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DRAFT
ENVIRONMENTAL IMPACT STATEMENT
ON THE WAUKEGAN
PCB ABATEMENT PROJECT

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SUMMARY

Polychlorinated biphenyls (PCBs) are chemical compounds that belong to the broad family of organic chemicals known as chlorinated hydrocarbons. The properties of PCBs include good chemical and thermal stability, non-conductivity, fire resistance, and low solubility in water. These properties resulted in the widespread use of PCBs in transformers and capacitors, and as an additive to hydraulic fluids, heat transfer fluids, and plasticizers. Although the manufacture of PCBs was halted in the United States in 1977, uncontained PCBs will persist in the environment for long periods of time because of their stability.

Research ~~carried out~~ conducted to date indicates that PCBs in an uncontained form can result in the following impacts:

- Direct impacts on the reproductive and growth capabilities of aquatic organisms and terrestrial animals;
- Direct impacts on human health from accidental ingestion of large amounts of PCBs ~~spilled into~~ found in food or from direct contact with PCBs in liquid or vapor forms; and
- Potential impacts on human health due to consumption of contaminated fish.

In 1976 it was discovered that the Outboard Marine Corporation (OMC) was discharging PCBs into Waukegan Harbor and into a ditch and settling pond north of the Harbor (North Ditch Drainage System). Subsequent investigations have determined that over a million pounds of PCBs are present in the two areas. Nearly 60% of that estimated amount is found in the soils of the North Ditch Drainage System. The remaining 40% is found in the sediments of Waukegan Harbor. Over 90 of the PCB mass inside the Harbor is in a small embayment at the north end of the Harbor (Slip #3). Approximately 64% of the PCBs in the North Ditch Drainage System are located in the soils beneath two ponded areas, the Crescent Ditch and Oval Lagoons. The remainder is found in the soils of the Parking Lot area, south of the East-West segment of the North Ditch. ~~The PCBs deposited in the soils of the Parking Lot are not in contact with any surface water, however.~~ but

Why not say they're in direct contact with ground H2O which flows towards lake.

A number of surveys have been carried out to determine the magnitude and extent of PCB deposits in different areas of the Harbor and North Ditch Drainage System. PCB concentrations in ~~surficial~~ Harbor sediments in Slip #3 range from 100 to 100,000 parts per million (ppm) and decrease significantly toward the Harbor mouth. The sediments at the entrance to the Harbor contain PCB concentrations that range from 0.10 to 10.0 ppm. The concentrations of PCBs in the surficial sediments of Lake Michigan typically range from 0.01 to 0.10 ppm. PCBs suspended or dissolved in the surface water of the Harbor and nearby coastal zone of the Lake are distributed in a similar fashion. The surface water in the central and northern parts of the Harbor contains PCB concentrations that are much higher than at the Harbor mouth and in Lake Michigan.

The greatest PCB concentrations in the North Ditch Drainage System are in the deep soils beneath the Crescent Ditch and Oval Lagoons, at the western or upstream end of the Ditch. The intermittently flowing waters in the North Ditch also are highly contaminated with PCBs. These waters flow into Lake Michigan at the northern edge of the OMC property, north of Waukegan Harbor.

~~In general, PCBs enter water bodies from direct discharges or from precipitation, due in part to volatilization (that is, exposed PCBs will evaporate, enter the atmosphere, coalesce with water droplets, and fall as precipitation). Because PCBs are relatively insoluble, once they enter a water body they tend to become absorbed in organic matter instead of dissolved in the water. PCBs also are known to accumulate preferentially in the fatty tissues of fish.~~

Fish monitoring programs conducted in the Great Lakes in the early 1970s indicated that PCB concentrations in coho salmon from Lake Michigan were two to three times greater than PCB concentrations in coho from Lake Huron and approximately ten times greater than PCB concentrations in coho from Lake Erie and Lake Superior. It also has been found that fish inside contaminated Lake Michigan harbors, including Waukegan Harbor, generally are the most highly contaminated of all fish tested in the Lake Michigan basin. Carp captured in highly contaminated harbor environments around Lake Michigan have been found to contain as much as 970 ppm PCB on a whole-body sample basis. Carp captured in open water areas of Lake Michigan have not been found to exceed 28 ppm PCB content.

Probably should mention the sequence 15 ppm here

PCB levels in some Lake Michigan fish appear to have decreased; for example, in 1979, lake trout sampled in open water areas had a median PCB content of less than 5 ppm (based on 36 samples), compared to a median PCB content of nearly 15 ppm in 1972 (based on 11 samples). However, 25% of all samples of Lake Michigan lake trout taken in 1979 had PCB concentrations that equaled or exceeded 10 ppm. The study of PCB accumulation processes in Waukegan Harbor fishes indicates that small plankton feeding fish and adult bottom feeding fish such as carp will continue to have PCB concentrations in excess of 5 ppm until the PCB concentrations in the water column of Waukegan Harbor are reduced from the present 0.01 parts per billion (ppb) to 0.30 ppb range to the 0.01 ppb to 0.02 ppb range. Salmon and trout which frequent the Harbor area in fall or spring also may accumulate excessive amounts of PCBs through gill contact with PCBs present in high levels in the water column.

There are varying estimates of the ongoing contribution of the Waukegan Harbor area PCBs to the PCB concentrations in the water and sediments of Lake Michigan. The difficulty in portraying the relative contribution of Waukegan area PCBs is that there is no precise understanding of the mass input of PCBs from other sources into Lake Michigan. It has been estimated that the long-term annual average rate of PCB movement from the Harbor into Lake Michigan is about 22 pounds per year. The rate of PCB movement to the Lake from the North Ditch Drainage System via groundwater and surface water is estimated to be a maximum of about 15 pounds per year. Based on these estimates, it is estimated that PCBs originating from the Harbor or North Ditch area make up the majority of the PCB load to the adjacent nearshore zone of Lake Michigan and at least 1.4% of the total mass of PCBs entering the Lake.

I'm not sure if we know what the current proportions are

Research studies on the direct impacts of PCBs on aquatic organisms found a positive correlation between fish fry mortality rates and water column PCB levels. In a laboratory study, lake trout fry exposed to PCB water column concentrations of 327 nanograms per liter (ng/l) had a 26% greater mortality rate than the control group. This water column concentration is similar to the elevated levels of dissolved PCBs found in the water column in the central area of Waukegan Harbor (300 to 400 ng/l).

Small amounts of dissolved PCBs also have been found to inhibit phytoplankton photosynthesis. Because phytoplankton are at the base of the Lake Michigan food chain, inhibition of phytoplankton photosynthesis will limit the poundage of sport fish that can be produced in the Lake. In one research study, PCB concentrations of 100 ng/l and 500 ng/l inhibited nanoplankton (a form of phytoplankton) photosynthesis by 8.9% and 18.9%, respectively.

PCBs have been found to produce a variety of toxic effects on terrestrial and avian species. The evidence indicates, though, that different commercial mixtures of PCBs elicit different toxic responses in the same species, and different species vary in their susceptibility to PCBs. In one study with mink, complete reproductive failure occurred with a dietary level of 5 ppm PCB. In the same study, 12 mink were fed a diet containing 30% coho salmon from Lake Michigan. None of these mink whelped although 11 of the 12 control animals whelped. Other research studies have linked PCBs with reproductive failure in fish-eating birds in the Great Lakes Basin (e.g., herring gulls, bald eagles, double-breasted cormorants).

what were the one?

The toxic effects of PCBs on humans from occupational or accidental exposure have been documented in several research studies. The most common of these health effects is chloracne, a dermatological ailment characterized by severe skin lesions. In addition to chloracne, occupational or accidental exposure to PCBs has been linked to impaired liver function. Although the evidence is inconclusive, some studies have indicated that PCBs are potential carcinogens. PCBs have produced cancer in animals in several laboratory studies, but additional epidemiological evidence is necessary to establish a link between PCBs and cancer in humans.

human

A positive correlation has been found between blood serum PCB levels and the consumption of fish from contaminated waterways. Persons who regularly consume sport fish from contaminated waterways have been found to have serum PCB levels that were greater than unexposed populations. An association between serum PCB levels and high blood pressure ("borderline and definite hypertension") also was found in a community-wide health study. Although additional research is required to understand more clearly the potential toxic, carcinogenic, and/or mutagenic effects of PCB on humans, it has been

clearly established that body burdens of PCBs are related to the level of exposure of PCBs. As long as uncontained PCBs are present in an area, the potential exists that increased and potentially harmful body burdens of PCBs will result.

The Waukegan area has the largest known uncontrolled mass of PCBs in the Lake Michigan basin and the foregoing material supports the assertion that these large quantities of uncontained PCBs represent an immediate and long-term threat to Lake Michigan area water quality, fish populations, and public health. The most immediate need is to abate the PCB contamination inside Waukegan Harbor. This segment of the project would halt most of the movement of PCBs from the area into Lake Michigan and greatly slow the rate of bioaccumulation in fish dwelling inside Waukegan Harbor and in the nearshore zone of Lake Michigan. A second segment of the project is to abate PCB contamination found in the North Ditch Drainage System. One objective of this segment of the project is to reduce the potential for a sustained or increased groundwater leaching and overland stormwater transport of PCBs directly into Lake Michigan. Another objective is to preclude accidental disruption of, and future human contact with, contaminated soils.

In order to develop an environmentally acceptable and effective abatement project for the two defined areas of contamination, all reasonable abatement alternatives were identified and screened for general feasibility and acceptability. The "No Action" Alternative also was evaluated to identify the long-term environmental consequences of taking no action to abate PCB contamination. The consequences of the No Action Alternative document the need for an abatement action. If no action were taken to abate PCB contamination in the project area the following impacts would continue to occur:

- Fish and other aquatic life inhabiting Waukegan Harbor would continue to be highly contaminated with PCBs. The fishing public could accumulate unacceptably high levels of PCBs from consuming fish caught in the Harbor vicinity.

- There is a large mass of PCBs in the North Ditch Drainage System ~~and the estimated rate of dispersal is low~~. Consequently, there would be a lengthy period of time during which it would be possible for animals or people to come into direct contact with PCBs or unknowingly disperse them into the environment.

with a slowly increasing rate of dispersal

- The relative significance of the PCB load to Lake Michigan from the Waukegan area would increase over time because it holds the largest known uncontained PCB mass in the Lake Michigan basin. ~~and, in time, other smaller uncontained masses of PCBs now affecting the basin will have dispersed or will have become sequestered in deep lake bed sediments.~~

- Routine channel dredging for navigational purposes could not take place and shipping activity that is vital to two Harbor based industries, Huron Portland Cement and National Gypsum, could be ~~halted as a result~~. Routine dredging for recreational boat access to Slip #3 would also be halted.

- The Waukegan Water Filtration Plant maintains an emergency water intake in the Waukegan Harbor. Extra scrutiny would be required for water taken from this intake to ensure that all water delivered through the system has PCB concentrations less than the Federal guideline of 1 ppb. Other lakefront communities near Waukegan Harbor that also rely on Lake Michigan for municipal water supplies also would be required to use extra scrutiny, and possibly increased treatment, to safeguard public water supplies.

- Users of the Waukegan Public Beach (could) come into direct contact with elevated levels of PCBs under certain hydrologic conditions.

- The present volatilization rate of PCBs from both areas would continue with the attendant risks associated with continuous public exposure to PCBs over a long period of time.

Several conceptual alternatives for abatement of PCB Harbor contamination were screened for technical and engineering feasibility. Among the alternatives considered were: excavation of Harbor sediments; dredging of Harbor sediments; in-place confinement of PCBs in parts of the Harbor; closure and filling of the entire Harbor; in-place destruction of PCBs; and in-place fixation of PCB-contaminated Harbor sediments. The alternative that was determined to be most feasible and [illegible] is the dredging of the northern third of the Harbor. The dredging would be accomplished in two phases and remove all surficial Harbor sediments with PCB concentrations in excess of 50 ppm. The first area to be dredged is in the highly contaminated Slip #3 (concentrations in excess of 500 ppm). The second phase would involve dredging the Harbor area south of Slip #3 (concentrations between 50 and 500 ppm). To complete the second phase of dredging, the area of the deepest PCB contamination just below the abandoned OMC outfall must be surrounded by a double-wall cofferdam, the water pumped out, and the sediments excavated to a depth

of up to 10 feet. This last step of phase two is essential to insure that PCBs will not continue to dissolve into Harbor water and continue to contaminate aquatic life. Interference with the operations of Larsen Marine Services, Inc., a marine sales and services company located adjacent to Slip #3, will be minimal since the launch facilities will not be blocked in any way. The cofferdam is recommended to have at least the inner wall erected immediately following the second phase of dredging in order to assure that the exposed high PCB concentrations do not contaminate the Harbor. Hydraulic or pneumatic dredges are recommended as the preferred removal method because of the small particle size associated with the surface muck and because these dredges produce less turbidity than other types. Dredging of the south central portion of the Harbor is not recommended at this time because of the high costs of removing the relatively small amounts of PCBs contained in a large volume of sediment.

The material to be dredged from the Harbor contains approximately 50% water by weight. After dredging it will be at least 90% water by weight. To reduce the water content of the dredged, contaminated sediments, a dewatering lagoon is proposed to be constructed on a vacant parcel of OMC land adjacent to the Harbor. During the dredging operation, the bottom sediment would be slurried with water and transferred to the lagoon by pipeline. After the sediment has settled, the excess water would be withdrawn and treated at a purification plant that would be built in conjunction with the lagoon. The treatment process would insure that all water returned to the Harbor has PCB concentrations less than 1 ppb.

The conceptual alternatives considered for abatement of PCB contamination in the North Ditch Drainage System are divided into two categories: physical removal of the contaminated soils; or in-place control of the PCBs. The options for physical removal include excavation or dredging of various sections. The options for in-place control include secure in-place disposal or confinement with a slurry wall and in-place destruction. These abatement alternatives and options have been preliminarily screened for their feasibility and effectiveness. The approach ~~tentatively~~ identified as the most feasible for the North Ditch Drainage System area is to ~~halt~~ reduce groundwater recharge and* by diverting the surface runoff, then excavate the soils with conventional earth

we need to be explicit by defining the ~~PARTS~~ by ~~PARTS~~ as necessary per request to NJ removal

*PCB contaminated sediment discharge to Lake Michigan ....

moving equipment. The collection and diversion of stormwater runoff also would halt groundwater flows through the area thus limiting the dispersion of PCBs.

Should be more specific and refer to parking lot only

Insufficient information concerning the actual distribution and movement of PCB contamination in the North Ditch Drainage System has prevented the development of final engineering plans and specifications for removal of contaminated soils. The project schedule developed thus far provides for the completion of a stormwater diversion regardless of the extent of excavation of soils in the North Ditch Drainage System. This diversion will dewater soils and halt the present rate of PCB movement into the surface water of the North Ditch and through the groundwater toward the public beach.

(Conceptual approaches) Feasible methods

The recommended abatement project requires the final disposal of PCB contaminated materials. ~~Existing technologies~~ for the final disposal of PCBs include landfilling, incineration, chemical treatment, and biodegradation. A screening of these alternatives indicated that landfilling is the most acceptable means of ultimate disposal. Although long-term storage in a landfill does not destroy the contaminants, the other disposal alternatives involve uncertain technologies, or in the case of incineration, are prohibitively expensive. The risk of offsite movement of PCBs associated with long-term storage in landfills would be minimal with proper landfill design and operation.

Six potential landfill sites were identified: two existing licensed hazardous waste disposal sites; two existing disposal sites that are not licensed for hazardous waste, but have the potential to become licensed; and two areas in Lake County that could be developed into new sites. The preferred disposal site has not yet been identified and no permits have been granted for the purpose of landfilling the PCB-contaminated wastes. Detailed engineering and cost proposals for the potential disposal sites will not be prepared by landfill owners participating in the bid process until the volume and composition of the PCB-contaminated materials is specified in greater detail. The development of this information requires further field study, particularly in the North Ditch Drainage System. The specific environmental impacts associated with the construction and operation of a final disposal site will be addressed when the recommended site is selected and the per-

through the permit process not another EIS

mitting process undertaken. The final disposal site must fulfill all applicable Federal and state licensing and permitting procedures so that secure and environmentally acceptable ultimate disposal of the contaminated material is ensured.

Four abatement project alternatives were developed from engineering plans for the selected options. The abatement alternatives consist of combinations of recommended components with other abatement activities that are potentially viable, but that cannot be unconditionally recommended until additional data are available. In sequence, the abatement project alternatives provide for cumulatively greater levels of PCB abatement. The five project alternatives are:

- Alternative #1 - No action
- Alternative #2 - Dredging and disposal of Waukegan Harbor sediments
- Alternative #3 - Dredging and disposal of Waukegan Harbor sediments and construction of the North Ditch Drainage System stormwater bypass
- Alternative #4 - Dredging and disposal of Waukegan Harbor sediments, construction of the North Ditch Drainage System stormwater bypass, and excavation of the Crescent and Oval Lagoon soils
- Alternative #5 - Dredging and disposal of Waukegan Harbor sediments, construction of the North Ditch Drainage System Stormwater bypass, excavation of the Crescent and Oval Lagoons, and excavation of contaminated soils from the Parking Lot.

The environmental consequences of each of the the project alternatives were assessed in terms of their impact on the natural and man-made environments. Because the project alternatives are consecutively more comprehensive, the impacts associated with the alternatives typically increase commensurately with the additional components.

The environmental consequences of the project alternatives on the natural environment include impacts on air quality, noise, topography and geology, soils, groundwater, surface water, terrestrial biota, and aquatic biota. The more important impacts are summarized in the following paragraphs.

Volatilization of PCBs during dredging and excavation operations would temporarily increase PCB concentrations in the air. Local air concentrations of PCBs during dredging operations will probably exceed the recommended NIOSH 8-hour standard of 1 microgram per cubic meter (ug/m^3), but should be well below the 500 ug/m^3 OSHA standard.

Noise would be produced by construction, dredging, and transportation activities. Although high noise levels could occur in localized areas on a periodic basis, particularly during construction activities, noise impacts would be of relatively short duration.

Construction of the dewatering lagoon and the final disposal site will modify the topography of the two areas. These physical changes are not expected to create any adverse environmental impacts. ~~The final disposal site could have an annoying aesthetic impact on adjacent areas.~~ The removal of contaminated soils from the North Ditch Drainage System would provide for future development in this area. Conversely, the establishment of a final disposal site for contaminated materials would preclude the use of several acres of soil in another location for agricultural production or residential development.

The impacts on groundwater associated with the project alternatives include the possible leakage of PCB contaminated water from the dewatering lagoon into the underlying soils and ultimately into the groundwater. A trial flooding of the lagoon with clean water is proposed to identify and repair cracks, gaps, or other anomalies in the clay liner before any contaminated sediments are placed in the lagoon. Additionally, the lagoon will contain an under-drain leachate collection system to collect any contaminants which do percolate through the liner and the groundwater beneath the lagoon will be monitored by test wells. Similar impacts are possible at the ultimate disposal site. However, because Federal and state regulations require proper safety systems to protect the groundwater at disposal sites, no adverse impacts are expected.

The quality of the surface water would be improved by implementation of the action alternatives. The removal of PCB contamination from the northern third of the Harbor (Alternative #2) would eliminate the present movement to the Lake of PCBs now in the Harbor. The implementation of an action to halt groundwater recharge and movement beneath the North Ditch Drainage System would put an end to the movement of PCBs from this area of contamination into the Lake (Alternative #3).

Reductions in PCB concentrations in the water column of the Harbor would result from Alternative #2 and would have a beneficial impact on aquatic biota. If no action is taken to abate the PCB contamination in the project area, all native Harbor fish and any Lake Michigan fish that occupy the Harbor for several weeks at a time will continue to accumulate extraordinarily high PCB body burdens. This situation would ~~possibly~~ exist for more than 10 years, depending on the long-term rate of dispersion and on the degree to which contaminated Harbor sediments would occasionally be disturbed, exposing the water column to PCBs.

The components of the man-made environment that could be affected by implementation of the four abatement alternatives include: land use, economics and population, transportation, recreation and tourism, sewer and utility lines, and cultural resources. The more important impacts on the man-made environment associated with the project alternatives are summarized in the following paragraphs.

The use of the vacant OMC property for a dewatering lagoon would preclude the use of the site for industrial development for the duration of the project (2 to 5 years). Altnough this is a short-term on site impact, there are long-term impacts associated with the development and use of a landfill for final disposal. These long-term impacts include the irreversible conversion of the land to other uses, changes in land use in surrounding areas, and the potential loss in property values on adjacent land.

The harbor dredging proposed in Alternative #2 would have direct impacts on Larsen Marine Services, Inc. which provides boat maintenance and launching facilities adjacent to Slip #3. Dredging activities

would directly impact these aspects of the company. The economic loss incurred by Larsen Marine Services, Inc. would vary depending on the scheduling and duration of dredging operations. Slip #3 is scheduled to be dredged in September or October 1983 and would take between two and four weeks to complete. Dredging of the area south of Slip #3 (Plan 2) is scheduled to take place in the spring or early summer of 1984 and is expected to last for six to eight weeks. Construction jobs would be created by implementation of the action alternatives and would have a short-term beneficial impact on local employment levels. Larsen Marine would be relieved of a ~~publicly perceived~~ problem at the marina and also would receive a deeper access channel from dredging and a new bulkhead from cofferdam construction.

The construction of the dewatering lagoon could cause roadway damage, create roadway congestion, and pose pedestrian safety problems in the Harbor area. Traffic congestion also could result from the transport of materials to the ultimate disposal site.

If no action is taken to abate PCB contamination, fishing from the Harbor may decrease further and nearby sport trolling also may decrease (including charter boat operations). Conversely, the removal of PCB-contaminated Harbor sediments would have a positive impact on the total recreational fishery. The construction activities associated with the project alternatives would produce noise, dust, and traffic congestion that could diminish people's enjoyment of the public beach adjacent to the project area.

The potential adverse impacts associated with the action alternatives can largely be minimized or eliminated with appropriate mitigative techniques. The dredging and disposal of Waukegan Harbor sediments ~~(Alternative #2)~~ is a recommended component of all of the action alternatives and requires the most extensive mitigative measures to prevent adverse impacts. ~~The most~~ An important mitigative measure proposed is the deployment of a double-walled silt curtain across the southernmost boundary of the Harbor dredging area to prevent the transport of PCBs out of the dredging area. and the selection of pneumatic or hydraulic dredging approach—

Several mitigative measures ~~also are proposed~~ will be used to reduce PCB volatilization during dredging and sediment dewatering. These include covering the contaminated sediments with water after they are removed from the Harbor, supplying project personnel with protective clothing, scheduling dredging activities to avoid periods of heavy beach use, and surrounding and covering heavily contaminated materials in the lagoon with less contaminated Harbor sediments.

The transport of PCB-contaminated materials from the project area to the ultimate disposal site creates a potential for non-localized impacts. These ~~would~~ will be reduced by the use of suitable transportation routes and scheduling to eliminate congestion problems. Proper precautions also ~~would~~ will be taken to control the likelihood of spills and a cleanup procedure would be developed and available should a spill occur during transport.

Many of the impacts associated with the ultimate disposal landfill site would be similar to those of the lagoon, and consequently similar mitigative measures would be required. Compliance with permit requirements will assure the proper use and testing ~~of~~ clay liners, the control of leachate and surface water runoff, the use of effective monitoring programs, and the operating efficiency of the water treatment systems.

there should be, at the text, a full discussion of the Alternative to be followed not the North Ditch Drainage System.

The EIS does not recommend a single course of action to be followed by USEPA to abate PCB contamination in Waukegan Harbor and the North Ditch Drainage System because of insufficient data regarding the extent of PCB contamination in portions of the project area. Information on the direct impacts of PCBs on aquatic organisms and the potential impacts on humans indicates, however, that an abatement action is required to reduce the existing extent of the problem. The implementation of Alternative #2, dredging and disposal of contaminated Harbor sediments, is unconditionally recommended and is considered an important step in reducing the threat associated with uncontained PCBs in the project area. Similarly, it is unconditionally recommended that some form of stormwater diversion be implemented to reduce the recharge and horizontal movement of groundwater in the North Ditch Drainage System. The complete diversion of stormwater from the North Ditch Drainage System will halt the migration of PCB masses toward the surface water and will

reduce or eliminate the existing rate of PCB movement to Lake Michigan. However, the environmental analysis of Alternatives #4 and #5 and the available data on the extent of PCB contamination in the North Ditch Drainage System do not provide a clear indication of a preferable alternative for the complete abatement of PCB contamination in this portion of the project area.

The EIS concludes that based on data regarding the magnitude and extent of the PCB problem, and the environmental analysis and limited cost data for each alternative, the selection of a specific course of action to be followed by USEPA for cleanup of the site will depend primarily on a comparison between the relative amount of abatement to be derived for a particular action to the costs associated with that action. Thus, the recommended action for the entire cleanup project will be determined when more complete information is available on the extent of PCB contamination in the North Ditch Drainage System and the costs associated with abatement in this area. Based on this information, the need to eliminate the direct and potential threats associated with PCB contamination in the North Ditch Drainage System can be compared with the costs of particular abatement actions. While the necessary field work and engineering studies for this portion of the project are taking place, the EIS recommends that the USEPA proceed with the implementation of Alternative #3, dredging and disposal of contaminated Harbor sediments and construction of the North Ditch Drainage System Stormwater bypass, so that the present movement of PCBs into Lake Michigan is eliminated.

This thought should be turned around "more detailed information also to better define extent of removal".

dredge and by-pass

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1.0. PURPOSE AND NEED FOR ACTION

1.1. Introduction

The project area is located in Waukegan, Illinois. Waukegan is situated on Lake Michigan approximately midway between Chicago and Milwaukee (Figure 1-1).

1.1.1. Background

Polychlorinated biphenyls (PCBs) are a class of chemical compounds that belong to the broad family of organic chemicals known as chlorinated hydrocarbons. PCBs do not occur naturally and were chemically synthesized for the first time in the late 1880s. The PCB product was first manufactured in 1929 by the Swann Chemical Company for use by electrical companies. In 1935, the Swann Chemical Company was purchased by the Monsanto Company which became the primary domestic manufacturer of PCBs and which marketed them under the trade name Aroclor. Between 1929 and 1971, when the manufacture and use of PCBs in the United States was curtailed sharply, Monsanto produced approximately 1.4 billion pounds of PCBs. Another one billion pounds have been produced in other countries during the last 40 years.

The widespread use of PCBs can be attributed to their chemical stability, fire resistance, non-conductivity, and low solubility in water. PCBs have been used mainly in fire- and pressure-resistant hydraulic fluids, as heat transfer fluids, as resistors and plasticizers, and in transformers and capacitors. They also have had limited use as pesticides and in rubber, inks, adhesives, carbonless reproduction paper, and as special coatings.

PCBs are produced by the chlorination of biphenyls. The degree of chlorination determines the chemical properties of each PCB product. The numbering system used to identify the different Aroclors produced by Monsanto indicates the average percentage of chlorine by weight. For example, in Aroclor 1254, the first two digits (12) indicate that it is a biphenyl with 12 carbons, and the last two digits (54) represent the percentage of chlorine by dry weight. The physical characteristics of PCBs change to some extent as the

Figure 1-1. Regional location map.

chlorine content increases. Pure biphenyls (that is, those with 0% chlorine) have the appearance of a white powder. As the percentage of chlorine increases, the appearance of PCBs changes from a colorless oil to a viscous liquid to a sticky resin. At 71.7% chlorine, PCBs again appear as white powders (Table 1-1). Typically, the specific gravity, boiling point, and melting point of PCBs increase as the percentage of chlorine increases.

Table 1-1. Physical and chemical properties of representative Aroclors (USEPA 1975).

Property	Appearance	% Chlorine	Specific Gravity	Flash Point (°C)
Biphenyl	White power	0	199	--
1221	Clear mobile oil	20.5-21.5	1,18-1.19	141-150
1242	Clear mobile oil	42	1.38-1.39	176-180
1248	Clear mobile oil	48	1.40-1.41	193-196
1254	Light yellow viscous liquid	54	1.49-1.50	none to boiling point
1260	Light yellow soft resin	60	1.55-1.56	none to boiling point
1262	Light yellow sticky viscous resin	62	1.57-1.64	--
1268	Light yellow sticky viscous resin	68	1.80-1.81	--
Decachloro-biphenyl	White powder	71.7	--	--

In the early 1960s, scientists measuring DDT levels in wildlife discovered evidence of an unidentified chemical compound. In 1966, a Swedish chemist isolated this chemical and identified it as PCB. Subsequently, PCB residues were detected in all parts of the world. Some PCBs leaked directly into wastewater that was discharged into water bodies. Some PCBs in closed

systems, such as transformers, were released into the environment whenever a transformer ~~broke~~ leaked. Other PCBs volatilized during the incineration of PCB-laden waste.

Uncontained PCBs cause concern because of their persistence in the environment and their toxicity to humans, animals, and aquatic organisms. PCBs are remarkably stable compounds that decompose or degrade very slowly. PCBs also are relatively insoluble in water and have a natural affinity for fatty tissue. The available data also imply that PCBs are not excreted to an appreciable extent prior to metabolism to more polar (soluble) compounds, and that long-term storage is in the skin and adipose (fatty) tissue (US Department of Health, Education and Welfare [USHEW] 1976). These factors--stability, insolubility in water, retention in organisms, and affinity for fatty tissue--cause PCBs to bioaccumulate in the organisms that consume them. For example, fish have been found to contain PCBs in concentrations that were several orders of magnitude greater than ambient water concentrations (US Environmental Protection Agency [USEPA] 1981). There is also evidence that PCBs biomagnify in the food chain. This means, for example, that as PCBs are taken in by microorganisms, aquatic insects, and aquatic plants, the concentration of PCBs in fish will increase to much higher levels as contaminated food organisms are consumed by small fish which are in turn consumed by larger game fish. The predicted accumulation of PCBs in fish in the vicinity of Waukegan Harbor is discussed in Section 1.4.

incorrect reference

At present, relatively little is known about the long-term toxic, carcinogenic, or mutagenic effects of PCBs on humans. There is well documented evidence, however, of severe toxic reactions in humans from occupational exposure to PCBs and from accidental consumption of highly PCB-contaminated food. In addition, laboratory experiments have found that PCBs elicit several different toxic responses in animals, in some cases at very low concentrations (USHEW 1976). The potential health effects on aquatic organisms, animals, and humans associated with exposure to PCBs are discussed in Section 1.5.

As additional evidence of PCB toxicity and persistence in the environment began to accumulate, several steps were taken. In 1971, Monsanto restricted

Sales were only allowed to

domestic sales of PCBs to closed system users. In 1977, the production of PCBs was voluntarily terminated by Monsanto due to passage of TSCA. The US Food and Drug Administration (FDA) in 1973 established "temporary" tolerance limits for PCB concentrations in different types of food. A recommended consumption limit of 5 parts per million (ppm) of PCBs was placed on fish and shellfish. The interstate transport of fish containing concentrations of PCBs greater than 5 ppm in the edible portion also was prohibited by the FDA.

In 1976, the Toxic Substances Control Act (TSCA) was enacted by Congress. The Act included a provision that banned the manufacture of PCBs, except for closed system uses, and prohibited the use of PCBs in non-closed systems. The USEPA, in establishing rules to implement TSCA, set a 50 ppm limit for the disposal of PCB materials. According to these rules, all material containing PCBs in excess of 50 ppm must be disposed of in a Federally-approved landfill or incinerator. This limit, however, is currently under review in Federal district court and by the Agency (see for example EDF vs. Costle).

The FDA proposed new, lower tolerance limits for PCBs in 1977. The proposal recommended that the tolerance level for fish and shellfish be reduced to 2 ppm. This proposal was based on new data concerning the direct toxicity of PCBs, indications from laboratory studies with experimental animals that PCBs are carcinogenic, and data from fish monitoring programs that revealed the widespread occurrence of PCB residues in fish. The proposed reductions were published in final form by the FDA in 1979; however, an objection and request for hearing by the National Fisheries Institute has prevented the promulgation of the new limit for control of interstate commerce and for recommending guidelines for the consumption of fish in the individual states.

1.1.2. Discovery of PCB Problem in Lake Michigan

In 1971, a USEPA study of Lake Michigan fish found mean concentrations of PCBs ranging from 2.7 ppm in rainbow smelt to 15 ppm in lake trout. PCB concentrations in excess of 5 ppm were present in all trout and salmon more than 12 inches long. The results of the monitoring program also found a positive correlation between the size of the fish, its percentage of fat and its age, and the concentration of PCBs in whole-body samples. The presence of

a contamination problem in Lake Michigan was supported further when the results of other monitoring programs indicated that PCB concentrations in coho salmon from Lake Michigan were two to three times greater than PCB concentrations in coho from Lake Huron and approximately ten times greater than PCB concentrations in coho from Lake Erie and Lake Superior (USEPA 1981).

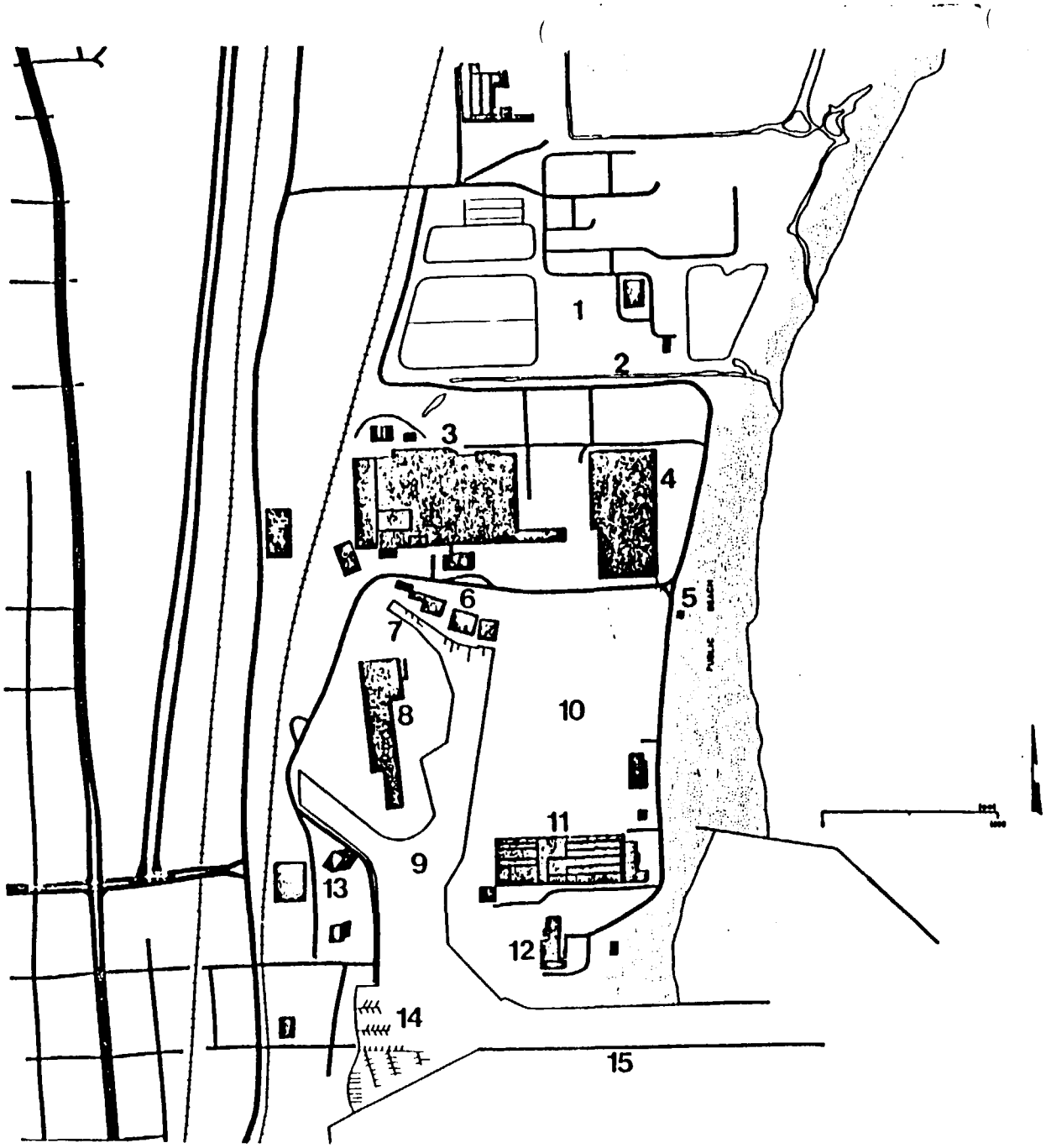
The states of Indiana, Wisconsin, and Michigan established their own fish monitoring programs in the early 1970s as did the US Fish and Wildlife Service. The results of these programs also showed very high PCB concentrations in Lake Michigan fish, concentrations that generally were above the FDA tolerance level. The results from these separate monitoring programs indicated that fish from the southern part of Lake Michigan had higher levels of contamination than did fish from the northern portion of the Lake. Based on this evidence, the sale of some species of Lake Michigan fish (primarily carp, salmon, and lake trout) was banned or restricted in Wisconsin and Michigan.

1.1.3. Extent of Use of PCBs in the Project Area

The Outboard Marine Corporation (OMC) operates the largest aluminum die-casting facility in the United States at its Johnson Outboards Division plant at Waukegan Harbor (Figure 1-2). PCBs were used in hydraulic fluids at this facility. There are varying estimates of the total amount of PCB products purchased by OMC. Based on documents ~~furnished~~ obtained by OMC and the Monsanto Company, it appears that more than 10 million pounds of PCBs in the form of various hydraulic fluids were purchased from Monsanto from 1954 to 1971 for use at the Johnson Outboards Division plant.

