PCB concentration in workroom air. This concentration is judged adequate to protect the health and provide for the safety of employees for up to a 10 hour workday, 40 hour workweek, over a working lifetime.

This 1 ug/m3 PCB atmospheric level was based on findings of adverse reproductive effects, potential human carcinogenicity and the failure to demonstrate the existence of a "no effects" level for injury to the liver. Although NIOSH recommended changing the occupational atmospheric standard to 1 ug/m3 (23), OSHA has not altered its federal standard of 1 mg/m3 for Aroclor 1242 and 0.5 mg/m3 for Aroclor 1254 (33).

Wastewater discharges of PCBs are regulated by the USEPA under 40 CFR s.129.105. This regulation is implemented through the National Pollution Discharge Elimination System (NPDES) permitting program. Discharge of PCBs by electrical capacitor manufacturers is severely limited through this program. The permits issued to two companies in New Bedford allow for continuing residual trace discharges of the chemical.

The disposal of PCB contaminated oils, soils, sludges, et cetera is regulated by the EPA under 40 CFR s. 761 (35). Oils which contain PCBs in concentrations exceeding 500 ppm (dry weight) must be disposed in an incinerator which complies with specific EPA "Annex I" guidelines. 40 CFR s.761.10 allows for the disposal of oils contaminated to a lesser degree - 50 to 500 ppm - by chemical waste landfilling or incineration in either a high efficiency boiler or Annex I incinerator.

All non-liquid wastes in the form of soil, rags, or debris must be disposed in an Annex I incinerator or chemical waste landfill if the PCB content exceeds 50 ppm dry weight. All dredge spoils and municipal sewage sludges containing PCBs in excess of 50 ppm (dry weight) must be disposed in an Annex I incinerator, chemical waste landfill or in a specially approved disposal site (35).

On October 30, 1980 the U.S. Court of Appeals for the District of Columbia required EPA to revise the 50 ppm limit, after ruling that insufficient scientific evidence had been presented to support it. The limit does, nonetheless, remain in effect on a temporary basis while EPA proceeds with the process of establishing a new standard.

THE NEW BEDFORD PCB PROBLEM

New Bedford, Massachusetts is a port city located on Buzzards Bay approximately 55 miles south of Boston. With a 1980 population of 98,500, New Bedford is Massachusetts' fourth largest municipality (36).

New Bedford is nationally known for its role in the development of the whaling industry and as the largest revenue-producing fishing port on the East Coast. New Bedford can accurately be referred to as "the scallop capital of the world." Surpassing Nantucket as the world's largest whaling port in 1830, New Bedford has historically been inextricably linked to the sea. In 1845, New Bedford was the nation's fourth largest port, surpassed only by New York, Boston and New Orleans.

The discovery of oil in Pennsylvania in 1860 signaled the beginning of the end for the whaling industry. Ironically, it was on New Bedford's own Fish Island that the process of refining petroleum was perfected. The decline of the whaling industry, already hurt by new found oil reserves, accelerated during the Civil War when Confederate raiders, most notably the Shenandoah and the Alabama, sank some fifty New Bedford whaling ships on the high seas.

The whaling industry's decline continued after the end of the war. The destruction of twenty-one whalers in the northern ice of Point Barrow in 1871 virtually signaled the end of New Bedford's whaling industry, although a few whalers sailed from New Bedford until 1920.

As the whaling industry foundered, the textile industry flourished. During the half century following the Civil War, 26 cotton textile mills were constructed along the New Bedford shore of the Acushnet River. New Bedford's textile industry concentrated on the production of fine cotton goods and became the world's leading producer in the late 1800's. The economic prosperity based on the textile industry lasted until the 1930's when the Great Depression dealt the industry a blow from which it never recovered.

Since the end of World War II, the City has attempted to broaden its economic base through the creation of an industrial park and other incentives designed to encourage the movement of new industry into the area. Two of the mainstays of the New Bedford economy, Aerovox Incorporated and Cornell Dubilier Electronics Incorporated are housed in old textile mill houses located on the banks of the Acushnet River estuary. Their use of polychlorinated biphenyls has brought a new series of problems to the New Bedford community.

Extensive PCB contamination of New Bedford Harbor was documented in 1976 when the Environmental Protection Agency conducted a New England-wide PCB survey and found high levels of the chemical in various harbor locations. Testing revealed that two industrial operations, Aerovox and Cornell Dubilier were discharging wastewaters containing PCBs to New Bedford Harbor both by direct

COMMONWEALTH OF MASSACHUSETTS

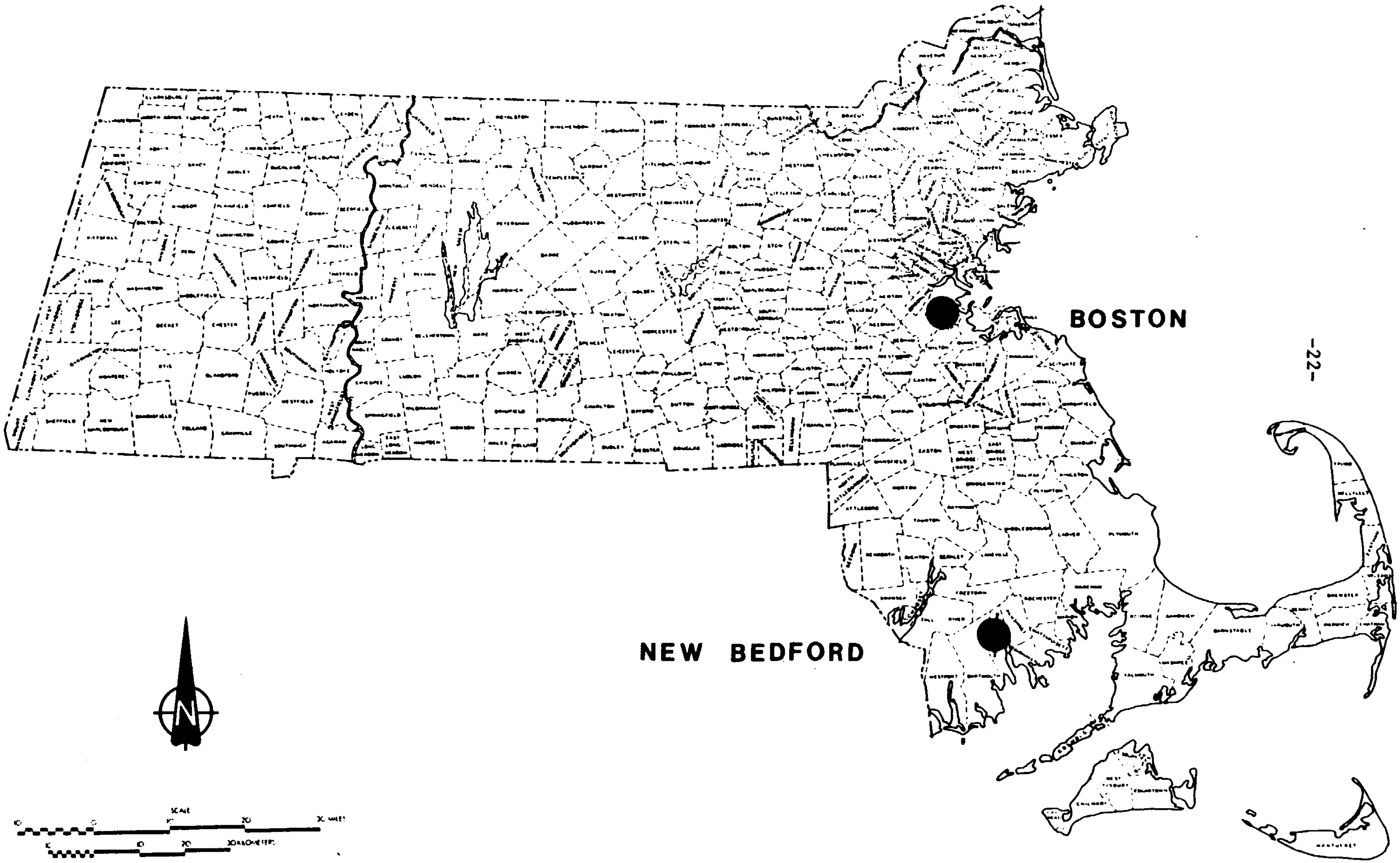


Figure 5. Locational Map

discharge and indirectly via the New Bedford Municipal wastewater treatment facility (37).

Since this initial survey of the New Bedford area, a much better (although not yet complete) understanding of the extent of PCB contamination has been gained. The direct discharge of PCB contaminated wastewater from Cornell Dubilier has been significantly reduced while the Aerovox discharge has been nearly eliminated. The discharge of PCBs from New Bedford's municipal wastewater treatment plant however, remains significant. Recent studies have shown that 200 to 700 pounds of PCBs are being discharged per year (38,39,40, 41,64).

The sediments underlying the entire 985 acre New Bedford/Fairhaven Harbor contain elevated levels of PCBs. Concentrations range from a few parts per million to over 100,000 ppm. Portions of western Buzzards Bay sediments are also contaminated, with concentrations occasionally exceeding 50 ppm (77). The water column in New Bedford Harbor has been measured to contain PCBs in the parts per billion range (42), well in excess of EPA's 1 part per trillion guideline (43).

Widespread contamination of the Acushnet River estuary environs has resulted in the accumulation of PCBs in many marine species. Thousands of acres have been closed to the harvesting of shellfish, finfish and lobsters because of PCB pollution. Figure 7 shows the three closure areas established by the Massachusetts Department of Public Health on September 25, 1979 (44). Area I (New Bedford Harbor) is closed to the taking of all finfish, shellfish and lobsters. Area II is closed to the taking of lobster and bottom feeding finfish (eels, scup, flounder and tautog). Area III is closed to the taking of lobsters. Responsibility for enforcement of these closures is entrusted to the Massachusetts Division of Law Enforcement. (It must be noted that large portions of the estuary and Harbor also are contaminated by elevated levels of fecal coliform and heavy metals. These also affect harvesting of fish, shellfish and crustaceans.)