1.1.4. Discovery of PCB Contamination in Waukegan Harbor

In 1975, the Illinois Environmental Protection Agency (IEPA) conducted effluent sampling at OMC's manufacturing facilities in Waukegan. The sampling included tests for PCBs in an effort to identify contributors to the Lake Michigan contamination problem. The results of these tests, transmitted to USEPA in January 1976, showed that the PCB concentrations in the effluent being discharged from OMC outfalls into Waukegan Harbor (hereinafter referred to as the Harbor) and the North Ditch Drainage System (a short tributary that



NUMBERED FEATURES IN THE

PROJECT AREA

1. North Shore Sanitary District Waste Treatment Facilities
2. East-West Section of the North Ditch
3. OMC Plant #2
4. OMC New Die Cast Complex
5. Concession Stand
6. Larsen Marine
7. Slip #3
8. Huron Cements
9. Center of Waukegan Harbor
10. OMC owned vacant land
11. Johnson Outboards Plant #1
12. Waukegan Water Filtration Plant
13. Goldbond Building Products
14. Marina and Public Launch
15. South Harbor Breakwater

Figure 1-2. Map of the project area in Waukegan, Illinois.

empties into Lake Michigan; (Figure 1-2) ranged from 8 to 11 ppm. At these levels, it was estimated that as much as 9 to 10 pounds of PCBs were being discharged daily.

The discharges apparently resulted from leaks in hydraulic lines and die cast machines in the Johnson Outboards Division aluminum die-casting facility. The PCBs that leaked from hydraulic lines ended up in floor drains that discharged directly into the Harbor, Lake Michigan, and the North Ditch Drainage System. OMC also withdrew water for industrial use from the most highly PCB-contaminated portion of the Harbor, used it in the plant for cooling water, and discharged it into outfalls that led to the North Ditch and Lake Michigan. This industrial process water was also ~~[illegible]~~ contaminated with PCBs and helped circulate the historically discharged PCBs into the Lake from the Harbor.

Estimates of the total amount of PCBs discharged to the North Ditch and the Harbor range between 1.3 to 2.0 million pounds of PCBs. OMC, in a correspondence to USEPA, estimated a total discharge of 1.3 to 1.7 million pounds of PCBs. Mason and Hanger (USEPA 1981) indicate that OMC is able to account for all but 1.5 to 2.0 million pounds of the PCBs purchased. ~~[illegible]~~ (1981) used a mathematical model of the North Ditch and Harbor to estimate the mass of PCBs that was discharged. Based on this model, the "best" estimate of PCBs discharged from OMC over a period of approximately 20 years was 1.6 million pounds (~~[illegible]~~ 1981) .

reference but cites Johnson differently

Numerous sampling programs have been conducted to determine the locations of zones of contamination and the spread of PCB-contaminated material in the North Ditch and Harbor. In 1979, another area of contamination was discovered in the soils beneath the OMC parking lot (hereinafter referred to as the Parking Lot), which is located south of the east-west section of the North Ditch. It is not clear at this time how the soils in this area became contaminated with PCBs. The magnitude of PCB contamination in the three areas is described in more detail in Section 1.2.

1.1.5. Statutory and Regulatory Framework

The National Environmental Policy Act of 1969 (NEPA; Public Law [PL] 91-190) requires that Federal agencies consider the impact of their actions on the environment. Under Section 102(2)(c) of the Act, Federal agencies are required to prepare a detailed environmental impact statement (EIS) that addresses the following points prior to implementation of major Federal actions that will significantly affect the quality of the human environment:

- The environmental impact of the proposed action;
- Any adverse environmental effects that cannot be avoided if the proposal is implemented;
- Alternatives to the proposed action;
- The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
- Any irreversible and irretrievable commitments of resources that would be associated with the proposed action if it is implemented.

Revised regulations for implementing the procedural requirements of NEPA were published by the Council on Environmental Quality (CEQ) in 1978 in the Code of Federal Regulations (40 CFR Parts 1500-1508). According to the regulations, one of the purposes of NEPA is to "...foster excellent decision making that protects, restores and enhances the environment" (40 CFR 1500.1(C)). change quote

In December 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act. The Act authorized a $1.6 billion fund (the "Superfund") that would enable the Federal government to pay for the cleanup of hazardous substances released into the environment. ~~The legislation~~ establishes liability for those who release the hazardous substances. ~~into the environment, but does not contain provisions for situations that include joint and several liability. In such instances, therefore, reliance is placed on common law principles in determining which parties should be severally liable.~~ The legislation enables the government to sue the responsible parties to recover the costs it incurred in remedying releases of hazardous materials

into the environment, but places limitations on the amounts of liability. No provision is made for third-party compensation (payments for costs incurred by affected individuals or organizations).

USEPA has established an interim policy for insuring compliance with NEPA while carrying out actions taken under the Superfund legislation (By memo, Michael B. Cook, Deputy Assistant Administrator, USEPA, to Superfund Regional Coordinators, 18 May 1981). The policy requires that USEPA identify environmentally sensitive resources in the immediate vicinity of the site during the preliminary assessment, site inspection, or field investigation. Following the site assessment, "...full consideration should be given to assessment of environmental effects during field investigation and the development of alternatives for permanent remedy." This feasibility study is to serve as the Environmental Assessment (EA) as described in 40 CFR 1508.9. Based on the findings of the feasibility study/EA, the USEPA Regional Administrator is required to determine if an EIS is required. This determination is to be made in accordance with the appropriate CEQ regulations (40 CFR 1501.4) and Section 102(2)(C) of NEPA. If it is determined that an EIS is required, the responsible regional official is to assure that an EIS is prepared in accordance with the CEQ regulations.

Not - entire project is EIS

In June 1981, USEPA's feasibility study on this project indicated that Harbor dredging was the only practical, proven technology available for cleanup of the Harbor. Consequently, USEPA concluded that an extended discussion in an EIS on alternative methods of cleanup, as opposed to alternative methods of operation of the dredge, would serve no constructive purpose under NEPA. It also was concluded that the other aspects of the project, that is, the excavation of the North Ditch Drainage System and Parking Lot, and the transport and final disposal of PCB-contaminated materials, could result in a range of environmental impacts depending on the alternatives selected for these components of the project. Accordingly, USEPA determined that in order to comply with the provisions of NEPA and at the same time pursue an expeditious solution to the cleanup of PCB-contamination in the project area, an environmental assessment would be prepared for the Harbor dredging and dewatering lagoon portion of the project and an environmental impact statement would be prepared on the other components of the project.

In November 1981, the EA was published by USEPA. The EA determined that "no significant adverse environmental impacts upon the quality of the human environment will result from the proposed dredging and the attendant necessary construction of the temporary dredged sediment dewatering lagoon." Based on this determination, USEPA has issued a "Finding of No Significant Impact" (FNSI) for these proposed components of the project. The FNSI was issued by the Regional Administrator in conjunction with the publication of the EA and as provided under 40 CFR Section 1508.13. This action will enable USEPA to proceed with Harbor dredging and construction of the dewatering lagoon prior to the issuance of a Record of Decision on this EIS. A Notice of Intent to Prepare an EIS was published by USEPA in the Federal Register on 31 July 1981. A copy of the Notice of Intent is included in Appendix A.

In accordance with Section 404(b) of the Clean Water Act of 1977, a permit from the US Army Corps of Engineers (COE) must be applied for and received to carry out dredging activities in a navigable waterway. An application for a 404 permit was filed by USEPA on 17 September 1981. As of November 1981, approval of this application by the COE is pending. Should discuss status of IEPA and IDOT permit applications —

1.1.6. Public Involvement with the Project

One of the requirements of the CEQ regulations is that Federal agencies must "...make diligent efforts to involve the public in preparing and implementing their NEPA procedures" (40 CFR 1506.6). USEPA has taken several actions to involve the public in the evaluation of alternatives for the cleanup of PCB-contaminated materials in the Waukegan Harbor area. In December 1978, USEPA held a public meeting in Waukegan to discuss the Agency's legal and technical plans for abatement of PCB contamination. In November 1980, USEPA's Region V Regional Administrator hosted meetings with the public and with local congressional representatives to explain the Agency's proposed cleanup program.

In January 1981, an information document prepared by USEPA was released that presented "...an opportunity for thorough and thoughtful public review of and comment on the total approach that the Agency is prepared to take to resolve the problem." In February 1981, as a follow-up to the report, a

public meeting was held at the Lake County Courthouse in Waukegan to summarize the planning and engineering studies that had been performed.

In July 1981, a copy of the Notice of Intent to Prepare an EIS was sent to the 230 names on the mailing list compiled by USEPA for this project. The mailing list includes Federal, State, and local agencies, conservation organizations, citizens groups, and individuals that had previously expressed an interest in the project. A copy of the Notice of Intent also was published in the Federal Register on 31 July 1981.

A scoping meeting was held on 21 August 1981 at the Waukegan City Hall to discuss the scope of the project with regard to the EIS and to answer questions on the status of the project. A press release was sent to all Waukegan and Chicago area news agencies to publicize the meeting. At that meeting, the schedule for and costs of the proposed project were announced.

Copies of the draft EIS were provided to the Mayor of Waukegan, the Waukegan Port District, the Waukegan Public Library, and Federal and State agencies. Copies of the Summary Document also were sent to all persons or organizations on the mailing list and to any other person or organization that requested one. The EIS also is available for review in the USEPA Region V Office of the Superfund.

1.1.7. Chronology of Events

A brief outline of the significant events to date concerning the PCB problem in Waukegan Harbor is listed below.

Date	Event
1929	PCBs first manufactured in US by Swann Chemical Co. (the PCB product later is purchased by the Monsanto Company and marketed under the trade name "Aroclor").
1966	Unknown chemical detected in pesticide monitoring programs is identified by a Swedish chemist as PCB.
1971	Results of USEPA study show PCB concentrations of 2.7 to 15.0 ppm in Lake Michigan fish.

1971	Indiana and Wisconsin initiate monitoring programs to gather data on concentrations of DDT, PCB and other chemicals in Lake Michigan fish.
1971	Monsanto restricts sale of PCBs to closed-system uses.
1971	Sale of some species of Lake Michigan fish banned or restricted in Michigan and Wisconsin.
1972	Fish monitoring programs initiated by Michigan and US Fish and Wildlife Service.
1973	FDA establishes "temporary" tolerance limit for PCBs in fish and shellfish of 5 ppm.
January-December 1975	Illinois Environmental Protection Agency (IEPA) conducts effluent sampling of OMC outfalls for PCBs.
June 1975	OMC issued a National Pollutant Discharge Elimination System (NPDES) permit. PCB component of discharge not reported in application. No limits imposed on PCBs.
November 1975	USEPA convenes National Conference on PCBs; data on persistence and toxicity of PCBs presented.
January 1976	Results of IEPA analysis of OMC effluent indicate PCB discharges of approximately 9 to 10 pounds per day.
February 1976	USEPA and IEPA issue Administrative Enforcement Order for compliance with Section 309 of the Clean Water Act. Order requires elimination of PCB discharges from all 14 OMC outfalls within 30 days.
March 1976	OMC proposes plan to eliminate PCB discharge and applies for modification of its NPDES permit to authorize some discharge of PCBs.
May 1976	USEPA requests that the US Army Corps of Engineers forego maintenance dredging of Waukegan Harbor, pending the results of a survey of Harbor sediments by USEPA.
May-June 1976	USEPA and IEPA collect and analyze test samples of sediments in Harbor and North Ditch. PCB concentrations as high as 246,000 ppm in North Ditch sediments and 9,900 ppm in Harbor sediments are discovered.
May 1976	USEPA issues a superseding Administrative Enforcement Order requiring immediate cessation of PCB discharges from all outfalls except Outfall 009. A deadline of 31 December 1976 is established for cessation of PCB discharges from Outfall 009.

May 1976	OMC requests an adjudicatory hearing regarding its request for a modification to its NPDES permit.
May 1976	US Army Corps of Engineers agrees not to perform scheduled dredging of Harbor.
June 1976	OMC requests a stay of the alleged "contested provisions" of its discharge permit under the superseding Enforcement Order.
May-August 1976	OMC performs extensive sampling of outfalls pursuant to superseding Enforcement Order.
June 1976	USEPA stays part of the superseding Enforcement Order on the condition that OMC complete sampling and engineering work by the time required in the Order.
February-August 1976	OMC implements several steps to eliminate sources of PCB contamination (two outfalls sealed, some internal contaminated sewers sealed, portions of process wastewater system restructured into a closed loop).
September 1976	OMC declines to act on USEPA's demand for immediate action to remove PCB sediments.
October 1976	OMC presents results of its own effluent sampling program. Results indicate discharge of PCBs is reduced to approximately 2 pounds per day (lb/d). OMC proposes to eliminate most of remaining discharge (all from Outfall 009). Data show no net discharge of PCBs from other outfalls.
1976	Congress enacts TSCA. Manufacture of PCBs is banned except for use in closed systems. USEPA is required to regulate the disposal of PCBs. Use of PCBs in non-closed systems is prohibited.
April 1977	FDA proposes new tolerance limits for PCBs; recommends that level for fish and shellfish be reduced from 5 to 2 ppm.
1977	Monsanto voluntarily terminates domestic production of PCBs at all its facilities.
1977	Negotiations conducted between OMC, IEPA, and USEPA concerning responsibility for cleanup of Harbor and North Ditch.
1 March 1978	OMC sues USEPA under the Clean Water Act and the Administrative Procedures Act. OMC alleges that it is the responsibility of US to determine if a cleanup should be conducted in Waukegan and to pay for any such cleanup.

17 March 1978	Following breakdown of negotiations, suit is filed against OMC by US Attorney on behalf of USEPA. The suit alleges that PCB discharges by OMC have harmed Lake Michigan waters and aquatic life and that they pose a threat to health and the environment. The suit also requests that OMC dispose of the North Ditch soils in a safe manner and dredge and dispose of the contaminated Harbor sediments.
June-November 1978	USEPA conducts preliminary evaluation of alternatives for removal/destruction of PCB contaminated sediments in the Harbor and North Ditch.
October 1978	Protective order is issued by Federal District Court at request of OMC. Order provides that data gathered since October 1978 on PCB concentrations cannot be discussed until "...the data and tests are used in the prosecution of this matter."
December 1978	OMC files a third-party complaint against Monsanto, alleging negligence and a breach of products liability law.
December 1978 - February 1981	USEPA conducts studies to assess the nature and extent of environmental problems in air, surface water, groundwater, soils, and sediments of Waukegan Harbor and North Ditch areas and southern Lake Michigan.
June 1979	USEPA monitors a dredging project conducted by the Waukegan Port District in a relatively uncontaminated portion of Waukegan Harbor (a clam shell dredge and silt curtains were employed).
November 1979	The Regional Response Team (RRT), a regional planning body made up of Federal, State, and local agencies convened to coordinate the activities of those agencies during an uncontrolled pollutant discharge (40 CFR 1510.34), determined that a remedial action was necessary pursuant to the emergency provisions of Section 311 of the Clean Water Act. The RRT recommended that a bypass be constructed around the North Ditch.
December 1979 - January 1980	During site preparation for construction of the bypass, USEPA discovers new areas of substantial PCB contamination along the proposed path of North Ditch bypass and beneath OMC's north parking lot. Bypass construction is postponed.
July 1980	US sues Monsanto, alleging violations of Refuse Act and products liability law, and negligence as a supplier of PCBs.

July 1980	US files amendment to add three counts to its complaint against Monsanto; alleges violation of Refuse Act, products liability law, and Federal common law of nuisance. Amendment allowed by Federal District Court.
July 1980	Monsanto files cross-claim against OMC, based on new allegations made by US.
July 1980	USEPA conducts soil sampling to locate possible zones of PCB contamination elsewhere on OMC's property.
July 1980	USEPA begins updating preliminary remedial action alternatives assessment and identifying ultimate disposal and/or destruction alternatives, for Waukegan Harbor, North Ditch and Parking Lot areas of contamination.
September 1980	Special Congressional appropriation of $1.5 million in USEPA budget made "...to begin the cleanup of Waukegan Harbor."
October 1980	RRT is again convened and presented with available Harbor data. RRT determines that a limited remedial action is necessary pursuant to emergency provisions under Section 311 of the Clean Water Act. Based on available data, the RRT cites the urgent need to abate the ongoing uncontrolled release of PCB's from the sediment to Waukegan Harbor and Lake Michigan. The RRT, with the assistance of USEPA, evaluates feasible alternatives for Harbor remedial action and determines that dredging of the northern most areas of the Harbor should be undertaken as soon as detailed plans and specifications can be readied. USEPA begins preparation of these plans and specifications.
November 1980	USEPA issues a public statement which describes the proposed dredging plan and requests comments from the public.
December 1980	Comprehensive Environmental Response, Compensation, and Liability Act ("Superfund") passed. Authorizes $1.6 billion for five years to pay for costs of cleanup of hazardous substances released into the environment.
January 1981	USEPA completes preliminary remedial action alternatives assessment for abatement of PCB contamination in Waukegan Harbor, North Ditch, and Parking Lot areas.

January 1981	USEPA issues a public report which discusses in detail a proposal for a comprehensive, feasible remedial cleanup project for Waukegan Harbor, North Ditch, and Parking Lot areas under the emergency provisions of Section 311 of the Clean Water Act. Potential funding sources including Superfund are first identified. Public comments are requested.
January 1981	USEPA holds a public meeting in Waukegan to solicit comments on the proposed cleanup project.
February 1981	USEPA begins preparation of a detailed environmental assessment of the proposed project using all available information.
April-July 1981	USEPA Region V determines that, if Superfund dollars are to be used, requirements of the National Environmental Policy Act must be satisfied.
June 1981	The USEPA segments the Waukegan Harbor cleanup project in terms of NEPA compliance. An environmental assessment will be prepared to consider the issues associated with the selection of dredging as the alternative in the abatement of the Waukegan Harbor contamination problem and the construction for the necessary dewatering lagoon. The Draft EIS will address the other aspects of the proposed cleanup project.
31 July 1981	USEPA issues a Notice of Intent to prepare an EIS on cleanup of Waukegan Harbor, the North Ditch, and the Parking Lot and the removal, transportation, and ultimate disposal of contaminated materials.
21 August 1981	USEPA holds a public scoping meeting to identify issues of concern which must be addressed in the Draft EIS (40 CFR 1501.7).

segmented EA for funded or unfunded segments

1.2. Magnitude of the PCB Contamination

The purpose of this section is to define the magnitude of the PCB contamination problem in Waukegan Harbor, the North Ditch Drainage System, and Lake Michigan, and assess the extent and importance of the movement of PCBs originating from the project area into Lake Michigan and the atmosphere. Available PCB concentration data for the water column and bed sediments or soils of these areas were used to estimate the PCB mass in distinct sectors of the bed sediments of Waukegan Harbor and the soils of the North Ditch.

1.2.1. Amount and Distribution of PCBs in the Project Area

Estimates of the mass of PCBs in the bed sediments (all material in the bottom of a particular water body) of the Waukegan Harbor and the soils in the North Ditch have been made (HydroQual, Inc. 1981; Mason and Hanger 1981) to determine the ~~approx~~ extent of PCB contamination. These estimates vary somewhat, but are on the order of a total of over one million pounds of PCBs in the project area (Table 1-2). The variability of these estimates results largely from the different methods used to group and average the field data on bottom sediment and soil PCB concentrations. Estimates of the total PCB mass in the Parking Lot as of October 1981 are not ~~precise~~ as detailed as these formulas. Further field and laboratory studies are underway to obtain ~~a better~~ a more extensive data base. ~~Present estimates of the PCB mass in the Parking Lot area must be regarded as tentative.~~

The distribution of PCB masses in the project area is extremely important for the formulation of reasonable alternatives for the removal and disposal of the PCB-contaminated materials. More than 95% of the total PCB sediment mass in Waukegan Harbor is located in Slip #3, the area indicated as "Plan 1" for dredging (Figure 1-3). Slip #3 is the priority area for any abatement action conducted in the Harbor. Approximately 64% of the PCB mass in the North Ditch Drainage System is in the soils of the Crescent and Oval Lagoons on the western end of the Ditch. The priority for action in the North Ditch Drainage System is dependant upon the rate of PCB movement and discharge as described in Section 1.2.2. as well as on the mass distribution of PCBs.

1.2.1.1. Harbor Sediments and Water

Sediments

A number of surveys of bed sediment PCB contamination have been conducted in the Harbor between 1976 and 1981 (Appendix B). The data from these surveys indicate that surficial sediment PCB concentrations were highest (100 to 10,000 micrograms per gram [ug/g]) at the innermost Harbor locations and decreased several orders of magnitude to a range of 0.1 to 10.0 ug/g at the Harbor mouth (Figure 1-4). All of the highest bed sediment concentrations observed were within Slip #3. These values compare to a range of PCB sediment

Table 1-2. Estimates of PCB mass in Waukegan Harbor and North Ditch Drainage System (HydroQual, Inc. 1981 and Mason and Hanger 1981).

		HydroQual, Inc. (1981)			Mason and Hanger (1981)
		Low Estimate	Best Estimate	High Estimate	Single Estimate
WAUKEGAN HARBOR		166,780 lbs	*456,650 lbs	756,980 lbs	359,200 lbs
NORTH DITCH DRAINAGE SYSTEM	Crescent and Oval Lagoons	109,830 lbs	*611,580 lbs	1,163,100 lbs	495,000 lbs
	Parking Lot	--	--	--	*278,000 lbs
	Total	--	889,580 lbs	--	--
Estimated PROJECT AREA TOTAL			1,346,230 lbs		

* Indicates the components of totals

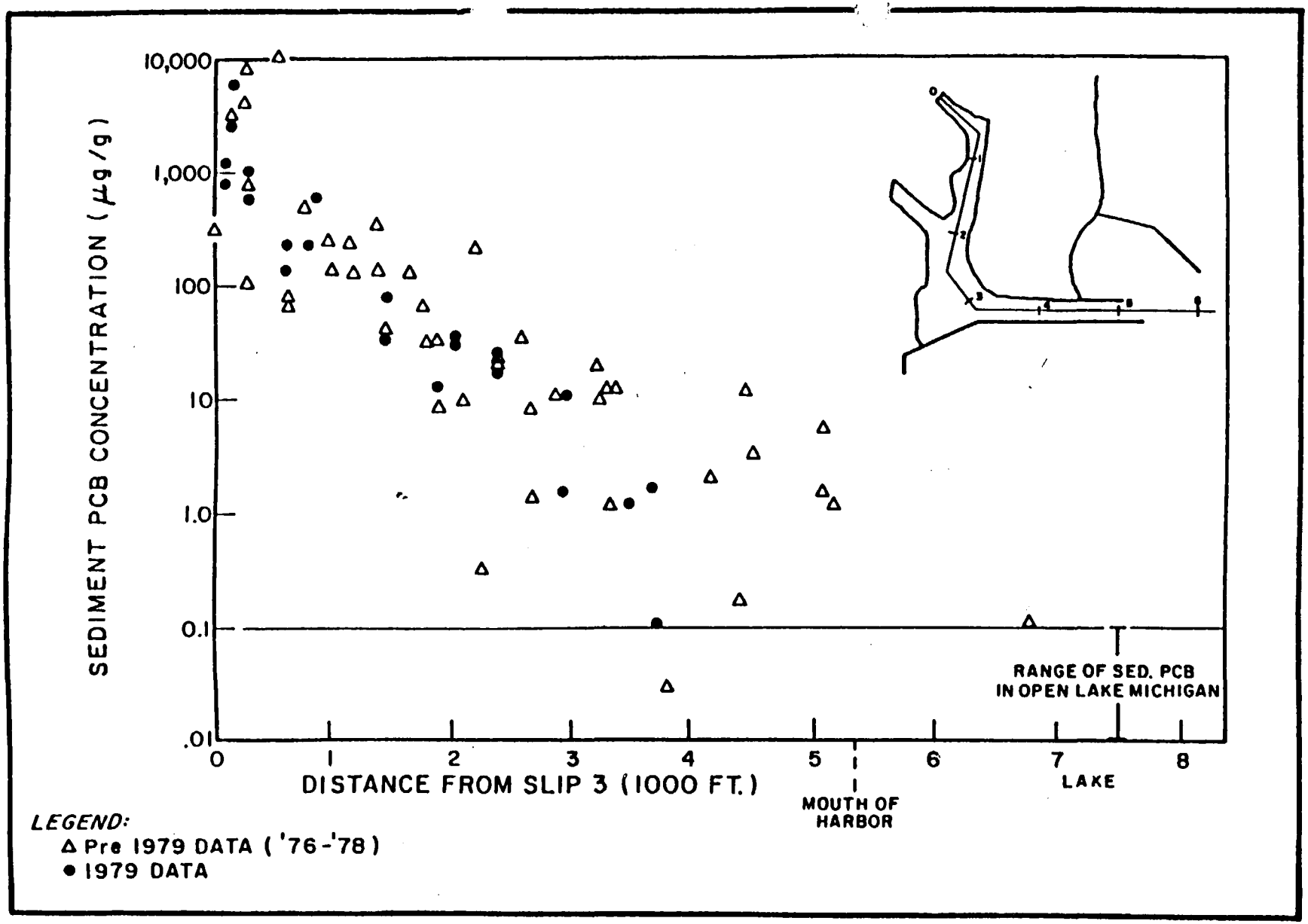


Figure 1-4. Concentrations of PCBs in surficial sediment along a transect through Waukegan Harbor (Hydro-Qual 1981).

concentrations for Lake Michigan of 0.01 to 0.1 ug/g (International Joint Commission [IJC] 1981). No differences are discernible between the earlier and more recent survey data for surficial Harbor sediments.

PCB concentrations at the lower Harbor sediment depths were determined from cores ~~taken from the inner part of the Harbor in Slip #3~~. Cores taken near the abandoned OMC outfall contain some of the highest PCB concentrations on record. At the outfall, PCB contamination has penetrated into the sand and clay layers underlying the contaminated muck. Concentrations of over ~~100,000~~ 500,000 ug/g were measured in the sand beneath the outfall. Concentrations of this magnitude previously were thought to be associated only with the overlying muck layer. ~~Recent data (May 1981) indicate that PCBs have penetrated the silty clay layer which underlies the sand and muck in the vicinity of the outfall. However, the deep underlying mass of PCBs beneath the outfall has largely ponded up and spread out laterally along the top of the clay layer, approximately 5 to 10 feet below the sediment/water interface (USEPA 1981).~~

500F ppm

Surface Water

Surveys of the surface water in Waukegan Harbor and adjacent areas in Lake Michigan were conducted during 1979 (Appendix B). Some of the data from these surveys, summarized in Figure 1-5, indicate that:

- Total PCB concentrations are more than one order of magnitude (more than ten times) higher at the inner Harbor than at the mouth of the Harbor (USEPA 19~~79~~80).
- The sharp decreases in concentrations evident in samples taken on 8 and 9 May 1979 (Figure 1-5) at the mouth of the Harbor are believed to be attributable to the complete flushing out of the Harbor by Lake Michigan water during a major storm event (~~Argonne National Laboratory~~ 1979).

1.2.1.2. North Ditch Soils and Water

Soils

~~At least half of the mass of PCB contamination in the project area, excluding the Parking Lot, appears to be in the North Ditch area (Table 1-2).~~

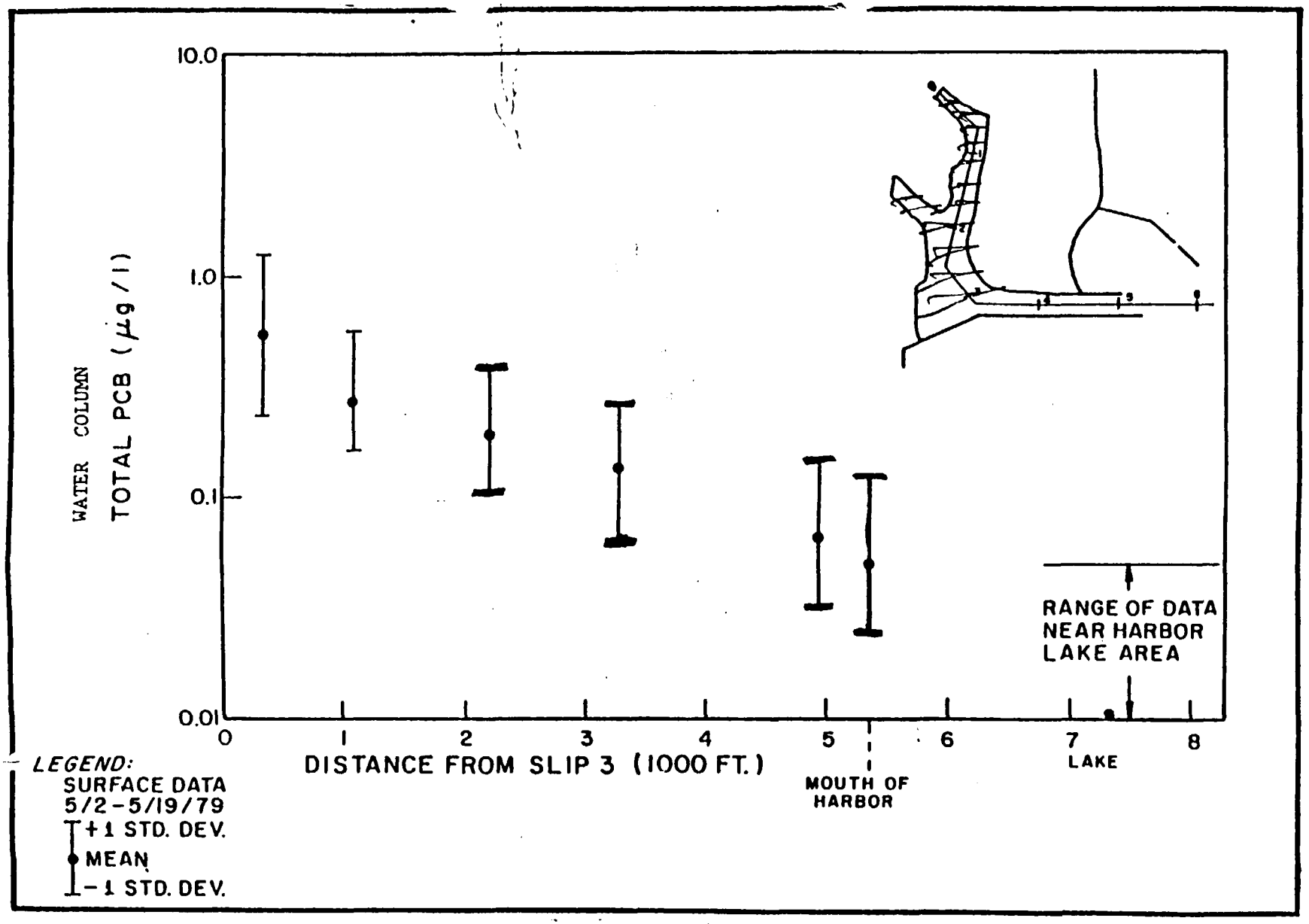


Figure 1-5. Total PCB concentrations along a transect through Waukegan Harbor, from daily survey data (HydroQual 1981).

~~Furthermore,~~ because more than 95% of all the PCB-contaminated soils in the North Ditch Drainage System (excluding the Parking Lot) are located in the Crescent and Oval Lagoon area, it is possible that the magnitude of PCB contamination of these sections is greater than that of Slip #3 in the Harbor. The results of sampling conducted during 1976 and 1977 confirm that the highest PCB concentrations in the project area are present in the deep soils beneath the Crescent and Oval Lagoon sections of the Ditch (Appendix B).

Surface Water

The data on PCB concentrations in the water of the North Ditch were obtained during a study of sediment transport in the Ditch by Noehre and Graf (1980). The study was conducted from March to November 1979 at the footbridge approximately 200 feet above the mouth of the Ditch. The average total PCB concentration during the sampling period was 9.25 micrograms per liter (ug/l). This is approximately two orders of magnitude (one hundred times) higher than the concentrations found in surface water near the mouth of the Harbor.

1.2.1.3. Lake Michigan Sediments and Water near Waukegan

Sediments

The bottom sediments of the near-Harbor area were sampled during 1980 (Armstrong 1980). The results of this survey indicated that PCB concentrations decreased with increasing distance from the Harbor. At sampling stations near the mouth of the Harbor, the PCB sediment concentrations varied between 25 and 39 nannograms per gram (ng/g) (dry weight). Concentrations at the more distant station decreased to the 5 to 22 ng/g range. Concentrations of PCBs in samples taken from the surficial sediments of the southern basin of Lake Michigan are not uniform and the PCB distribution in these sediments is not indicative of the overall significance of individual land based sources of PCBs (Figure 1-6) (Armstrong 1980). It is likely that all PCB sources to Lake Michigan contribute to the PCBs which are in the sediments of the depositional zones of the Lake. These sources of PCBs are discussed in Section 1.2.2.2.

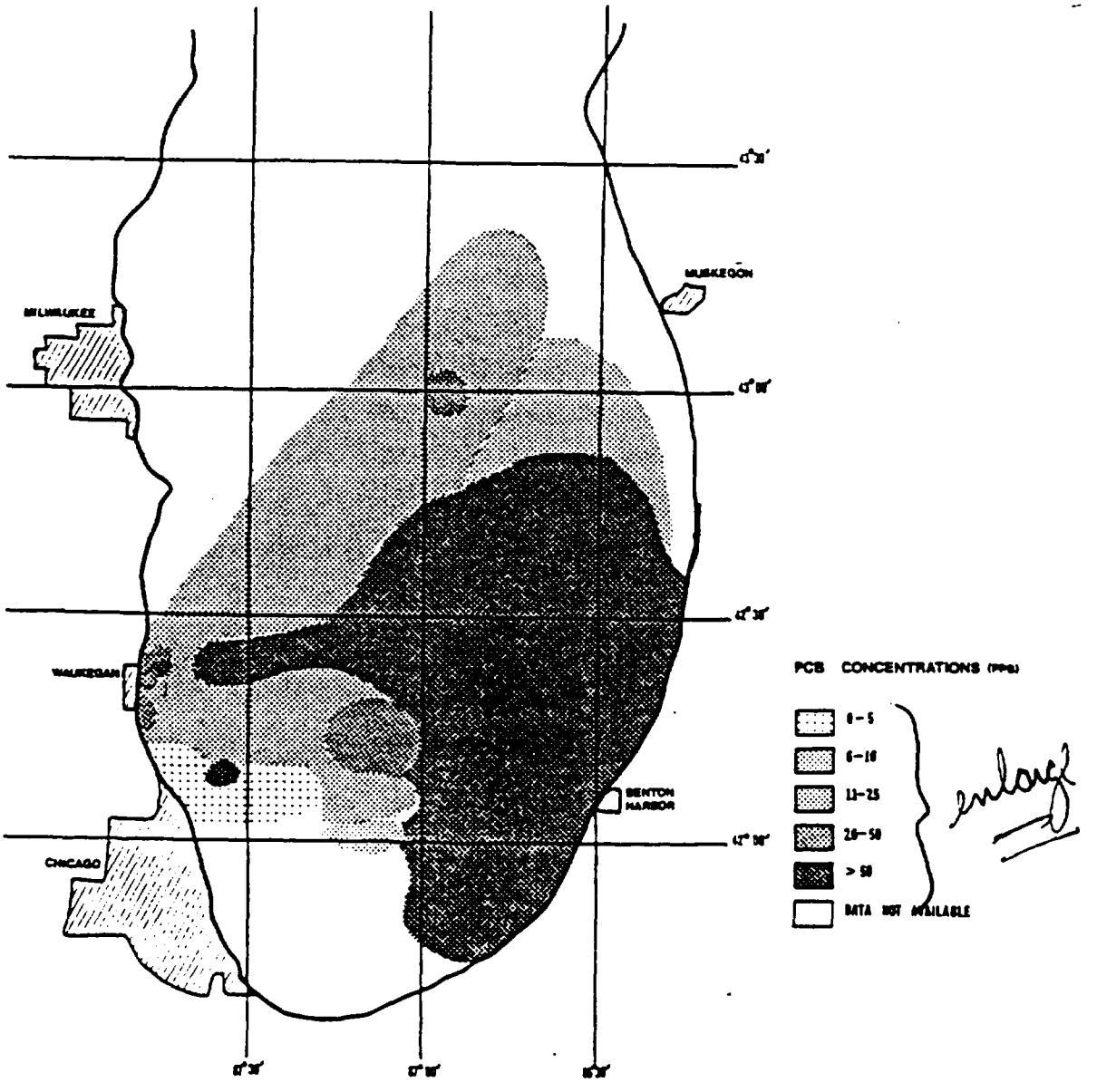


Figure 1-6. Generalized distribution of PCB concentrations in the surficial sediments of the southern basin of Lake Michigan. Derived from data gathered by Armstrong (1980).

needs to be cleared with Armstrong? why

units wrong

It CAN be inferred from the data of Armstrong (1980) that the generally high PCB concentrations (25 to 89 ppm) in the surficial sediments off Waukegan are unique to that area and that the largely mineral sediments of the nearshore zone would not sustain these levels of PCBs under conditions of storm-generated currents unless there were a continuing source of PCBs. Some of the sedimentary samples taken in the nearshore zone off Waukegan were reported to be close to 200 ppm. These high concentrations were reported to be associated with sediments with a high organic content and where historic deposits of Harbor dredge spoils may have been made (Armstrong 1980).

Surface Water

Limited surface water samples were collected offshore from the mouth of the Harbor as part of another study (HydroQual 1981). The total PCB concentrations measured ~~in samples taken~~ approximately 1.5 kilometers (km) lakeward from the Harbor mouth ranged from 10 to 50 ng/l.

1.2.2. Movement of PCBs

wrong reference

Estimates of the mass rates of PCB movement out of the North Ditch Drainage System and Waukegan Harbor have been made on a long term annual average basis (USEPA 1980). The background material which gives the detailed methodology for the calculation of these rates is presented in Appendix B. The mechanism and significance of PCB movement in both areas is discussed below.

1.2.2.1. Movement of PCBs within the North Ditch Drainage System and the Harbor

PCB Movement in the North Ditch Drainage System

I'm uncertain about this discussion

There are two distinct zones or "enclaves" of PCB-saturated soils in the North Ditch Drainage System. According to field studies conducted by JRB Associates, Inc., and Warzyn Engineering, Inc. (USEPA 1980), the highest concentrations of PCBs at, or beneath the water table are at the extreme east and west ends of the North Ditch Drainage System (Figure 3-1). The concentrations in the centers of these enclaves are sufficiently high to allow them to

be described as PCBs in liquid form which have displaced water from the interstitial spaces in soils. Because PCBs are denser than water, there is a tendency for liquid PCBs to sink through porous, sandy soil, displacing groundwater until low permeability soils are encountered at greater depth (Figure 1-7). Downward (vertical) movement of these enclaves is also aided in a minor way by groundwater percolating downward from the surface.

The horizontal movement of PCBs originating from these enclaves is important because it is the horizontal component which currently contributes PCBs to the surface waters of the North Ditch and ultimately to Lake Michigan. ~~The gradual horizontal movement of the PCB enclaves themselves is also important, but from a long-term point of view.~~ but

The horizontal movement of PCBs in the North Ditch Drainage System results from the movement of groundwater in the area. Hydrogeological investigations and modeling analyses conducted by JRB Associates, Inc., (USEPA 1980) indicate that there are three characteristics of PCB movement associated with horizontal movement of groundwater. The first is the migration of the PCB enclave itself. In this case, the groundwater flows through the soils have a net horizontal component of motion, gradually causing the entire enclave of contamination (liquid PCBs and PCB-saturated soil particles) to migrate. Migration, therefore, refers only to the gradual net shift of an entire enclave of PCBs. Dispersion of PCBs from the enclave refers to the process whereby PCBs are desorbed (removed) from saturated soils or dissolved from the liquid PCB mass in the enclave by groundwater and moved out of the enclave. PCBs dispersed in this manner are subsequently absorbed onto less contaminated, outlying soils. Flux refers to the process of PCBs dissolving into groundwater and moving with it, by advection, to a point of discharge to the surface water. Because PCBs can only dissolve into water in very small amounts and tend to be rapidly taken out of solution by uncontaminated soils, the flux or discharge of PCBs into surface waters becomes significant only when all soils between the enclave and the surface waters have absorbed the maximum amount of PCBs or if there is a direct hydraulic connection.

"surface loss" or "runoff"

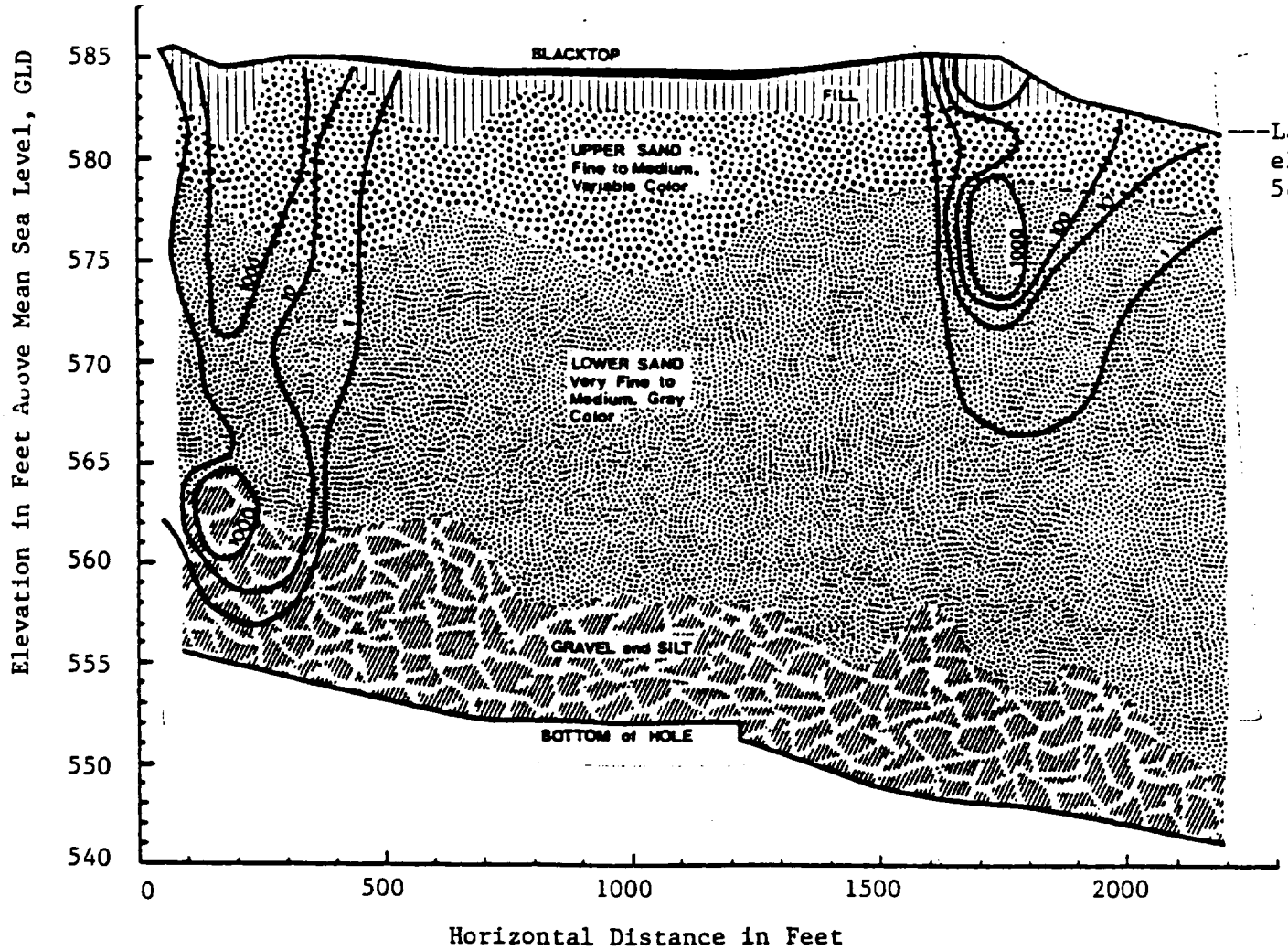


Figure 1-7. Cross-sectional view along transect of boring holes in a line running east and west (D-D' on Figure 3-1). Isopleths represent PCB concentrations in soils (ug/g). Derived from JRB Associates report to USEPA(1980).

if its derived from here it could be original in this text

It is emphasized that gradual enclave migration is not currently analogous to enlargement of the enclave (dispersion) or to flux of PCBs from the enclave into the surface waters (discharge). At some point in the future, however, migration will create flux if an abatement action is not taken.

The PCB enclave at the west end of the North Ditch under the Crescent and Oval Lagoons was found to be essentially stationary in terms of horizontal migration (USEPA 1980). Short-term (back and forth) shifts in enclave position were found to result from rapid rises in water levels and temporarily reversed groundwater gradients in the area. These short-term shifts brought the enclave back to the original position, however, when water levels fell and the usual gradients were re-established. Additionally, the groundwater flow through the PCB-saturated soils of this area has slowly released PCBs to the groundwater which in turn has carried the contaminants to absorption at unsaturated soils. This dispersion of the PCBs from the western enclave has produced the present configuration in which the highest concentrations of PCBs are found in the center of the enclave, and lower concentrations are found along the outlying margins of the area (Figure 1-7). Continuing storm-related fluxes of PCBs discharging from the western enclave into the North Ditch waters have also been identified. The contact of surface water with the contaminated groundwater in the Crescent and Oval Lagoon area causes a discharge of PCBs into Lake Michigan. The estimated magnitude of this discharge is described in more detail in Appendix B.

The PCB-saturated enclave at the east end of the North Ditch, under the Parking Lot owned by OMC, was found to be migrating eastward toward Lake Michigan as a consequence of storm related (non-reversing) eastward groundwater flow. This net groundwater flow was found to have caused the enclave to migrate slowly toward the Lake and also to have resulted in some dispersion of the enclave. There is currently no detectable flux of PCBs into the surface water from the eastern enclave. However, based on observed rates of net groundwater movement, it was estimated that the leading edge of this enclave will disperse to Lake Michigan in approximately 30 years (2010 A.D.) Additionally, as the enclave migrates eastward, liquid PCBs and PCB-saturated sediments will eventually be in contact with the surface waters of Lake Michigan and significant lakeward fluxes ~~could occasionally~~ would result. It has

been estimated that in approximately 60 years the flux to the Lake of PCBs associated with peak groundwater flow could reach at least 10 grams per day from the eastern enclave (USEPA 1980).

The results of the groundwater monitoring and modeling analyses described above indicate that the discharge of PCBs from the two enclaves of contamination is different for each area and that the discharge characteristics will change during the next 30 to 60 years. Assuming that runoff conditions associated with storm events continue relatively unchanged, the western PCB enclave would remain relatively stationary but would continue to contribute a ~~relatively~~ constant annual flux of dissolved PCBs into Lake Michigan via discharge through the North Ditch Drainage System. Because the groundwater in the eastern zone of contamination is not in contact with the surface waters of the North Ditch nor of the Lake, there is at present no significant discharge of PCBs from the eastern enclave. However, the eastern enclave of contamination is migrating eastward and is also dispersing. If migration and dispersion continue as projected, future discharges of PCBs out of the eastern enclave and into the Lake ~~could~~ will occur. The significance of these PCB discharges will be primarily a function of the frequency and magnitude of storm events which induce eastward groundwater movement in the vicinity of the Parking Lot.

Movement of PCBs in Waukegan Harbor

PCBs that are deposited on the bottom of Waukegan Harbor are not completely at rest. They can be mechanically resuspended or dissolved into the water column at variable rates depending on the degree of water exchange, turbulence, and/or their location within the Harbor. After mechanical forces or Lake water movements act indirectly to increase Harbor water turbulence and resuspend sediment-bound PCBs, those contaminated sediments which do not again settle to the bottom of the Harbor move into Lake Michigan. This sediment movement process may be likened to a wine bottle containing sediments or "dregs" which are stirred up as the bottle is tipped for pouring. If the wine is carefully poured, much of the dregs will resettle and little will leave the bottle. However, the slightest horizontal motion of the pourer's arm will cause the wine to slosh or "oscillate" back-and-forth. The dregs will then be resuspended and more will pour out with the wine.

The resuspension of contaminated sediments and the direct dissolution of PCBs into unsaturated water are enhanced in Waukegan Harbor by a combination of natural and man-made forces. Currents may evolve which are occasionally of sufficient velocity to greatly stir up and redistribute sediments in parts of the Harbor. It has been reported that dredging, commercial shipping activity, and recreational boating also may significantly disturb Harbor sediments for brief intervals (public testimony at a scoping meeting held in Waukegan, August 1981). However, the waters of Waukegan Harbor are rather isolated from Lake Michigan as they are "bottled up" by the retaining walls which almost completely surround the Harbor. There is no opportunity at Waukegan Harbor for complete flow-through of Lake water to provide a flushing action. While there are one or more storm sewers discharging into the Harbor, there is no surface water drainage with enough runoff flow to provide complete flushing during rainstorms. As a result of these special circumstances, the exchange of Harbor water with Lake Michigan water is caused ~~only~~ by complex interactions associated with the natural oscillations of Lake Michigan and by (certain infrequent and extreme) meteorological events. Specifically, water exchange and continuous sediment resuspension are associated with frequent, short-wave horizontal oscillations of water between the Harbor and Lake Michigan; with the rapid rise and fall of water levels during Lake Michigan seiches; and with the wind-driven exchange of density-stratified layers of water. (In the latter case, warm Harbor water is blown out of the mouth of the Harbor by a westerly wind as cold Lake water re-enters the Harbor along the bottom to replace the equivalent outflow volume.)

The greatest amounts of PCBs move into Harbor waters through direct dissolution in the northern area of the Harbor where the most highly contaminated sediments are found. Concentrations of both dissolved and suspended PCBs are higher at the north end of the Harbor than at the south end (USEPA 1981). As indicated in Figure 1-5, the reported elevation of total PCBs in the northerly part of the Harbor is at odds with what seems intuitively obvious: that horizontal Harbor water oscillations caused by horizontal Lake oscillations should disrupt contaminated sediments to the greatest degree close to the Lake, that is, nearer to the Harbor mouth. The contradiction is explained by the fact that horizontal oscillations of Harbor water are translated into vertical oscillations of Harbor water (hence to eddy currents) as a "dead end"

or retaining wall is approached. These vertical oscillations are able to keep the water turbulent and fine particles in suspension. Additionally, fine particulate sediments tend to be deposited mostly in the muck layers along the base of retaining walls and in the northern half of the Harbor near and in Slip #3 (USEPA 1981). As long as fine sediment particles (clay and organic matter) are kept in suspension in the highly contaminated northern part of the Harbor they will continue to hold or adsorb the maximum amount of PCBs they can accept under the co-presence of a large dissolved PCB fraction. A strong summer wind out of the north or northwest, therefore, may move highly contaminated particulates out of the northerly Harbor area, especially from Slip #3. Thus, PCB movements inside the Harbor may be seen as having extremely variable characteristics depending on local meteorological conditions.

The frequent horizontal oscillation of Lake and Harbor waters promote a gradual interchange of these waters and thereby creates a consistent annual rate of PCB movement out of the Harbor and into Lake Michigan. This "baseline" rate of PCB movement has been modeled under steady-state conditions and verified with field measurements of parameters such as turbidity and total chloride associated with the total PCB concentrations (USEPA 1980). The rate of steady movement of PCBs to the Lake was shown to amount to a flux of approximately 8.8 pounds per year as a function of the fairly continuous horizontal water oscillations driven by the short-wave water movements of Lake Michigan (USEPA 1981). The modeling calculations are summarized in Appendix B. More extreme episodes of water interchange between the Lake and Harbor are associated with surges, seiches and storm-wind generated stratified flow. The significance of these extreme episodes with regard to PCB flux to the Lake was estimated based on reasonable assumptions on the most probable annual frequency of such events in the vicinity of Waukegan. These assumptions are also discussed in Appendix B. Adding the flux of PCBs associated with these episodic events to the steady-state modeling estimated flux gives an estimated 22 pounds of PCBs per year moving out into Lake Michigan from Waukegan Harbor on a long-term annual average basis (USEPA 1981).

The modeling of steady PCB movements lakeward and the assumptions concerning extreme summer season meteorological and hydrologic events do not take into account the potential of the violent Lake Michigan storms of late fall or

winter which cannot, practically speaking, be measured and modeled. The lakeward movement of PCBs out of the Harbor during the winter may be underestimated and hence the range of annual PCB flux presented should be viewed as conservative. Additionally, the rationale for an abatement action in the Harbor is based on more than the halting of PCB movement lakeward. Sediment disturbances and redistribution of highly contaminated materials within the Harbor will continue indefinitely until abatement actions are taken. Commercial navigation and recreational boating have the potential to disturb and expose highly contaminated materials, directly, through turbulence induced by propellors, bow wave pressure, and by ship bow-thrusters. These disturbances and perhaps the major storm events which generate turbulence in the Harbor will sustain the potential for continued exposure of highly contaminated bottom sediments to the water column and hence will promote the surficial redistribution of PCBs throughout the Harbor. Therefore, the rationale for an abatement action is based upon the need to preclude exposure and resuspension of highly contaminated Harbor sediments. ~~Highly contaminated sediments are defined as those sediments having in excess of 50 milligrams of PCBs per kilogram of sediment (mg/kg) on a dry weight basis, which is approximately the same as 50 ppm on a dry weight basis.~~

remove 1 del EA

1.2.2.2. Significance of PCB Movement Out of the Project Area

The movement of PCBs from the project area into Lake Michigan must be compared to mass inputs of PCBs from other sources to place it into proper perspective. To provide the framework for such a comparison, one scale of impact was established with the whole of Lake Michigan as the upper boundary and another scale was established as the near-shore sector with a 10-kilometer (6.2 miles) radius as the localized area of impact. Although the 10-kilometer radius area was selected arbitrarily, it represents a reasonably-sized area that excludes possible influences from other sources such as the City of Chicago to the south. The area of the Lake within this radius also coincides roughly with the eastward extent of the unstratified, nearshore zone of Lake Michigan. The impacts on biota in this area are of concern for this project.

The long-term average PCB mass load from the combined Waukegan Harbor/North Ditch system to Lake Michigan is estimated to be 22 to 44 pounds per year (lb/yr) (USEPA 1981). If it is assumed that the dry deposition load of PCBs to the entire Lake is approximately 550 to 1,100 lb/yr and that rainfall and dry deposition are uniform over the Lake (USEPA 1981), then the 22 to 44 lb/yr PCB load from the Waukegan Harbor/North Ditch area could represent from 49% to 80.0% of the total load to the near-shore (10 km) sector (Figure 1-8).

For the lake as a whole, the input from the Waukegan Harbor/North Ditch area represents a much smaller percentage. The project area load to the Lake is exceeded greatly by all other combined PCB sources to the Lake (Figure 1-9). Various estimates of the present total PCB mass input to the whole of Lake Michigan indicate a PCB contamination range of 50 to 100 ug/l (Murphy and Rzeszutho 1978) and a mean value of 21 ug/l from measurement of total PCB concentration in precipitation in the Great Lakes area (Strohan and Huneault 1979). This would result in a PCB load from precipitation into Lake Michigan ranging from 2,000 to 10,000 lb/yr. Additional inputs from dry deposition and from tributaries to the Lake are estimated to account for 1,100 to 2,300 lb/yr, resulting in a total direct atmospheric and runoff mass PCB input to Lake Michigan of from 3,100 to 12,300 lb/yr. Based on these figures, the total PCB mass input from the Harbor/Ditch system at Waukegan would represent from 0.2% to 1.4% of the total PCB mass input to all of Lake Michigan.

The purpose for presenting the estimated annual PCB loading rates in the pie diagram format ~~of Figures 1-8 and 1-9~~ is to give a broad perspective on the need to halt the net movement of PCBs out of the project area. These figures indicate that the load of PCBs from Waukegan approaches a "limit of insignificance" as the perspective extends toward all of Lake Michigan. That is, the load of PCBs appears to become trivial in comparison with the more diffuse sources of dryfall and rainfall. This point of view neglects, however, the inherent fallibility of estimating a precipitation or dryfall load of PCBs to Lake Michigan. Some of the problems with estimating these diffuse source loads are discussed in the following paragraph.

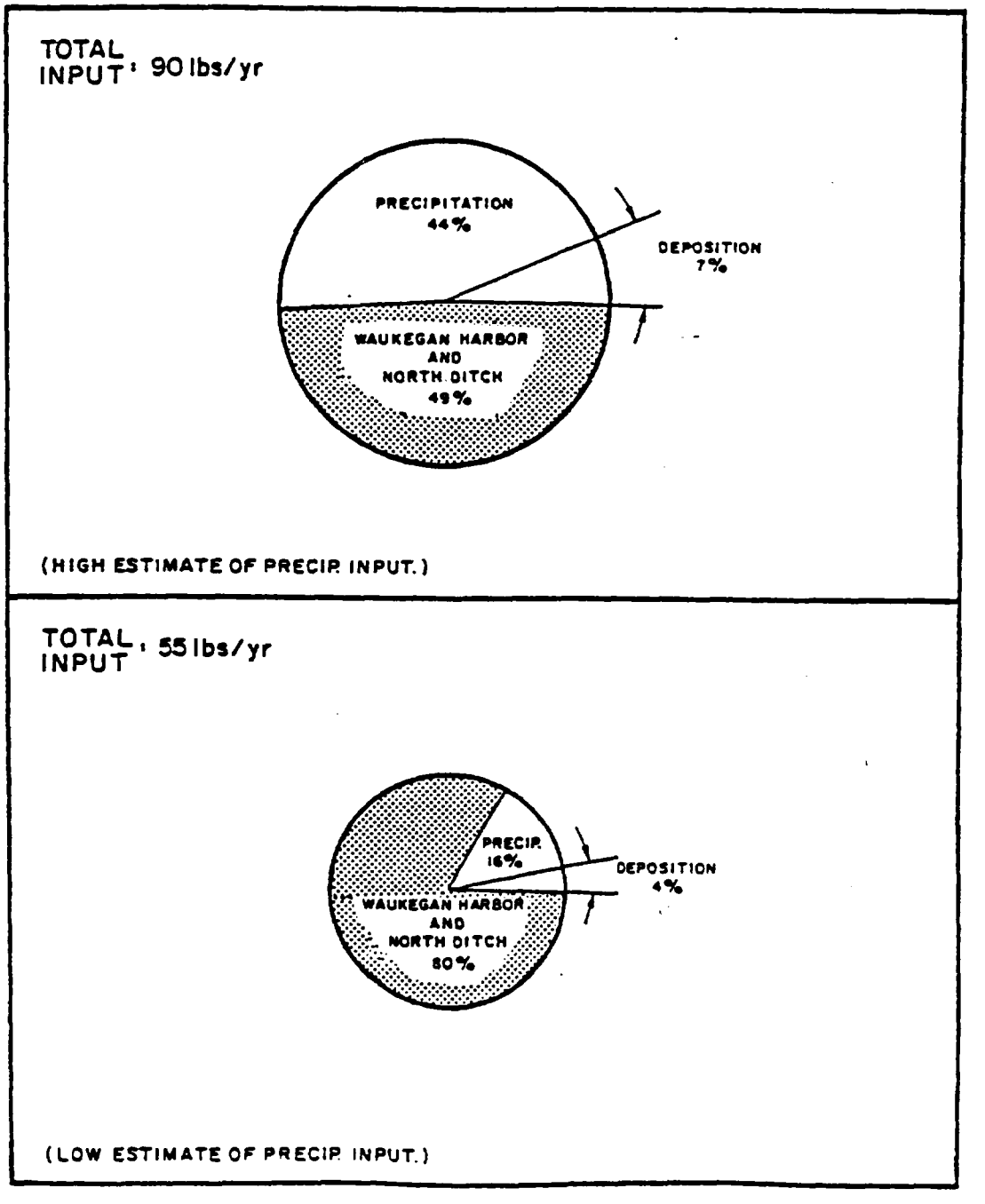


Figure 1-8. The range and distribution of the total PCB loads to the nearshore sector of Lake Michigan adjacent to Waukegan Harbor (HydroQual 1981).

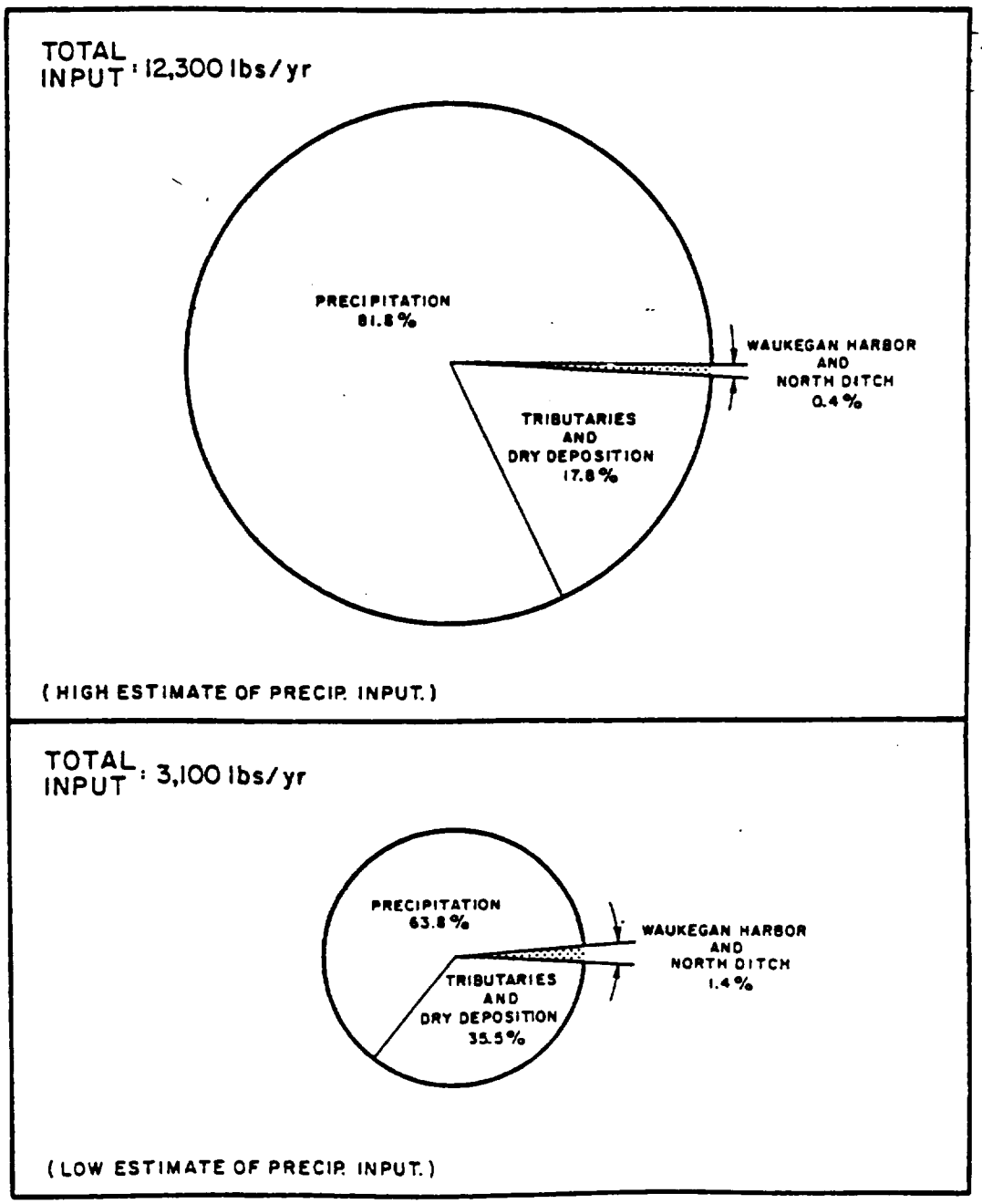


Figure 1-9. The range and distribution of total PCB loads to all of Lake Michigan (HydroQual 1981).

The lakeward movement of PCBs via precipitation and dryfall is clearly related to meteorological phenomena which are not necessarily uniform over Lake Michigan in a given year or from year to year. Most importantly, PCBs that are volatilized from the water surface of Lake Michigan are absorbed to atmospheric dust of the appropriate chemical affinity and thereafter scoured or "scavenged" by rain drops moving directly into Lake Michigan and into watersheds which drain into the Lake. The movement of PCBs out of the Lake into the atmosphere and back to the Lake via precipitation represents a very complex PCB cycling process of undetermined extent (personal communication, Dr. Anders Andren, University of Wisconsin, Water Chemistry Program, to WAPORA, Inc., October 1981). Differing rates of Aroclor volatility and solubility, variable PCB absorption rates to particulates in the atmosphere, and the uncertain role of wind and solar radiation over the Lake in this cycling process would give atmospheric PCB cycling estimates much less precision than is desired. The implication of these considerations is that an important fraction of all diffuse PCB sources to Lake Michigan in a given year may originate, via this cycling process, from the Waukegan area. Therefore, the pie diagrams presented in Figures 1-8 and 1-9 probably seriously underestimate the significance of the PCB load attributable to the Waukegan Harbor area on the entire PCB load to Lake Michigan.

1.2.2.3. Movement of PCBs into the Atmosphere

It has been estimated that the present volatilization rate of PCBs from the entire project area (1,190,000 square feet [ft^2]) is approximately 1.5 kilograms or 3.33 pounds per month (USEPA 1981). ~~Adverse air quality impacts~~ from the Volatilization of PCBs in the Waukegan Harbor/North Ditch area will continue to occur until the contaminants are removed from the project area.

1.3. Presence of PCBs in the Fishes of Lake Michigan

After the initial discovery of an apparent PCB contamination problem in Lake Michigan fishes (Section 1.1.2.), and before the publication of this information, six independent governmental data-gathering programs were underway to determine the status of PCB contamination in important fish species, to determine the potential adverse effects on public health, and to monitor the

trends in PCB bioaccumulation over time. These studies were supplemented by several independent research projects. The major governmental agencies which have been involved with PCB monitoring in the Lake Michigan basin are:

- Illinois Environmental Protection Agency
- Indiana State Board of Health
- Michigan Department of Natural Resources
- Wisconsin Department of Natural Resources
- US Fish and Wildlife Service, Great Lakes Research Laboratory and Columbia National Fishery Research Laboratory
- US Environmental Protection Agency, Region V.

The data gathered by these agencies initially included measurements of many parameters in addition to measurements of PCB concentrations in fish flesh. Numerous other potentially toxic substances also were tested for in fish. It was on the basis of this background information that the persistence and continuing movement of PCBs into Lake Michigan was hypothesized. The US Fish and Wildlife Service reported that concentrations of the pesticide DDT decreased rapidly in fish flesh once the ban on the use of this substance had been implemented. However, the slow downward trend (or lack of such a trend) for PCBs in some Lake Michigan fishes, following the similar restrictions imposed on the use of PCBs, differed considerably from the pattern for DDT. Because PCB concentrations in fish did not appear to be declining, scientists from these agencies became concerned that a continuing source of PCBs was affecting Lake Michigan fish well after restrictions had been imposed.

By the late 1970s it had become widely accepted that PCBs bioaccumulate in direct correlation with age of the fish when the concentration of PCBs in the aquatic environment remains relatively constant. This was verified by the observation that the more long-lived Lake Michigan fishes such as lake trout were the most highly contaminated. However, lake trout of exactly the same length, age, and fat content, but caught in different parts of Lake Michigan, did not have identical PCB content. Through this and other examples, it became apparent that the Lake was not uniformly dispersing PCBs to all sectors of the aquatic environment and that all species of fish also were not affected uniformly.

Subsequent research by the USEPA and by the Wisconsin Department of Natural Resources revealed several land-based "hot spot" sources of PCBs to Lake Michigan. These were areas where large amounts of PCBs had been released into watersheds draining to Lake Michigan. In 1976, it was shown that highly PCB-contaminated sediments and extraordinarily contaminated fish were present in the Wisconsin in the Lower Green Bay, in Sheboygan Harbor, in the Sturgeon Bay Ship Canal, and in Milwaukee Harbor. USEPA identified the parallel situation in Waukegan Harbor area shortly afterward. Fish captured in Sheboygan Harbor and in Waukegan Harbor proved generally to be the most contaminated of all Lake Michigan harbor fish and were much more contaminated by PCBs than were identical species captured in the open waters of Lake Michigan (Figure 1-10).

where is the fish report?

Fish flesh PCB content data from all the published and some unpublished sources were evaluated in 1981, and a status report developed on the presence of PCBs in the fishes of Lake Michigan (USEPA 1981). This report made special reference to Waukegan Harbor and other "hot spot" sources of PCBs. It also gave more detail on the processes of bioaccumulation, and included references on this subject as well as an unabridged listing of historical data on PCB contamination in fishes of Lake Michigan and its harbors (Appendix C). Significant conclusions drawn from the available data and assembled in this status report are described in the following paragraphs. The aggregate data represent all Lake Michigan fish samples taken between 1971 and 1979 except for those from Green Bay which are excluded because of Green Bay's changing ecological and pollutional nature. Mathematical averaging and statistical treatment of the data were not appropriate because all types of samples were looked at simultaneously (e.g., whole-fish and fillet samples).

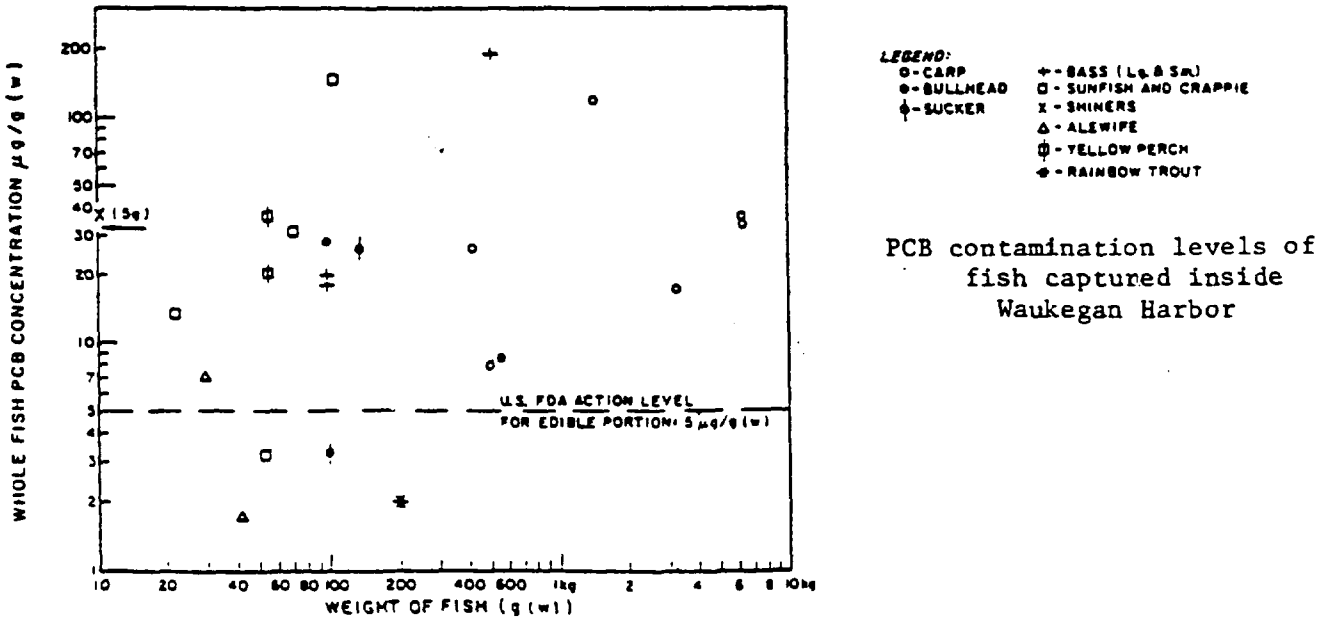
Coregonid Fishes

Fish from the whitefish, bloater, and lake herring group (coregonid fishes) of Lake Michigan are the least contaminated fish for which extensive data were available. The aggregate data set median PCB content of this group was less than 2 ppm in 1979. This represented a continuous downward trend from 1972 when the median PCB content was in excess of 5 ppm. Because fish of this group are insignificant to the sport fishery and are considered rare in

PCB content of carp and goldfish captured in highly contaminated harbors and estuaries along the west shore of Lake Michigan: all data sources combined, 1971 through 1979.

Lower Green Bay Estuary			Sturgeon Bay Harbor and Ship Canal			Sheboygan River Estuary			Milwaukee Harbor and River Estuary			Waukegan Harbor			All Lake Michigan (excluding Green Bay)		
#	L	PCB	#	L	PCB	#	L	PCB	#	L	PCB	#	L	PCB	#	L	PCB
1	17.3	2.5	4	20.0	4.2	1	25.0	2.0	3	5.0	4.2	2	—	8.2	1	21.0	0.7
1	19.3	3.8	1	23.0	18.3	4	14.8	2.0	1	16.6	12.0	3	11.1	27.8	5	24.5	1.7
1	10.2	4.4	1	26.0	21.5	5	13.3	8.4	2	27.6	13.0	1	22.5	37.3	5	26.7	1.9
3	17.0	5.2				2	27.6	13.0	2	25.8	17.0	1	24.0	38.5	5	20.5	1.9
5	18.1	5.8				1	27.0	15.0	4	14.5	17.0	1	—	131.0	5	22.5	2.3
5	14.0	5.9				1	22.0	16.5	5	15.5	18.0				4	20.3	2.7
1	12.8	6.6				2	25.8	17.0	6	6.5	20.0				1	23.8	2.8
5	12.2	7.4				1	23.0	17.0							1	23.0	2.9
3	22.0	7.8				1	10.5	24.0							4	21.5	3.2
5	16.0	14.0				2	21.1	26.0							1	21.5	3.8
5	20.0	14.0				3	11.3	49.0							1	24.7	5.9
3	17.6	17.0				1	31.0	80.0							1	34.0	7.0
5	20.4	17.0				4	25.3	130.0							1	30.5	12.0
4	26.3	43.0				1	22.0	150.0							1	19.0	13.6
5	19.0	63.0				1	25.0	180.0							1	26.1	14.0
1	14.8	90.0				3	13.6	180.0							1	26.6	14.5
						2	20.5	220.0							2	27.3	18.0
						1	25.0	240.0							1	30.3	24.0
						1	25.0	250.0							1	24.3	28.0
						1	27.0	250.0									
						3	21.7	370.0									
						1	23.5	333.0									
						3	23.3	350.0									
						5	19.7	460.0									
						5	17.3	750.0									
						1	24.5	970.0									

- number of fish in composite sample or in numerical average
L - average or median length of fish in the sample (inches)
PCB - concentration of all forms of PCBs, in ppm, representing an average or composite value for the fish in the sample



PCB contamination levels of fish captured inside Waukegan Harbor

Figure 1-10. Comparison of carp captured in contaminated Lake Michigan Harbors with fish of all types captured inside Waukegan Harbor.