Much of the PCB sampling done before 1980 was analyzed for only one PCB blend, Aroclor 1254. Woods Hole Oceanographic Institution scientists have presented evidence suggesting that the PCB contamination is often understated by factors of three to five (81). If so, the extent of PCB contamination in New Bedford Harbor and Buzzard's Bay is greater than much of the historical data indicate.

Considering only Aroclor 1254, the PCB levels in five finfish species have been found to exceed the U.S. Food and Drug standard of five parts per million. Of 183 lobsters sampled between 1976 and 1980, a median concentration of 4.9 ppm was found in edible tissues. The average value was 8.7 ppm, the maximum 84 and the minimum 0.1. These values include all lobsters analyzed in Areas I, II, III and beyond, thereby representing lobsters captured in a twenty-eight square mile, or 18,000 acre, area. Table 4 presents data on the finfish results.

The New Bedford Municipal landfill contains over 500,000 pounds of PCBs

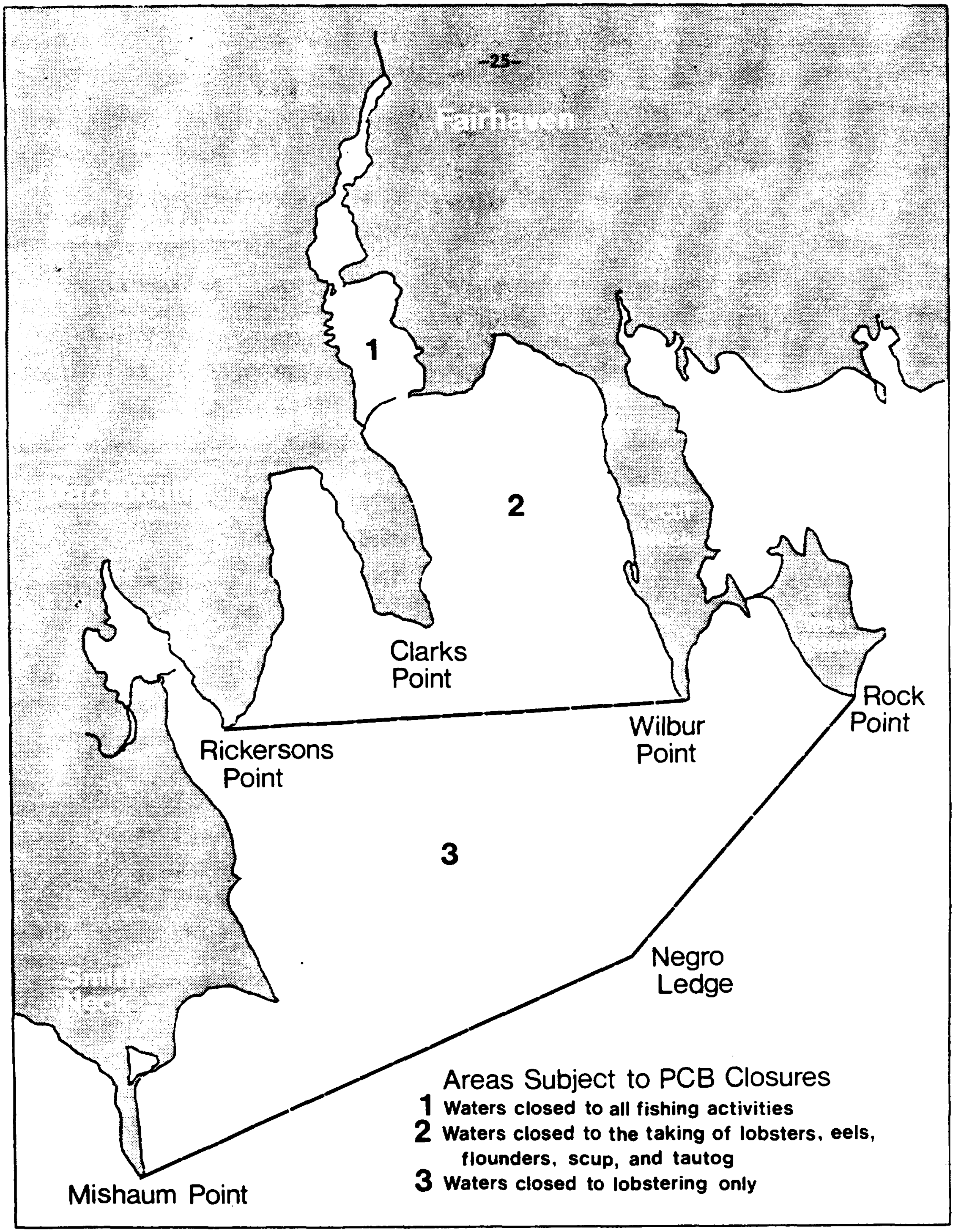


Figure 7. Fishing Closure Areas established by the Massachusetts Department of Public Health.

Table 4. PCB Concentrations in New Bedford Area Finfishes (1976-1980).

Species	Median	Mean	High	Low	No. Sampled
American eel	24	131	730	11	32
Cunner	38	38	57	20	2
Summer flounder	7.4	9.3	22	0.2	10
Window pane	5.5	8.8	14.3	3.1	30
Winter flounder	6.8	6.4	22	0	44
Silver hake	3.5	3.5	6.4	0.7	2
Scup	2.3	2.1	11.4	0	50
Bluefish	0.3	2.1	16.5	0.2	11
Tautog	0.9	1.7	11.0	0.1	17
Striped bass	0.9	1.2	3.0	0.1	8
Fourspot flounder	0.8	0.8	—	—	1
Butterfish	0.5	0.5	0.9	LT 0.1	4
Black sea bass	0.4	0.4	—	—	1
Dogfish	0.2	0.2	—	—	1
Red hake	LT 0.1	LT 0.1	—	—	1

LT = less than

Data compiled from Kolek and Ceurvels (45).

New Bedford landfill

(9,37). Waste products from Aerovox, Cornell Dubilier, and the New Bedford sewage treatment plant have been disposed in this landfill. Most of the PCBs disposed at the landfill are contained in reject capacitors from Aerovox and Cornell Dubilier.

Contaminated waste oils and other materials from these industries were, it is believed, also disposed at the landfill. The residuals removed in the wastewater treatment process including grit, sludge and ash are the major remaining source of PCBs entering the New Bedford landfill.

Two other areas known to contain substantial quantities of PCB wastes are the properties of Aerovox and Cornell Dubilier. Landfilling at these two sites has taken place over the years and some of the materials used as fill were apparently contaminated with PCBs. Even today capacitors containing concentrations of PCBs in the thousands of parts per million litter the New Bedford Harbor foreshore behind the Aerovox factory. Upland sediments in the vicinity of Cornell Dubilier contain up to 99,000 ppm (dry weight) PCBs (47). This is nearly equivalent to 10 percent PCB by weight.

Other sites in New Bedford are suspected to contain substantial quantities of PCBs. One, Sullivan's Ledge, is located on Hathaway Road near the municipal landfill. This site, a former quarry is now a vacant lot. The filling of the quarry occurred when the City of New Bedford used the area as a dumpsite for brush, rubble, demolition and industrial wastes (48).

Waste oils containing PCBs were reportedly used by New Bedford, and possibly other, municipal public works departments in the oiling of local roadways (49). In summary, past activities in New Bedford have created an environment in which PCBs may be found in many locations within the community.

No community-wide testing has been done to date, however some New Bedford area residents have been found to contain elevated levels of PCBs in their blood. In 1981, two small-scale epidemiological studies were conducted by the Massachusetts Department of Public Health, Harvard's School of Public Health and the Centers for Disease Control in Atlanta, Georgia. Heavy fish eaters and occupationally exposed individuals were purposely selected. The results of the blood testing presented in Table 5 indicate that several of those residents tested are among the most highly contaminated reported in the United States (50,51). Because the studies selected individuals known to have been exposed, it is not presently possible to relate these results to the community population as a whole.

Discussions of the known and suspected sources of New Bedford area PCB contamination follow. Based on information gathered to date, efforts have been made to quantify the level of PCBs released to the environment from the various sources.

Table 5. Summary of Blood Serum Testing*
(analyses conducted for Aroclor 1260)

	MALES	FEMALES	TOTAL
Number of people sampled:	39	12	51
Average PCB level (ppb):	42	18	36
Median PCB level (ppb):	17	9	15
Range (ppb):	2 - 343	4 - 64	2 - 343
Number (percentage) greater than 30 ppb:	13 (33%)	3 (25%)	16 (31%)

* Only one percent of the American population contains blood serum PCB levels in excess of 30 ppb (50).

source of table: MDPH (51).

Aerovox Incorporated

"Aerovox Incorporated, (a subsidiary of R.T.E. Corporation) is located at 740 Belleville Avenue, New Bedford, Massachusetts. Aerovox's sole product is capacitors, (which) are used in a wide variety of electrical applications ranging from ballasts used in flourescent light fixtures to atomic energy research... All capacitors produced are used as components in other electrical products.... The physical size of (these products) ranges from units of approximately 1 cubic inch to units of 5,000 cubic inches." From: Santos (4), page 161.

The Aerovox facility used PCBs as impregnation fluids from 1947 to October 1978 (52,80). During this period, capacitors were manufactured containing paper, paper foil and mica. "Aroclor 1242 was used until 1971 when Aroclor 1016 was introduced...(completely replacing) 1242 as the impregnation fluid. Aroclors 1254 and 1252 (were also used) but the quantities are unknown. Between January 1973 and December 1975, Aerovox used more than four million pounds of PCB impregnation fluid in its manufacturing process.