Lake Michigan (Becker 1976), the apparent improvement is of small importance to human populations except as an indicator of the overall contamination of all deepwater or plankton feeding fish species. Of all samples of "chubs" (bloaters) or whitefish taken from Lake Michigan (excluding Green Bay) in 1979, 36% equaled or exceeded 2 ppm in PCB content. Only 3% of the 1979 samples equaled or exceeded 5 ppm.

There is some concern that the aggregation of sampling data for this group could weaken conclusions because not all samples were of the same type, and that the aggregate median PCB content figure is biased due to the variance in number from year to year of whole-fish samples tested. An analysis of the available data revealed that between 61% and 75% of the samples tested in every year were fillet samples. Therefore, there appears to be no serious upward bias or variability introduced by grouping all of the samples for this group of fishes.

Lake Trout

In 1979, lake trout were highly contaminated in Lake Michigan; the PCB content of 39% of the samples equaled or exceeded 5 ppm. The aggregate median PCB content of lake trout did fall below 5 ppm in 1978 and 1979, representing a continuous, downward trend from a median PCB content of nearly 15 ppm in 1972. Almost 25% of the Lake Michigan lake trout samples taken in 1979 had a PCB content of 10 ppm or greater.

Again, there is a concern with bias introduced by the aggregation of all types of samples for lake trout. Analysis of the data sets revealed that the percentage of lake trout samples taken between 1974 and 1979 that were "fillet" only was between 55% and 100%. In contrast to the expected findings, however, the lake trout fillet samples examined in 1979 were, on a medial basis, more highly contaminated than whole-fish lake trout samples. There appeared to be no serious upward bias caused by the aggregation of all types of lake trout samples in the data set.

similar for lake-out
?

Trout and Salmon

There were no apparent trends for the medians of the annual aggregate data sets representing the group of Lake Michigan coho salmon, chinook salmon, brown trout, and rainbow trout. The data were highly variable from year to year, but the total data set sizes often were small. Based on the historic data, no conclusions could be reached with regard to trends in PCB content for this important group of fishes. There also were no distinctions apparent between the north and south sectors of the Lake. The lack of an apparent trend and the high degree of variability in the data for this group may be a reflection of the divergent PCB exposure histories for populations of each species in the group. Thus, the variability in PCB content may be the "real" trend, reflecting the migratory behavior of these species and ecological changes in Lake Michigan. Without exception, at least 11% of all samples of fish from this group for a given year equaled or exceeded 5 ppm PCB content. In 1979, 43% of all the samples equaled or exceeded 5 ppm PCB content. Between 1972 and 1979, the percent of all the aggregated samples for this group that were tested as "fillet" only ranged between 50% and 100%.

Differences Between North and South Sectors of Lake Michigan

Aggregation of fish PCB content data for the north and south sectors of Lake Michigan, respectively, revealed distinct trends for the coregonid fishes and for lake trout. This distinction supports the hypothesis that localized, land-based sources of PCBs associated with the urban centers of the southern Lake Michigan basin exerted a strong, local influence on the rate of PCB accumulation in some fish. Lake trout and coregonid fish tended to be more highly contaminated with PCBs in the southern half of Lake Michigan.

1.4. Predicted Accumulation in Fish of the Waukegan Harbor Vicinity

One of the major concerns regarding the discharge of PCBs to Waukegan Harbor is the potential for accumulation of the chemical in the aquatic food chain and subsequent potential transfer to man through intake of contaminated fish. A considerable and growing literature exists on the accumulation of PCBs by various aquatic organisms. Thomann (1981) has compiled much of this

literature with the specific aim of determining the relative amount of PCB that would be concentrated by an aquatic organism directly from the water and the amount of PCB that would be accumulated through ingestion of contaminated prey (bio-magnification). The relative amount of PCB in the organism compared to that in the water is called the concentration factor. This factor varies depending on whether the organism obtains PCBs primarily from water or from food or both.

A comparison of concentration factors from different waters throughout the world was made by Thomann (1981). The data showed a divergence between the amount of PCBs taken up by fish from the water only and that of PCBs accumulated from both the water and food. At organism sizes of about 0.1 meters (m) (about 4 inches) the bioaccumulation factor is about $10^{6.6}$ ug/g (dry) per ug/g (water) or about 4 times higher than the factor from water alone. The difference is attributed to the predation of contaminated prey, the low excretion rate of PCBs, and a hypothesized high absorption rate of PCBs from the food. For larger fish of about 0.5 m (about 20 inches long), there is a more substantial increase in the amount of PCB in the fish relative to water (Figure 1-11). This increase is attributed to the consumption of PCB-contaminated prey and the longer life spans of some of the larger organisms.

Harbor bioassay data?

Data on the PCB concentration in fish collected from Waukegan Harbor have been compiled from several sources (USEPA 1979a b, 1981; Steiner 1979; and Veith 1980). These sources reported that the following species were collected in various locations in Harbor:

Largemouth and Smallmouth Bass	Yellow Perch
Sunfish, Crappie	Rainbow Trout
Shiners	Bullhead
Alewife	Sucker
Carp	

A plot of the whole-fish PCB concentration (in ug PCB/g (w); g (w) = grams wet weight) versus the weight of the fish for all of the species that were collected is presented in Figure 1-10. About 80% of the total number (or group) of fish for which PCBs were measured (23) had concentrations above the

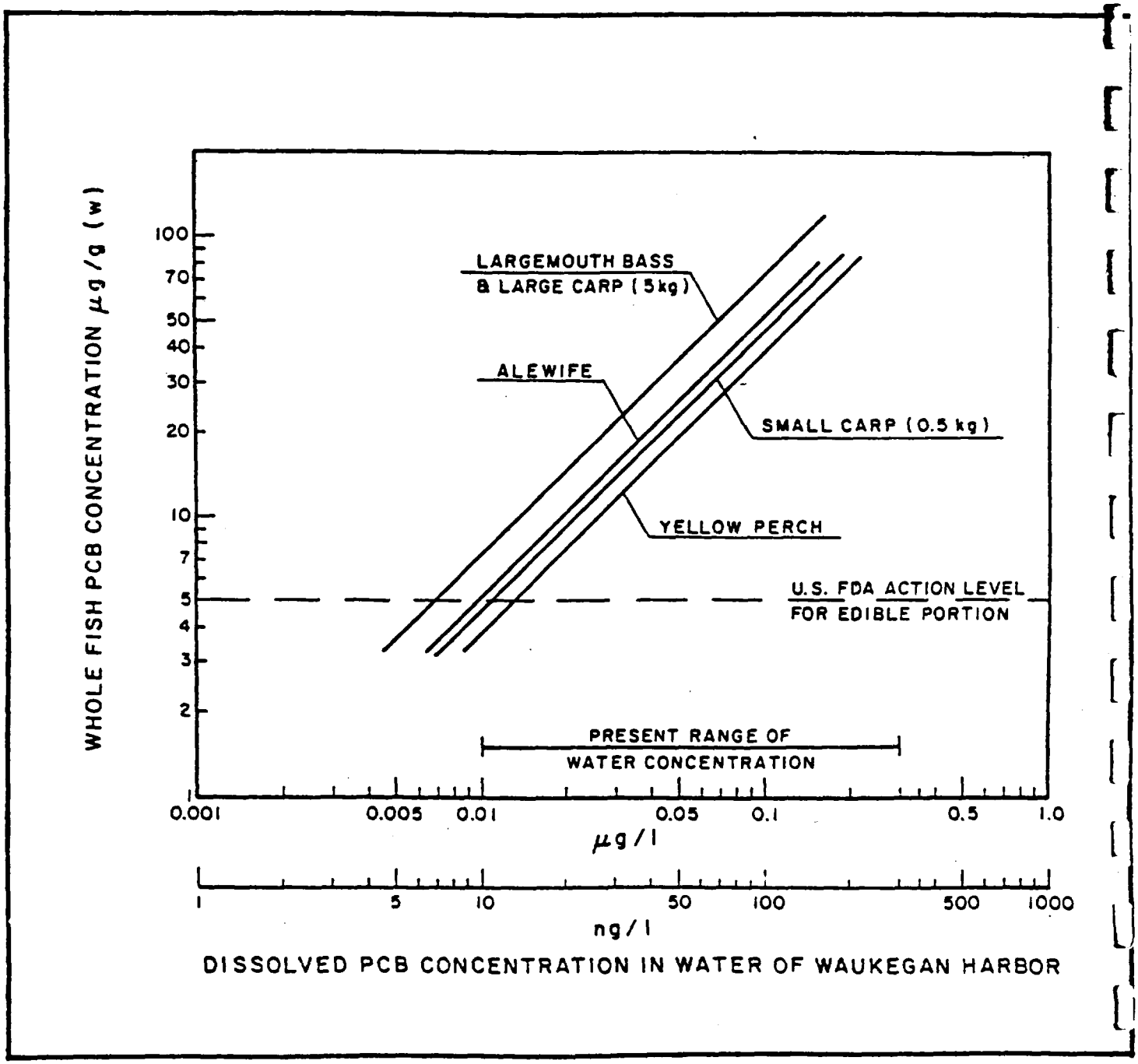


Figure 1-11. The estimated relationship between PCB concentration in fish found inside Waukegan Harbor and water column dissolved PCB concentration (HydroQual 198

personal communication 60-70% as an average (Swain)

USFDA action level of 5 ug/g (w) for the edible portion. The comparison between whole fish and edible portion is not entirely direct, but the edible portion would normally be at the least 20% of the whole body concentration. Some fish sampled carried concentrations of PCB in excess of 100 ug/g (w). The range of concentrations for all species of from 2 ug/g to 187 ug/g is approximately the range observed for the Hudson River and estuary (Hydroscience 1978), a water body that also is highly contaminated with PCBs. The considerable scattering in the data reflects the exposure of the fish to PCB concentrations in the Harbor over varying lengths of time. The variation in the concentration of each species also is dependent on lipid content and age of the fish and different feeding preferences. For example, carp are bottom or detritus feeders and, therefore, come into contact with the extremely high PCB concentrations in the bottom sediments. Largemouth bass are carnivorous predators and may bioaccumulate PCB markedly because of their higher position in the food chain.

It is useful to model the relationship between the Waukegan Harbor water column concentration of PCBs and the resulting concentration in native, "warm water" species in order to estimate the response of the fish to abatement programs. Although other important "cold water" fishes such as lake trout and coho salmon have been obtained in the waters off-shore of Waukegan Harbor (Vidal 1979; Vidal 1980; Hess 1980), there are only limited data to indicate any significant occurrence of these fishes in Waukegan Harbor proper. (Vidal [1979] reported that dead, mature chinook salmon were observed in Waukegan Harbor in October 1975 and September 1976.) In addition, the data on the PCB content of such salmonid fishes in the Harbor proper are limited to several samples. Therefore, it was not possible to model the relationship between fishes such as lake trout, which may only transiently inhabit the Harbor, and the PCB contamination in the Harbor before or after dredging.

A lack of detailed PCB data on the near-shore Lake Michigan environment also precludes an in-depth evaluation of the PCB water column concentrations and related PCB levels in important deepwater fishes. In general, the PCB concentrations in the waters immediately outside the Harbor (i.e., within approximately a 1 km radius) are about 0.01-0.02 ug/l and then drop rapidly to open lake values of 0.005-0.01 ug/l. On the basis of these water concen-

trations, PCB concentrations in fish of the nearshore zone may be lower compared to those within the Harbor proper. This may also be true for the PCB concentration of the warm water or Harbor dwelling fish found offshore of Waukegan. Muench (1980) reported a value of 0.49 ug/g (w) of Aroclor 1254 for chub off Waukegan. Lake trout collected off Waukegan Harbor in depths of about 10-30 meters were reported to have PCB concentrations (fillet with skin) of 0.5-5.4 ug/g (w) during 1978-1980 (Hess and Muench 1980). Because of the limited occurrence of open lake fish in Waukegan Harbor, analysis must be limited only to those fish that have been caught in the Waukegan Harbor proper and for which adequate PCB content data are available.

The analysis framework follows the model given by Thomann (USEPA 1981). Four representative fish were examined including: (1.) alewife; (2.) yellow perch; (3.) carp at 0.5 kg size; and (4.) largemouth bass.

Based on the data shown in Figure 1-10, it was assumed that the bioconcentration factor (i.e., uptake from water only) across all levels of the food chain is 100 ug PCB/g (w) in the organism per ug PCB/l of water. The food chain was assumed to have the following components:

1. Level 1 - Phytoplankton and detritus which absorb or adsorb PCB directly from the water.

2. Level 2 - Zooplankton which take up PCBs from the water or from consuming phytoplankton.

3. Level 3 - Fish which consume zooplankton or other organisms representative of Level 2. The fish assumed in this group are: alewife; yellow perch; and carp.

4. Level 4 - Fish which consume smaller fish and therefore represent a carnivorous level in the food chain. Largemouth bass is considered at this level.

Using reasonable assumptions on growth rate, specific consumption of food, and excretion rate of PCB, the relationships between the PCB concentrations in the organisms at a given food chain level and the PCB concentration in the water were derived. For level 2, this lead to the following simple equation:

$$C_2 - 190\ C_w$$

where C_2 is the concentration of PCB in the organism of the second food chain level (e.g., zooplankton) in ug PCB/g (w) and C_w is the dissolved PCB concentration in the water in ug PCB/l. For level 3, the intermediate level of the food chain, a series of relationships was derived for each species:

Alewife	$C_3 - 510\ C_w$
Yellow Perch	$C_3 - 380\ C_w$
Carp (0.5 kg)	$C_3 - 460\ C_w$
Carp (5.0 kg)	$C_3 - 710\ C_w$

No direct interaction of carp with the sediment was included in the above relationships. The degree to which carp would accumulate PCBs from the sediments is not sufficiently understood for such an interaction to be incorporated. For level 4, represented by the largemouth bass, the following equation was estimated:

$$C_4 - 730\ C_w$$

In each of the equations, the feeding was assumed to be on organisms at the next lower level and also included uptake from water. These relationships are only approximate and reflect the general process of weight gains, feeding habits, and excretion.

These relationships are shown graphically in Figure 1-11. This figure presents the results of the food chain model in terms of the relationship between the PCB concentrations in fish species of Waukegan Harbor and the PCB concentration in the water column. With this plot it is possible to assess the impact on PCB concentrations in fish that would result from a projected change in the water column PCB concentration. For the present range of PCB

concentrations in Waukegan Harbor water, the calculated concentrations in the fish are generally within the range of reported data presented in Figure 1-10. It appears, however, that alewife have been exposed to a lower time-averaged water concentration because the observed values shown in Figure 1-10 are below 10 ug/g. Figure 1-11 shows that for alewife this would represent exposure at a level of about 0.01-0.02 ug/l, the lower end of the reported range.

The principal conclusion supported by the data presented in Figure 1-11 is that Harbor water concentrations must reach levels of about 0.01-0.02 ug/l PCB in order to have representative species reach whole-body levels of PCB in the 5-10 ug/g range. As described in Section 4.0., the 0.01-0.02 ug/l dissolved PCB range is approximately attainable by dredging of the highly contaminated sediments of the Harbor.

The food chain model calculations indicate that in order to significantly reduce the typical fish PCB body burden in Waukegan Harbor, the currently observed water column PCB concentrations of about 0.01-0.3 ug/l must be reduced to the range of 0.01-0.02 ug/l.

1.5. Documentation of PCB Impacts

Research carried out to date indicates that PCBs in an uncontained form can result in the following impacts:

- Direct impacts on the reproductive and growth capabilities of aquatic organisms and terrestrial animals;
- Direct impacts on human health from accidental ingestion of large amounts of PCBs spilled into food or from direct contact with PCBs in liquid or vapor forms; and
- Potential impacts on human health from consumption of contaminated fish.

1.5.1. Effects of PCBs on Aquatic Organisms and Terrestrial Animals

To ensure a self-sustaining community of fish, a certain critical percentage must survive from the larval stage to maturity. If the critical percentage that must reach maturity is not attained, fish populations will

decline and a stocking program will be required to maintain the population. If the cause of the decline is not corrected, a continual stocking program is required. Because hatchery fish are generally not as adaptable or healthy as wild fish, reliance on them to maintain natural fish populations usually results in populations that are below expectations.

Factors that may contribute to a decline in fish populations and require a stocking program can be natural or man-made. Toxic substances such as pesticides and industrial chemicals have been shown to be detrimental to aquatic organisms. Although the biological impact of PCBs dissolved in the water column is not fully understood, evidence exists which suggests that PCBs in the water column can adversely impact fish during the early stages of growth.

Willford (1980) found a direct correlation between fish fry mortality rates in Lake Michigan lake trout and PCB and DDE levels in the water column (DDE is a degradation product of DDT and is known to be present in Lake Michigan along with PCBs). Lake trout fry exposed over a six-month period to PCB and DDE levels similar to the levels found in western Lake Michigan open water (10.0 ng/l PCB and 1.0 ng/l DDE) had a 20% higher mortality rate than fry raised in uncontaminated water (Willford 1980). Combined PCB and DDE levels 5 and 25 times greater than simulated Lake Michigan ambient concentrations resulted in slightly higher mortality rates (22% and 26%, respectively) above the control group. Based on the results of this experiment, it was concluded that the combined Lake Michigan DDE and PCB levels result in significant mortality increases in lake trout fry and that these chlorinated hydrocarbons may be an important contributing factor in the inability of lake trout to reproduce successfully in Lake Michigan (Willford 1980). The PCB fraction of the greatest laboratory levels used by Willford (327 ng/l PCB) is similar to the elevated level of dissolved PCBs found in the water column in the central area of Waukegan Harbor (300 to 400 ng/l).

Concentrations of PCBs in Waukegan Harbor are not evenly represented by the water column levels. PCBs tend to concentrate at levels above those found in the water column in two sectors: the surficial bottom sediment and the air/water interface. Increased concentrations in these sectors result from

the tendency of PCBs to partition into organic compounds by adsorption. The organic fraction can move PCBs downward with settling particulate matter or upward into the plankton, oil, and foam at the air/water interface, and held there by what is generally referred to as "the surface film effect." Bottom sediments are used as a food source for bottom feeding fish and are commonly the depository for developing eggs and larvae when used as a spawning ground. Additionally, the surface film is a rich food source to many types of young fish (Wangersky 1976). Although documentation does not yet exist, it is speculated that an increased biological hazard exists for fish feeding on bottom dwelling organisms of Waukegan Harbor and outlying water, or using the Waukegan area sediments as a spawning ground. In the central Waukegan Harbor area, fish would encounter PCB concentrations in the surficial sediments that range from 8 to 3,600 ppm (Armstrong 1980) and which are 20,000 to 1,000,000 times more concentrated than the levels typically found in the Waukegan Harbor water column. Although no PCB concentration data are available for the surface film sector of the Harbor, the known affinity of PCBs to become adsorbed into organic compounds and the increased presence of such compounds at the air/water interface suggests that PCBs may have an increased adverse impact on the biota through this sector.

To date, 29 fishes (9 total species, 6 game species) have been captured in Waukegan Harbor for the purpose of determining bioconcentration factors for PCBs. The relative scarcity of some fish in the Waukegan vicinity as evidenced by the low number of species captured may be related to the high levels of PCBs and other pollutants found in the area.

In addition to the impacts of PCBs on fish fry mortality, there are indications that small amounts of dissolved PCBs also can inhibit phytoplankton photosynthesis (McNaught et al. 1981). Because phytoplankton are at the base of the Lake Michigan food chain, inhibition of phytoplankton photosynthesis will limit the poundage of sport fish that can be produced in the Lake. In one experimental study, PCB concentrations of 5 ng/l inhibited nanoplankton photosynthesis by 5.7% (McNaught et al. 1981). Concentrations of 100 ng/l and 500 ng/l inhibited nanoplankton photosynthesis by 8.9% and 18.9%, respectively (McNaught et al. 1981). PCB concentrations of 5 ng/l are comparable to the levels found in the open waters of Lake Michigan, and concentrations of 500 ng/l are comparable to present levels in Waukegan Harbor.

Although of less significance for this project, the available evidence indicates that PCBs can cause a variety of health effects in terrestrial mammals. The evidence also indicates that the different commercial mixtures of PCBs elicit different toxic responses, and that different animal species vary in their susceptiblity to PCBs (USHEW 1976). For example, a dietary level of 5 ppm of Aroclor 1254 severely affected mink reproduction while a dietary level of 2.5 ppm of Aroclor 1248 resulted in reduced reproduction in rhesus monkeys (USHEW 1976). In a concurrent study, a dietary level of 20 ppm of Aroclor 1254 depressed reproduction in rats while in the same rat strain a dietary level of 500 ppm of Aroclor 1260 was necessary to reduce reproduction (USHEW 1976).

Liver tumors have been produced in laboratory studies on mice with Aroclor 1254 and Kanechlor 500 (a Japanese PCB product) and in rats with Kanechlor 400 and Aroclor 1260 (USHEW 1976). According to USHEW (1976):

> "The dietary levels of the PCBs in all of the studies were 100 ppm or more, a high level when compared to the daily average human intake of PCBs but not very high for subgroups with a high intake of fish from polluted waterways or in some occupational situations. This is emphasized by the fact that the dietary levels which affect reproduction (2.5 ppm in the monkey and 1 ppm in the mink) of some commercial PCB mixtures do not represent a no-effect level. It is presently not known what the no-effect levels are."

1.5.2. Impacts on Human Health from Occupational or Industrial Exposure to PCBs

In 1936, Schwartz (USHEW 1976) reported on the adverse health effects resulting from occupational exposure to PCBs. The effects described by Schwartz included skin lesions and symptoms of systematic poisoning among workers who were reported to have inhaled chlorodiphenyls. The skin lesions described by Schwartz in 1936 have come to be known as chloracne. Chloracne is similar to adolescent acne but is generally more severe and the lesion distribution is inconsistent with adolescent acne. Occupational exposure to a variety of PCB mixtures has caused chloracne and, to date, no commercial PCB mixture has been shown to have more or less chloracnegenic properties than others (USHEW, National Institute for Occupational Safety and Health [NIOSH] 1977).

In addition to chloracne, occupational exposure to PCBs has been linked to impaired liver function (NIOSH 1977). Slight liver injury was detected in workers exposed to PCBs at 0.1 nannograms per cubic meter (ng/m^3) and historical evidence of liver injury was found in the medical records of workers in a plant where PCB exposures were less than 0.25 mg/m^3 air (NIOSH 1977). The abnormalities in liver function that have been detected include elevated serum triglycerides, abnormal serum triglycerides, elevated serum enzyme activities, and abnormalities in various other liver function tests (NIOSH 1977). According to NIOSH (1977):

what does this really mean?

> "A level of exposure at which liver injury will not occur is not indicated by the occupational exposure studies, since evidence of liver injury has been found in the occupational studies with the lowest PCB concentrations."

Laboratory experiments on animals also have found liver injury at relatively low concentrations of PCBs. Microscopic evidence of liver injury in animals exposed to 1.5 mg/m^3 of Aroclor 1254 for 31 weeks was found by Trean et al. as cited in (NIOSH 1977). Linder et al. (NIOSH 1977) found increased liver weights in rats fed Aroclor 1254 at 1 ppm for two generations. In discussing the result of various studies on PCB related effects on liver function in humans and animals, NIOSH (1977) concludes:

> "Since indications of liver injury can be found in reports of both occupational studies and animal experiments with the lowest PCB exposure, there is no proof of an exposure level that is adequately low to prevent liver injury."

There also is evidence that PCBs could be potential carcinogens. Rats developed liver tumors with a dietary level of 10 ppm of Aroclors 1242, 1254, and 1260 (42 CFR 6532-6555). A high incidence of pituitary tumors also was found in rats fed PCBs in this same experiment. Health studies conducted to date on the incidence of cancer in workers routinely exposed to PCBs are inconclusive, however, in establishing a correlation between PCBs and carcinoma. A preliminary study of workers considered likely to have been exposed to Aroclor 1254 between 1949 and 1957 did not find a significantly greater incidence of cancer than was expected (8 cancers were observed and 5.7 were expected) (NIOSH 1977). However, the three melanomas and two cancers of the

greater or lower?

pancreas present in the study group were significantly different than calculated expectations (NIOSH 1977).

In addition to the potential health impacts associated with PCB compounds, commercially used mixtures of PCBs often contain impurities and chemical breakdown products such as chlorinated naphthlalenes and polychlorinated dibenzofurans (PCDFs). Toxicity data on PCB mixtures indicate that PCDFs pose the greatest threat to human health of all the potential PCB mixture components.

In 1968, rice oil contaminated with PCBs was identified as being responsible for the outbreak of "Yusho disease" in Japan. Concentrations of PCDFs in the rice oil were high (5 ppm) as a result of their high concentration in the PCB mixture being used as a heat transfer medium in the rice oil processing (Karatsune and others 1975). PCDFs are reported to be 200 to 500 times more toxic than PCBs alone, and symptoms of the "Yusho disease" appeared to be more severe than those that would be expected from only PCB contamination of the rice oil (Cordle and others 1978).

Health effects were documented in more than 2,000 Japanese who consumed the contaminated rice oil. A dose response, epidemiologic study was performed on the patients which revealed that the average concentration of PCBs in the rice oil was 2,500 ppm. The clinical symptoms of Yusho were evident after an average cumulative intake of 2,000 milligrams (mg). Lesser symptoms also appeared after the ingestion of only 500 mg (Cordle and others 1978).

The typical clinical symptoms included chloracne, increased skin discolorations and eye discharges, recurrent visual disturbances, weakness, numbness in the arms and legs, headaches, and liver dysfunction. Ulcers in the uterus, stillbirths, and miscarriages also occurred. Children born to mothers exposed to PCBs exhibited skin discolorations that faded as the children grew. Some infants also had discolored fingernails and gums and increased eye discharges. The authors of the study also observed several infants with swollen faces (caused by excess serous fluid) and with bulging eyeballs. From these symptoms, it was concluded that PCBs can cross the placenta to affect the fetus (Environmental Health Resources Center [EHRC]

1976). The disease was prolonged in adults, a possible indication that humans metabolize and excrete PCBs at a slow rate. The symptoms used to diagnose Yusho are presented in Appendix D.

PCBs were present in the blood and tissues of Yusho patients, and PCDFs were present in the liver and adipose (fatty) tissue. Based on this observation it was concluded that the liver tends to preferentially accumulate PCDFs rather than PCBs. Because of the presence of PCDFs in Yusho oil and the uncertainties associated with the diagnosis of the disease itself, it is difficult in this case to directly determine the human health effects that are attributable only to PCBs.

1.5.3. Potential Human Health Effects Associated with the Consumption of PCB-Contaminated Fish

It is very difficult to calculate the extent of human exposure to PCBs through the consumption of contaminated fish because the levels of PCBs in fish differ significantly as does the amount of fish consumed by different persons. Different groups may be exposed to higher risk because they consume large quantities of fish or because they may be more sensitive to the toxic effects of PCBs (for example, pregnant women, children, or dieters).

Serious data gaps currently exist for these calculations, especially for the Lake Michigan area. The Michigan Department of Public Health has attempted to correlate PCB blood levels with the consumption of Lake Michigan fish (Cordle et al. 1978). Exposed and control subjects were used from five lakeshore areas in Michigan. The exposed group consumed at least 24 to 26 pounds of Lake Michigan fish per year and the control group ate less than 6 pounds of Lake Michigan fish per year. Significant differences were noted between the concentrations of PCBs in raw fish and in cooked fish (Table 1-3).

Table 1-3. PCB concentrations in raw and cooked fish (Cordle et al. 1978).

Species	Mean PCB Levels in Raw Fish (ppm) 1973	1974	Range of PCB Levels in Cooked Fish (ppm)
Lake trout	18.93	22.91	1.03 to 4.67
Coho salmon	12.17	10.45	0.48 to 5.3
Other fish	--	--	0.36 to 2.06

These differences are due to various methods of preparation, trimming away of fat, and the cooking itself. A significant correlation was found between the amount of fish consumed and the level of PCBs in the blood of the subjects. No annual variation in blood PCB levels was noted between 1973 and 1974. Even when the consumption of fish was stopped for 90 days or longer, blood levels did not change significantly. PCB blood levels either rose or did not change for most of the study participants (Cordle et al. 1978). PCBs also were present in breast milk samples.

The amount of fish eaten by the exposed group was calculated by apportioning the reported annual fish consumption by frequency of species eaten and the cooked fish PCB levels of those fish. It was determined that an average of 46.5 milligrams per year (mg/yr) of PCBs were consumed per person with a range of 14.17 mg/yr to 114.31 mg/yr. Therefore, the exposed group was ingesting between 0.49 micrograms per kilogram of body weight per day (ug/kg body weight/day) and 3.94 ug/kg body weight/day of PCBs with a mean daily dose of 1.7 ug/kg body weight/day. This mean ingestion level exceeds the recommended maximum allowable ingestion of 1.0 ug/kg of body weight/day that is recommended for prolonged exposure to PCBs (Cordle et al. 1978).

On the basis of this information, it was considered likely that persons who consume large amounts of contaminated Lake Michigan fish are exceeding the recommended daily limit. If members of the exposed group continue to consume contaminated fish at the same rates as were found in this study and if net buildup occurs, these persons could reach the 200 mg/kg-body weight safety limit in about 4.3 years (or less if larger quantities of fish are eaten).

A recently released study found a high positve correlation between serum PCB levels and measured blood pressure (Kreiss et al. 1981). In a community-wide study conducted in Triana, Alabama (a community of 458 persons), the geometric mean serum level of PCBs was found to be 17.2 ug/l (Kreiss et al. 1981). Although no major point source of PCB contamination was discovered in the study, fish taken in a composite sample from an adjacent creek averaged 2.64 ppm PCB. The study found that "age was the most powerful predictor of the log PCB level" (Kreiss et al. 1981). Fish consumption also correlated positively with PCB levels when evaluated independantly of age. In contrast with other studies, however, breast-fed children were not found to have significantly higher PCB levels than bottle-fed children.

The most significant findings of this study were that the serum cholesterol level was positively associated with serum PCB levels, independent of other variables, and "rates of borderline and definite hypertension for study participants were 30% higher than expected on the basis of national rates for a population of the same age, race, and sex composition" (Kreiss et al 1981). The authors also noted that "...the level of PCB contamination of fish in Lake Michigan is higher than that in Indian Creek (the adjacent waterway); the mean and range of PCB levels measured in the blood of Michigan fishermen are higher than those measured for Triana residents who eat comparable amounts of fish. Nevertheless, the proportion of Triana residents with high PCB serum values reflects the consumption of fish that at present have a mean PCB level close to the stayed FDA tolerance of 2 mg/kg" (Kreiss et al. 1981).

FDA Regulations

In 1971, the Food and Drug Administration (FDA) began taking steps to control the amount of PCBs in foods subject to interstate commerce regulations. A temporary tolerance level of 5.0 ppm was established for the edible portion of fish. This tolerance level was determined in an attempt to balance the potential harm to the consumer and the economic impact of setting such a limit. Therefore, while the tolerance level does consider "acceptable daily intakes" (ADI), it is not based solely on these ADIs (Wessel 1975). The acceptable daily intake of 1.0 ug/kg of body weight/day can be surpassed by a fish-consuming public that obtains its fish by sport fishing in areas with highly contaminated fish.

Public Awareness of the PCB Contamination Problem

The results of recent surveys of Lake Michigan fishermen indicated that although they are aware of the PCB problem, they probably will continue to fish in the Great Lakes (Schenborn 1979). More than 50% of the fishermen surveyed ate or usually ate the trout and salmon they caught despite the PCB warnings. Thirty percent ate less fish because of the warnings, but only 1% stopped eating fish. Almost none of the fishermen stopped fishing; they continued to devote the same amount of time to fishing. The fishermen surveyed also were asked if they believed that fish stocking should continue. Despite the knowledge that the fish would have high levels of PCBs, 93% replied that stocking should continue (Schenborn 1979).

The FDA has proposed that the recommended maximum limit for PCB intake be reduced from 1 ug/kg body weight/day to 0.4 ug/kg body weight/day. This roughly equates to recommending that people avoid consuming fish having 5.0 mg PCB per kilogram of flesh (mg/kg) and eat only fish with 2.0 mg PCB/kg or less. This would set the maximum "safe" limit for a lifetime of PCB intake at between 175 to 2,000 ug. No truly "safe" or "no effect" unit for PCB consumption exists at the present time. There still is a great deal that is not known about the human health effects of PCBs, and the FDA is in the difficult position of setting a "safe" limit while also considering the economic implications of establishing such a limit. Lake Michigan commercial and sport fisherman have strongly opposed a reduction of the FDA tolerance limit. It is certain, however, that fish captured in highly contaminated harbors or river mouth areas pose the greatest potential health hazard to the fishing public because of the extremely elevated PCB concentrations that are often found in such fish. For purposes of comparison, the PCB concentrations of carp caught in some contaminated Lake Michigan harbors are shown in Figure 1-10.

1.6. Overview of the Need for an Abatement Action

The approximate extent of the PCB contamination problem in the project area and in the whole of Lake Michigan has been documented in the preceding sections of this chapter and the potential impacts on aquatic organisms and human health also have been described. Although this information indicates

that an abatement action of some type is needed, the full magnitude of the PCB problem encompasses more than the direct effects on aquatic organisms and the potential human health impacts. Less direct but perhaps more immediate impacts are associated with the effects on recreation and the economy of the project area and possibly Lake Michigan AREA as a whole.

Although the details of the potential public health impacts associated with PCBs are not widely understood by the public, people do understand the posted State of Illinois warnings concerning the high PCB concentrations in fish taken in Waukegan Harbor (Schenborn 1979). The effects of such actions often spill over to Lake Michigan as a whole and can lead to economic losses to the Waukegan area as well as to other communities that derive economic benefits from Lake-related recreational activities. Such a loss of revenues may be caused by lowered recreational fishing demand and reduction of the associated daily expenditures (estimated at approximately $25/day per person), restrictions on commercial fishing, lower charter boat demand, lower pleasure boat usage, and lower overall recreational and/or tourist potential for the area. No dollar estimate can be placed on these potential losses, but the effect on an area such as Waukegan could be substantial because the revenue generated from such activities is an important component of the financial well-being of the City of Waukegan, especially with the present high levels of unemployment.

In addition to potential economic losses, the PCB contamination problem results in a certain psychological impact associated with the desirability of the Lake, the Harbor, and the project area as a place to do business or to engage in recreation. This stigma does not necessarily stem from direct hazards or impacts, but from fears of a misunderstood problem. The effects that such an impact may have on the economic base and growth of the project area cannot be quantified, but can be considered to inhibit growth and impact the quality of life. For these reasons, an abatement action in Waukegan Harbor and the North Ditch area, particularly an action that would result in the removal of PCB-contaminated material, could result in twofold benefits related to both public health and economic well-being. Although less obvious, this latter benefit is extremely important both to the project area and to the entire Lake.

2.0. PROJECT ALTERNATIVES

The major goal of abating PCB contamination in the Waukegan Harbor and North Ditch Drainage System is to protect the health of all citizens who use and enjoy the waters of Lake Michigan, ~~and~~ held in the public trust by the Federal government and by the state governments of Illinois, Indiana, Michigan, and Wisconsin. Another underlying goal of abating PCB contamination in the project area is to protect and restore the aquatic ecosystem of Lake Michigan. Large expenditures of public money have been made to control point and diffuse sources of pollution in the Lake Michigan drainage basin. It is estimated by USEPA that more than 1,700,000,000 federal dollars have been spent in the Lake Michigan basin for municipal waste treatment facilities alone. Additionally, large sums of Federal and state monies have been expended for the rearing, stocking, and management of game fish in Lake Michigan. Thus, it has been at considerable expense that commercial and sport fisheries have been sustained and the ecosystem protected. One of the largest detriments to a productive, safe harvest of Lake Michigan fishes is the ~~widespread~~ presence of toxic substances in the aquatic ecosystem. Scientific investigations and public forums have focused on PCB contamination in the Lake Michigan Basin for nearly a decade and the evidence cited in Chapter 1.0. of this EIS indicates that the abatement of PCB contamination in the project area would help improve Lake Michigan water quality and enhance it's fishery.

The project area is delineated into two geographic zones: Waukegan Harbor and the adjacent area known as the North Ditch Drainage System (Figure 1-2). For the purpose of abatement project development, a more detailed nomenclature was developed for the sub-areas of these two geographic zones. The Harbor was divided into 3 sectors to depict the relative degree of contamination within the boundaries of each sector (Figure 2-4). The North Ditch Drainage System was divided into three sectors: the Crescent and Oval Lagoon area, the East-West Segment of the North Ditch, and the Parking Lot. The most immediate need is to abate the PCB contamination inside Waukegan Harbor in order to halt the immediate rate of movement of PCBs into Lake Michigan and to slow the rate of PCB bioaccumulation in fish inside Waukegan Harbor and in the nearshore zone of Lake Michigan. The long-term benefit of the Harbor cleanup project would be to reduce the total load of particulate-bound and dissolved

concurrent

PCBs to all of Lake Michigan. A subsequent need is to abate existing PCB contamination in the North Ditch Drainage System. The immediate benefit of abating the contamination in this area would be a reduction in the sustained leaching and overland transport of PCBs directly into Lake Michigan. The long-range benefits of the North Ditch cleanup would include protecting persons from accidental contact with currently deposited PCB-contaminated materials in the area and eliminating the current easterly migration of PCB enclaves toward the public beach and the Lake.

Abatement of PCB contamination in both Waukegan Harbor and the North Ditch Drainage System has been approached as ~~an~~ complex engineering task that has significant environmental and legal issues associated with it. The utmost consideration of natural resource values and social and financial impacts was given in the development and engineering of an overall abatement project for both contaminated areas. The overall alternatives evaluation process conducted by USEPA is summarized as follows:

- Establish ~~an scientifically accurate~~ understanding of the impacts of the PCB contamination on human health and/or on natural resource areas;
- Project the longevity ~~of~~ PCB movement into the environment from the project area and estimate the future adverse impacts of that movement if no abatement action were taken;
- Identify ~~all~~ potentially useful conceptual alternatives for the abatement of PCB contamination;
- Screen the conceptual alternatives by evaluating their feasibility and potential environmental impacts and select at least one conceptual alternative that is appropriate for each area of contamination;
- Identify and screen the engineering options available (for implementation of the selected alternative);
- Develop a list of total project alternatives that encompasses the two zones of contamination and that includes different levels of abatement that can be achieved, the costs of achieving them, and a schedule for their implementation; and
- Communicate with the public and with interested governmental agencies at appropriate points during project planning and development.

This section of the EIS includes a detailed description of the selection of project alternatives and provides a framework for comparison of these alternatives with the non-abatement or No Action Alternative.

2.1. The No Action Alternative

By definition, the only alternative to abatement is the No Action Alternative, that is, leaving the PCB-contaminated materials as they currently exist as described in Section 1.2.1. This alternative has the obvious benefit of requiring no direct expenditures, although as discussed in Section 1.6. certain indirect costs to society and to some private enterprises are associated with it. For example, maintenance dredging in the Harbor would become prohibitively expensive due to the disposal methods that would be required.

The duration of the adverse impacts that are associated with the No Action Alternative is of interest for the purposes of assessing the benefits of an abatement action. The length of time over which these adverse impacts could be sustained is discussed in the following two sections.

2.1.1. Longevity of the Problem

HQ can't say

The mathematical model of the water quality of Waukegan Harbor, as described in Appendix B, was used to calculate the flux of PCBs into Lake Michigan. Continuous modeling runs projected no change in PCB flux lakeward over a five-year period, and Harbor bottom sediment, surficial PCB concentrations were projected to be unchanged by the last modeling run. It was noted that field data on sedimentary PCB concentrations collected in 1976 and in 1978 showed no temporal difference in sedimentary concentrations when compared to 1979 field data (USEPA 1981). It was estimated, therefore, that present rates of PCB flux and levels of sedimentary PCB contamination will remain unchanged for 10 years or more in Waukegan Harbor.

2.1.2. Future Impacts on Public Health

2.1.2.1. Waukegan Harbor

If an abatement action is not implemented, fish inside Waukegan Harbor will remain highly contaminated with PCBs. The potential period over which such fish contamination could last would be at least as long as the time required for the PCBs from the project area to completely disperse into Lake Michigan.

2.1.2.2. North Ditch Drainage System

The estimated rate of PCB dispersal into the environment from this area is low, although the total mass of PCBs deposited there is great. Consequently, there will be a lengthy period of time during which it will be possible for animals or humans to come into direct contact with PCBs. Any fish, birds, or humans that enter the area potentially may be exposed to high PCB levels. This problem could persist for 100 or more years, depending on the eventual rates of PCB dispersal and on the erosional and depositional processes in the urban watershed area that drains into the North Ditch. From the long-range perspective, one of the most important consequences of the No Action Alternative for the North Ditch Drainage System is that people may accidentally come into contact with the PCBs deposited there. Any private or governmental activities related to sewer installation, road maintenance, power transmission line maintenance, new building construction, or other service installations in the area could place unprotected workers and passersby at risk. Repositioning of contaminated soils where transport to surface waters is possible as a result of the above mentioned activities would also be an environmental concern.

Groundwater in the soils of portions of the North Ditch Drainage System are highly contaminated with PCBs and existing information indicates that some of this contamination is moving eastward toward the public beach where people eventually may come into direct contact with PCBs. In 30 to 60 years from the present, the rate of PCB flux lakeward from the easternmost enclave of PCB contamination may also increase dramatically, recreating the bioaccumulation problems that now exist in Lake Michigan.

2.1.2.3. Lake Michigan

A major element in the consideration of the long-range effects of the dispersal of PCBs from the project area is the fact that the relative significance of the PCB load to the Lake will increase above the present level before it decreases. Thus, the potential public health impacts of project area PCB masses will become more important as they disperse to Lake Michigan. This situation will occur because the project area encompasses the largest known uncontained PCB mass in the Great Lakes Basin and this mass is located directly on the coastline of Lake Michigan. In time, other smaller uncontained masses of PCBs affecting the Basin presumably will disperse across the world environment or become sequestered in deep Lake sediments. It is probable that these other PCB sources will disperse completely before the Waukegan PCB mass will have done so. Therefore, it is logical to assume that the load of PCBs from the project area into Lake Michigan eventually may become the largest land based source of PCBs that will affect fish and the persons who consume them.

2.2. Description of Potentially Feasible Methods to Abate the PCB Contamination

In 1976, PCB contamination was found in Waukegan Harbor and in a portion of the adjacent area referred to as the North Ditch Drainage System. In 1979, a new area of contamination was discovered in the soils of the OMC parking lot (hereinafter termed the Parking Lot) south of the East-West section of the North Ditch. These areas are shown on Figure 1-2 (Section 1.1.), which presents a map of the project area. Field studies that measured the extent of PCB contamination in and around Waukegan required several years to complete, and it was not until 1980 that the full extent of the contamination in the Harbor was revealed (USEPA 1981). Additional field studies are required in the North Ditch Drainage System to identify the full extent and magnitude of the contamination in thise area. Since that time, numerous conceptual designs or plans have been discussed as potential components of an abatement plan for all PCB contamination. Initial screening was conducted to determine which conceptual plans would receive detailed engineering work.

parking lot

actually The parking lot only

For the purposes of screening abatement alternatives, the concept of feasibility was used in the broadest sense. The objective was to select a feasible alternative from which a detailed abatement project could be developed. Because of continued PCB movement into Lake Michigan and associated public health and natural resource concerns, time was not devoted to concepts that were environmentally, socially, or technically unacceptable. All components of the project were reviewed with these constraints in mind. The potentially feasible alternatives that were reviewed are discussed in the following sections (USEPA 1981).

2.2.1. Removal of Contaminated Harbor Sediments

2.2.1.1. Excavation of Harbor Sediments

In this concept, a dam would be built across a portion of the Harbor ~~entrance~~ and the water behind the dam would be pumped through a water treatment system and back into Lake Michigan. Exposed Harbor sediments then would be excavated and transported to a final disposal site. After excavation is completed, the dam would be removed and the Harbor returned to normal use.

2.2.1.2. Dredging of Harbor Sediments

Dredging could be used to remove contaminated sediments from portions of Waukegan Harbor without causing long-term impacts on existing uses of the Harbor. This approach would require the development of engineering plans that would restrict the dispersal of PCBs during dredging. Three types of dredges could be used for dredging of Harbor sediments: mechanical; hydraulic; or pneumatic. ~~Each has certain advantages and drawbacks for the proposed project.~~ Dredging also requires the dewatering of removed material and the final disposal of the remaining solids by an appropriate method such as landfilling or incineration.

2.2.2. Confinement, Fixation, or Destruction of PCBs in the Harbor

All of the concepts described in this section involve methods that would not require removal of PCB-contaminated material from the Waukegan area.

2.2.2.1. Closure of the Entire Harbor

This concept involves the installation of a permanent dam across the entrance of the Harbor to halt movement of PCBs into the Lake and to exclude fish from entering the Harbor. Optionally, this alternative could include filling the entire Harbor with earth.

2.2.2.2. Confinement of Contaminated Sediments in Portions of the Harbor

— Waste material —

In this concept, the northern portion of the Harbor including Slip #3 would be sealed off by a permanent, impermeable dam. Contaminated materials then would then be dredged from the remainder of the Harbor and placed behind the dam. Overflow water would be treated to remove PCBs. A clay slurry wall would be constructed around the area on the western, northern, and eastern perimeters. The slurry wall would extend down into the natural clay layers to seal off horizontal groundwater flow. Finally, the sediments inside the enclosure would be fixed to solidify or aggregate them, and the entire area would be covered with clay and soil. The upper portion of the Harbor then would no longer exist; in its place would be a permanent PCB waste-disposal site.

2.2.2.3. In-Place Destruction of PCBs Present in Harbor Sediments

In-place destruction would be accomplished by introducing a ~~foreign~~ chemical or biological agent into a contaminated material. The agent would be thoroughly mixed with all the contaminated material. Potential methods for biochemical destruction of PCBs have been demonstrated in laboratory tests or small, experimental pilot plant applications. For example, investigators in a midwestern laboratory have been working with a mutant strain of bacteria that is capable of destroying PCBs in situ (in the contaminated areas rather than at other locations) (USEPA 1981). However, these bacteria were reported to require aerobic (oxygenated) conditions and the addition of nutrients and other chemicals to sustain the process. Several chemical methods have been developed for destroying PCBs that are in the form of pure liquids or contaminated oils. Processes of chemical destruction would be applicable only if the PCBs could be extracted from contaminated soil materials. Organic

solvents such as hexane could be used to extract PCBs from dredge spoils, but cannot be used under water for this purpose. The use of ultraviolet light energy to destroy PCBs is not applicable to PCBs that are dispersed through sediments.

2.2.2.4. In-Place Fixation of PCB-Contaminated Harbor Sediments

In-place fixation techniques have been used at other hazardous waste disposal sites. Potential fixing agents include portland cement, lime, sodium silicate, and certain polymers. Regardless of the fixing agent used, the process requires complete contact with contaminated material to solidify it and therefore would necessitate considerable mixing of Harbor sediments. After mixing is completed, the fixing agent-contaminated material mixture becomes hardened or aggregated. According to USEPA (1981), a ~~successful~~ sediment-fixation project has been carried out in a Japanese harbor. In that harbor PCB-contaminated sediments were stabilized in place in 1973 and no significant leaching has been reported since that time. The long-term stability and leaching rate of PCBs in the fixed sediments is unknown in this reported case.

2.2.3 Diversion of Water with No Excavation ~~of~~ or in Place Control Contaminated Soils

By-pass - discussion here

This concept deals with the North Ditch Drainage System, including the Parking Lot that is adjacent to the east end of the North Ditch. The estimated extent of PCB contamination of the subsoils of these areas is described in Section 1.2.1.2. The levels of contamination in these subsoils are high, and thus it is desirable to divert as much surface water as possible from these areas. The diversion of surface runoff water will lessen the amount of PCBs transported to Lake Michigan.

When there is sufficient surface water in the North Ditch Drainage System to result in a discharge to Lake Michigan such as during a summer storm event, suspended and dissolved PCBs are transported in that water eastward toward the beach/waterfront area and are discharged into the Lake north of the Harbor entrance (Section 1.2.2.1.). This process is defined as overland transport. Additionally, a portion of the surface water in the North Ditch percolates downward, locally recharging the groundwater and inducing lateral movement of

JRB - ? Included

PCBs into the Lake via the groundwater (JRB Associates 1981). This process is called subsurface transport.

It is not possible to ascertain from the available data which of these transport processes would contribute the greatest amount of PCBs to Lake Michigan over the long term. Estimates of the present annual PCB load to the Lake from the North Ditch area through both methods of transport are presented in Section 1.2.2.1. Alternative conceptual methods to abate both overland and subsurface transport of PCBs from the North Ditch drainage system by the diversion of surface runoff waters and industrial process water are discussed in the following sections.

2.2.3.1. Industrial Cooling Water Diversion → location of ditch change + portion of ditch flow

When hydrologic conditions are such that surface water is being discharged from the East-West section of the North Ditch into Lake Michigan, a portion of the discharged water and the PCBs contained in it originates directly from Waukegan Harbor. This occurs because OMC currently withdraws water from the Harbor for industrial cooling purposes and then discharges it into the North Ditch (USEPA 1981). Some of that water presumably recharges groundwater beneath the Ditch. The diversion of industrial cooling water from the North Ditch could be accomplished either by pumping that water through a new pipeline or storm sewer to Lake Michigan or by pumping it into an impermeable open channel or sluiceway that would be graded to carry water directly into the Lake.

2.2.3.2. Overland Diversion of Stormwater — is this the by-pass?

Stormwater enters the North Ditch Drainage System from direct precipitation, from adjacent industrial storm drains, and from the urban and transportation corridor lands to the west of the OMC property. In the summer of 1979, the peak discharge at the mouth of the North Ditch was measured at 5.3 cubic feet per second (cfs) reflecting the combined sources of stormwater during a single summer storm (Noehre and Graf 1980). Although this measurement may typify the contributions of the more significant storms to peak discharge, discharges during lesser storm events would not be related to peak inflow

volumes in a predictable way because the water level in Lake Michigan sometimes changes rapidly and results in temporary flooding of the Ditch. The rate of groundwater recharge in the North Ditch Drainage System is variable and depends on storm runoff flow, on whether the flow is being detained by sediments deposited at the mouth of the ditch by wind and wave action, and on whether the ditch also has been flooded by Lake Michigan water (Noehre and Graf 1980)

One concept of diverting stormwater to minimize overland and subsurface transport of PCBs involves grading the drainage system to eliminate depressions and collecting and diverting all runoff water to the Lake via a pipeline and/or an impervious, open sluiceway placed in the existing drainageway. The pavement would be extended outward from the pipeline/sluiceway path to cover the contaminated soils to reduce downward percolation into the groundwater. After the recharge of groundwater beneath the drainage system is reduced to a negligible amount through the diversion of surface waters, a lateral movement of PCBs would be brought about only by a change in the Lake level or by upward recharge from deeper aquifers. No artesian flows have been found in the vicinity of the North Ditch Drainage System. Lake water interchange with groundwater in the system would be minimal as long as water in the Lake and the North Ditch are able to reach equilibrium quickly.

In creating this type of diversion, the land surface must be elevated sufficiently to preclude the possibility of groundwater reaching or exceeding the elevation of the paved-over surface. Therefore, if the diversion were implemented, the contaminated portion of the North Ditch Drainage System would resemble a paved, somewhat elevated parking lot containing an east-west sluiceway. Stormwater arriving from upland areas to the west of the OMC property would be detained in settling basins prior to discharge to the sluiceway or storm sewer to reduce sedimentation in those conduits.

Alternatively, the detained stormwater could be shunted directly into Waukegan Harbor if the contaminated sediments present in the Harbor were removed. This type of diversion would not eliminate local stormwater flows from the Drainage System and could not be implemented until the Harbor abatement project were completed.

If a storm sewer in the drainageway were utilized for the diversion, the point of discharge would have to extend for a great distance out into Lake Michigan, beyond the influence of littoral sediment drift. This is the only conceivable way to avoid eventual clogging of the outfall by drifting sediments. If the sluiceway alone were employed for the diversion, a groin system perpendicular to the shore may have to be constructed to prevent waterborne sediments from eventually clogging the outfall of the sluiceway. Additionally, windbreaks may be needed to prevent windblown sediments from clogging the outfall.

2.2.4. Complete Abatement of PCB Contamination in Soils of the North Ditch Drainage System

Several alternatives have been assessed for the complete abatement of the contamination in the North Ditch Drainage System. The alternatives addressed in the conceptual stage can be divided into two main categories: By pass

- Physical removal of the soils
- In-place control of the soils

The removal alternatives included excavation of various sections in various volumes and dredging. The in-place control alternatives included secure disposal, in-place destruction, and slurry wall confinement. The in-place control conceptual alternatives have not been addressed in detail from an engineering standpoint. Therefore, no plans and specifications are available for those conceptual alternatives.

2.2.4.1. Excavation of Contaminated Soils

This conceptual alternative addresses the removal of contaminated soils in the North Ditch including the Crescent and Oval Lagoons and the Parking Lot. This alternative would require the construction of a storm sewer bypass. A description of the anticipated construction activities required for excavation is presented in the following paragraphs and is illustrated in Figure 2-1.

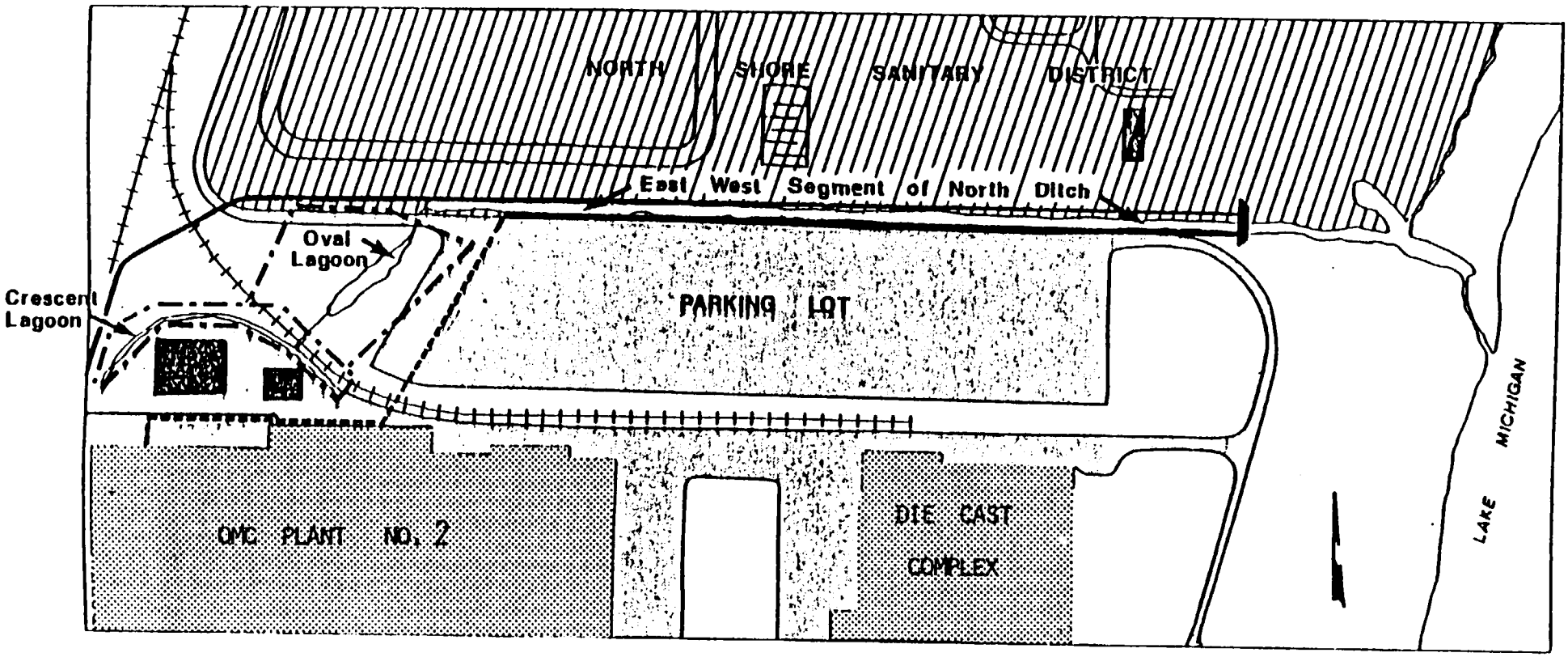


Figure 2-1. Anticipated construction activities for stormwater diversion, and slurry wall installation - leading up to excavation of contaminated soils in the Crescent and Oval Lagoon area. (Derived from Mason and Hanger Engineers, Report to USEPA, 1981.)

----- Existing Storm Sewer

—— Planned Diversionary Storm Sewer

—·— Planned Slurry Wall Around Areas of Greatest Contamination

North Ditch Bypass

The existing 36-inch storm sewer that flows northward at the west edge of the OMC property would be tied into a new storm sewer and would be directed to Lake Michigan by the shortest feasible route through the contaminated East-West Section of the North Ditch. There are several existing smaller (approximately 12-inch) storm sewers that come from the northwest quadrant of the OMC main building. These also would be diverted along with the 36-inch storm sewer flow to the new underground storm sewer. A small amount of surface area between the OMC building and the Crescent Lagoon would remain without any existing surface water catch basins. New catch basins would be installed to collect this water and direct it to the 36-inch storm sewer extension. All surface water that now runs into the Crescent Lagoon would be collected under this plan.

In order to collect the surface water runoff around the Crescent Lagoon as described above, it would be necessary to excavate a portion of the southwestern end of the North Ditch. It is estimated that any PCB contamination that may be present in this area would be so shallow that all of the contaminated materials would be removed during the excavation necessary to install the storm sewer. It is estimated that only about 220 cubic yards of contaminated material would be removed during this portion of the work. These materials would be combined with other contaminated materials for final disposal and would be replaced with new, clean material so that after construction is complete the area where the new storm sewer was installed would be "clean."

The new storm sewer would be constructed at a point just west of the contaminated East-West Section of the North Ditch. When construction is completed to this point, it would be necessary to block this new storm sewer and to divert any water that it collects until the bypass of the East-West Section and the total North Ditch Drainage System bypass are both completed. The diversion would be accomplished by the use of pumps that would be placed in a manhole in the new bypass.

The new storm sewer would be constructed in segments (a preliminary estimate of the size of each segment is 38 inches by 60 inches) to Lake Michigan during the period in which the North Ditch is being cleaned out. The excavated material would be replaced with new material. It is currently estimated that the East-West Section of the Ditch could be cleaned out to an acceptable level ~~(no more than 50 ppm of PCBs remaining)~~ by removing 2 to 5 feet of material from the sides and the bottom of the Ditch. This is estimated to represent approximately 7,000 cubic yards of contaminated material. It would be necessary to dewater the area during the excavation. This water is expected to be contaminated; therefore, it would be necessary to treat it before disposal. This waste treatment system, if required, also would be available if contaminated groundwater is discovered during the dewatering associated with the storm sewer installation.

While the new storm sewer is being installed in the North Ditch, it would be necessary to install a second storm sewer parallel to the 36-inch diversion sewer. This second sewer would carry surface water from the existing Parking Lot, from the remainder of the OMC building and the effluents from the OMC building. These two storm sewers would be built simultaneously along the centerline of the East-West Section of the North Ditch until the entire bypass is completed.

After the bypass described above is completed, the area surrounding the two new storm sewers could be paved as an extension of the existing Parking Lot. This work should result in the removal of the contamination in the East-West portion of the North Ditch and the diversion of all flows to Lake Michigan that normally would pass through the contaminated portions of the North Ditch Drainage System.

Crescent Lagoon Cleanup

The use of a slurry wall rather than a cofferdam is preferred for the cleanup of the Crescent Lagoon because the installation of a slurry wall would not disturb existing structures as would pile driving for a cofferdam. A slurry wall also would form a good water cutoff and allow for maximum excavation of contaminated materials. However, the wall probably would be more

expensive than a cofferdam. This would be especially true for excavation of the deepest contaminated material because the slurry wall must be braced from side to side or otherwise stiffened at the top for lateral stability.

After additional subsurface investigations reveal the total extent of the excavation necessary on each side of the North Ditch, the exact location of the slurry wall could be determined. When this is done and the slurry wall installed, dewatering of the area inside the slurry wall would begin. All water removed from within the slurry wall would be treated before disposal. It is recommended that the area of suspected highest contamination be excavated first. This location now appears to be the location just north of the Die Storage Building in the area of the abandoned outfalls from the main OMC building. Excavation would proceed as required and the material would be hauled away for final disposal. Because the excavation would take place in a dewatered condition, the material excavated would be sampled as excavation proceeds (USEPA 1981).

Just a quick turnaround on results

An on-site laboratory could be used to give quick estimates of the contamination levels. If it should be determined by examination of samples taken during excavation that contamination is not as widespread as previously believed, the quantity of materials to be removed could be reduced. After all contaminated materials are removed, the excavation could be filled with clean material to an elevation equal to or slightly higher than that of the surrounding area. The area could then be paved and used for other purposes.

Oval Lagoon Cleanup

The Oval Lagoon is located downstream of the Crescent Lagoon, between the Crescent Lagoon and the East-West Section of the North Ditch. Because there are no structures near the sides of the Oval Lagoon, it may be possible to place the slurry wall back from the sides of the Oval Lagoon to a location where it would be possible to excavate at a slope without use of bracing structures between the sides of the slurry wall. Some special bracing of the slurry wall would be required at the ends (inlet and outlet) of the Oval Lagoon because the excavation must be performed near these walls. It is presumed that the excavation would not have to be as deep in the Oval Lagoon

as would be required in certain locations in the Crescent Lagoon. The slurry wall in both Lagoons would have the same configuration; no matter how deep the excavation is, the slurry wall must cut off all water flow into the area between the walls. Excavation in the Oval Lagoon also would be accomplished under dewatered conditions because the water level would be lowered by pumping. This water also would be treated before discharge if required.

Contaminated Soils Removal in and near the Parking Lot

PCB contamination has been discovered in the east end of the Parking Lot adjacent to the North Ditch and in the area on both sides of the east access road to the Parking Lot. Contamination levels exceed 10,000 ppm at a depth of 9 feet at some locations. Contamination levels of 150 ppm have been measured between the Parking Lot and North Ditch at a depth of 29 feet below the surface. Approximately 250,000 square feet of the Parking Lot and adjacent area (a volume of 105,000 cubic yards) has been estimated to be contaminated to a level of 50 ppm or greater. Based on ~~Burns~~ core borings, it is estimated that there may be 278,000 pounds of PCB in this material. (reference)

For the purpose of obtaining a preliminary cost estimate, contamination was estimated to extend to a depth of 10 feet or less in the Parking Lot except near Bore Hole B15 where contamination is known to extend to a depth of 29 feet. The most practical way to dewater to a depth of 10 to 15 feet in the Parking Lot is to use a wellpoint system around the perimeter of the contaminated area except where contamination extends to a depth of 29 feet. A slurry wall would have to be constructed to dewater below 15 feet. The elevation of the Parking Lot currently is approximately 3 feet above the existing water surface of the North Ditch.

The construction of the North Ditch Drainage System Bypass would assist in excavation because stormwater in the North Ditch is a major source of recharge to the groundwater and keeps the water table near the land surface. The bypass would replace the ditch with a pipe, thereby eliminating this recharge. After the drop in the water table induced by well pumping inside the slurry walls, excavation with conventional earthmoving equipment can proceed. It would be necessary to limit the size of the areas around which a

wellpoint system is placed. The reason for this is to prevent a lowering of groundwater level over the whole site which might result in damage to structures located near the dewatered areas such as the lagoons of the North Shore Sanitary District Plant or buildings on the OMC plant site.

A slurry wall arrangement around the perimeter of deep contamination would be required to excavate as far down as 30 feet. It is assumed for the purpose of estimating costs that the high-voltage power line footings need not be disturbed by excavation or slurry wall construction. A 12-inch high pressure gas line that passes underneath the Parking Lot would have to be relocated in order to excavate the contaminated material.

Contaminated Soil Volumes Removed From the North Ditch Drainage System

A total of approximately 180,000 cubic yards (yd^3) of contaminated soil may have to be removed through excavation. This estimate is based on implementation of all the activities described above. Several alternative removal options have been suggested which result in removal of lower volumes of material. The difference in total volumes removed would be dependent on the magnitude of activity anticipated in the Parking Lot. The potential levels of removal are as follows (By letter, Jack Braun, USEPA, to WAPORA, Inc., July 1981):

a) Construction of a bypass storm sewer and removal of 7,000 yd^3 of contaminated soils;

b) Same as (a), plus removal of 41,000 yd^3 of contaminated soils from the lagoons in the North Ditch;

c) Same as (b), plus removal of 40,000 yd^3 of contaminated soils from the Parking Lot;

d) Same as (b), plus removal of 70,000 yd^3 of contaminated soils from the Parking Lot;

e) Same as (b), plus removal of 100,000 yd^3 of contaminated soils from the Parking Lot; and

f) Same as (b), plus removal of 131,000 yd^3 of contaminated soils from the Parking Lot.

These volumes represent the most current official estimates of actual amounts of material that may have to be excavated from the area and should be considered tentative.

2.2.4.2. Dredging of North Ditch Soils

One alternative considered is the dredging of contaminated soils in the North Ditch with a ~~Mud Cat~~ dredge. However, since the consideration of that alternative, extensive PCB contamination has been discovered in other areas around the North Ditch area. Some of this contamination was found to be as deep as 25 feet. Although the shallower contaminated areas could be dredged, the use of a Mud Cat dredge is normally not feasible for deeper removal of soils.

2.2.4.3. In-Place Landfill Disposal

The contaminated soils of the North Ditch and Parking Lot area are in a sense already in "storage" although they are certainly not secure. Securing them in their present location could be attempted by placing them in an on-site landfill that would prevent their movement through the soils, into the groundwater, or into the air. In order to insure this kind of long-term security in the landfills licensed for storage of toxic materials, USEPA (which regulates such sites under TSCA) and the State of Illinois employ stringent requirements. USEPA normally requires at least three feet of low permeability clay as a liner and a leachate collection system to act as a backup in case PCBs get through the clay. Proximity to surface water bodies and to groundwater also is restricted. Placement of contaminated soils into an on-site landfill would eliminate the requirements associated with hauling materials to an offsite ultimate disposal area as would be the case with excavation or dredging of the soils.

2.2.4.4. In-Place Slurry Wall Confinement

This concept would involve the construction of vertical walls of bentonite clay 2.5 feet wide. The walls would extend 25 to 30 feet downward and into the natural silt and clay layer underlying the PCB contamination. This

would effectively cut off horizontal groundwater motion. Such walls could be installed on OMC property around the perimeters of the Crescent Lagoon, the Oval Lagoon, and the Parking Lot contamination zone after a stormwater diversion has been constructed. This approach could significantly reduce PCB migration. Under this alternative, the only removal of contaminated material would occur as a result of slurry wall construction and as a result of a stormwater diversion construction.

2.2.5. Final Disposal of PCBs

The conceptual alternatives to abate PCB contamination in the North Ditch and in Waukegan Harbor were presented in previous sections. Many of the alternatives described require that the contaminated material be removed, dewatered, and taken to a final disposal site. Existing technologies for final disposal of contaminated PCB materials include landfilling, incineration, chemical treatment, and biodegradation. These alternative technologies and their applicabilities to the Waukegan project area are described in the following sections.

2.2.5.1. Landfilling

Landfilling of contaminated PCB sediments requires that permits be issued by the appropriate Federal, state, and local authorities for the landfill to accept such wastes. The permitting process requires that detailed investigations be completed regarding geologic, groundwater, surface water, socioeconomic, transportation, treatment, and monitoring concerns. If the site is located in an environmentally sensitive area, it must be engineered to be secure and protect this environment. Engineering criteria include considerations of groundwater depth, proper construction of a protective liner, leachate collection systems, leachate monitoring systems, leachate treatment systems, groundwater monitoring, and control of gas production. The landfill, when completed and permitted, must be able to securely contain the contaminants.

2.2.5.2. Incineration

An incinerator used for incinerating PCBs must satisfy the requirements of 40 CFR 761.40 under TSCA which include: (1) approval by the USEPA Regional Administrator; (2) maintenance of a temperature of 1,200°C (2,192°F) and a 2-second dwell time in the secondary combustion unit and 3% excess oxygen in the stack gas or maintenance of a temperature of 1,600°C (2,912°F) and a 1.5-second dwell time in the secondary combustion unit and 2% excess oxygen in the stack gas; and (3) a combustion efficiency of 99.9% or greater. Other requirements also exist, especially in regard to monitoring. The USEPA Regional Administrator can waive some of the requirements, but approval also must be obtained from the appropriate state agency. The status of existing PCB incinerators as of June 1980 is listed below:

Soc - to get updated list

- ENSCO, El Dorado, Arkansas (commercial). Capacity is limited to 60 lbs PCB/hour (by regulation) or about 3 cubic yards of solids per hour, whichever is less. The secondary combustion unit temperature is 2,200°F, with a 4.5-second dwell time. All ash must be sent to a hazardous waste landfill (by Arkansas regulation). The costs for incinerating 100 cubic yards of solids would be $400,000 or $500,000. Most of this cost is for monitoring and ash disposal.

- Rollins, Deer Park, Texas (commercial). This incinerator has been approved by the USEPA Regional Administrator.

- Tennessee Eastman, Kingsport, Massachusetts (private). Accepts on-site wastes only.

- General Electric, Pittsfield, Massachusetts, and Waterford, N.Y. (private). Accepts GE wastes only.

- MB Associates, San Ramon, California. MB Associates designed and constructed a mobile field-use incinerator under a USEPA contract for the USEPA Oil and Hazardous Material Spills Branch, Edison, NJ. This incinerator had not yet been demonstrated as of January 1981 (USEPA 1981).

Three manufacturers offer large incinerators capable of burning PCB-contaminated solids:

- Nichols/Herreshoff multiple-hearth furnace (Nichols Engineering and Research Corporation, Bellemeade, NJ). The large-capacity unit can process about 40 cubic yards per hour.
- Von Roll rotary kiln (a European incinerator marketed in the US by Koppers Company). The large-capacity unit can process about 60 cubic yards per hour.
- Prenco, Inc., of Madison Heights, Michigan, manufactures a much smaller capacity incinerator that currently is being prepared for a test burn.

(cite reference)

Nichols has reported a successful test burn on Hudson River PCB-contaminated dredge spoils. The PCBs in the stack gas and ash residue were reduced below detectable limits. The secondary combustion temperature was 1,800°F (982°C) for a dwell time of 5 to 7 seconds. Operation of the incinerator much in excess of 1,800°F is not recommended by Nichols because of the formation of excessive Nitrous Oxides (NO_x).

The Von Roll unit can maintain a temperature of 1,350°C (2,462°F) for 3 seconds according to the manufacturer. Again, excessive NO_x would be formed at temperatures in excess of 1,800°F.

2.2.5.3. Chemical Treatment

Chemical degradation has been applied to pure PCBs in laboratory studies (MPI 1980d as cited in USEPA 1981), but large-scale degradation has not proven feasible. A chemical process has been developed by the Goodyear Tire and Rubber Company (Goodyear 1980) in which sodium metal is reacted with PCBs at high temperatures (350°C [662°F]). The process is slow and is carried out in an autoclave. It is still in the laboratory stage. Sunohio has developed a process called PCBX that has been demonstrated to detoxify typical transformer oil. This process may be suitable for other PCB-contaminated oils (Sunohio 1980 as cited in USEPA 1981). However, the process is not designed for the detoxification of PCB-contaminated sediments.

2.2.5.4. Biochemical Degradation

Biochemical degradation of some PCBs (the lower Aroclors) has been found to be successful by the General Electric Corporation. Five types of microorganisms have been shown to have the ability to degrade PCBs under laboratory conditions. Much work still is required before a suitable microorganism is found that can degrade all PCBs in soil materials in-situ within a reasonable timespan.

2.3. Screening of Potentially Feasible Methods to Abate the PCB Contamination

2.3.1. Screening of Harbor Abatement Alternatives

Conceptual alternatives considered for the abatement of PCB-contamination in Waukegan Harbor include:

- Excavation of Harbor Sediments
- Dredging of Harbor Sediments
- Closure of the Entire Harbor
- Confinement of Contaminated Sediments in Portions of the Harbor
- In-place Destruction of PCBs Present in Harbor Sediments
- In-place Fixation of PCBs Present in Harbor Sediments.

In the following sections the advanages and drawbacks of each alternative are discussed and conclusions are presented as to the acceptability and feasibility of these alternatives.

2.3.1.1. Excavation of Harbor Sediments

There are several serious engineering problems to overcome before this method could be used in Waukegan Harbor. If water were drained from the Harbor, sheet piling now retaining the Harbor's outer walls and the adjacent shoreline areas can be expected to cave-in. To prevent this, a slurry wall or other shoreline-retaining technique would have to be employed around most of

the Harbor. These factors, would render excavation an expensive and difficult alternative. Some evaporation of PCBs from the Harbor sediments could be expected during excavation. Waukegan Harbor is an important harbor of refuge on Lake Michigan and has considerable recreational and commercial importance. Lengthy closure of the Harbor for such excavation would result in economic loss for a number of industries and also may meet with strong community resistance.

Because of the engineering and environmental problems, excavation of all Harbor sediments is not considered to be a good option for the Harbor component of the project. However, limited excavation inside a cofferdam may be appropriate where deep contamination is found in Slip #3, and where excavation inside a temporary structure may be the only practical means for the removal of contaminated materials in a confined area.

2.3.1.2. Dredging of Harbor Sediments

Harbor dredging techniques commonly are used in Lake Michigan harbors and equipment and experienced contractors are available. Methods to minimize sediment ~~re~~suspension and transport during dredging have been tested and applied in similar situations (Barnard 1978). Volatility will be minimal as long as the dredged sediments remain saturated with water. Conflicts with existing Harbor uses can be minimized by the scheduling of dredging activities. Only portions of the Harbor would undergo dredging at any one time; the remainder can be left open. The cleanup would be complete and final. In order to complete the dredging and dewatering activities efficiently and safely, a dewatering facility would have to be built as close as possible to the Harbor. Therefore, vacant land would need to be obtained for temporary use, preferably with frontage on the Harbor. Any of the available dredging methods are considered to be potential options for the Harbor component of the project. The choice of a preferred method would depend on abatement effectiveness, on environmental constraints, on the availability of equipment, and on cost.