"Sources of PCB contaminated solid wastes included reject capacitors, diatomaceous earth from Aroclor filtration,...chemical resistant gloves, air duct filters and absorbent material used to clean small PCB spills and drippings"... From: Santos (4), page 162.

According to Santos, Aerovox estimated that more than 164,000 pounds of PCBs were contained in capacitors sent to the New Bedford landfill during 1973, 1974 and 1975. Santos estimates that approximately 6,000 pounds (dry weight) of diatomaceous earth used to filter PCB oil at the Aerovox factory were also disposed in the landfill. Estimates of the quantity of other PCB contaminated solid wastes generated by Aerovox are not available.

"Sources of PCB contaminated liquid wastes included residue from the trichloreothylene distillation process...(and) the contents of drip pans... At the time of an EPA plant inspection in December 1975, the storage area for contaminated Aroclor was located in the basement of Aerovox's facility, away from the fresh Aroclor storage area. The (area formally used for storage) is concrete and contains no drains." From: Santos (4), page 164.

During the years 1971 through 1977 when PCBs were used at Aerovox, contaminated fluids were stored in capped 55 gallon steel drums. During these years, the drums were periodically trucked to Bridgeport, New Jersey for incineration. Prior to 1971 the exact method of disposal used is unknown (4). It is suspected that large quantities went to Sullivan's Ledge and to the New Bedford landfill for disposal.

Aerovox currently has two potential wastewater discharges; direct discharge to the Acushnet River estuary and an indirect discharge via the New Bedford Wastewater Treatment Plant located on Clark's Point. On the north side of the plant an external trough runs the length of the building and leads directly to

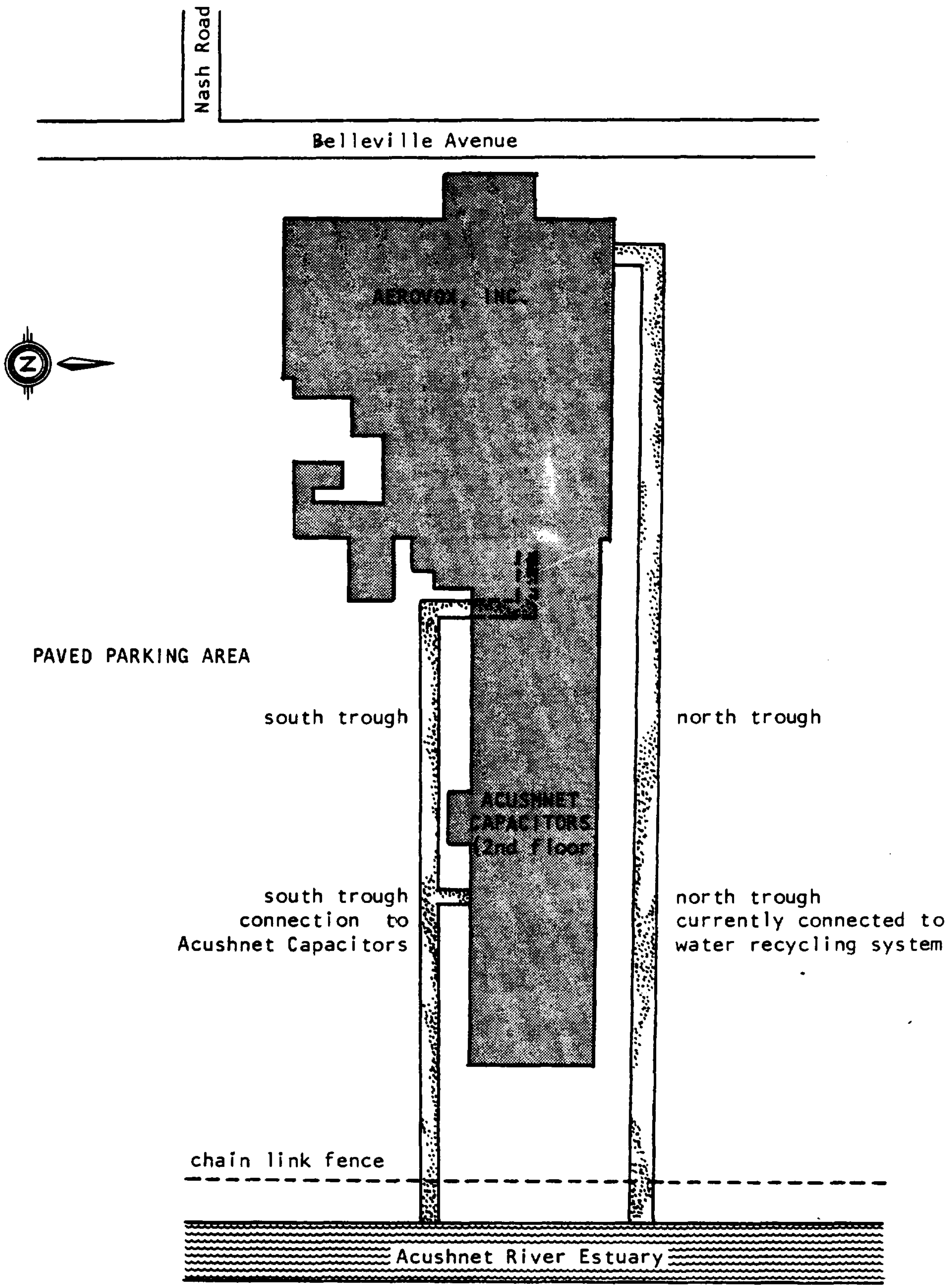


Figure 8. Schematic of Aerovox Incorporated; New Bedford, Massachusetts
Figure modified from: Versar (52), page 3, Aerovox comments (80).

the Acushnet River (see Figure 8). At one time, the trough received multiple discharges of non-contact cooling water from vacuum pumps. In December 1975, the trough flow was estimated at 650,000 gallons per day (gpd). A closed cycle cooling system has been installed, but occasional discharges from this trough may nonetheless occur.

In January 1976, the sanitary waste discharges from Aerovox to the New Bedford wastewater treatment plant via the municipal sewer system contained from 72 to 400 ppb of PCBs (53). Two wastewater grab samples collected by DEQE in 1981 failed to identify any PCBs in the pipeline leading from Aerovox to the New Bedford wastewater treatment plant (41). Further sampling efforts will be conducted by state and federal agencies to accurately document the current situation.

In 1976 the north trough effluent contained 29 to 51 ppb PCBs (53). After an EPA sampling effort in June 1981, which documented the presence of sediments containing from 40 to 22,000 ppm PCBs (52), Aerovox cleaned the north and south troughs and disposed of the contaminated materials in accordance with state and federal laws.

This and other sampling studies undertaken by EPA and DEQE have documented the presence of high levels of PCBs in all soils tested on the Aerovox property. Soils inside the chain link fence which surrounds the property were sampled and found to contain up to 24,000 ppm (52). Seaward of the fence, sediment sampling revealed levels of up to 190,000 ppm (40,54).

The National Institute for Occupational Safety and Health (NIOSH) performed an extensive industrial hygiene survey of the Aerovox facility in March 1977. As part of this survey, both "personal" and "area" air samples were collected throughout the facility and analyzed for PCB content. Results indicated that the 29 personal and 25 area air samples which had been collected and analyzed for PCBs ranged from 0.17 mg/m3 to 1.26 mg/m3 (33). The current Occupational Safety and Health Administration (OSHA) standard for Aroclor 1254 is 0.5 mg/m3. The standard for Arolcor 1242 is 1.0 mg/m3. In a recent criteria document, NIOSH has recommended an upper limit of 1.0 microgram total PCBs per cubic meter of air (1.0 ug/m3) as a time weighted average throughout a ten hour workday or 40 hour week (23,33).

Cornell Dubilier Electronics Corporation

Cornell Dubilier is located at 1605 East Rodney French Boulevard, New Bedford, Massachusetts and is engaged in the manufacture and sale of capacitors for use in consumer products. Cornell Dubilier Electronics Incorporated is a wholly owned subsidary of Federal Pacific Electric, which is in turn wholly owned by Exxon.

Most of the capacitors manufactured by Cornell Dubilier prior to mid-1977 contained PCBs. A relatively small number, however, were produced using mineral oil and no PCBs. Aroclor 1016 was in use from 1971 to 1977 while Aroclor 1242 was used prior to 1971 (4).

"Relatively small amounts of Aroclor 1254 had (also) been used as an impregnation fluid until early 1975. It is estimated that between January 1971 and January 1976, Cornell Dubilier...used more than 3.1 million pounds of Aroclor 1016 and 24,000 pounds of Aroclor 1254.

"In December 1976, EPA Region I performed an on-site inspection of Cornell Dubilier's facilities. At that time, information was obtained about the generation and disposal of liquid and solid PCB wastes.

"Sources of PCB contaminated solid wastes included reject capacitors, contaminated solder from sealing operations, diatomaceous earth from filters, absorbent material used to clean small spills and drippings, wiping rags and gloves. The exact quantity of PCB solid wastes generated by Cornell Dubilier is not known, however it has been estimated that from January 1971 through January 1976, more than 270,000 pounds of Aroclor have been sent to the New Bedford landfill. (Most of this as reject capacitors).

"Records were not maintained by Cornell Dubilier on the total (pounds) of PCBs disposed in the New Bedford landfill, nor were records kept on the breakdown by (Aroclor). Cornell Dubilier has estimated that 99% of the PCBs disposed in the New Bedford landfill were in hermetically sealed capacitors with the balance being contained in absorbent materials." From: Santos (4), pages 157 and 158.

"Sources of PCB contaminated liquid wastes generated by Cornell Dubilier (included)... residue from (the) trichloroethylene distillation operation, drippings from valves and connections, unreclaimable PCB drippings from capacitors and racks after impregnation, and contaminated vacuum oil. These contaminated PCB liquid wastes were put in 55 gallon color coded drums, placed on pallets, and stored in an open area at the rear of the building... Typically, wastes were allowed to accumulate in this area until (their quantity warranted shipment to) a disposal company for incineration. In 1971, an estimated 180,000 pounds of PCBs were shipped via railroad tank car and sent to... St. Louis, Missouri for incineration.

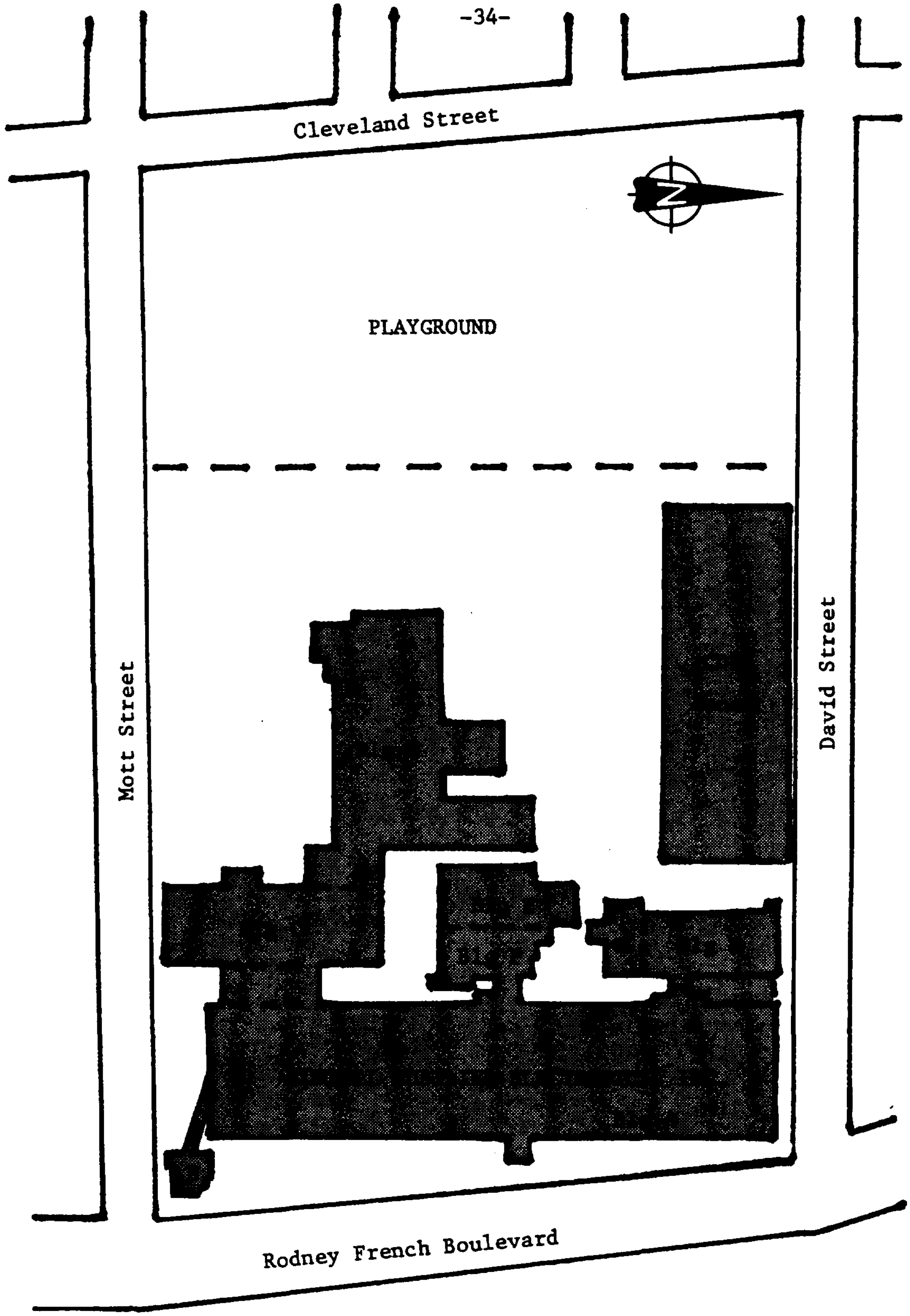
During 1973 and 1974,... 489,060 pounds of PCBs were shipped to... Model City, New York for incineration... There are no accurate records on the (quantity) of PCBs incinerated before 1973 or on the type of PCB compound incinerated during any period." From: Santos (4), pages 158 and 159. Liquid wastes may have been disposed at the New Bedford landfill, Sullivan's Ledge or elsewhere.

Cornell Dubilier Electronics Corporation wastewater discharges go (a) to the municipal wastewater treatment plant via the City of New Bedford's sewers and (b) to the Acushnet River via a city storm sewer. Cornell Dubilier's direct discharge permit, NPDES #MA0003930, allows for limited discharge of PCBs to Buzzard's Bay. Monitoring conducted by the Corporation and the state Divison of Water Pollution Control (DWPC) reveal that less than one-half pound of PCBs are annually discharged in this manner. EPA sampling in 1976 found up to 110 ppb PCBs in this discharge (53). The PCB concentration is now generally maintained at or below 5 ppb (56).

Cornell Dubilier's discharge to the municipal wastewater system has proven somewhat difficult to monitor. The presence of combined sewer overflows which apparently allow some seawater to enter during high tides confuses the sampling effort. Nonetheless, EPA sampling in 1976 located one discharge containing up to 2900 ppb PCBs (53). Three grab samples taken by the Commonwealth of Massachusetts in 1981 show that the wastewater in the municipal sewer line downstream of the factory still contains as much as 118 ppb PCBs (41). Sediments removed from the city sewer line were found to contain 660 ppm (47).

September 1978 air monitoring conducted at several sites in New Bedford documented the atmospheric PCB level at Cornell Dubilier to be 767 to 862 ng/m3 (57). These values approach the NIOSH recommended standard of 1.0 ug/m3 (i.e., 1000 ng/m3).

Soils sampled on the Cornell Dubilier property during a June 1981 EPA inspection contained from 4400 to 99,000 ppm PCBs (47). That is, the soil at the Cornell Dubilier property has been found to contain up to 10% PCBs. The playground area immediately west of Cornell Dubilier was filled with dredge spoils during the construction of the nearby hurricane barrier in the mid-1960s. Sediment samples taken in this area reveal that the soils contain PCBs at concentrations below 5 ppm (58).



Cornell Dubilier Electronics Incorporated plant layout.
figure from EG&G (55), page 2.

New Bedford Municipal Wastewater Treatment Plant

Located at the southern terminus of Clark's Cove, the New Bedford Wastewater Treatment Plant discharges a daily average of 26.5 million gallons of primary treated wastewater to Buzzards Bay. The historical discharge of PCBs by Aerovox and Cornell Dubilier into the municipal treatment plant has apparently resulted in the contamination of the sewer lines and the treatment facility. Recent monitoring by the Commonwealth of Massachusetts and the city's present consultant, Camp Dresser and McKee, reveals that the facility discharges approximately 200 - 700 pounds of PCBs per year. Wastewater sampling results are presented in Tables 6 through 8.

New Bedford's primary treatment plant was constructed in the early 70's and became operational in 1975. Although Robert Charles Engineering, Inc. designed the facility to remove 50 percent of the solids from the incoming wastewater, it has failed to remove one-half of this amount (25 percent) during all but five of the months during its first five years of operation (October 1975 - July 1980). Self monitoring reports submitted by the treatment plant chemist show that the plant discharged more solids than it received as raw sewage during thirty-one of these fifty-eight months (59).

As depicted in Figure 10, wastewater entering the facility passes through coarse screens to remove bottles, cans, sticks, and rags. These screenings are raked, collected and transported to the municipal landfill for disposal. The wastewater next flows through a grit chamber where gravel and coarse sand are removed. This grit is also trucked to the City landfill for disposal.

The wastewater is then pumped to sedimentation tanks where settling of the heavier solids occurs. The liquid effluent from these tanks is chlorinated and discharged to Buzzards Bay via a 3,300 foot long outfall pipe. The sludge which settles to the bottom of these basins is thickened and pumped to centrifuges for dewatering. The dewatered sludge is incinerated on the premises in a multiple hearth incinerator and the residual ash is taken to the landfill where it is dumped with the screenings and grit.

Wastewater treatment plant sludge, incinerator flue gas and residual ash have all been found to contain measurable amounts of PCBs. The only analysis of wastewater grit which has been conducted (in 1981) revealed a concentration of 30 ppm (40). Grease and scum have never been tested for PCBs. Information on PCB levels in sludge and ash is presented in Tables 6 and 7.

In 1977, EPA contracted with GCA Corporation to study the atmospheric release of PCBs during sludge incineration. GCA concluded that the release of PCBs to the atmosphere from the stack during incineration ranged from 3 to 10.6 ug/m3. A series of tests in 1977 suggested that, when operating, the New Bedford incinerator destroyed between 46-77% of the PCBs fed into the process (60). Other EPA sampling efforts found ambient atmospheric PCB levels downwind of the incinerator to range from .013 to .240 ug/m3 during March 1977 and January 1978 (9,61).

Although the level of contamination is below EPA hazardous waste criteria, the wastewater, sludges and other residuals contain PCB levels much higher than those encountered at most municipal treatment facilities. Local, state and federal entities are presently expending funds to study and design changes to improve the wastewater treatment facility and to accomodate the City's needs.

The wastewater collection system contains approximately thirty combined sewer overflows (CSOs) and these overflows may, during periods of wet weather, release PCB contaminated wastewaters. Monitoring of the CSOs for PCBs and an evaluation of their magnitude, if any, will be addressed in future sewage system studies. An evaluation of industrial discharges and the level of industrial pretreatment needed to protect the municipal facilities and the waters of Buzzards Bay from contamination will also be undertaken in the near future.