2.3.1.3. Closure of the Entire Harbor

Permanent closure of Waukegan Harbor would eliminate the present rate of PCB movement into Lake Michigan. However, some PCB movement within the groundwater still would be possible and could eventually result in movement of PCBs to Lake Michigan. Volatility could become a problem because the stagnation that would result could cause anoxic conditions under which more PCBs could dissolve into the water. The only way to preclude the volatility problem would be to fill up the entire Harbor. Closure and/or filling of the Harbor would result in the total loss of an important recreational resource and would displace the shipping commerce important to at least two industries. Additionally, the large mass of PCBs at the shore of Lake Michigan would not be contained completely. Because of these problems, Harbor closure is unacceptable from both an environmental and a social standpoint.

2.3.1.4. Confinement of PCB-Contaminated Sediments in Portions of the Harbor

see USEPA discussion of slurry wall in Ex

Water should help us on Tuesday

The apparent simplicity of this concept and the reduced need for ultimate disposal capacity offsite initially make this option seem attractive. However, there are seropis technical, environmental, and social problems associated with confining (encapsulating) PCB-contaminated materials in the Harbor. The cost of making PCBs in encapsulated material secure is not known. Construction and operation of what amounts to a hazardous waste disposal site in Waukegan Harbor would run into difficulties with the State of Illinois and Federal permitting requirements due to environmental concerns and because areas of navigable water would be lost. In particular, USEPA's PCB land disposal requirements set forth at 40CFR, 761.41 would not be met. In addition, implementation of this option would set a precedent that could potentially be applied in other situations where in-place disposal may be even less secure.

IDOT?

Monitoring of PCB movement and leachate collection would be difficult and costly, owing to high groundwater elevations at the site. There is an absence of previous technical experience on the security of PCBs disposed of in this manner. At a minimum, this concept would involve loss of some of the business

property of Larsen Marine Company, a loss of some docking and marina services now offered to the public, and the loss of a substantial area of navigable water. Under the present Superfund Program implemented by USEPA, the State of Illinois would be responsible for management of the site. If the encapsulated waste subsequently became insecure due to design failure, there would be no mechanism or funds for abatement. Another disadvantage of encapsulation is that it would retain a large volume of PCBs in a heavily used area where disruptive changes in land use are likely to occur. Because of these problems and uncertainities, encapsulation of PCB-contaminated materials in a portion of Waukegan Harbor is not considered to be an acceptable alternative for the Harbor component of the abatement project.

2.3.1.5. In-Place Destruction of PCBs Present in Harbor Sediments

The complete mixing necessary to promote the reaction of a biological or chemical destroying agent with the entire mass of Harbor all PCBs could not occur in-place without considerable roiling of the sediments. Such a roiling could cause an increase in the rate of PCB movement into Lake Michigan. The effectiveness of recently developed chemical or biochemical agents has not been tested on full-scale projects, and the environmental impacts of the agents are unknown. Additionally, there is a risk that destruction techniques will not be well adapted to environments where the water chemistry and temperature are nonuniform and uncontrollable. Therefore, biological methods could be both unreliable and dangerous to the aquatic environment if employed in-situ. Native organisms would consume the cultivated degradors and could therefore become highly contaminated by the PCB breakdown products. PCB breakdown products have been demonstrated to have more adverse impacts on humans and aquatic organisms than the original PCB isomer mixtures (Section 1.5.). The technical problems in controlling conditions favoring biological breakdown, the uncertainty of a complete breakdown process, and the high potential for adverse environmental impacts make in-place (in-situ) biological destruction unacceptable for development of a Harbor abatement project. Similar disadvantages exist for chemical breakdown agents which could be utilized in-situ. In-place destruction of PCBs is not considered to be an acceptable abatement alternative due to the above-mentioned technical problems.

The additional alternative of removing contaminated sediments by dredging or excavation and subsequently leaching PCBs with steam or organic solvents to allow chemical destruction to take place, away from the Harbor, can not be considered a cost effective approach. In order to remove all contaminated sediments from the Harbor, all the costs of the dredging alternative including landfill disposal of the partially decontaminated (leached) sediments would be accrued in addition to the costs of leaching and breakdown.

2.3.1.6. In-Place Fixation of Contaminated Harbor Sediments

Complete mixing of a fixing or "cementing" agent with the sediments may be difficult to achieve. The process would have to be continuous, because once the agent has hardened in the bottom sediments it would be difficult to renew the process and to keep complete continuity with the aggregate. Alternatively, a Japanese Company has developed a process for continuous in-place stabilization of contaminated sediments (USEPA 1981). The process, used in Japan in 1973, involves pumping a slurry of portland cement and proprietary additives through a pile into the contaminated sediments. This is done at closely spaced intervals until the entire sediment bed becomes a series of vertical columns of stabilized material standing side by side. The long-term stability of fixed sediment has not been adequately demonstrated because the Japanese process has only been in use since 1973. All of the drawbacks related to the long-term integrity, monitoring and mitigation noted previously for inplace confinement alternative would also apply to in-place fixation. In-place fixation would also result in the bottom of the Harbor becoming a permanent PCB disposal site which could not be approved under 40 CFR 761.41. Injection of fixation material into bottom sediments would also increase sediment volume, thereby decreasing harbor depth and hindering navigation. Future maintenance dredging or navigation improvements would not be possible because such activities would disturb the integrity of the bottom aggregate. The consequent impact on navigation resulting from sediment build up would ultimately cause severe economic hardship to the recreation and commercial industries independent on the Harbor. Due to the aforementioned problems, in-place fixation cannot be considered as an acceptable abatement alternative.

2.3.2. Screening of North Ditch Drainage System Abatement Alternatives

2.3.2.1. Excavation of Contaminated Soils

Potential problems with excavation in the North Ditch Drainage System include: (1) the PCB contamination is below the water table; (2) excavation may structurally endanger nearby buildings; and (3) there is a potential for increased PCB volatilization. Mitigative measures for these problems are available, however. For example, the water table can be lowered by the use of wellpoints. In addition, a slurry wall could be constructed down to the silty clay where deep excavation is required (such as for the Crescent Lagoon and the Oval Lagoon). Pumping rates for the wells would be dependent on local transmissivity and groundwater gradients. These factors have to be addressed, and a determination would have to be made as to the number of wells and the pumping rates required for dewatering prior to excavation. In order to control sediment roiling, the North Ditch stormwater would have to be diverted so that excavation could be performed in dewatered conditions.

Due to the depth of contamination (approximately 25 feet), excavation would endanger the structural integrity of nearby buildings. To avoid this, the construction of a slurry wall may be required for the Crescent Lagoon portion of the North Ditch if the PCB-contamination is determined to be closer than 30 feet to existing buildings. Otherwise, in-place fixation may have to be considered for the soils closest to buildings.

PCB volatilization control can be accomplished by excavating in short increments. In this manner, only a small portion of the PCB-contaminated soil would be exposed at ay one time. This procedure would reduce the potential for PCB volatilization. In addition, the excavated, more highly-contaminated soils could be covered with tarps, plastic sheeting, or organic material to lessen volatility.

Use of small shovels, front-end loaders, small draglines, small buckets, or other dry-earth-handling equipment would be most appropriate because of the sloped banks and shallow water depth in the East-West Section of the North Ditch. This type of equipment could be used only if the Ditch can be dewatered in short sections during excavation (USEPA 1981).

If the above constraints can be met, excavation is a feasible method of complete PCB contamination abatement.

2.3.2.2. Dredging of North Ditch Soils

Although dredging initially was posed as a conceptual alternative, it is not practical for reaching contamination present in compacted materials at deeper levels. Therefore, this alternative should not be considered further.

2.3.2.3. In-Place Landfill Disposal

This alternative poses several serious disadvantages. With groundwater levels only two feet below the surface in some areas and Lake Michigan only a short distance away, it would be difficult to establish an absolutely secure disposal site. This would be especially true under the condition of very high water levels in the Lake. The State of Illinois requires an underlayer of at least 10 feet of highly impermeable clay for a landfill containing PCBs. Such landfill requirements could not be met without significant engineering and construction activities and disruption of existing uses of the Harbor and beach areas. In-place landfill disposal cannot be recommended as long as other viable means of complete abatement can be implemented.

how?

2.3.2.4. In-Place Slurry Wall Confinement

This option has several disadvantages. The first is the unknown level of reliability for the slurry groundwater cutoff walls. Failure of these underground, man-made walls may ultimately result in a degree of leaching from the area similar to what is now naturally occurring. Similar concerns have been expressed over the permeability and uniformity of the existing underlying silty clay layer. In-place slurry wall confinement raises other serious questions related to the long-term use and character of the site. The effectiveness of containment would be jeopardized whenever water tables lower enough to dry out a portion of the slurry wall and cause cracks to develop. Subsequent wet weather and water table elevation could promote leaching through the wall at discrete failure points. The probability that the wall would be overtopped occasionally with water due to very high water levels in

Lake Michigan is unknown. In order to assure long-term security, the deed for the property wherein confinement would take place would need to include restrictive covenants relating to excavation or construction activities and use.

The relatively low cost of slurry wall confinement does encourage serious consideration of the implementation of this alternative if funds for the more expensive excavation approaches are not available and if the long-term integrity of confinement can be demonstrated.

2.3.3. Screening of Final Disposal Alternatives

The final disposal alternatives discussed in Section 2.2.4. are screened in this section by means of a discussion of the advantages and disadvantages of each.

2.3.3.1. Landfilling

The main disadvantage of landfilling is that the process does not ultimately destroy the contaminant, but places it in a secure protected environment. Because the contaminant is not destroyed, there exists a risk of groundwater and surface water contamination as well as the possibility of air pollution through volatilization. These problems eventually could lead to public health hazards in the area immediately surrounding the landfill.

refer to 40 CFR 761

The risks involved with long-term storage in landfills can be greatly reduced or eliminated by the use of proper design. Landfilling presently is used for disposal of many toxic materials because of a lack of other applicable technologies and favorable costs. Landfilling is considered the best option for disposal of toxic substances which are dispersed in soil materials. This conceptual alternative is recommended as an acceptable means of ultimate disposal, pending the outcome of the permit issuance process for landfill sites that are proposed as repositories of contaminated materials from the project area.

This will provide more detail on technical requirements for landfill

2.3.3.2. Incineration

Incineration will destroy PCBs if this process is performed properly. This method currently is utilized in several places for destruction of oils laden with PCBs. Costs for PCB-contaminated oil incineration are at a level that can be justified for use in sizeable projects. Although studies and test burns have been performed on sediments laden with PCBs, no large facility is yet permitted for this concept. The costs involved also are prohibitive at present due to the excessive energy requirements associated with heating the contaminated soils to a temperature which destroys PCBs. Therefore, this conceptual alternative is not recommended for ultimate disposal of PCB contaminated wastes.

2.3.3.3. Chemical Treatment

Chemical treatment to destroy PCBs has been used in pure or oil-based forms only. Due to the fact that PCBs in the project area are dispersed in soil materials, very large amounts of chemicals would be needed to achieve full PCB degradation and the degradative agents would then be dispersed through the soil, necessitating a costly disposal or treatment of the same material. To date, none of the chemical treatment processes have been permitted to use with PCB-contaminated sediment. In addition, the volumes anticipated to be treated would more than likely be cost-prohibitive. Therefore, chemical degradation is not recommended for ultimate disposal of PCB-contaminated materials from the project area.

2.3.3.4. Biochemical Treatment

Biological destruction of PCBs has been evaluated in laboratory environments. This method may prove to be a viable alternative in the future. Currently, however, many technical questions and problems exist that must be overcome before this process can be given serious consideration. The constraints are similar to those for in situ destruction of Harbor sediments.

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2.4. Comparison and Selection of Recommended Alternative Options

Conceptual alternatives proposed to abate PCB contamination in the project area have been presented in previous sections. These alternatives were screened (Section 2.3.) to develop the final project alternatives. A summary of the screening process outcome is presented in Figure 2-2. Screening consisted of a review of social, environmental, and engineering acceptability. The conceptual alternatives selected for the project include the removal and landfill disposal of the contaminated material. Ultimate disposal therefore requires the selection of a mode of loading and hauling contaminated materials to a landfill. Each of the selected alternatives may have a number of engineering options and associated costs. The component options, costs, and recommendations and a proposed schedule for the recommended project are described in this section.

2.4.1. The Project Alternative

This section of the report addresses the potential component options of the project alternative, encompassing the Harbor and the North Ditch Drainage System segments of the project. The selected project provides for the dredging of Waukegan Harbor and final landfill disposal of contaminated sediments. The project ~~also~~ further provides for the diversion of stormwater from the North Ditch Drainage System and, conditionally, for the removal and landfill disposal of contaminated soils.

2.4.1.1. Removal Component Options for the Harbor and North Ditch Drainage System

<u>Waukegan Harbor Dredging Options</u>

While there are several techniques commonly employed for dredging, it is important to choose the proper dredging technique to minimize the dispersal of PCBs during the operation. Commonly used techniques include mechanical dredging, hydraulic dredging, and pneumatic dredging. Several of the common techniques are illustrated schematically in Figure 2-3.

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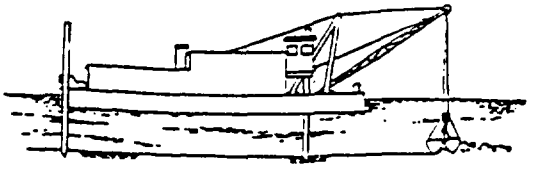
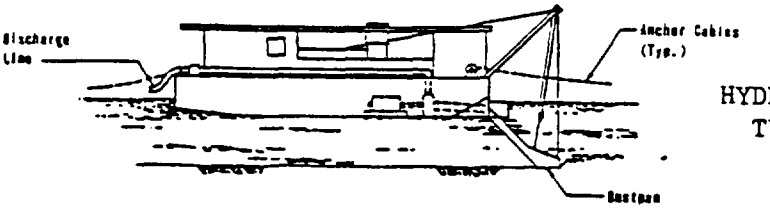
PROJECT AREA		CONCEPTUAL ALTERNATIVE
NORTH DITCH DRAINAGE SYSTEM (Including Crescent and Oval Lagoons and OMC Parking Lot)	WAUKEGAN HARBOR (Including all Areas of Contamination)	FOR ABATEMENT OF PCB CONTAMINATION
Conditionally Recommended	Acceptable in slip #3 where PCBs have penetrated clay	EXCAVATION OF CONTAMINATED SOILS/SEDIMENTS
NA	Recommended	DREDGING OF CONTAMINATED SOILS/SEDIMENTS
Merits further study as a conceptual alternative. In-place fixation has limited applicability where excavation is difficult to complete near buildings.	NA	IN-PLACE CONTAINMENT OR ENCAPSULATION OF PCB-CONTAMINATED SOILS/SEDIMENTS
NA	NA	IN-PLACE DESTRUCTION OF PCBs IN CONTAMINATED SOILS/SEDIMENTS
NA	NA	ON-SITE SECURE LANDFILL DISPOSAL OF PCB-CONTAMINATED MATERIALS
Recommended	Recommended	OFF-SITE SECURE LANDFILL DISPOSAL OF PCB-CONTAMINATED MATERIALS
NA	NA	INCINERATION OF PCB CONTAMINATED SOILS/SEDIMENTS
NA	NA	CHEMICAL DESTRUCTION OF PCBs IN OFF-SITE DISPOSAL FACILITY
NA	NA	BIOLOGICAL BREAKDOWN OF PCBs IN OFF-SITE DISPOSAL FACILITY
Merits further study if the recommended conceptual alternative is not implementable.	Not Applicable	DIVERSION OF STORMWATER AND INDUSTRIAL PROCESS COOLING WATER

Figure 2- 2 Summary presentation of the screening of conceptual alternatives for abatement of PCB contamination in the project area. NA indicates that the conceptual alternative is considered to be Not Acceptable for environmental and social reasons or because engineering feasibility is not good.



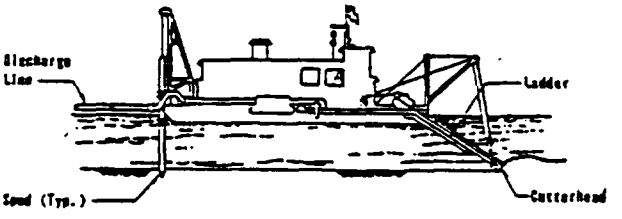
MECHANICAL TYPE

CLAMSHELL DREDGE



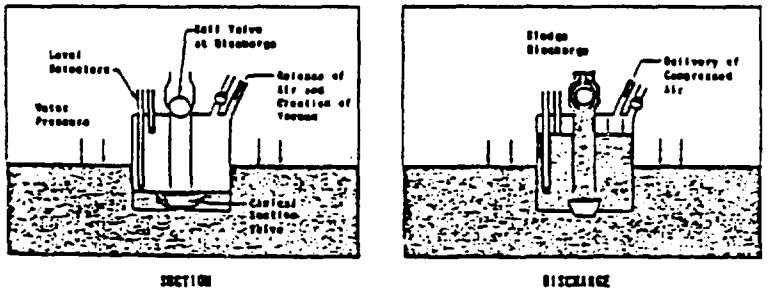
HYDRAULIC TYPE

DUSTPAN DREDGE



HYDRAULIC TYPE

CUTTERHEAD SUCTION DREDGE



PNEUMATIC TYPE

OOZER PUMP OPERATION

Figure 2-3. Examples of several common ~~dredging techniques.~~ types of dredges The illustrations are derived from figures originally published by the New York State Department of Environmental Conservation (Malcolm Pirnie, Inc., 1978).

Mechanical dredges include clamshells, slippers, draglines, and bucket chain dredges. Each of these mechanical devices scoops or shovels up the sediment and brings it to the surface where it can be placed in a transporting vehicle (truck, barge, etc.). The min environmental concern with any mechanical dredging technique is the turbidity that may produced. A considerable disturbance and resuspension of sediment generally occurs when the digging mechanism enters the sediment. It has been estimated that 15 to 30% of the much may be lost as the device lifts the material. In deeper water, loses near 50% have been reported. Clamshells with watertight buckets can reduce the turbidity by as much as 30 to 60% assuming that the jaws close completely (USEPA 1980). Some of the losses during lifting and swinging can be mitigated by using a watertight bucket. However, large debris, which are frequently encountered on harbor bottoms, can be caught in the jaws resulting in incomplete closure and partial or total loss of the material being lifter.

Another problem is the lack of positive control for determining how deep or where the dredge is digging, particularly for the clamshell dredge, which would be the most suitable of the mechanical dredges. The bucket free-falls to the bottom of the body of water, producing a variable depth of digging ("cut") depending upon the consistency of the material and the amount of free-fall. It is very difficult to drop the bucket so it overlaps the bite of the prevous cut. This results in small areas being dredged twice and other being missed entirely. In uncontaminated material, the dredge operator drags the bucket at a fixed depth to level the areas missed by the bucket. In the highly contaminated sediments of Waukegan Harbor, this would be undesirable because of the need to capture as much of the contaminated sediment as possible. Turbidity increases will then cause the desorption rate of PCBs to increase (USEPA 1981). This in turn, would increase the difficulty of final PCB removal. If large amounts of PCBs were lost to the water column, other steps such as the addition of activated powdered carbon would have to be taken. Such steps would drastically increase the time schedule, costs, and risk of adverse impacts to the environment. Because of the PCB loss problems associated with mechanical dredging, this option is not recommended.

Hydraulic dredges use a suction line, a centrifugal suction pump, and a discharge line which floats on a series of pontoon floats (Figure 2-3). The sediments and some additional bottom water needed to allow the mixture to flow properly are sucked up by the pump and conveyed directly to the disposal site by the discharge pipeline. Resuspension and the subsequent loss of PCB contaminated sediments is considerably less with hydraulic than with the mechanical dredges because resuspended material also tends to be sucked up by the dredge rather than dispersing into the water column. This resuspension can be further minimized by properly selecting the location and shape of the suction mouth. The typical hydraulic dredge has the suction mouth mounted on a rigid "ladder" structure which is lowered or raised to the desired depth of the wire ropes anchored to the shore or to the bottom in an arc around a piling-like "spud" which is lowered into the bottom sediments from the hull. Rather than pivoting around a spud, some hydraulic mechanisms such as the dust pan dredge have a horizontally elongated intake mouth or box and are moved forward or backward. This allows a very precise positioning of the suction mouth and control over the depth of the cut. If the material to be dredged is consolidated, a cutter head may be necessary to dislodge and slurry the sediments. The cutter can produce increased turbidity, but this can be minimized by proper selection of cutter rotation speed, suction velocity and rate of swing or advance of the dredge. There are also shrouded cutters available that tend to contain any resuspended sediments near the suction mouth for pick up (Barnard 1978).

Pneumatic dredges use hydrostatic pressure to fill a submerged dredged head chamber with sediment and then use compressed air to force the sediments up through a discharge pipe that leads out of the chamber (Figure 2-3). Surface water turbidity is lower and less water is conveyed with the sediment if this method is used. The two commercially available pneumatic dredges are the Italian-designed Pneuma Dredge and the Japanese Oozer Dredge. The Pneuma Dredge has been used successfully to remove a small amount of PCB-contaminated sediments from the Duwamish Waterway, Seattle Harbor, Washington. Very low turbidity levels were generated during this operation. The Oozer Dredge also has been reported to operate with very low turbidity levels in Japan. It can be equipped with underwater television cameras to visually monitor the operation. The disadvantage of both dredges is that they are quite large and would

have difficulty maneuvering from barges in Slip #3. Under proper operating conditions, the pneumatic dredge can also control the resuspension of contaminated sediments more effectively than mechanical or hydraulic dredges. However, there may be increased volatilization of PCBs to the atmosphere due to compressed air coming in contact with PCB-contamination and then being released to the atmosphere through the discharge line. The pneumatic dredge head can be placed on a ladder and hull like the hydraulic dredge for positive positioning. However, the pneumatic dredge would be somewhat less effective in sand.

Dredging options include carrying out the project in ~~three~~ two phases:

- Dredging and excavation of Slip #3 (Plan 1)
- Dredging of the Harbor area containing greater than 50 ppm PCB (Plan 2)
- ~~Dredging of the Harbor areas containing greater than 50 ppm~~ (Plan 3).

? should be written based on results - true 50ppm

Engineering plans were originally completed for all three dredging areas delineated in Figure 2-4. Water quality and bioaccumulation models of PCB movement in the Waukegan area indicate that the incremental public health benefits that would be achieved by implementation of Plan 3 are considerably less than those that would be achieved through implementation of Plan 1 and Plan 2 (USEPA 1981). The Plan 3 area contains a large volume of sediments with relatively low PCB content. A major part of the project schedule and money would be required to clean up the small amount of widely-dispersed PCB contamination that exists in the central Harbor area delineated as Plan 3. It has also been determined that the public health and welfare would be protected if the dredging of all sediments in excess of 50ppm PCB content is performed.

It is recommended that dredging of contaminated Harbor sediments be conducted over two phases in which the most contaminated materials would be dredged first. That is, Plan 1 should be implemented first, followed by Plan 2. Under this two-phase stepped approach, the maximum benefit to public health will be achieved. Any contaminated materials transferred out of the Plan 1 area during the dredging of this area would have an opportunity to

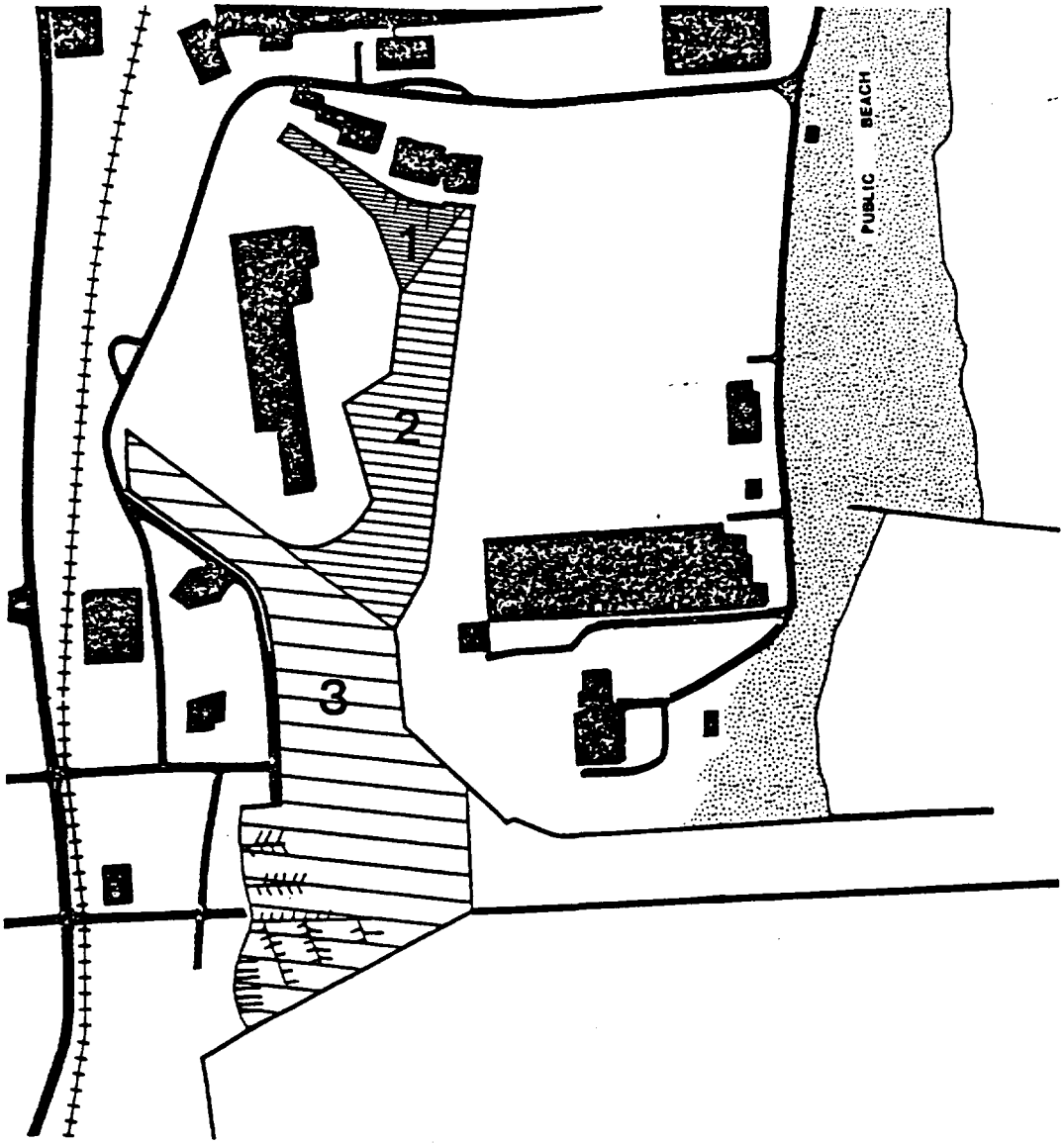


Figure 2-4. Schematic representation of optional dredging plans for the Waukegan Harbor PCB abatement project. Areas labled as 1,2, and 3 are distinguished to indicate different levels of contamination. The greatest contamination is in area 1 and the least is in area 3. Implementation of Dredging Plan 2 would be inclusive of areas 1 and 2 (USEPA 1981).

settle and be removed during the Plan 2 implementation, and any sediment entering Slip #3 after it has been dredged once (under Plan 1) can be re-dredged during the implementation of Plan 2. This scheme will maximize the potential to leave no contaminated sedimentary materials in the Harbor in excess of 50 ppm PCB content. Completion of Plan 2 of the dredging program in Waukegan Harbor must include the excavation of deep PCB contamination in the vicinity of the abandoned OMC discharge inside Slip #3. To dredge to the necessary depth of approximately 10 feet below the sediment surface over the limited surface area where deep contamination is located would be technically difficult and environmentally inadviseable. To prevent resuspension and dissolution of PCBs from the highly contaminated sediments of this area the recommended course of action is to install a double-walled and braced cofferdam around the area and excavate the soils inside of it for hauling directly to a landfill (USEPA 1980). The innermost cofferdam wall would be erected immediately following the first phase of the dredging to preclude transfer of the newly exposed PCBs into the Harbor water. The cofferdam would not be erected in a location which would preclude other uses of the Harbor.

The USEPA has determined that mechanical dredging is not a viable technique for removing PCB contaminated sediments from Waukegan Harbor due to the serious problems associated with mechanical dredging, principally the uncontrolled resuspension and subsequent loss of PCB contaminated sediment and lack of accuracy in the cut.

Because hydraulic and pneumatic dredging are proven removal techniques which accurately remove sediments and minimize resuspension and subsequent loss of PCB contaminated sediment, USEPA has determined that either technique would be viable for removing contaminated sediments from Waukegan Harbor.

Both the hydraulic, and pneumatic dredges withdraw excess water along with the sediments when dredging. Therefore, to minimize costs, it would be necessary to dewater the dredged sediments before disposing of them. A temporary lagoon or pond is the only proven method available for dewatering large quantities of dredged materials. The lagoon would provide for settling of the sediments pumped from the dredge and the overlying water would be drawn off, treated to remove remaining contaminants, and discharged to the Harbor.

was this ever published? don't think so

It is ~~recommended~~ essential that a dewatering lagoon and a treatment plant be constructed to accomplish this step. There are two vacant parcels of land near Waukegan Harbor on which a lagoon and treatment facility could be accomodated. The site that appears to offer the safest and most cost-effective opportunity for lagoon construction and operation is the vacant OMC property adjacent to the east side of the Harbor (USEPA 1981). The alternate site for the lagoon would be the vacant land west of the railroad tracks and northwest of the Harbor (Section 3.2.1.1., Figure 3-5). If the alternate site were to be utilized for the lagoon, there would be serious engineering feasibility and environmental problems to overcome. The lagoon would be located approximately 0.5 miles from the nearest point of Harbor access. A pipeline transport system would be needed to move dredged materials across a public roadway, across a railroad track, and through private property. The increased cost and potential environmental problems associated with transport of dredged materials to the alternate site make it the least preferred location (USEPA 1981). Because of the convenience, safety, and cost advantages of building the lagoon as close as possible to the Harbor, it is recommended that the lagoon and treatment plant be constructed on the vacant OMC property.

Lagoon Description

During the dredging operation, the bottom sediment would be slurried with water and transferred to the temporary lagoon. The sediment would be allowed to settle and the excess water withdrawn, treated to remove PCBs, and then returned to the Harbor. The treated water would contain PCB concentrations that will always be less than 1 ppb (USEPA 1981).

Initial engineering plans considered the construction of two lagoons, a north lagoon and an adjacent south lagoon. The north lagoon would have included a separate small section for the highly contaminated sediment excavated from Slip #3. The two lagoons would have had sufficient capacity (150,000 yd^3 each) to contain all the contaminated sediment above 10 ppm PCB, excavated sand and clay from Slip #3, slurry water, and water used to clean out the residual sediments and to flush out the slurry lines. The pair of lagoons were ~~intended to be used~~ for sediment dewatering over a period of 2 to 5 years.

why discuss discarded design approach?

Based on a more recent cost analysis, it is recommended that the plans specify the construction of a single, smaller lagoon with a total capacity that would depend on the extent of the dredging to be completed. The most up-to-date plans call for dredging of all sediment containing more than 50 ppm of PCBs. This would necessitate a lagoon with a total capacity of 100,000 cubic yards. It is expected that the dredged sediments would be allowed to settle for approximately one ~~year~~ 3 months, after which time the sediments would be removed for final disposal using special sludge-handling equipment. The construction of the lagoon would be similar to that of a secure landfill and would use impermeable clay liners and leachate collection systems. The design is shown in Figure 2-5 as Section A-A (a cross-section through the bottom of the lagoon). There would be a 1-foot clay liner above the existing ground and a leachate collection system above the liner. The leachate collection system would have perforated pipes (wellpoints) located in a 1-foot-thick gravel layer. Above the leachate collector would be 3 feet of impermeable clay which would be compacted during construction to achieve a permeability coefficient of at least 10^{-7} cm/sec. The primary purpose of the bottom-most system is to provide safe leachate collection in case the upper-most clay liner fails. In addition, it could be used to test the integrity of the clay liner.

A 12-inch-thick layer of ~~sand~~ gravel would be placed above the uppermost clay liner to facilitate the final dewatering of the sediments in the lagoon. The sand piles (generally less than 5 ppm PCB) on vacant land owned by OMC could be used for this purpose. The dredged sediments would, in time, achieve approximately the same moisture content in the lagoon as they possess in the Harbor. Drainage systems in the sand layer would be used to further reduce water content when settling is complete and overlying water has been pumped away.

The sides of the lagoon would be diked with a ramp for access. The design is shown in Figure 2-5 as Section B-B. The 3-foot clay liner will extend up the slope of the lagoon from its bottom and would be in contact with the contaminated sediments. The diked sides would have a 3:1 slope for stability, and the dike would be constructed of soil material brought in from off the site and perhaps some material from the existing sand piles. The leachate collection system would extend through the dike walls, as shown in Figure 2-5,

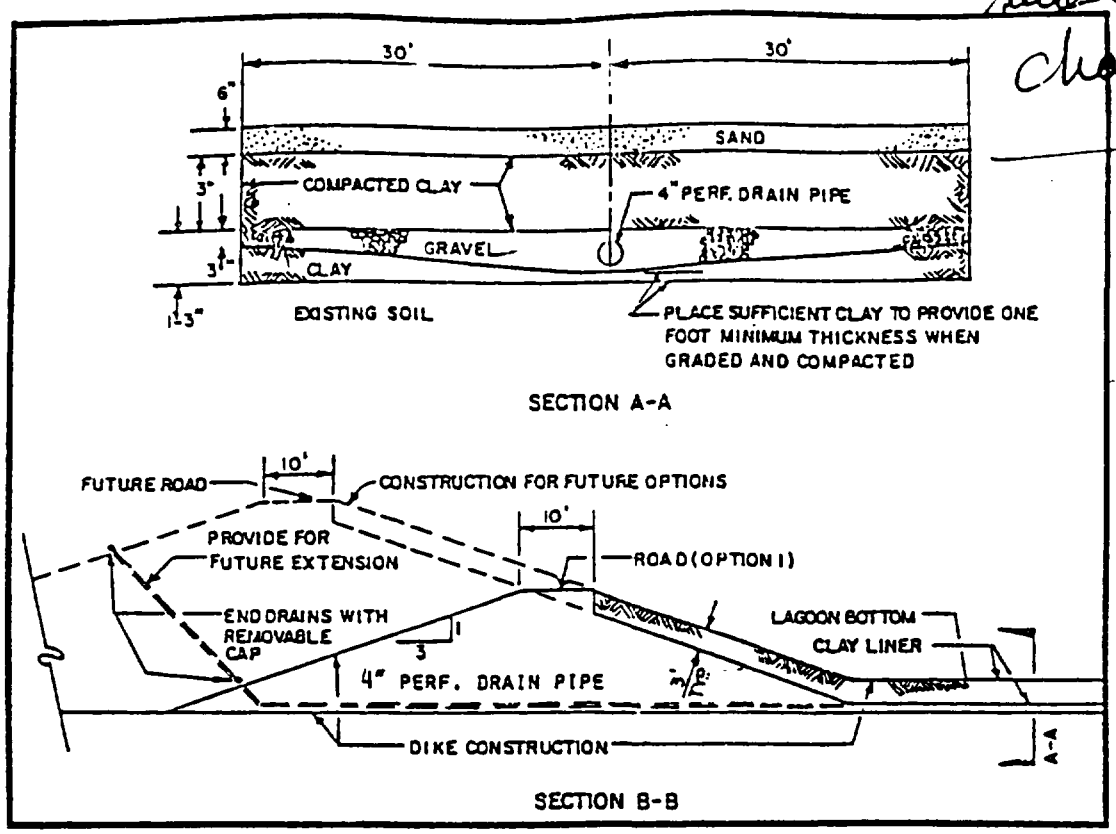


Figure 2-5. Cross sections of lagoon. Derived from Mason and Hanger Engineers, report to USEPA (1980).

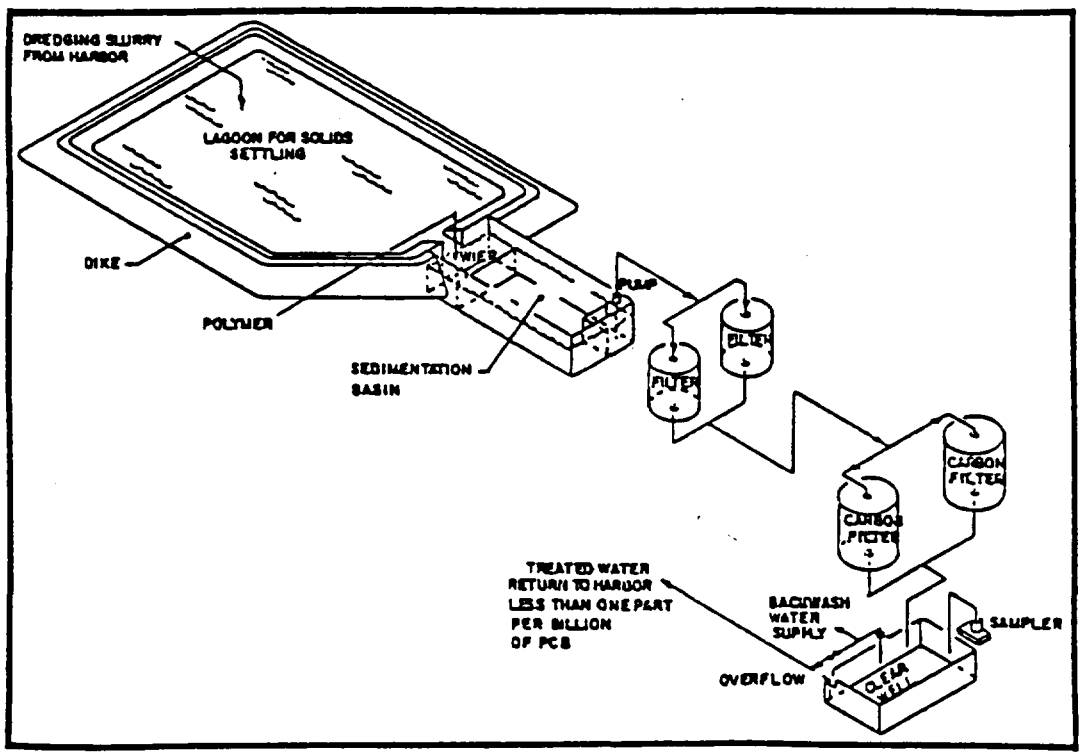


Figure 2-6. Treatment system for removal of PCBs from excess water. Derived from Mason and Hanger Engineers, report to USEPA (1980).

to facilitate the collection of samples and the removal of any leachate collected.