The City applied for a waiver of the National secondary wastewater treatment requirement in late 1979 (38). Although the state has not supported this application, the EPA has neither approved nor rejected the City's request. According to the findings of a 1977 EPA study, secondary treatment assists in PCB removal (62). Some questions remain as to the cost effectiveness of secondary treatment and there exist some concerns about how to dispose of the additional quantities of sludge produced (especially if the incineration process is ever terminated).

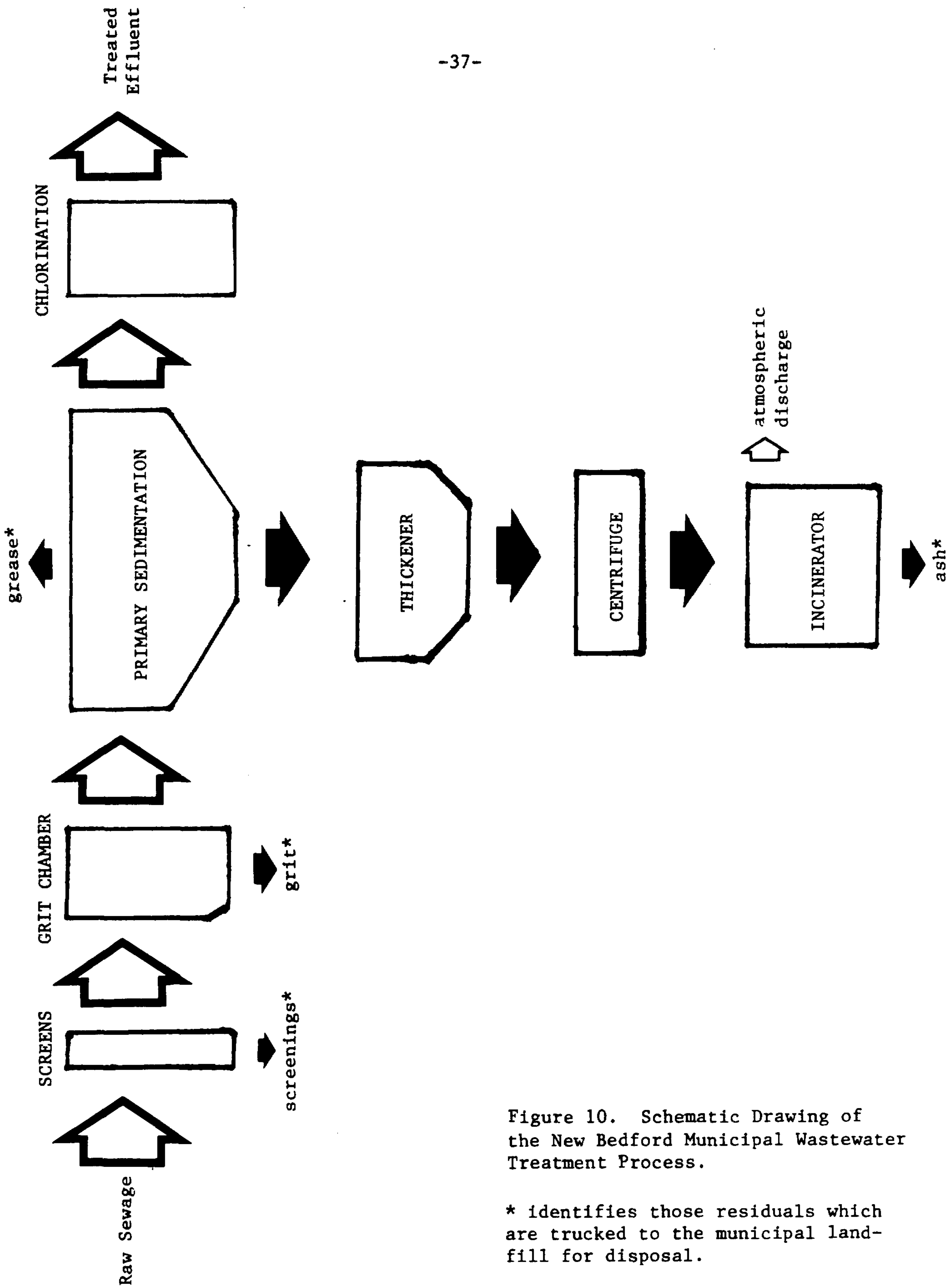


Figure 10. Schematic Drawing of the New Bedford Municipal Wastewater Treatment Process.

* identifies those residuals which are trucked to the municipal landfill for disposal.

Table 6. New Bedford Wastewater Treatment Plant Analyses for PCBs in Wastewater

Date	Laboratory	Raw Sewage PCBs (ppb)	Treated Sewage (ppb)
7/14/76	EPA (53)	106	119
2/9/77	GCA (60)	NR	3.50
3/1/77	GCA (60)	NR	8.25
	GCA (60)	NR	3.00
	GCA (60)	NR	20
	GCA (60)	NR	5.75
4/79	CDM (38)	NR	21
5/79	CDM (38)	NR	9.3
3/80	DWPC (63)	NR	0.1
2/23/81	DWPC (41)	1.28	8.16
2/24/81	DWPC (41)	ND	1.43
2/25/81	DWPC (41)	7.61	ND
	CDM (39)	6.2	8.1
2/26/81	DWPC (41)	ND	ND
3/2/81	DWPC (41)	ND	ND
3/3/81	DWPC (41)	ND	ND
3/4/81	DWPC (41)	ND	ND
	CDM (39)	2.6	5.6
3/5/81	DWPC (41)	ND	ND
6/81	EPA (40)	43	33
3/10 -	DWPC (64)	1.6	3.2
3/15/82*	DWPC (64)	0.7	1.8
3/16 -	DWPC (64)	2.6	5.7
3/20/82*	DWPC (64)	5.8	4.3
3/21 -	DWPC (64)	2.4	3.9
3/25/82*	DWPC (64)	2.0	3.8

ND = none detected
NR = not reported
* = composite samples, run in duplicate

Table 7. New Bedford Wastewater Treatment Plant
Analyses for PCBs in Sludge

Date	Laboratory		Dry weight (ppb)	Wet weight (ppb)
3/26/76	EPA	(53)	73,600	
4/76	EPA	(53)	30,800	
2/9/77	GCA	(60)	5,400	
	GCA	(60)	80,000	
3/1/77	GCA	(60)	2,250	
	GCA	(60)	2,200	
3/3/77	GCA	(60)	1,400	
2/26/81	DWPC	(41)	330 *	114
	CDM	(39)	1,526	
3/2/81	DWPC	(41)	2,900 *	1,016
3/3/81	DWPC	(41)	520 *	181
	DWPC	(41)	490 *	173
3/4/81	DWPC	(41)	410 *	142
	CDM	(39)	391.6	
6/81	EPA	(40)	70,000	
9/12/81	DEQE	(58)	9,000	
9/13/81	DEQE	(58)	14,000	
9/15/81	DEQE	(58)	29,000	
	DEQE	(58)	16,000	
9/16/81	DEQE	(58)	17,000	
9/17/81	DEQE	(58)	12,000	
10/6/81	DEQE	(58)	9,900	
10/7/81	DEQE	(58)	16,000	
10/8/81	DEQE	(58)	16,000	

*calculated assuming 35% solids.

Table 8. New Bedford Wastewater Treatment Plant Analyses for PCBs in Incinerator Ash

Date	Laboratory	Ash Dry Weight (ppb - PCB)
2/9/77	GCA (60)	2,000
3/1/77	GCA (60)	950
	GCA (60)	2,350
	GCA (60)	1,000
3/3/77	GCA (60)	1,700
2/26/81	DWPC (41)	ND
	CDM (39)	100.5
6/81	EPA (40)	ND

ND = none detected

New Bedford Municipal Landfill

omit

Located north of Hathaway Road and west of Route 140, the New Bedford Municipal Landfill has been used as a repository for domestic, commercial and industrial wastes since the early 1920's. The landfill is located one-half mile southeast of the Paskamanset River near the southern end of a large glacial lake deposit that extends from the Apponagansett Swamp to the northern limit of the Acushnet Cedar Swamp. The landfill includes 40 acres of marshland, 24 of which (as of 1978) were filled with refuse and cover material. The geology of the area consists of a layer of freshwater peat varying from 7 to 10 feet thick, underlain by a thin layer of silty fine sand, and then layers of stratified silts and clayey silts with thin layers of silty clay. The sand and silt layers vary from 8 to 36 feet deep (9).

Originally operated as an open dump, the site is now maintained as a landfill in accordance with state and federal regulations. For decades, Aerovox Incorporated and Cornell Dubilier Electronics Incorporated reportedly disposed reject capacitors and other wastes at this site. Historically, over one-half million pounds of PCBs have been disposed in the municipal landfill (9). Prior to 1970, Aroclor 1242 was the predominant PCB material disposed. From 1970 to 1977, Aroclor 1016 replaced 1242 as the PCB most commonly used in Aerovox's and Cornell Dubilier's capacitors and presumably in the waste products disposed at the New Bedford landfill.

Monitoring for PCBs has revealed no significant groundwater contamination problems in the area of the landfill (68). The discharge of PCBs to the atmosphere may, however, be significant. Data compiled by EPA in 1978 (9) revealed that the summertime atmospheric level of PCBs exceeded the NIOSH (National Institute of Safety and Health) recommended eight hour workplace exposure limit of 1 ug/m3. No atmospheric monitoring has been conducted since 1978. Lately, some concerns have been raised over the placement of monitoring wells at the landfill and the results of the 1978 groundwater leachate study are now being questioned.

EPA's 1978 study of New Bedford municipal landfill concluded that "volatilization is a likely and possibly principal mode of transport of PCBs from the landfill" (Stratton, et al. (9), page 39). This finding is supported by the results of landfill studies in the Upper Hudson River Basin by the New York Department of Environmental Conservation. In New York, it was found that PCBs disposed in dumps, landfills and contaminated dredge disposal sites were primarily released to the air and that only small amounts of PCBs were leached out with groundwater (65).

Sullivan's Ledge

Locally known as "Sullivan's Ledge", approximately ten acres of land located on Hathaway Road abutting the New Bedford Holiday Inn was formerly managed by the City of New Bedford as a dump. Preceeding its use as an industrial dump, a quarry was located on this site. After the quarry filled with water, Sullivan's Ledge became a neighborhood swimming hole. Today the site is completely covered over and has been graded nearly level. Rubble, brush and other demolition materials are evident. A brook flows along the southern and eastern borders of the property under Hathaway Road through a municipal golf course to the Appponagansett Swamp in the vicinity of the New Bedford municipal landfill.

Although not presently utilized as a dumpsite, in years past the City of New Bedford used Sullivan's Ledge as an industrial dump. Rubber tires were the primary waste product disposed, but industrial waste oils and sludges were also disposed at Sullivan's Ledge (48). According to landfill operators and one local official (quoted in an EPA memorandum (66)), PCBs were disposed at this site. It is possible that large volumes of PCBs are buried in Sullivan's Ledge. At this time little is known about the extent of contamination.

Only two samples collected at Sullivan's Ledge have been tested for PCBs. No detectable levels were found in the one water sample obtained from the brook adjoining the property. The sediments underlying this brook were found to contain PCBs at a concentration of 288 parts per billion (9). No air monitoring results are available for the area through June of 1982.

Other / Suspected PCB Sources

In addition to the direct discharges of PCB-containing wastewaters from the New Bedford Wastewater Treatment Plant, Aerovox and Cornell Dubilier, other yet unidentified discharges of PCB-contaminated waters may be entering New Bedford Harbor. Numerous combined sewer overflows (CSOs) and storm sewer outfalls discharge into the estuary. It is very likely that PCBs are discharged from those CSOs immediately downstream of Aerovox and Cornell Dubilier during storm events. These CSOs are located at the Coggeshall Street Bridge and at the head of Clark's Cove. Other CSOs may also contribute to the PCB contamination.

Urban storm drains in New Bedford, Acushnet and Fairhaven may carry measurable levels of PCBs into the harbor. The source of these PCBs - if present - could be atmospheric fallout and/or residual PCBs remaining on the roadways from years of oiling the roads with PCB contaminated waste oils. Urban runoff from the Aerovox and Cornell Dubilier properties may contain PCBs as may runoff from railroad sidings where PCBs were transferred from railcar to tank truck for delivery to the factories.

Sampling conducted in the vicinity of the Fairhaven municipal wastewater treatment plant outfall pipe has revealed high concentrations of PCBs in the sediments (67). The cause of this pool of PCB contamination is unknown. A 1981 EPA testing of the Fairhaven wastewater revealed a PCB concentration of 26 ppb (40); however, subsequent studies conducted by the Massachusetts DEQE have found the discharge concentration to be below detection.

In the mid-1970's Camp Dresser and McKee, under contract to the Southeastern Regional Planning and Economic Development District (SRPEDD), produced a report documenting the historical solid waste disposal practices in New Bedford, Acushnet, Fairhaven and Dartmouth. In addition to Sullivan's Ledge and the present municipal landfill, several sites were discussed (48). Any number of these locales may contain PCBs.

Although there exists no evidence that scrap dealers in the New Bedford area may have inadvertently contaminated their properties by accepting materials containing PCBs for metal recycling, this situation was found to exist in the Upper Hudson River Valley. It may be the situation in the New Bedford area as well.

Any area near the Aerovox and Cornell Dubilier factories which received fill between the 1940's and 1977 could possibly be contaminated with PCBs. Sediments dredged from New Bedford Harbor anytime during the last forty years probably contained PCBs. In a proposal to study PCBs in old dredge disposal sites, ten sites where dredge disposal materials were used as fill were identified. These sites are given in Table 9.

Runoff from the North Dartmouth Mall, according to research conducted by Gidlab (68), is believed to contribute PCBs to the Paskamanset River. This mall is located in North Dartmouth at the junction of Route 6 and Faunce Corner Road.

Table 9. Historical Upland Dredge Material Disposal Sites

Upland Disposal Site	Contractor	Location Dredged
Fairhaven landfill	Fairhaven Marine	Fairhaven Marine
Route 195 crossing	Mass. DPW	
Popes Island		North Terminal
Disposal area off Mt. Pleasant St. behind the New Bedford airport	Joe Perry Construction Co.	Quaker Oats Plant
North Fort Phoenix Beach	Mass. Waterways/ Mass. DPW	
South Terminal/Standard-Times site; behind dike at playing fields	New Bedford Redevelopment Authority	
Merrill's Warf	New Bedford Redevelopment Authority	Merrill's Warf
West Island Dump, Fairhaven		Various Locations in the harbor
Acushnet Co., Plant "A" parking lot		
North side of Coggeshall St. in Fairhaven		

Source: Tibbetts (69), page 5.

CHRONOLOGY

New Bedford Area PCB Contamination and Control

1941	Cornell Dubilier Electronics Incorporated begins operations in New Bedford. PCBs are used in the manufacture of electronic capacitors.
1947	Aerovox Corporation first uses PCBs as an impregnation fluid in the commercial manufacture of electronic capacitors.
1971	Aroclor 1016 is substituted for Aroclor 1242 in the manufacture of electronic capacitors at both Aerovox and Cornell Dubilier.
1973	Aerovox Corporation is sold to Belleville Industries, Inc. which subsequently changed its name to Aerovox Incorporated.
1973	Camp Dresser and McKee, under contract to the Southeastern Regional Planning and Economic Development District (SRPEDD), prepares a "Greater New Bedford Solid Waste Study" (48). A number of industrial waste dump sites in New Bedford, Acushnet, Dartmouth and Fairhaven are listed.
1974	Scientists from Woods Hole Oceanographic Institution report elevated concentrations of PCBs at a location in the outer harbor (78).
1974	New England Aquarium report documents the presence of low level PCB contamination throughout Buzzard's Bay (70).
1976	EPA sampling of Aerovox, Cornell Dubilier and the New Bedford Wastewater Treatment Plant reveal significant levels of PCBs in the industrial and municipal discharges. High levels of PCBs are also found in harbor sediments and marine life.
1976	EPA publishes report titled "New England PCB Waste Management Study" (37). Aerovox and Cornell Dubilier were identified as users of PCBs and the New Bedford Municipal landfill was documented as a disposal location.
1976	Woods Hole Oceanographic Institution initiates PCB sampling of sediments and marine life in New Bedford Harbor and Buzzard's Bay.
1976	Massachusetts Division of Marine Fisheries (DMF) initiates sampling of Buzzard's Bay finfish and shellfish for PCBs.

1976 Scientists of Massachusetts Audubon Society and Bodega Marine Laboratory, CA, report elevated concentrations of PCBs in birds and waters of Buzzards Bay (79).

1977 Monsanto (the only American producer of PCBs) ceases the production and sale of PCBs.

1977 Massachusetts DMF begins sampling lobsters for PCBs.

1977 Massachusetts Department of Public Health (DPH) issues warnings that lobsters and bottom feeding finfish from a defined area in Buzzard's Bay should not be consumed after learning the foodstuffs contain PCBs in concentrations exceeding 5 ppm. USFDA determines that the situation constitutes an intrastate matter and therefore is not within Food and Drug's jurisdiction.

1977 GCA Corporation prepares a report under contract to EPA titled "PCB Compounds Emanating from the New Bedford Municipal Wastewater Incinerator" (60). The study concludes that only 2 to 3 percent of the PCBs present in sewage sludge before incineration are released with the flue gas. The scrubber water effluent was found to contain 16 to 37 percent of the PCB input, the ash contained up to 14 percent.

1977 EPA publishes a report entitled "PCBs Removal in Publicly-Owned Treatment Works" (62). This document states that PCB removal in municipal treatment processes is strongly correlated with solids removal, i.e., typical secondary treatment plants can be expected to remove 80-90 percent of the PCBs present in the wastewater, typical primary plants up to 50 %.

1977 Aerovox develops a process to remove a large percentage of PCB impregnating fluid from faulty capacitors. Company submits proposal to DEQE requesting approval for the disposal of evacuated capacitors in the New Bedford Municipal landfill. DEQE disallows practice after determining that each ton of evacuated reject capacitors would contain 13 pounds of Aroclor 1016.

1977 An industrial hygiene survey conducted at Aerovox by the National Institute for Occupational Safety and Health (NIOSH) finds high levels of PCBs in the factory's atmosphere. All 54 air sampling results exceeded the recommended NIOSH limit of 1 ug/m3. The range (measured as Aroclor 1016) of atmospheric PCB concentrations was found to be 10-1260 ug/m3 (33).

1977 Cornell Dubilier ceases the production of PCB containing capacitors. Dioctyl phthalate (DOP) fluid is substituted for PCB.

1978 Massachusetts DEQE initiates an annual sediment sampling program with over 20 stations in New Bedford Harbor and Buzzard's Bay.

1978 U.S. EPA Region I prepares a summary report of all PCB data in New England titled, "Polychlorinated Biphenyls in New England" (71).

1978 Southeastern Massachusetts University conducts a study of PCB levels in Buzzard's Bay shellfish (72). Oysters in the Slocum's River exhibit relatively low levels of PCB contamination.

1978 Aerovox ceases use of PCBs in manufacturing processes.

1978 U.S. EPA study titled "Environmental Assessment of Polychlorinated Biphenyls (PCBs) Near New Bedford, Massachusetts, Municipal Landfill" (9) concluded that atmospheric release of PCBs from the landfill is most likely the principal mode of their escape. Sampling conducted during the summer of 1977 found atmospheric PCB levels in excess of 1 ug/m3, the NIOSH recommended eight hour exposure limit.