Procedures also would be employed to minimize volatilization during the initial placement and temporary storage of the sediments in the lagoon. For example, the dredge spoil discharge pipe would be placed on floats that then can be controlled to discharge the sediments evenly around the lagoon. The pipe also would be vertical at the discharge point, and it would be located below the surface of the water to minimize turbulance and subsequent volatilization of PCBs.

Water Treatment Description

Excess water would build up in the lagoon because water would be used to slurry Harbor sediments into the lagoon, to vacuum up remaining contaminated Harbor sediments, and to flush out slurry lines. This supernatant water would be treated for removal of PCBs before being returned to the Harbor. Treatment will consist of (Figure 2-6):

- Settling of the sediments in the lagoon;
- Pumping excess water and sending it into a smaller sedimentation basin where a polymer will be added to coagulate and settle fine sediment;
- Pumping the sedimentation basin water through pressure filters; and
- Conveying filter effluent through carbon filters to a clear well.

The water in the clear well would be monitored for PCB content before it is returned to the Harbor. A 1 ppb limitation of PCB concentration would be maintained for water returned to the Harbor. Rainwater and leachate water would be treated in essentially the same manner except that the operation would be intermittent and the volume smaller.

Leachate Monitoring

Six groundwater monitoring wells are proposed to be installed and monitored. The monitoring well pumped discharges would be analyzed for PCBs, pH, specific conductance, and chlorinated organics and would be combined with sediment leachate and rainwater and treated.

In addition, the lagoon would have a leachate collection system that would be sampled on a predetermined, periodic basis and analyzed for PCBs. The leachate collection system consists of perforated pipe in a bed of gravel-sand which in turn is sandwiched between layers of clay liners. The contents of the perforated pipe would be pumped out as required and transferred to a point (for example, the sedimentation basin) where a uniform sample could be collected for analysis. Any collected leachate water then would be treated to remove PCBs. The dredged sediments would rest on a 12 ~~6~~-inch bed of sand which would contain perforated pipe. ~~This~~ The leachate from this ~~sand~~ gravel bed also would be periodically pumped out and disposed of as described above.

North Ditch Drainage System Contaminated Soils Removal Options

According to info. current (available, parking lot contamination

The level of detailed information on the actual extent of PCB contamination in the North Ditch Drainage System is not yet adequate for the development of complete plans for removal of contaminated soils. For example, additional core-boring studies will be needed to fully develop the engineering options for removal of Parking Lot soils. On-site core boring and grab sample tests must also be conducted during excavation of soils in the Crescent and Oval Lagoons to determine the full extent of PCB contamination.

Additional data could result in removal of less material ...

Conceptual alternatives for the abatement of PCB contamination in all areas of North Ditch Drainage System the have been described and evaluated in Sections 2.2 and 2.3. Depending on funding availability, on the selection of final disposal options, ~~and on USEPA policy~~, options may be developed for any of the environmentally acceptable conceptual alternatives. ~~If the contaminated soils are to be removed for direct transport to a final disposal site (as described in Section 2.2.5.), the generalized options are as follows~~ Presumed and are as follows:

- Construct a North Ditch and Parking Lot area bypass storm sewer, generating 7,000 yd^3 of contaminated soils for disposal

- Excavate the Crescent and Oval Lagoon portions of the North Ditch, generating up to 41,000 yd^3 of contaminated soils for disposal; and

- Complete the bypass and excavations as in the first two options, and remove between 40,000 and 131,000 yd^3 of contaminated soils from the Parking Lot for disposal (more accurate

estimation of the total quantity is dependent on further field investigations).

The desirability of implementing one or more of the above options is highly dependent upon further testing of PCB distribution ~~and on engineering work (as well as on policy and funding considerations)~~ in the parking lot and in the assessment of the relative effectiveness and costs of the alternatives. For the purposes of this EIS, it will be assumed that full removal of contaminated sediments may be required in the North Ditch and the Parking Lot area. Implementation of a lesser removal and disposal project than the full-scope project is discussed under the five full project alternatives described in Section 2.5.

2.4.2. Transport Component Options

Transportation of the contaminated sediment to the final disposal site could be accomplished by using trucks, barges, or railroad cars. The final selection would depend on disposal site location, transportation access, and cost. Regardless of the transport mode that is selected, proper precautions must be taken to reduce the risk of accidents and consequent spillage. The potential impact and mitigating measures for the transport options are discussed in Chapters 4.0 and 5.0. Because the final disposal site is unknown, no recommendation has been made at this time for a specific transportation option.

2.4.1.3. Final Disposal Component Options

Several methodologies were employed to establish landfill options. Of interest were existing sites licensed to accept PCB wastes, existing landfills (not licensed but with the potential to become licensed), and areas with natural and man-made environmental characteristics that would enable them to be developed into secure licensed landfill sites.

Three efforts were employed to identify such options. The first was a preliminary and final screening study by Warzyn Engineering, Inc. under contract to USEPA (1981). Potential landfill site options reviewed in a pre-

liminary fashion by this study included:

- Browning-Ferris Industries, Inc. (BFI) - Lake County IL
- CECOS International (CERN) - Williamsburg OH
- C.I.D. - Cook County IL
- Joliet Army Ammunition Plant - Joliet IL
- Ft. Sheridan Army Facility - North of Highland Park IL
- Great Lakes Naval Base - North Chicago IL
- Nuclear Engineering - Sheffield IL
- Waste Management, Inc. - Livingston AL
- CECOS - possible Northern Illinois site
- Potential use of ~~vacant~~ OMC land ~~near the Harbor.~~

Several of the facilities expressed a positive interest in accepting the PCB wastes. The facilities were further assessed according to the physical/environmental and socioeconomic criteria that were outlined in the scope of work including:

- Topography, soils, and bedrock;
- Groundwater and surface water;
- Site engineering and operations; and
- Haul distance to site, traffic patterns, and neighborhood characteristics
- The acceptability and availability of each site as a PCB dredge material disposal facility based upon site ownership and local and state zoning.

The potential use of ~~vacant~~ OMC land as a permanent landfill site was determined to be unacceptable for environmental reasons and was not considered further in the screening process.

What about OMC parking lot?

The second effort involved location of undeveloped areas in Lake County that potentially could sustain a landfill based on land use and natural soil permeability characteristics. This screening process was conducted by WAPORA, Inc., and entailed the preparation of Lake County IL maps depicting existing native clay deposits as well as areas presently developed or proposed to be developed (platted). This screening process located two areas which on the basis of the general soils and land use criteria seemed to be the most suitable for new landfill development for disposal of PCB-contaminated material in Lake County. The methodology employed in the selection of these sites is contained in Appendix E. Both new site options are located in the northeastern quadrant of Lake County. The present ownership and availability of these sites have not been assessed. The identification of new site options serves principally to illustrate the potential availability of areas close to Waukegan having characteristics suitable for new landfill development.

The third effort in identifying potential sites was a request for prequalification statements by the USEPA that appeared in the Commerce Business Daily on 24 June 1981. As a result of the request, the USEPA received ten replies, of which two were licensed sites for PCB disposal and three were proposed new sites. Five of the responses were received from companies that indicated an interest in the project but did not propose a specific approach or disposal site location.

These three efforts identified six potential sites: two sites licensed for PCB disposal; one unlicensed site in Lake County (with the potential to become licensed for PCB disposal); one unlicensed site near Calumet City IL (with the potential to become licensed for PCB disposal); and two areas in Lake County which could be developed into new sites. These optional sites were:

- SCA Chemical Waste Services, Inc., Model City NY site (licensed)
- CECOS International (CERN), Williamsburg OH site (licensed)
- Browning-Ferris Industries, Inc., Lake County IL site (unlicensed)

- Potential New Site 1, Lake County
- Potential New Site 2, Lake County
- Chemical Waste Management Co., Calumet City, IL site (unlicensed).

This list includes one unlicensed site (Chemical Waste Management Co.) which has responded to the USEPA request with a proposal to accept material that is contaminated with low to moderate levels of PCBs. It is felt that further development of the Chemical Waste Management Co. proposal is potentially valuable if an alternate disposal site for the more highly contaminated waste can be found or if highly contaminated materials can be amended with uncontaminated materials at the site.

Therefore, there are at least six potential landfill sites that can be reviewed in terms of the environmental and site design characteristics and incremental costs per unit of distance for hauling of contaminated materials. Environmental characteristics need not be evaluated in detail for the optional sites that have already received licenses to dispose of PCBs since they have been carefully reviewed during the permitting process and each represents a secure, safe option for disposal. The descriptions of the characteristics and location of each optional site are presented more fully in Appendix E. Also included in Appendix E are the methodologies employed for the calculation of hauling costs for contaminated materials and a characterization of the contaminated wastes to be disposed of. The affected environment for each optional landfill site is discussed in detail in Section 3.0. A summary matrix has been developed to give an overview of the characteristics and locations of the optional sites and the estimated costs of loading and trucking all the contaminated material generated from the dredging of Waukegan Harbor and from the excavation of the North Ditch Drainage System soils (Figure 2-7)

It is emphasized that the list of optional sites may expand as more proposals are developed from the bidding process among private contractors. Therefore, while the landfill site options listed here may represent the majority of potentially available options, the list must not be construed as

SCREENING PARAMETER / Site	Distance from Waukegan via Public Roadway (miles)	Distance from Waukegan via Water Routes (miles)	Transport Mode Proposed	Incremental Costs for Truck Hauling	Land Use Suitability	Surface Water Resource Suitability	Hydrogeologic Suitability	Soils Suitability	License Status
MODEL CITY NEW YORK S.C.A. Chemical Waste Services, Inc.	More than 550 miles	Approximately 800 miles	Barge and Truck	[1]$98.00/yd. [2]$12.7 mil. total	Data are not available at the present time.	Located 6 miles from Lake Ontario, in its drainage area. Suitability indeterminable from present data base.	No data are available at the present time.	No data are available at the present time.	Currently licensed to receive PCBs
WILLIAMSBURG OH CECOS, Inc. C.E.R., Inc.	350 miles	Approximately 800 miles	Barge and/or Truck	[1]$65.00/yd. [2]$21.7 mil. total	Compatible with existing rural land use; suitability dependent on public reaction from development along surrounding public roadways.	Close to flash-flood-prone streams; upstream from new reservoir and Ohio R. (above Cincinnati.) in Mississippi watershed.	Groundwater varies between 2' to 20' below surface; underlain by 40' to 50' of clayey sediment with discontinuous sandstone.	Considerable extent of fine-textured soils present on site. A lens of sand and silt also is present at an unspecified depth.	Currently licensed to receive PCBs
CALUMET CITY IL Chemical Waste Management, Inc.	35 miles	67 miles	Barge or Truck	[1]$20.00/yd. [2]$6.7 mil. total	Compatible with adjacent industrial and transportation uses. Suitability dependent on public opinion on adjacent marsh areas and housing to the south.	In oxbow bend of Calumet River-tributary to Illinois R. and Mississippi R. In flood plain and in contact with surface water drainage.	Site at the ground water surface due to its location in the flood plain.	No detailed soils information reviewed. Fine-textured soil predominates to the west, stratified sand and silt to the east	Not licensed to receive PCBs.
LAKE CO. IL Browning-Ferris Industries, Inc.	13 miles	N.A.	Truck	[1]$10.00/yd. [2]$3.3 mil. total	Suitability dependent on public opinion from newly developing areas. Compatible now, but changing to low-density, rural residential uses.	On surface water divide; 0.75 mile from Des Plaines River, the nearest stream. In Mississippi R. watershed.	Ground water is 6' 12' below proposed site; underlain by silty clay to at least 50' to 70'.	Considerable variation in texture of surface soils; difficulty in meeting permeability limits.	Not licensed to receive PCBs.
LAKE CO. IL New Site Option #1	7 miles	N.A.	Truck	[1]$ 9.00/yd. [2]$3.0 mil. total	Generally compatible with rural land uses, but suitability dependent on extent of future development in surrounding areas.	Low relief; diffuse surface drainage over a 3 mile course into Des Plaines R., in Mississippi watershed. Standing water common.	Ground water surface unknown. Existing surface aquifer poor water supply. Next aquifer (150') good production; underlain by clayey till.	Limited areas of fine-textured soils of unknown thickness are present.	Undeveloped and unlicensed.
LAKE CO. IL New Site Option #2	10 miles	N.A.	Truck	[1]$ 9.50/yd. [2]$3.2 mil. total	Generally compatible with rural land uses, but strong objection likely due to on-site residences.	Intermittent tributary to Des Plaines R. 0.1 mile from site. Standing water common. In Mississippi watershed.	Ground water surface unknown. Existing surface aquifer poor source for water supply. Next aquifer (100') with poor to fair production; underlain by clayey till.	Considerable areas of fine-textured soils are present.	Undeveloped and unlicensed

[1] Based upon interpolation and extrapolation of the hauling costs to Browning-Ferris Industries, Inc., and CECOS (WSEPM 1981).

[2] Includes hauling and loading for 55,000 yards of material from Harbor, 179,000 yards from Ditch and Parking Lot system and 100,000 yards of contaminated lagoon materials - a total of 334,000 yards of material.

[3] Number of buildings within a 0.5 mile radius.

[4] USEPA groundwater criteria of 5 feet below the surface of the ground.

Figure 2-7. Locations and characteristics of potential landfill sites.

complete. Additionally, none of the characteristics listed can be considered as a "fatal flaw" nor as a ranking criterion for site selection. Sound engineering practices can circumvent many of the apparent constraints noted for each site.

2.4.1.4. Matrix of Recommended Project Component Options and Costs

Waukegan Harbor

After evaluating the conceptual alternatives, including no action, USEPA has selected removal by dredging as its preferred alternative to abate the Waukegan Harbor PCB contamination problem. USEPA has further determined that dredging can optionally be accomplished using a hydraulic or pneumatic dredge, and that the necessary dewatering lagoon must be constructed on OMC's vacant property adjacent to the Harbor.

It is recommended that dredging Plans 1 and 2 (Figure 2-4) be carried out and that the resultant dewatered volumes of sediment be disposed of in a licensed landfill. It is not possible to accurately estimate the cost of the ultimate disposal of this material until the landfill site is identified. However, an approximate cost estimate has been developed for loading and hauling to a landfill site, assuming that the Harbor materials will be disposed of in Lake County IL (USEPA 1980). A summary of the available options of dredging, storing and dewatering and landfilling of PCB-contaminated Waukegan Harbor sediments is presented in Table 2-1. The recommended options are indicated with an asterisk (*).

North Ditch Drainage System

The excavation of PCB-contaminated soils from the North Ditch Drainage System including the accompanying construction of a storm sewer bypass is conditionally recommended as a conceptual alternative. However, because a certain amount of engineering work has been completed on the plans for excavation, options can be presented under the assumption that some degree of removal will take place. The bypass construction plan would remain the same regardless of the degree of excavation accomplished. Conversely, the amount

→ T.R. are these correct? specific percentages should be used

WAUKEGAN HARBOR DREDGING PLANS Waukegan Harbor		PCB Concentration Range for Surficial Sediments: in ug/g-(dry wt. basis)	Estimated Mass of PCBs: % of total in Harbor	Estimated Mass of PCBs: Amount	Total Estimated Volume of Materials Slated for Removal by Dredging
Plan 1 (Slip #3)	a) Dredge surficial muck and sand sediments b) Excavate deeply contaminated materials from inside a cofferdam	500 ug/g to 10,000 ug/g 8 m	98%	350,000 lbs.	11,000 cubic yards
Plan 2 (north of Slip #1 to Slip #3)	a) Dredge surficial muck and sand sediments	50 ug/g to 500 ug/g 14	1.5%	7,000 lbs.	39,000 cubic yards
Plan 3 (Slip #1 and Central Harbor)	a) Dredge surficial muck and sand sediments	10 ug/g to 50 ug/g 29	less than 1.0%	2,000 lbs.	120,000 cubic yards
Harbor Mouth	a) No plan to dredge and dispose of sand from Harbor mouth in this project.	0.1 ug/g to 10 ug/g	less than 1.0%	250 lbs.	---

OPTIONAL ACTIONS	COMPARATIVE COSTS AND BENEFITS: Liquid Capacity and Cost of Lagoon(s)	[1,2]Approximate Landfill Disposal Capacity/Cost	Estimated Net Percent Reduction in PCB Movement from the Harbor to the Lake. (USEPA 1981)
*Implement Plans 1 and 2	100,000 yards/$4.0 million	147,800 yards/$1.48 million hauling; plus fee	Approaching 100% reduction if no surficial sediments containing more than 50 ug/g remain.
Implement Plans 1, 2 and 3	300,000 yards/ ---	267,800 yards/$2.68 million hauling; plus fee	Approaching 100% reduction if no surficial sediments containing more than 50 ug/g remain.

[1]Assumes 100,000 yards of storage lagoon underdrain materials may need to be disposed of.

[2]Based on estimate of $10.00/yard fee to cover loading and hauling costs to landfill in Lake County, IL.

Table 2-1. A summary of the options available for dredging, storing, dewatering and landfilling of PCB contaminated Harbor sediments. Some comparative costs and benefits of the dredging plan options are presented in the lower half of the table. The recommended option is indicated with an asterix (*).

of soil that is to be removed from the Crescent and Oval Lagoon portions of the North Ditch Drainage System as well as from the Parking Lot, would be highly dependent upon advance field studies and upon the levels of contamination encountered during the excavation process.

As a result of the above circumstances, the volumes to be landfilled must be assumed to be those described by current "best estimates" of all contaminated materials that have PCB concentrations greater than 50 ppm. Again, the cost of landfilling can be considered only as an approximate estimate, within the assumption that the North Ditch Drainage System solids will be disposed of in a Lake County IL site. A summary of the available options for excavating and landfilling PCB-contaminated North Ditch Drainage System soils is presented in Table 2-2.

2.4.2. The Recommended Project Schedule

Resolution of a complete project schedule has not yet been accomplished, although the general order of events has been carefully contemplated and a tentative project schedule has been prepared. Critical Path Method (CPM) project planning is now underway for the long range scheduling of the recommended abatement project and for making the detailed arrangements necessary for abatement of Harbor and North Ditch Drainage System contamination.

Some of the factors that will be critical in the development of a schedule which represents a practical construction activity plan are listed below:

- Construction funds must become available pending a State of Illinois Legislative commitment for providing at least 10% of the total project funds which are to be expended. This financial obligation, which must be met by the State to enable a Superfund project to go forward at Waukegan, is a requirement of the Federal legislation.

- Licensed landfill operators must submit bids and show a willingness contractually to accept the designated amount(s) of contaminated materials prior to their removal from the Harbor and/or North Ditch Drainage System.

- This Environmental Impact Statement must be completed in a form which is acceptable to interested persons and agencies.

Tony — we need to check these numbers —

Plans for North Ditch Drainage System	PCB Concentration Range for Surficial Soils: in ug/g- (dry wt. basis)	Estimated Mass of PCBs: Percent of Total in Drainage System	Estimated Mass of PCBs: Amount	Total Estimated Volume of Materials Slated for Removal
Plan to Construct Bypass Storm Sewer	undetermined	less than 1%	4,270 lbs.	7,000 yards
Plan for Excavation of Contaminated Soils From Crescent and Oval Lagoons	7 ug/g to 115,000 ug/g	70%	611,580 lbs.	41,000 yards
Plan for Excavation of Contaminated Soils From Parking Lot	uncertain	30%	278,000 lbs. (rough extimate)	40,000 yards to 131,000 yards (depending on further studies)

OPTIONAL ACTIONS	[1]Approximate Landfill Disposal Capacity/Cost	Estimated Net Percent Reduction in PCB Movement from Drainage System into Lake (USEPA 1981).
Construct Bypass Only	7,000 yards/$70 thousand, hauling; plus fee	[2]63% to 79% (range of estimates) ?
Excavate Crescent and Oval Lagoons	48,000 yards/$480 thousand, hauling; plus fee	— — —
Excavate Parking Lot	up to 179,000 yards/$1.8 million, hauling; plus fee	— — —

[1]Based on estimate of $10.00/yard fee to cover loading and hauling costs to landfill in Lake County, IL.

[2]Based on computer modeling projections by HydroQual, Inc. (USEPA 1981)

Table 2-2. A summary of the options available for excavating and landfilling of PCB contaminated soils from the North Ditch Drainage System. Some comparative costs and benefits of these options are presented in the lower half of the table.

- The required property access must be obtained to allow a commitment to be made for dewatering lagoon construction.

- Additional field studies must be conducted in the North Ditch Drainage System, particularly in the Parking Lot.

- Potential conflicts with existing activities in and around the Harbor area must be identified and the schedule adjusted to provide appropriate mitigation.

- Climatological conditions during various times of the year place some constraints on dredging and excavating activities, depending on the weather and the equipment to be employed.

Plans are being made to address these potential constraints and the project as currently recommended, is progressing. As the uncertainties become resolved, more finite dates and objectives will be developed for the North Ditch Drainage System. The tentative project schedule is as follows: Tony — is schedule too tight?

1	February 1982	Publish the Draft EIS Notice of Availability in the Federal Register
15	March 1983	Award contract(s) for storage lagoon and dredging activities
15	May 1983	Award contract and begin North Ditch bypass work
1	September 1983	Lagoon construction completed and tested
1	October 1983	Start dredging activities for Plan 1 (Slip #3)
1	November 1983	Storage lagoon covered for winter
1	March 1984	Install treatment plant next to storage lagoon
1	April 1984	Resume North Ditch bypass construction
15	April 1984	Initiate dredging Plan 2; and return to redredge any resettled contamination (over 50 ppm) in the Plan 1 area
15	June 1984	Begin transport of sediments from the lagoon to the landfill
1	November 1984	Complete North Ditch bypass work
15	October 1984	Begin to remove contaminated underdrain system of lagoon and transport to the landfill

* need to indicate further data gathering in parking lot area

what about excavation of oil lagoon and current ditch?

1 October 1985 Lagoon construction site closed and restored.

2.5. Summary of Alternatives

Based on the preceding discussions regarding feasible conceptual alternatives for the abatement of PCB contamination and the various component options associated with the selected alternatives, five total project area alternatives have been developed for further evaluation. These alternatives encompass the Waukegan Harbor and North Ditch Drainage System abatement action recommendations. A brief discussion of these alternatives follows and is summarized in Figure 2-8.

2.5.1. Alternative #1 - No Action

This alternative essentially represents the option of taking no action regarding the PCB contamination problem in Waukegan Harbor and the North Ditch site. As discussed in Section 2.1., this alternative would not resolve the problem but would simply maintain the existing conditions.

2.5.2. Alternative #2 - Dredging and Disposal of Waukegan Harbor Sediments

This alternative requires the dredging of PCB contaminants from Waukegan Harbor as per the recommendations of Plan 1 and Plan 2 (TABLE 2-1), with ultimate disposal in a landfill after dewatering is completed. The components associated with this alternative are:

- Construction of the dewatering lagoon and treatment plant;
- Dredging of the Harbor in phases;
- Operation of dewatering and treatment plant facilities during the second phase of dredging;
- Excavation of the contents of the lagoon;
- Transportation of sediments and underdrain system to an ultimate disposal site; and
- Operation and maintenance of the ultimate disposal site(s).

Not part of our project

	Waukegan Harbor Sediment Removal Components					North Ditch Bypass Components			Crescent and Lagoon Excavation Components			Parking Lot Components			Components Common to All Alternatives	
	Dewatering Lagoon Construction	Diversion of Water	Harbor Dredging	Operation of Dewatering Lagoon	Excavation of Dewatering Lagoon Contents	Excavation of Ditch	Dewatering of Ditch and Treatment of Water	Installment of Storm Sewer and Filling	Construction of Slurry Wall	Dewatering of Lagoon and Treatment of Water	Excavation of Crescent and Oval Lagoons	Dewatering of Well	Construction of Slurry Wall	Excavation of Parking Lot	Transport of PCB-contaminated Materials	Operation and Maintenance of Ultimate Disposal Site
Alternative #1																
Alternative #2	*	*	*	*	*										*	*
Alternative #3	*	*	*	*	*	*	*	*							*	*
* Alternative #4	*	*	*	*	*	*	*	*	*	*	*				*	*
Alternative #5	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Figure 2-8. Summary of project alternatives for the removal of PCB-contaminated materials from the project area.

Under this alternative, no diversions, bypasses, excavation, or other construction activities are proposed for the North Ditch or Parking Lot.

2.5.3. Alternative #3 - Dredging and Disposal of Waukegan Harbor Sediments and Construction of the North Ditch Drainage System Stormwater Diversion

This alternative includes all of the aspects and components of Alternative #2 regarding Waukegan Harbor, and also includes the construction of the North Ditch Drainage System Bypass (an underground storm sewer). This storm sewer would intercept the existing storm sewer that now brings North Ditch surface waters to the Crescent Lagoon and would carry this water all the way to Lake Michigan. Other cooling water discharges from OMC also would be diverted from the North Ditch to the same storm sewer. The construction of the storm sewer would proceed in phases along with the excavation, and would include the following components:

- Excavate PCB contaminated material from a trench along the North Ditch (approximately 7,000 yds^3);
- Dewater trench and treat contaminated water (if necessary);
- Install storm sewer in ditch and backfill with clean materials;
- Transport 7,000 yds^3 of PCB-contaminated material directly to an ultimate disposal site(s); and
- [Operation and maintenance of the ultimate disposal site(s).]

No other activity is proposed for the North Ditch under this alternative. Depending on scheduling, the transport and ultimate disposal of PCB contaminated material from the North Ditch and the storage lagoon may be done simultaneously.

2.5.4. Alternative #4 - Dredging and Disposal of Waukegan Harbor Sediments, Construction of the North Ditch Drainage System Stormwater Diversion, and Excavation of the Crescent and Oval Lagoons

This alternative includes all of the aspects and components of Alternative #3 regarding Waukegan Harbor and the North Ditch Drainage System, and also requires the excavation of the Crescent and Oval Lagoons to remove PCB-

some areas contaminated as high as 400 ppm

contaminated soils. This alternative would include the following additional components:

- Construction of a slurry wall around the Crescent and Oval Lagoons;
- Dewatering of the Crescent and Oval Lagoons with a wellpoint system;
- Treatment of contaminated well water;
- Excavation of dewatered, PCB-contaminated soils;
- Direct transport and/or placement into treatment lagoon of PCB-contaminated soils to an ultimate disposal site(s); and
- Operation and maintenance of the ultimate disposal site(s).

out

As with the other alternatives, the transport and disposal of PCB-contaminated materials may be accomplished simultaneously for the storage lagoon contents, the North Ditch Bypass soils, and the Crescent and Oval Lagoon soils, if the schedule permits.*

2.5.5. Alternative #5 - Dredging and Disposal of Waukegan Harbor Sediments, Construction of the North Ditch Drainage System Stormwater Diversion, Excavation of the Crescent and Oval Lagoons, and Removal of Contaminated Soils from the Parking Lot

This alternative includes all of the aspects and components of Alternative #4 regarding Waukegan Harbor and the North Ditch Drainage System, It requires the removal of between 40,000 and 131,000 yd^3 of PCB-contaminated soil from the Parking Lot portion of the North Ditch Drainage System and from beneath the Cresent and Oval Lagoon portions. Because the exact extent of PCB contamination in the Parking Lot has not yet been determined, the total magnitude of the required excavation also is uncertain. However, this alternative would involve the following components regardless of the volume of Parking Lot material to be excavated:

- Dewatering soils via a wellpoint system;
- Construction of slurry wall (if excavation below 15 feet);

- Excavation of contaminated soils (from 40,000 to 131,000 yd^3)
- Transportation of an unknown volume of PCB-contaminated soils to an ultimate disposal site(s); and
- Operation and maintenance of the ultimate disposal site(s).

The transport and disposal of PCB-contaminated materials could be accomplished simultaneously for all or some aspects of this alternative, if schedules permit. In addition, the volume of material to be transported would vary greatly depending upon the magnitude of PCB contamination found in the Parking Lot.

Based on the first level of review and screening (Sections 2.1. and 2.2.), it is recommended that the project be developed, planned, and engineered using the conceptual alternative listed here. It is recommended that PCB contaminated materials be removed from Waukegan Harbor by an appropriate dredging technique and by pass and excavation. This technology requires the use of a temporary, on-site dewatering facility for dredge spoils and the development of a final disposal method.

A Harbor dredging program has been proposed by Mason & Hanger Engineers (USEPA 1981). Dredging options include carrying out the project in three phases: dredging and excavation of Slip #3 (Plan 1); dredging of the Harbor area containing greater than 50 ppm PCBs (Plan 2); and dredging of the Harbor areas containing greater than 10 ppm PCBs (Plan 3). Engineering plans have been completed for all three dredging areas delineated on the project map.

This is not the way to sell EA

- Basis for dredging is amount of removal and fish flesh levels -

Water quality and bioaccumulation models of PCB movement in the Waukegan area indicate that the incremental public health benefits that would be achieved by implementation of Plan 3 are considerably less than those that would be achieved through implementation of Plan 1 and Plan 2 (USEPA 1981). There is a large volume of sediments in the Plan 3 area with relatively low PCB content. Consequently a significant amount of the project schedule and funds would be required to clean up the small amount of widely dispersed-PCB contaminated sediments in the central Harbor area.

somewhere earlier we should say in one sentance alternative 4, plan 1, plan 2, etc. - refer plans to level of removal in ppm's

It is recommended that dredging of contaminated Harbor sediments be conducted over two phases whereby the most contaminated materials are dredged first. That is, Plan 1 should be implemented first, followed by Plan 2. Under this two-phase approach, maximum benefit to public health would be achieved. Any contaminated materials transferred out of the Plan 1 area during dredging would be removed during the Plan 2 implementation.

The construction of a sediment dewatering facility is a necessary element of the project regardless of the extent of dredging. This facility must be constructed and completed prior to the initiation of the dredging program and must contain a water treatment facility. Thus, site clearing and preparation must begin at the earliest possible time. The construction of the dredge spoils dewatering facility (lagoon) is a critical first step in the Waukegan Harbor PCB cleanup schedule. The following chapter discusses the recommended design of the lagoon and treatment facilities and the potential environmental impacts associated with their construction and use.

— Bypass, etc.

— excavation of current ditch and oval lagoon materials

50 cont'd

3.0. AFFECTED ENVIRONMENT

The affected environment consists of the natural and man-made resources of the Waukegan Coastal Zone and the sites which are under consideration for disposition of the PCB-contaminated materials from Waukegan Harbor and the North Ditch. For the purposes of this EIS, Waukegan Harbor is broadly defined as the area encompassing both Waukegan Harbor and the nearshore zone of Lake Michigan along northern Illinois. Four of the identified ultimate disposal sites are located in Illinois, three of which are in Lake County. The two remaining sites are fully licensed facilities located in Ohio and New York.

3.1. Natural Environment

The natural environment includes the resources of the project area that exist independently of man, although their present conditions may reflect past or present human activities. The aspects considered in this report include climate, air resources, and noise levels; topography, geology, and soils; groundwater and surface water resources; and terrestrial and aquatic biota.

3.1.1. Climate of the Waukegan Coastal Zone

The climate of Waukegan is predominantly continental and is similar to that of Chicago. However, the presence of the Great Lakes, especially Lake Michigan, has a moderating effect on climatic conditions. The passage of cold and warm air masses over the Lakes helps to moderate extreme temperatures. Cold winter temperatures usually occur when cold air masses from the north reach the area without passing over Lake Superior. Conversely, extreme summer temperatures are caused by southerly and southwesterly winds that are not influenced by the Lakes. Local lake breezes help to cool the high summer temperatures, but may not be able to cool a strong southerly wind. However, an effective lake breeze will cause daytime summer lakefront temperatures to be 10°F or more cooler than inland temperatures. The areal extent of this cooling action varies, depending on the strength of the lake breeze (NOAA 1980). In 1980, the average summer temperature was 72.2°F and the average winter temperature was 24.3°F (Appendix F).

Hot and humid conditions may persist for several days in the summer, but these conditions can change if winds shift to a northerly direction. High humidities also may occur when winds blow off the Lake, but temperatures tend to be cooler and more comfortable under these circumstances (NOAA 1980).

Although precipitation in the project area is produced primarily by warm moist air masses that pass over the Gulf of Mexico, Lake Michigan often is the source of moisture for heavy winter snowfalls. Thunderstorms which occur in the summer usually are heavy and variable (NOAA 1980).

The predominant winds are from the west-northwest and are stronger along the lakefront. Wind speeds in Chicago in 1980 averaged 9.9 mph. Average wind speeds were higher in the winter months (10.7 mph) than in the summer months (8.0 mph).

3.1.2. Air Quality of the Waukegan Coastal Zone

Waukegan, Illinois is located in Air Quality Control Region (AQCR) #67, the Metro Chicago Interstate AQCR. The air quality of this AQCR is determined on the basis of the National Ambient Air Quality Standards (NAAQS) set forth in the Clean Air Act of 1970. These standards and the Illinois Ambient Air Quality Standards are presented in Appendix F. The Federal and State standards are identical with the exception of standards for ozone (O_3) and lead (Pb).

Illinois Env. Pro. Ag.

Air quality is monitored at Waukegan by the (IEPA.) When the measured concentration of a pollutant in a particular area does not exceed the primary standard or the secondary standard, the area is designated as an attainment area for that pollutant. Waukegan is an attainment area for nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). IEPA is currently conducting a study on the entire Chicago Metro area (including Waukegan) to determine if any areas should be reclassified for SO_2. The results of the study will be available in late 1981. Until that time, the present classifications for SO_2 remain in effect. Lake County is classified as a nonattainment area for the secondary standard for total suspended particulates (TSP) and as a nonattainment area for O_3 (for which no secondary standard has been set). Waukegan is unclassi-

fied for carbon monoxide (CO) because no monitoring data are available. However, IEPA believes that CO concentrations at Waukegan violate the standards for this pollutant and has recommended further study of CO concentrations in that area (By telephone, Jim Maloney, IEPA, to WAPORA, Inc., 25 June 1981).

3.1.3. Noise Levels in the Waukegan Harbor Vicinity

Several industries are located in the Harbor area (Section 3.2.1.1.) and noise generated by industrial operations may be expected near and around the Harbor. The majority of this noise can be attributed to transportation-related activities (truck hauling, barge traffic, and railroads). The strict enforcement of the 5-knot speed limit in the Harbor is effective in reducing noise levels attributable to barge traffic. It also minimizes noise generated by recreational boats. Some railroad noise may also be expected from the two lines that run along the western border of the Harbor (Section 3.2.3.3.).

3.1.4. Topography and Geology

3.1.4.1. Waukegan Coastal Zone

<u>Topography</u>

Lake County is located in the Wheaton Morainal part of the Great Lakes section of the Central Lowland province (US Soil Conservation Service [SCS] 1970). A narrow strip of land approximately 2.0 to 3.0 miles wide along the eastern edge of the County, in which much of the the City of Waukegan is located, drains into Lake Michigan. The majority of the remaining land area drains into the Des Plaines River or into the Fox River in the western part of the County.

The elevations in the project area are less than 600 feet above mean sea level (msl) and the entire harbor area east of Pershing Road is slightly less than 590 feet msl (USGS 1966). The area immediately surrounding Waukegan Harbor is relatively flat and has a slight slope to the east toward Lake Michigan.

The coastal water and Harbor water are designated as within Zone A2 of the flood hazard boundary map prepared for the city of Waukegan by the Federal Insurance Administration of the US Department of Housing and Urban Development (1976). This designation indicates that there is a 2-foot elevation difference between the land areas that would be affected by the 10-year flood and the 100-year flood. The highest elevation reached during the 10-year flood is 582 feet msl and the highest elevation reached during the 100-year flood is 584 feet msl. The land immediately surrounding Waukegan Harbor is within Zone C, a designation which indicates an area of minimal flooding (above the 100-year flood).

Geology

till or silurian?

The shore of Lake Michigan is underlain by dolomite of middle Silurian age and glacial deposits of the Wadsworth Till Member of the Wedron Formation, which has been assigned an age of approximately 13,000 years before present (B.P.) on the basis of radiocarbon dating. The Wadsworth Till makes up the Zion City Moraine, which at Waukegan forms a prominent bluff approximately 50 feet above lake level. The Wadsworth Till is a gray silty clay till with a clay content of approximately 40% (Wickham et al. 1978).

The action of wind and water processes on these materials along the shore of the Lake in the vicinity of Waukegan has resulted in the development of beach and shore features that are related to recent and present limnological conditions. From Waukegan north about 14 miles to Kenosha, the shore is fronted by the Zion Beach Ridge Complex which forms a sandy plain about one mile wide. The beach features on this plain range in age from about 3,500 years at the north end to modern at the south end. ?