1978 Tibbetts Engineering Corporation submits an unsolicited proposal to DEQE titled "PCBs Analysis of Materials Dredged from the New Bedford Harbor Bottom from 1-30 Years Ago and Subsequently Used as 'Fill' on Dry Land for Various Projects" (69). Ten upland sites which have been filled by materials dredged from New Bedford Harbor during the years 1948 to 1978 are identified in this report.

1979 Massachusetts Department of Public Health exercises its legal authority to close areas of Buzzard's Bay to the taking of lobsters, finfish and shellfish because of PCB contamination (44).

1979 Massachusetts Representative Roger Goyette forms an ad hoc committee to assess the PCB contamination problem in New Bedford.

1979 Camp Dresser and McKee, on behalf of the City of New Bedford, submits an application for a waiver of the secondary municipal wastewater treatment requirement to EPA (38). Data on PCBs in harbor sediments, shellfish and wastewater are included.

1980 Gidley Laboratories, Inc. under contract to the Dartmouth Conservation Commission publishes a report on PCB monitoring (68). Gidlab concluded that the PCBs in New Bedford's municipal landfill are not polluting the Dartmouth town wells, but recommends continued annual monitoring.

1980 University of South Carolina graduate students test a PCB air sampler at the New Bedford municipal landfill. Sampling conducted during June detected 25-53 ng/m3 PCBs (Aroclor 1016 plus 1254) upwind of the landfill (73). No downwind results were obtained.

1980 Woods Hole Oceanographic Institution-sponsored workshop on PCBs in New Bedford. Funded by Sea Grant, all of the state agencies and laboratories involved in PCB analysis meet to compare and discuss analytical problems.

1980 DEQE and EPA designate New Bedford Harbor PCB problem as a priority issue in the 1980 State - EPA agreement.

1981 A report on the PCB Data Needs and Dredge Techniques for the Acushnet River - New Bedford Harbor Area is prepared by Richard Tomczyk, DEQE, in compliance with 1980 State - EPA Agreement (74).

1981 Secretary John Bewick of the Massachusetts Executive Office of Environmental Affairs establishes a PCB task force. DEQE chairs committee and holds monthly meetings to coordinate activities.

1981 Malcolm Pirnie, Inc. under contract to DEQE/DWPC prepares a Draft "Acushnet River Estuary PCB Study" (75). PCB contaminated areas of New Bedford Harbor and Buzzard's Bay are identified. Additional sampling of sediments, marine life, air and water is recommended. An estimated project cost for removal of 90 percent of the PCB contaminated sediments is given as $130 million.

1981 Small scale epidemiology study of New Bedford residents is undertaken by Massachusetts Department of Public Health, Harvard's School of Public Health and the Centers for Disease Control in Atlanta, Georgia (50). Fish eaters and industrially exposed workers were selected for study. Results of the limited blood testing reveal that those tested are among the highest PCB contaminated in the United States.

1981 Massachusetts Division of Marine Fisheries prepares a comprehensive "Polychlorinated Biphenyl (PCB) Analyses of Marine Organisms in the New Bedford Area, 1976-1980" (45). The report concludes: "Review of the data collected to date indicate that sampling results are insufficient to establish definitive PCB trends in the biota of New Bedford Harbor." DMF subsequently petitions the Massachusetts Department of Public Health to reopen one area closed to the taking of lobsters due to PCB pollution.

1981 EPA coordinates the inspections of four sites in the New Bedford area for compliance with PCB regulations under the Toxic Substance Control Act (TSCA): Aerovox, Cornell Dubilier, the New Bedford Municipal Wastewater Treatment Plant and the Fairhaven Municipal Wastewater Treatment Plant.

1981 EPA and State officials meet with representatives of Aerovox and Cornell Dubilier to discuss TSCA sampling results. Both firms prepare limited site clean up and monitoring proposals.

1981 Representative Roger Goyette of New Bedford chairs ad hoc/PCB task force meeting at Woods Hole.

1981 Enforcement of Massachusetts Department of Public Health's lobster closure is fully enacted for the first time since its issuance in 1979. Bureaucratic snafus are overcome and two Environmental Affairs agencies (Division of Marine Fisheries and Division of Law Enforcement) assist DPH's enforcement effort.

1981 EPA and Massachusetts Coastal Zone Management personnel visit PCB contamination sites in Bloomington, Indiana; Waukegan, Illionois; and the Upper Hudson River region in New York state.

1981 Massachusetts Divison of Water Pollution Control (DWPC) Technical Assistance Branch collects over 100 sediment samples and fourteen harbor water column samples for PCB analyses by Cambridge Analytical Associates. Results document sediment concentrations in 1000's ppm in the upper reach of the estuary (42).

1981 DWPC undertakes New Bedford municipal sewer sampling program.

1981 Versar, under contract to EPA, prepares a voluminous report titled "Comprehensive List of Industrial Facilities located Within Region I which May Handle or Use PCB Materials" (76). Ten New Bedford area companies are listed, however neither Aerovox nor Cornell Dubilier are cited. The firms noted include two bakeries, three fish processors, three rubber products manufacturers, an equipment rental firm and a welding equipment manufacturer.

1981 DMF conducts additional lobster sampling and again appeals to DPH for a reopening of Area III to commercial lobstering. DMF sampling of 42 lobsters captured in November 1981 indicates an average PCB concentration of 1.0 ppm.

1981 Massachusetts DEQE nominates New Bedford Harbor as a priority federal Superfund site.

1982 EPA Environmental Impact Office initiates a regional New Bedford PCB Environmental Impact Study.

1982 U.S. Coast Guard joins state and federal agencies in the sampling of harbor sediments. USCG posts a warning sign in the heavily contaminated area seaward of Aerovox.

1982 Massachusetts Department of Public Health, in cooperation with the Centers for Disease Control in Atlanta, publishes the results of a second PCB blood test conducted on New Bedford area residents. Findings support the 1981 results which show that heavy fish eaters and industrially exposed persons generally contain high PCB levels (50,51).

CASE HISTORIES OF PCB POLLUTION

Waukegan Harbor, Illinois

The area of contamination encompasses a 37 acre Lake Michigan harbor, an adjacent upland industrial area and a lengthy drainage ditch.

√ PCB concentrations up to 250,000 ppm (or 25%) have been observed in upland and submerged harbor sediments.

√ Fish containing PCBs at levels exceeding 100 ppm have been captured within the harbor. Immediately outside Waukegan Harbor, the fish exhibit PCB levels characteristic of Lake Michigan fishes (ie., averaging and occasionally exceeding the 2-5 ppm range).

EPA has prepared a plan for Waukegan Harbor cleanup for implementation as a result of court action or under Superfund. As indicated in EPA's Waukegan Harbor Report (5), one-third of the harbor area is proposed to be dredged. 50,000 cubic yards of dredge spoils would be dewatered in a lagoon on vacant property adjoining the harbor and disposed in an offsite landfill. An additional 100,000 cubic yards or more of contaminated upland soils may be removed for disposal. Alternative approaches being considered include inplace confinement.

OMC-Johnson Motors, which apparently used PCBs in hydraulic fluids, and Monsanto Corporation, the former manufacturer of PCBs, are being sued by EPA for the total cost of the cleanup which may equal or exceed $40 million.

Bloomington, Indiana

PCB contamination of the City's "Winston Thomas" wastewater treatment plant has resulted in the stockpiling of six years accumulation of sludge. This amounts to about 34,000 cubic yards of PCB contaminated material averaging 100-500 ppm.

About two drums of wastewater grit with PCB levels exceeding 1 ppm is collected daily. Transporting and disposing this grit at an EPA approved hazardous waste landfill costs the City $60 per drum. An equal amount of grit (less than 1 ppm PCB) is disposed at the county landfill at no charge to the City.

Thousands of wastewater PCB samples have been collected and analyzed by City personnel since 1975. Bloomington owns two gas chromatographs for the sole purpose of PCB analyses and employs a half-time technician to operate this equipment.

A five mile stretch of municipal sewer lines was cleaned to remove PCB contaminated sediments at a cost of approximately $45,000.

Several Westinghouse capacitor dump sites have been located in and around Bloomington, including one uncontrolled dump on City property.

Westinghouse, a large employer in Bloomington, is being sued by the City for over $300 million.

Upper Hudson River, New York

In 1975, PCB levels in some Hudson River fish were found to exceed the Food and Drug Administration tolerance level of 5 ppm. As a result, the New York State Department of Environmental Conservation (NYSDEC), with the advice of the Department of Health, instituted a ban on fishing in the upper Hudson River from the Troy Dam to Fort Edward. In the lower Hudson River, commercial fishing was restricted and recreational fishermen were advised to restrict fish consumption to one meal per week (American eel excluded).

Among principal users of PCBs in New York State were General Electric's capacitor manufacturing plants in Fort Edward and Hudson Falls. In over 25 years of operations, thousands of pounds of chemicals were discharged into the Hudson River from these two plants. Unfortunately, the dangers associated with PCBs in the environment were not understood and serious damage was done to the river.

The Hudson River, rich in organic sediments such as wood chips, has provided ample opportunity for PCB absorption. Years of industrial manufacture have left more than 600,000 lbs of PCBs in the river, with more than half this total adhering to sediments within 40 miles of the original discharge at Fort Edward.

The State has noted not only public health implications but also economic impacts on fisheries, agriculture and difficulties in maintaining port, channel, and canal traffic due to problems with dredge spoil disposal.

In 1976, after lengthy hearings, the State and General Electric, sharing the responsibility, agreed to seek ways to remove PCBs from the river. The two parties established a $7 million fund for research and engineering studies which were carried out by consultants, universities, federal and state agencies in one of the most comprehensive investigations of a toxic problem ever undertaken in this country.

These studies found that the PCB-contaminated sediments in the upper Hudson River act as a source to the entire downstream river system. According to 1979 US Geological Survey readings at the Troy Dam, nearly 7,000 lbs of the chemical is washing over the dam annually. The 154-mile portion of the river below the dam and extending south to Manhatten Island is estuarine, affected by tides and salt water influx.

The Hudson has much of its contamination concentrated in a relatively small area. NYSDEC has located 40 "hot spots" in the upper Hudson where PCB concentration is equal to or greater than 50 ppm. Removal of these hot spots from the river would greatly reduce the amount of PCBs available to the ecosystem.

Research has also found that PCBs are evaporated into the air and subsequently travel considerable distances via wind action.

The NYSDEC has recommended that the Hudson River Reclamation Project dredge and safely encapsulate over 135,000 lbs of PCB-contaminated sediments from the "hot spots".

In September 1980, Congress authorized the EPA to expend not more than $20 million for removal of PCB-contaminated material from the upper Hudson River under Section 116 of the Clean Water Act. Since that time NYSDEC has been working with EPA as a cooperating agency to write and finalize an Environmental Impact Statement on the project. In May of 1981 the draft EIS was published covering the removal of all 40 hot spots, and a smaller project limited by available funding to remove and safely encapsulate over 20 of the hot spots.

Additionally, NYSDEC and G.E. reached an agreement in September of 1980 whereby the company agreed to fund remedial actions as seven PCB-contaminated land disposal sites in the Upper Hudson Valley. Engineering reports for four of these sites are currently under review by NYSDEC and construction has begun on a fifth site.

GLOSSARY

Index to abbreviations and acronyms

CDM - Camp Dresser & McKee, Inc.
CFR - Code of Federal Regulations
Cl - chlorine
CSO - combined sewer overflow
CZM - Massachusetts Coastal Zone Management

DDT - 1,1,1 - trichloro - 2,2 - bis (p-chlorophenyl) ethane
DEQE - Massachusetts Department of Environmental Quality Engineering
DMF - Massachusetts Division of Marine Fisheries
DOP - dioctyl phthalate
DPH - Massachusetts Department of Public Health
DPW - Massachusetts Department of Public Works
DWPC - Massachusetts Division of Water Pollution Control

EPA - United States Environmental Protection Agency

FDA - United States Food and Drug Administration

GC - gas chromatograph
GCA - GCA Corporation
GC/MS - gas chromatograph/mass spectrometer
G.E. - General Electric Corporation
gpd - gallons per day

IARC - International Agency for Research on Cancer

kg - kilogram

LT - less than

MDPH - Massachusetts Department of Public Health
mg - milligrams
mg/g - milligrams per gram, generally equivalent to parts per thousand
mg/l - milligrams per liter, generally equivalent to parts per million
mg/kg - milligrams per kilogram, generally equivalent to parts per million
MS - mass spectrometer

NAS - National Academy of Sciences
ND - none detected
NFI - National Fisheries Institute

ng/l	- nanograms per liter, generally equivalent to parts per trillion
ng/m3	- nanograms per cubic meter
NIOSH	- United States National Institute for Occupational Safety and Health
NPDES	- National Pollution Discharge Elimination System
NR	- not reported
NYSDEC	- New York State Department of Environmental Conservation
OMC	- Outboard Marine Corporation
OSHA	- United States Occupational Safety and Health Administration
PCB	- polychlorinated biphenyl
PCDF	- polychlorinated dibenzofuran
PCQ	- polychlorinated quaterphenyl
ppb	- parts per billion
ppm	- parts per million
RTE	- RTE Corporation
SRPEDD	- Southeastern (Massachusetts) Regional Planning and Economic Development District
TSCA	- Toxic Substance Control Act
ug/day	- micrograms per day
ug/kg	- micrograms per kilogram, generally equivalent to parts per billion
ug/l	- micrograms per liter, generally equivalent to parts per billion
ug/m3	- micrograms per cubic meter
USCG	- United States Coast Guard
USEPA	- United States Environmental Protection Agency
USFDA	- United States Food and Drug Administration

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Chronology

New Bedford Area PCB Contamination and Control (update to June 1982

PCB Pollution in the New Bedford, Massachusetts Area: A status Report)

May 1982	U.S. EPA issues Consent Order to Aerovox under which the company will perform environmental studies leading to proposed remedial action for that portion of company property adjacent to the Acushnet River.
May 1982	U.S. EPA issues Consent Order to Cornell-Dubilier Electronics to undertake remedial action at the company's facility. Those actions include: evaluation of waste dielectric fluid handling system; evaluation of company's PCB discharges to the municipal sewer system; removing PCB - contaminated sediments from waste streams; controlling the release of PCB - contaminated soils from plant yard; and, monitoring groundwater in vicinity of plant for PCB's.
May 1982	Executive Order No. 216 established the Governor's Acushnet River Estuary PCB Commission to analyze the PCB problem and to make recommendations to the Governor on appropriate responses.
June 1982	Sediment samples taken near the existing Route 6 bridge linking New Bedford and Fairhaven show PCB levels to be below 50 ppm, the Massachusetts hazardous waste threshold. This removes some environmental obstacles and allows design work for bridge renovation to proceed.
June 1982	Massachusetts DEQE conducts sampling program in New Bedford Sewer lines. Results, issued in October of 1982, show that limited portions of the lines are contaminated with PCB's. These samples also show that significant amounts of PCB's (up to 500-700 lbs. /year) are being discharged from the Wastewater Treatment Plant into Buzzards Bay.
June 1982	The Commonwealth of Massachusetts submits areas of the Acushnet River Estuary, New Bedford Harbor, and Buzzards Bay, as well as certain waste disposal sites in New Bedford, as a candidate for listing on the federal Superfund National Priorities List. New Bedford is designated by the Commonwealth as its top priority site.
July 1982	PCB contaminated sites in the New Bedford area are added to the federal Superfund National Priorities List.
August 1982	Utilizing a Superfund Contractor, EPA initiates a comprehensive assessment of the PCB problem in the New Bedford area. Environmental investigations include: sampling at the New Bedford Landfill and Sullivan's Ledge; an area-wide ambient air monitoring program; a sediment PCB profile for the Acushnet River Estuary and the

	Harbor; biotic sampling from the Estuary, Harbor and nearby Buzzards Bay; and, a detailed study of contamination in the municipal sewer system. An engineering firm (Metcalf & Eddy) is contracted to establish a computerized data storage and retrieval system for samples taken in the New Bedford area.
September 1982	Governor's Acushnet River Estuary PCB Commission presents interim status report. It contains a series of recommendations of priorities for funding of studies and projects.
December 1982	U.S. EPA issues an Administrative Order to the City of New Bedford for violations of the Clean Water Act. The Order requires the implementation of specified operation and maintenance programs at the Wastewater Treatment Plant.
December 1982	U.S. EPA holds public meeting in New Bedford. State and federal officials review status of remedial action, request and receive public comment on proposals and timetable.
January 1983	U.S. Coast Guard initiates a study to determine whether PCB's are being transported out of the highly contaminated northern portion of the Acushnet River Estuary in the water column. Their results, released in April 1983, indicate that between 1,000 - 2,000 lbs/year migrate through the Harbor toward Buzzards Bay.
May 1983	A public meeting is held in New Bedford by U.S. EPA to publicly present the Remedial Action Master Plan (RAMP). The RAMP outlines studies to be conducted to further delineate contamination problems and a timetable for further actions. Presentation of the RAMP follows several months of public comment and state and federal agency review.
June 1983	The final report of the Governor's Acushnet River Estuary Commission, in the form of comments on the RAMP, are submitted. The Commission ceases activity.
July 1983	The Massachusetts Legislature approves a $150,000 item in the State Department of Environmental Quality Engineering budget "for the administration of a program for the City of New Bedford for a participation public education, and local coordination activities relative to the problem of P.C.B. contamination in the New Bedford area . . ."
August 1983	U.S. EPA allocates $3.4 million to fund remedial investigations and feasibility studies for New Bedford area.
September 1983	U.S. EPA issues CERCLA 106 Order to Cornell-Dubilier Electronics (CDE) requiring the company to remove PCB - contaminated sediments from portions of the municipal

sewer system downstream of the plant. EPA further orders the City of New Bedford to assist CDE in the sewer line clean-up. The City is also required to monitor PCB levels in the effluent of the Wastewater Treatment Plant for one year. To date no tests have been made.

November 1983	Massachusetts Department of Public Health issues a warning to pregnant and nursing women against eating bluefish due to elevated levels of PCB's found in samples. (No link was suggested between PCB's in the Acushnet River Estuary/New Bedford Harbor area and bluefish with PCB body burden). This action parallels similar testing and concerns by New Jersey (December 1982) and Rhode Island (February 1983). New Jersey tested striped bass (ave. 1.3 ppm in edible meat) bluefish (1.8), white perch (1.2), white catfish (1.9) and eels (3.3), taken from waters of the northern shore and 4 river basins of that state. Rhode Island found 23 of 25 samples of striped bass to be below 2 ppm.
December 1983	The City of New Bedford files a request for a waiver from federal Clean Water Act requirements to establish secondary treatment at the Wastewater Treatment Plant. The application states that no PCB's are presently being discharged in effluent from the plant.
December 1983	The National Oceanic and Atmospheric Administration (NOAA) files suit in federal court against Aerovox and Cornell-Dubilier Electronics for damages and losses of natural resources. The Attorney General's Office of the Commonwealth of Massachusetts files a similar suit.
January 1984	U.S. EPA performs a stack test at the sewage sludge incinerator of the New Bedford Wastewater Treatment Plant. The test will determine the efficiency of PCB destruction of the unit and will determine whether certain toxics by-products are being generated during the incineration process (results pending).