I thought it was provisional ?

The predominant littoral currents produce a southward sediment drift along the shore. In the Waukegan Harbor area, this phenomenon has resulted in the accumulation of a wide belt of storm- and winter wind-deposited sand ridges and intervals. Near the Commonwealth Edison Co. coal-fired generating station approximately one mile north of the Harbor, the shoreline is actively accreting and expanding toward Lake Michigan. Since 1970, approximately 50,000 cubic yards of material have accumulated in this area. The large volumes of southward drifting sediments have been deposited in the vicinity of

the Harbor as a result of the construction of jetties. Yearly maintenance dredging is necessary in these areas to remove material from the navigational channels. The shore in the vicinity of the proposed lagoon site is relatively stable because the amounts of sediment deposited and removed through these processes are approximately equal. Between the Commonwealth Edison Co. pier and Waukegan Harbor, the shore is maintained in the form of broad beaches and foreshores of low gradients. The Waukegan outer harbor jetty also acts to retain and stabilize this material (Collinson et al. 1974). These shoreline deposits are unconformable upon the underlying till deposits and typically are 25 to 30 feet thick (Hester and Fraser 1973).

Based on the results of soil borings obtained in the area of the spoil disposal confinement structures, sandy clay and clay of relatively high resistance are present to depths of 45 feet below lake level (Westerhoff and Novick, Inc. 1974). Modern sediments derived from fluvial deposits along the east shore of Lake Michigan are being deposited offshore from the area in which the borings were made. This material, the Waukegan Member of the Lake Michigan Formation, occurs in thicknesses up to 60 feet (Wickham et al. 1978).

In summary, an examination of the geology of the shoreline in the vicinity of the project area indicates that accretion rather than erosion is occurring and that erosion of the shore and/or the engineered facilities will not be a problem during the project period. Furthermore, the surficial sandy soils are underlain at shallow depths by clayey strata of great lateral extent.

3.1.4.2. Ultimate Disposal Sites

Browning-Ferris Industries, Inc. Site, Lake County IL

The topography in the vicinity of the site varies from nearly flat to gently rolling. Elevations typically range between 760 feet and 590 feet msl and the ground surface slopes eastward toward Lake Michigan. The variation in relief at the site is approximately 30 feet, from about 755 feet msl in the northern portion of the site to about 725 msl in the southwestern corner.

where WDCFR 761?

Thus the site generally meets the USEPA requirement of low to moderate relief. The area is underlain by a series of glacial tills with a total thickness of at least 200 feet. The tills are underlain by Silurian dolomite bedrock.

New Site, Option 1, Lake County IL

This site is located on relatively flat land east of Druce Lake, which contains some marshy areas. Elevations vary from 760 feet to 771 feet msl. There is a slight gradation and the land appears to slope toward the west. Based on the flatness and apparent marshiness of the area, it is likely that surface runoff is low and that much of the precipitation that falls on the area is retained there or percolates into the groundwater.

New Site, Option 2, Lake County IL

This site is located on the west slope of a north-south oriented topographic high located immediately east of the Des Plaines River. The elevations at this site vary from 744 feet to 750 feet msl at the northern part of the site and from 700 feet to 730 feet msl in the southern part. The site slopes toward the Des Plaines River. The estimated maximum slope of the site is approximately 2%. It is likely that the surface water drainage would diffusely follow this slope to the Des Plaines River.

Chemical Waste Management Co. Site, Calumet City IL

The proposed disposal area at the Calumet City site is located in the floodplain of the Little Calumet River directly south of Lake Calumet. The area immediately surrounding the site (out of the floodplain) is at an elevation of 585 feet msl. The site is assumed to be flat, without any general slope except for local depressions or inequalities in grade.

CECOS International (CERN) Site, Williamsburg OH

The topographic relief at the site is about 35 feet. Elevations range from about 879 feet msl adjacent to Pleasant Run Creek in the southwestern part to about 913 feet msl in the northeastern part. Both the currently used

areas and the proposed disposal areas are located in a relatively flat part of the site and meet the USEPA requirement of low to moderate relief.

SCA Chemical Waste Services, Inc. Site, Model City NY

not even from Region II or NYDEC?

No topographic or geologic data are available for this site at this time.

3.1.5. Soils

This should be used as argument against in-place, on-site encapsulation. good point!!

3.1.5.1. Waukegan Harbor Vicinity

The entire Waukegan Harbor area is made land (SCS 1970). Thus the substrate material likely is a mixture of spoil, building rubble, and beach sand. Prior to filling, the area was a combination of wet marsh soils and beach sands. Present soil characteristics are a function of man-made deposits and naturally deposited beach sands.

3.1.5.2. Ultimate Disposal Sites

Browning-Ferris Industries, Inc. Site, Lake County IL

Based on soil borings from the site (Warzyn Engineering 1980), approximately 0.5 feet to 1 foot of dark, silty/clayey topsoil is underlain by about 5 feet of moderately plastic, silty clay (CL-CH). This clay is underlain by a brown to gray, low plasticity silty clay (CL) to a depth of at least 50 feet to 70 feet below ground surface (687 feet msl). Interlayers of silt (ML), clayey silt (ML-CL), and silty and clayey sand (SM-SC) up to 3 feet thick occur in the clay soils. It appears that a continuous layer of silt and sand extends from the eastern border of the existing site and lies under the adjacent 74-acre site to the east. This layer ranges in thickness from 2 feet to 15 feet and is located at a depth of from 40 feet to 60 feet below the surface (690 feet to 718 feet msl).

Constant head permeability tests were performed on eight samples of the clay taken at the site at depths ranging from 20 feet to 42 feet. The values obtained ranged from 1.9×10^{-6} to 1.1×10^{-8} centimeters per second (cm/sec),

with an average of 4.3×10^{-7} cm/sec. Falling head permeability tests were made on eight samples taken at depths from 20 feet to 32 feet. The results of those tests ranged from 1×10^{-10} to 6×10^{-9} cm/sec, with an average of 2.4×10^{-8} cm/sec. The cation exchange capacities of the clays are low (approximately 3 to 6 milliequivalents per 100 grams (meq/100 g)).

The soils generally meet the thickness requirements of USEPA (4 feet) and IEPA (10 feet). The soils generally meet the USEPA soil permeability requirement (1×10^{-7} cm/sec), but only marginally meet the IEPA requirement (1×10^{-8} cm/sec). Recompaction of the clay soils could lower the permeability to 10^{-8} cm/sec or less. The liquid limit and plasticity index were not measured, although these measurements are required by USEPA criteria. All samples of the silty clay tested exceed the USEPA criterion for particle size finer than 200 mesh screen (P200) (greater than 30%).

The soils present on the current site and on the expansion area generally are silt loam soils overlying calcareous loam and silt loam glacial till (SCS 1970). The characteristics of these soils are given in Appendix E.

The proportion of fine material in each particle size range in a soil is estimated by the percentage of material of that particle size range in a sample of the soil that can pass through a series of sieves with progressively finer meshes. For two of the soils at the site, 55-75% of the materials in the 30- to 60-inch depth can pass through a No. 200 sieve. The ranges of percentage of material passing a No. 200 sieve for two other soils at the site are 50-75% and 30-75%, respectively.

The other five soils have ranges of 80-100% for material in the 30- to 60-inch depth. The suitability of the site for a secure landfill would depend primarily on the amount of finer textured material deeper in the profile and on engineered solutions to the presence of coarser-textured soil materials. The site generally meets the USEPA requirements regarding PCB disposal with respect to clay soil thickness (4 feet), soil permeability (1×10^{-7} cm/sec), and P200 content (greater than 30%). Similarly, the site also meets the IEPA soil thickness requirement of 10 feet. However, the results of soil permeability tests indicate that the soils only marginally meet the IEPA permeability

requirement of 1×10^{-8} cm/sec for hazardous waste sites. Engineering modifications, such as recompacting the base grades and side walls of the site or the use of synthetic liners, apparently are acceptable in place of the required soil permeability conditions.

New Site, Option 1, Lake County IL

The preferred portion of the site has Frankfort, Montgomery, and Nappanee soils (SCS 1970). The Frankfort and Nappanee soils were formed in thin windblown silt (about 8 inches thick) overlying silty clay glacial till. The Montgomery soil was formed in clayey lacustrine or glacial till. The Frankfort soil is level to gently sloping and somewhat poorly drained. The Montgomery soil is level to depressional and poorly drained to very poorly drained. The Nappanee soil is level to gently sloping and somewhat poorly drained. Information concerning these soils is presented in Appendix E.

New Site, Option 2, Lake County IL

The preferred portion of the site contains Montgomery and Nappanee Soils (US Soil Conservation Service 1970). The Aptakisic and Nappanee complex and the Zurich and Nappanee complex also have been identified in the area. The Frankfort and Nappanee soils were formed in thin windblown silt (approximately 8 inches thick) overlying silty clay glacial till. The Montgomery soil is level to depressional and poorly drained. The Nappanee soil is level to gently sloping and somewhat poorly drained. Additional information on these soils is presented in Appendix E.

Chemical Waste Management Co. Site, Calumet City IL

Detailed soil sheets have not been prepared for the area in the vicinity of the landfills. However, a generalized soil map has been prepared by the Soil Conservation Service (1979). The general soils of the site are the Urban land-Milford association on the western portion of the site and the Urban land-Selma-Oakville association on the eastern portion of the landfill site. In both associations, the urban land is severely disturbed and is covered with structures and paving.

The Urban land-Milford association is described as built-up areas and deep, nearly level, poorly drained soils that have a silty and clayey subsoil; these soils formed in glacial lake sediment. The majority of the soils in this association are naturally poorly drained and have a high water table. Clay content is high throughout the soil profile.

The Urban land-Selma-Oakville association is characterized as built-up areas and deep, level to undulating, well drained and poorly drained soils that have a loamy, silty, or sandy subsoil; these soils formed in glacial outwash and in glacial lake sediment. In areas where severe soil disturbance has not yet occurred, the soils are about evenly divided between poorly drained soils and well drained soils. The soil texture varies from loamy to sandy with interbedded layers of silt and fine sand.

The natural soils on the site may have been severely disturbed during construction of a nearby barge canal, during disposal of dredge spoils, or while removing borrow for the existing landfills. Site-specific soil borings and testing would be necessary before even tentative conclusions could be drawn on the characteristics of the soil material at the site.

CECOS International (CERN) Site, Williamsburg OH

The soils on the site consist of about 6 to 8 feet of a gray brown silty clay (CL) underlain by about 40 feet of a gray brown sandy clay till (SC, SC-SM). In the western portion of the site, discontinuous sand seams are present about 25 to 30 feet below grade. The eastern portion of the site contains a continuous sand seam approximately 5 feet thick. This seam extends over a 20-acre area where the new secured landfill cells are to be developed (Warzyn Engineering 1980). Based on the results of soil tests, the silty clay and clay till soils on the site generally have permeabilities less than 1×10^{-7} cm/sec. The average properties of the soil materials are:

	Surficial Silty Clay	Clay Till
Percent finer than 200 mesh screen	70%	30-59%
Liquid limit	30%	15-20%
Plasticity index	20%	5-7%

The permeability of tne sand and gravel, based on grain size, is within the range of 10^{-2} to 10^{-5} cm/sec.

The surficial silty clay and clay soils meet the requirements for permeability, particle size finer than 200 mesh screen, liquid limit, and plasticity index of the USEPA and conditionally meet those of the Ohio Environmental Protection Agency (OEPA). The underlying clay soils meet the requirements of USEPA for permeability and particle size finer than 200 mesh screen, but not for liquid limit and plasticity index. The clayey soil material meets the thickness requirements of USEPA (4 feet) and OEPA (25 feet).

The portion of the site containing waste storage cells has Clermont, Avonburg, and Rossmoyne soils (SCS 1975). These soils were formed in a silt mantle 18 to 40 inches thick overlying a weathered glacial till. The Clermont soil is nearly level and poorly drained. The Avonburg soil is nearly level to gently sloping and somewhat poorly drained. The Rossmoyne soil is nearly level to sloping and moderately well drained. Information concerning these soils is presented in Appendix E.

SCA Chemical Waste Services, Inc. Site, Model City NY

No information is available for this site at this time. ? hmm

3.1.6. Groundwater Resources

3.1.6.1. Waukegan Coastal Zone

The sand and gravel associated with glacial drift deposits in the vicinity of Waukegan and the Silurian dolomite in which they are located comprise the shallow groundwater system. Rainfall provides local recharge to this system and indirectly to deeper aquifers. In the Waukegan area, the next

important aquifer below the dolomite is the St. Peter Sandstone, the top of which is approximately 780 feet beneath the surface. In this part of Lake County, large quantities of good quality water occur mainly at considerable depths.

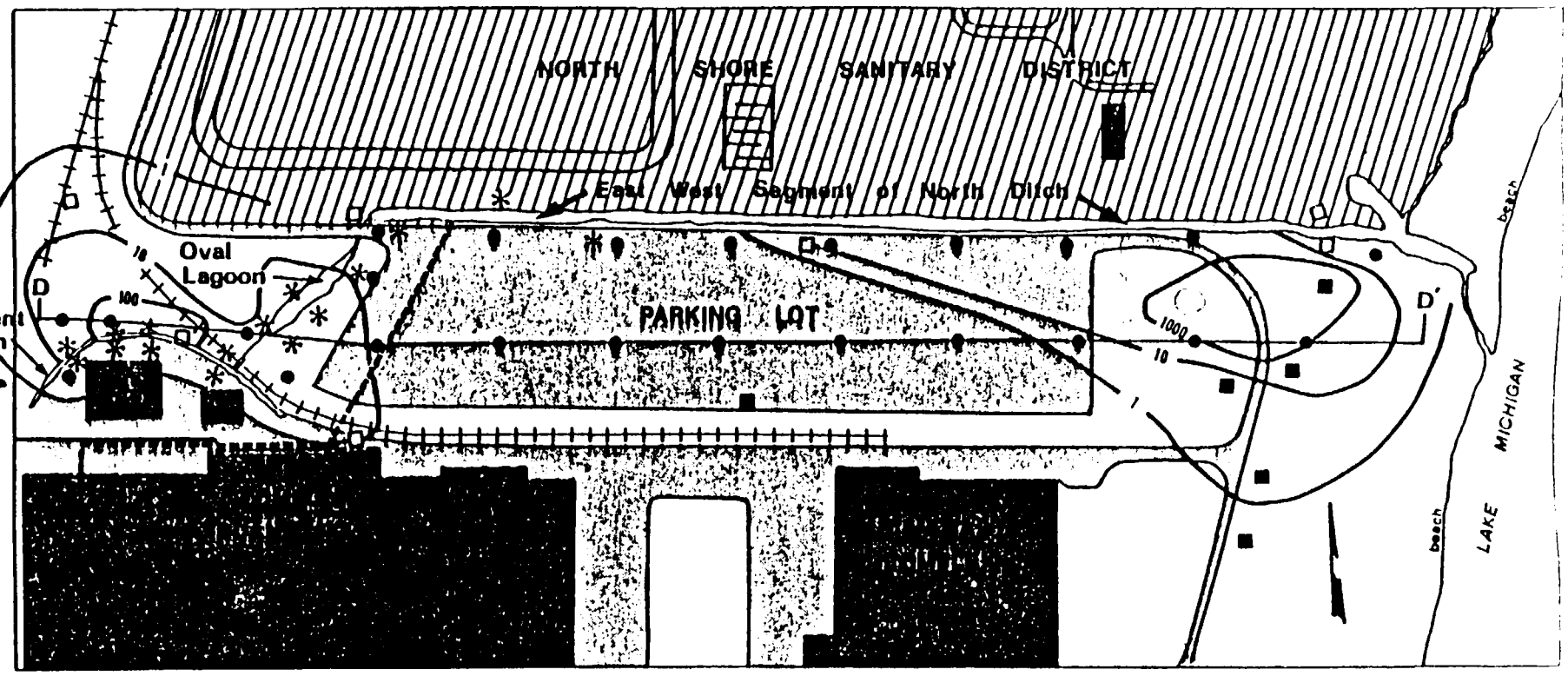
Sand and gravel deposits form the main aquifers in the shallow glacial drift. The distribution of these bodies is erratic and discontinuous, reflecting the nature of the glacial and periglacial water bodies in which they were deposited. The glacial till deposits slope gently toward Lake Michigan. A typical cross section of the beach ridge complex that makes up the Waukegan shore would show shallow sand and/or gravel aquifers approximately 10 to 15 feet thick at depths to 75 or 100 feet. In the Waukegan area, these aquifers are not exceptionally productive. The water of Lake Michigan does not recharge the subsurface aquifers.

A study of the hydrogeologic conditions in the vicinity of the North Ditch Drainage System was carried out by JRB Associates, Inc., from July 1979 through June 1980 (USEPA 1981). A total of 66 borings were drilled in the area, 22 of which were completed as groundwater monitoring wells. Among the monitoring wells, four groups of three were completed as piezometers (Figure 3-1).

Field investigations included water table observations, soil evaluations, and baildown tests performed at the site. Water levels observed in the piezometer wells were used to establish potentiometric surfaces and gradients which were depicted as a series of cross sections of the North Ditch area. Rates and directions of flow and data on the distribution of PCBs were used as input parameters in computations to assess the future movements and dispersion of PCBs in the groundwater of that area (Section 1.2.2.).

These computations were based upon observations of water table levels and groundwater movement made over two periods of approximately one month each, in 1979 and 1980. The determination of equipotential surfaces was based upon piezometer observations made approximately biweekly over a two-month period in 1979 and six times during a one-month period in 1980. Levels were recorded to within 0.01 feet.

high conc. of @ 400K ppm



----- Existing Storm Sewer

● Bore Holes

✱ Cores

□ Old Wells

■ New Wells

—— Isopleth of PCB Contamination

Figure 3-1. Sampling sites for hydrological evaluations and PCB concentrations. Isopleths represent areal distribution of PCBs (ug/g) associated with the soils of the sand aquifer. Concentrations of PCBs were determined by taking the arithmetic mean of PCB concentrations found over the entire length of a bore hole within the confines of the aquifer. (Derived from JRB Associates, Report to USEPA 1980.)

Should be in summary

The results of this investigation indicated that the contamination in the North Ditch and Parking Lot area is contained by a water table aquifer composed of sand and gravel. The water table aquifer is underlain by an aquitard and is hydraulically connected with the water of Lake Michigan. Water movement in the aquifer is influenced by water levels in Lake Michigan and by stormwater in the North Ditch. The North Ditch Drainage System is connected to the Lake. When the water level in the Ditch is relatively low, groundwater moves toward the Ditch in both a horizontal and vertical (upward) direction. When water in the Ditch is relatively high, recharge to the aquifer occurs at shallow soil depths. At greater depths, water passes under the Ditch with a slow lakeward component of movement. Following any rapid rises of the water level in the Ditch associated with storm water, the velocity of the lakeward groundwater flow increases.

In the general vicinity of Waukegan, water from the Silurian dolomite is reported to contain hydrogen sulfide in quantities sufficient to impair its quality for domestic use. The City of Waukegan obtains its water supply from Lake Michigan; thus little demand is placed on the shallow groundwater of the area (Larsen 1973).

3.1.6.2. Ultimate Disposal Sites

Browning-Ferris Industries, Inc. Site, Lake County IL

Groundwater typically is present from 5 to 20 feet below the surface of the ground in the vicinity of this site. The general direction of groundwater flow in the region is eastward toward Lake Michigan in the dolomite aquifer and at a depth within the glacial till formation. Locally, however, groundwater flow may be westward toward the Des Plaines River or its tributary or eastward toward Lake Michigan. The area is somewhat poorly drained and occasional marshy areas occur, particularly near Lake Michigan.

Groundwater is reported to exist between 11 feet and 17 feet below ground surface at the existing site and at 6.5 feet to greater than 12 feet below the surface at the proposed site. The groundwater flow direction was not reported for these sites, although this movement is likely to be in a southerly direc-

tion. The site is not located in a flood-prone area nor is it within the 100-year floodplain of any surface water body.

The site occupies a locally high topographic area and is surrounded by potential discharge points: the Des Plaines River to the west; lowlands to the south, and Lake Michigan to the east. Because of the thick sequence of clay at the site, the recharge characteristics are probably minimal. Locally, drinking water is obtained primarily from the dolomite bedrock aquifer. At least two private residences with deep wells are located along 9th Street at the southern boundary of the site. Several other residences located within 500 feet of the site boundary along 9th Street also may have private well water supplies.

New Site, Option 1, Lake County IL

This site is underlain by glacially deposited till of the Wadsworth Member of the Waldron Formation of Woodfordian age. The surface lithology is characterized by Larsen (1973) as yellow-brown to gray-brown pebbly silt with local areas of clayey silt. The aquifer performance of this material is classified as poor (Larsen 1973). The till in the vicinity of the site is approximately 250 feet thick and lies directly over the dolomite of Silurian age. The dolomite in this area forms an aquifer of good to excellent quality. The water from this aquifer in the general area of the site has been reported to contain hydrogen sulfide in quantities that impair its acceptability for domestic use.

New Site, Option 2, Lake County IL

The site is situated on till of the Wadsworth Member of the Waldron Formation of Woodfordian age. According to a map prepared by Larsen (1973), the substrate in the northern half of the site is yellow to brown to gray, pebbly silty clay till while the substrate in the southern half is brown to gray pebbly clay, with local lacustrine beds.

Approximately 100 feet of till overlie nearly 40 feet of sand and gravel. The sand and gravel beds are underlain by dolomite of Silurian age that is approximately 150 feet thick. Larsen (1973) described the aquifer

properties of the sand and gravel beds as fair to poor and the aquifer properties of the dolomite as good to excellent. The sand and gravel and the dolomite together form a shallow aquifer system. It has been reported that local areas in the general vicinity of the site contain concentrations of hydrogen sulfide that preclude domestic use of the water.

Chemical Waste Management Co. Site, Calumet City IL

This site is located on the lake plain of ancient Lake Chicago. It is underlain by well-bedded deposits of silt and silty clay with local thin beds of clay and lenses of sand and gravel. The shallow aquifer system lies very close to the surface at the site, which is located within the floodplain of the Calumet River. The elevation of the water table in the area coincides with or is slightly higher than the elevation of the water in the River and in nearby Lake Calumet. The shallow aquifer system is recharged by seepage from precipitation at the surface.

CECOS International (CERN) Site, Williamsburg OH

The groundwater generally is within 2 feet of the surface in the northern portion of the site. The depth to groundwater varies from about 2 feet to 20 feet in the southern portion of the site and from 2 feet to 7 feet in the western area. This condition does not meet the OEPA requirement of 5 feet below the ground surface in certain areas.

The groundwater flows generally in a southerly direction toward the East Branch and southwestward toward Pleasant Run Creek, both of which are local discharge points. Based on water level measurements taken from nested wells in the western and northeastern portions of the site, the vertical hydraulic gradients generally are slightly upward, but are seasonally downward during recharge events. In the northern portion of the site, the vertical hydraulic gradients are steeply downward in the vicinity of the pumped wells in response to the pumping. There seems to be little hydraulic connection between the groundwater flow systems in the soils and in the underlying bedrock, although there appears to be good hydraulic connection within the bedrock formation.

It appears that six residences exist at the western boundary of the site, that these residences have private wells, and that they are now owned by CECOS.

SCA Chemical Waste Services, Inc. Site, Model City NY

No information is available for this site at this time.

3.1.7. Surface Water Resources

3.1.7.1. Waukegan Coastal Zone

Water Movement

In the nearshore zone of the Lake, the most important phenomena of water movement are surface waves, longshore currents, seiches, and surges. The highest waves, fastest longshore currents, and most sudden changes in water levels (surges and seiches) that could suspend and transport PCB contamination are associated with storm winds (NOAA 1976). Water movement phenomena such as seiches and surges that transport PCB contamination out of Waukegan Harbor are dealt with at length in the model of PCB movement (USEPA 1981; Section 1.2.2.). Nearshore zone water movement outside the Harbor may result in the greatest dispersion of PCBs and hence can bring about the most widespread impacts on the biota of Lake Michigan (Section 1.2.2.). Thus coastal, longshore water movement is emphasized in this section.

Characteristics of water movement are unique in terms of magnitude, direction, and frequency for the littoral or "beach" zone and for the broader band of water (5 miles wide) defined as the nearshore zone. Generalities in regard to direction and magnitude of nearshore currents do not necessarily apply at all times to littoral currents (NOAA 1976). The primary impact of waves on the littoral zone around the Harbor can be described in terms of incoming wave height, period, velocity, and direction. The secondary impact of strong winds piling up waves against a shoreline can be described in terms of locally strong induced currents moving parallel to the shoreline in the littoral zone as water level equilibrium is re-established (NOAA 1976).

Only limited wind and wave data are available for Lake Michigan and for the Harbor area. However, wave hindcast techniques have been used to synthesize the appropriate site-specific wave data for use in design and assessment of riparian structures (Resio and Vincent 1976). A table of extreme wave return interval information (Appendix G) was derived by the use of hindcast techniques. This table is the basis of the following description of the probable littoral zone wave conditions likely to exist at Waukegan.

A line drawn normal (perpendicular) to the Lake Michigan shoreline at Waukegan is oriented at approximately 300° Azimuth. Therefore, waves incident from the normal will be arriving from the east-southeast (ESE) as the observer stands at the Harbor looking lakeward. Incident waves arriving from the east will be running parallel to the Harbor entrance walls at Waukegan. The data in Table 3-1, which were derived from the design wave information presented in Appendix G, show that wave heights are greatest in winter and that waves from the east generally are higher than ESE waves. The greatest wave impacts on water movement close to Waukegan Harbor occur during the winter months. Extreme events, such as storm-generated waves in excess of 20 feet in height, are infrequent.

Storm-driven surface currents in the littoral zone can be very strong. These currents develop in the following manner. As waves approach a beach, water is being moved forward in a direction somewhat to the right of the angle of approach of the waves. This deflection is due to the action of the earth's rotation, which causes a phenomenon known as the Coriolis effect. Incoming water is transformed into longshore currents if the waves move at an angle other than the normal (perpendicular to the beach). Water moving normal to the beach reestablishes equilibrium by flowing in alternating longshore and outshore (rip) currents, depending on beach and bottom topography. These currents are of interest from the standpoint of local transport of PCB-contaminated materials that are dispersing from the Harbor or North Ditch.

Nearshore zone current patterns are of interest in regard to potential movement of PCB contamination over great distances along the coast of Lake Michigan. There is a public awareness of combined sewer overflow events in Lake Michigan coastal cities that at times necessitate the closing of beaches.

Table 3-1. Estimates of extreme wave return intervals for the Waukegan Harbor area. Estimates are derived from Table E of Appendix E33 of Resio and Vincent (1976).

		WAVES FROM EAST-SOUTHEAST		WAVES FROM EAST	
	Wave Return Interval (years)	Height (feet)	Standard Deviation (feet)	Height (feet)	Standard Deviation (feet)
Winter	5	8.9	1.7	9.2	0.8
	10	11.5	2.2	12.5	1.1
	20	14.1	2.8	15.7	1.3
	50	17.4	3.4	20.3	1.6
	100	20.0	4.0	23.6	1.9
Spring	5	4.9	0.8	4.9	0.8
	10	5.9	1.1	5.9	1.1
	20	6.6	1.3	7.2	1.3
	50	7.9	1.6	8.5	1.6
	100	8.9	1.9	9.8	1.9
Summer	5	3.0	1.2	5.2	1.1
	10	4.9	1.6	6.9	1.4
	20	6.9	1.9	8.5	1.8
	50	9.2	2.4	10.8	2.2
	100	11.2	2.8	12.5	2.6
Autumn	5	10.8	0.8	10.8	0.8
	10	11.8	1.1	11.8	1.1
	20	12.8	1.3	12.5	1.3
	50	14.1	1.6	13.4	1.6
	100	15.1	1.9	14.4	1.9

Thus there is an appreciation by the public that land-based pollutants may move with nearshore currents and remain relatively undispersed, staying sufficiently concentrated so as to result in water quality problems far from the point of origin. Published data on southeastern Lake Michigan nearshore currents apply principally to surface currents, whereas the nearshore zone bottom currents may be equally pertinent to PCB transport. There is general agreement between published studies that storm-driven nearshore surface currents generally parallel the shore, with direction being a function of prevailing wind direction. Nearshore surface currents were measured at two stations offshore from Waukegan between 25 April and 28 July 1979 (USEPA 1979). The nearshore zone current directions off Waukegan throughout the 94-day interval were found to be either shore parallel, too low to measure, or changing. Currents flowed to the south on 35 days, flowed to the north on 39 days, and were zero or changing in direction on 20 days. The highest current speed was recorded on 24 May 1979. That current was measured as peaking at approximately 0.5 meters per second (m/sec) flowing toward the south (USEPA 1979). If such a current were sustained for one day as is indicated by the record, net water transport would be over 43 km (26.8 miles) for an undispersed water parcel. No site-specific data are available for nearshore surface currents of the autumn and winter months. However, cold-season storms typically are the most severe (Table 3-1), making it likely that the greatest range of PCB transport from Waukegan would occur in autumn and winter.

potential movement of PCB

Nearshore zone current fields are pertinent to the PCB contamination at Waukegan because the geographic range of adverse impacts will be related to the distance that storm-driven currents move before their post-storm velocities decrease enough to allow settling of the suspended materials to which the PCBs are bound. It can be expected that currents approaching speeds of 0.5 m/sec near Waukegan result from a storm wind that simultaneously affects a large area of Lake Michigan. During such events there should be a continuous current field of longshore water movement up or down the coast. Net transport of PCB-contaminated materials as much as 10 or 20 miles from Waukegan over a one day period probably would occur only with a continuous current field (a spatially-continuous flow velocity) in a shore-parallel direction.

what are we trying to say here?

A review of the current data collected offshore from Waukegan in July 1979 (USEPA 1979) indicated that a current on the order of 0.2m/second was sustained for up to one day and that a current with a velocity on the order of 0.1 m/sec was sustained for several days (in shore-parallel directions). In both cases, net transport could exceed 10 miles along the coast. To determine whether the current field at these velocities extended as far as 10 miles along the shore in either direction, a comparison was made with July 1979 current data gathered near Oak Creek, Wisconsin, approximately 39 miles north of Waukegan. The data of interest are from the period 31 June through 16 July 1979 and were gathered at a depth of 16.4 feet in the nearshore zone off Lake Michigan (south of Milwaukee) where the total depth was 23 feet (Metropolitan Milwaukee Sanitary District 1981). A comparison of simultaneously-gathered current velocities and direction data between that station and the USEPA (1981) station off Waukegan shows a correlation in the following three factors: the times at which highest speeds were attained; the period over which they were sustained; and the direction in which the shore parallel currents flowed. In other words, the comparison suggests that the current fields were similar between Waukegan, Illinois and Oak Creek, Wisconsin in response to storm winds that moved surface water in shore-parallel currents at speeds ranging from 0.1 to 0.2 m/sec.

Data are not available that would allow analysis of eastward-flowing current field transport of contaminated materials from the Waukegan area, although eastward flows similar to the longshore current velocities were measured off Waukegan in 1979 (USEPA 1979).

Water Quality

The water quality data of greatest interest are turbidity, suspended solids, chemical oxygen demand (COD), biochemical oxygen demand (BOD), and oil and grease because they reflect spatial and temporal variations in the amount of suspended organic material in the surface water. It is generally acknowledged that PCBs have a high affinity for organic materials and absorb to them preferentially. Therefore, when the parameters of interest are found in high concentrations, it can be inferred that there also are increased amounts of PCBs associated with suspended autochthonous material.

indigenous

The clarity of water is affected by numerous suspended particles, including clays, dead plant material, and plankton. In part, water clarity is proportional to turbidity as measured in the field (Torrey 1976), although the degree of light penetration is also related to other factors. Background turbidity levels in surface waters are influenced by such variables as current, coastal erosion rates, and size of suspended particles (Torrey 1976).

Seasonal variations in turbidity are evident from sampling data obtained from studies on Lake Michigan by various agencies. Sampling data for five USGS sampling stations located on the Illinois shore of Lake Michigan, collected during the months of April to October from 1968 to 1976, are shown in Appendix G (US Geological Survey) [USGS] 1978, 1979. The results indicate that levels are high in the spring, decrease during the summer months, and increase gradually in the autumn (Figure 3-2). Although the data are variable among the five stations, the levels were consistently lowest at the two Waukegan Beach stations. Annual sampling done at three stations near Waukegan Harbor by Industrial Bio-test Laboratories, Inc., (1971b) (Figure 3-3) resulted in a similar seasonal pattern (Figure 3-4). Limnetics, Inc. (1974a, 1974b) sampled turbidity near Waukegan Harbor on 14 March 1974 and on 24-25 July 1974 (Appendix G). Turbidity levels ranged from 2 to 5 Jackson Turbidity Units (JTU) in July and from 57 to 59 JTU in March. The higher springtime levels are thought to be due primarily to the effects of spring runoff and increased storm-related movement of water and sediment. Spatial variations of turbidity levels near Waukegan are also evident from the data in Figure 3-2.

Total suspended solids (TSS) concentrations in Lake Michigan also are related to turbidity. The TSS represent non-filterable residue consisting of several components including material eroded from the shoreline and particulate matter that is carried in by currents or resuspended from the bottom by turbulent wave action (Torrey 1976). Aquatic organisms contribute to the organic portion of TSS concentrations.

In 1971, seasonal variations of the TSSs were evident at sampling stations (Figure 3-2) located at Zion Beach, at the Commonwealth Edison Co. coal-fired generating station north of Waukegan Harbor, and at North Chicago (Appendix G; Industrial Bio-test Laboratories 1971b). Maximum levels measured

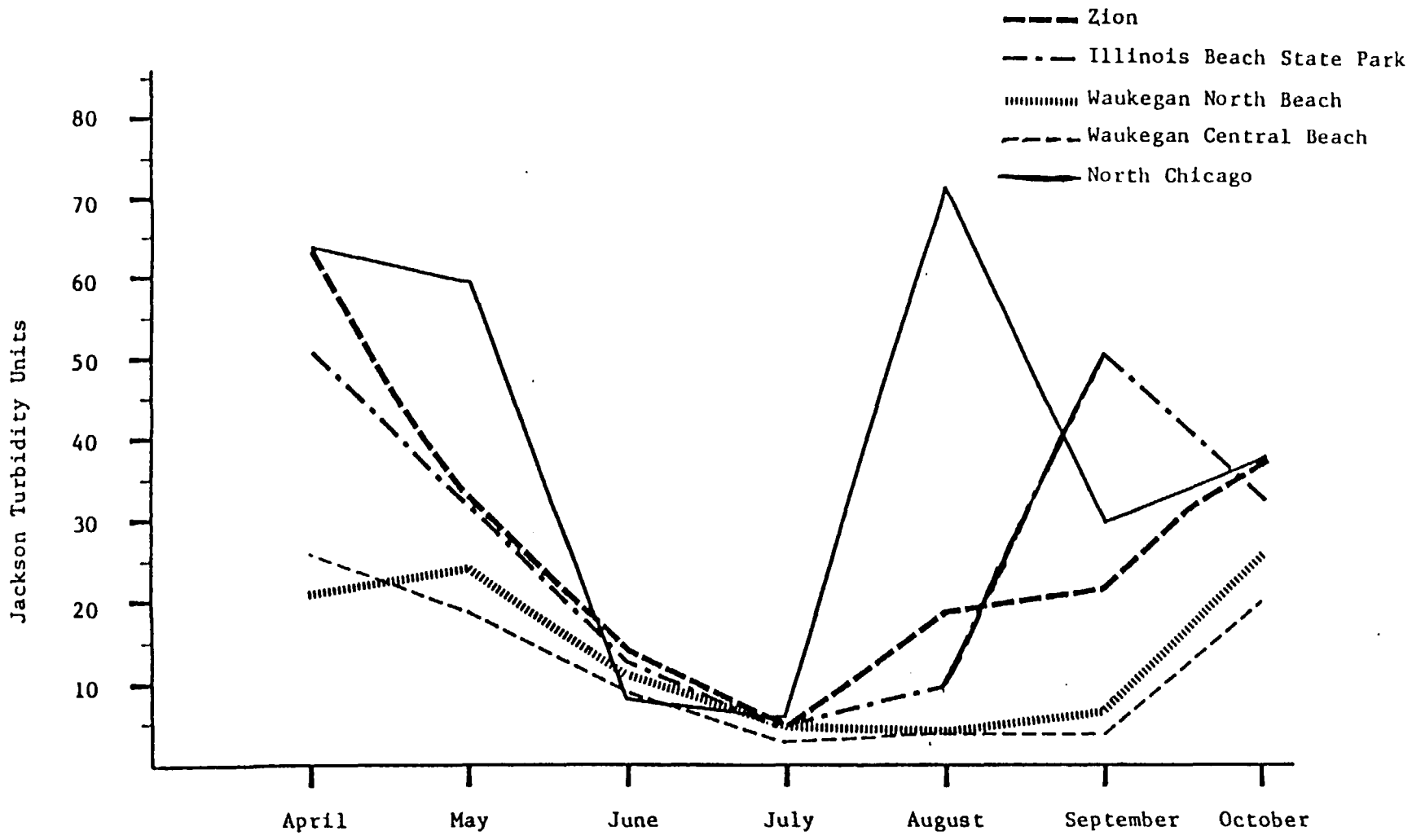


Figure 3-2. Turbidity levels at five locations in the Waukegan coastal zone; measured between April and October of 1972 (USGS 1978).

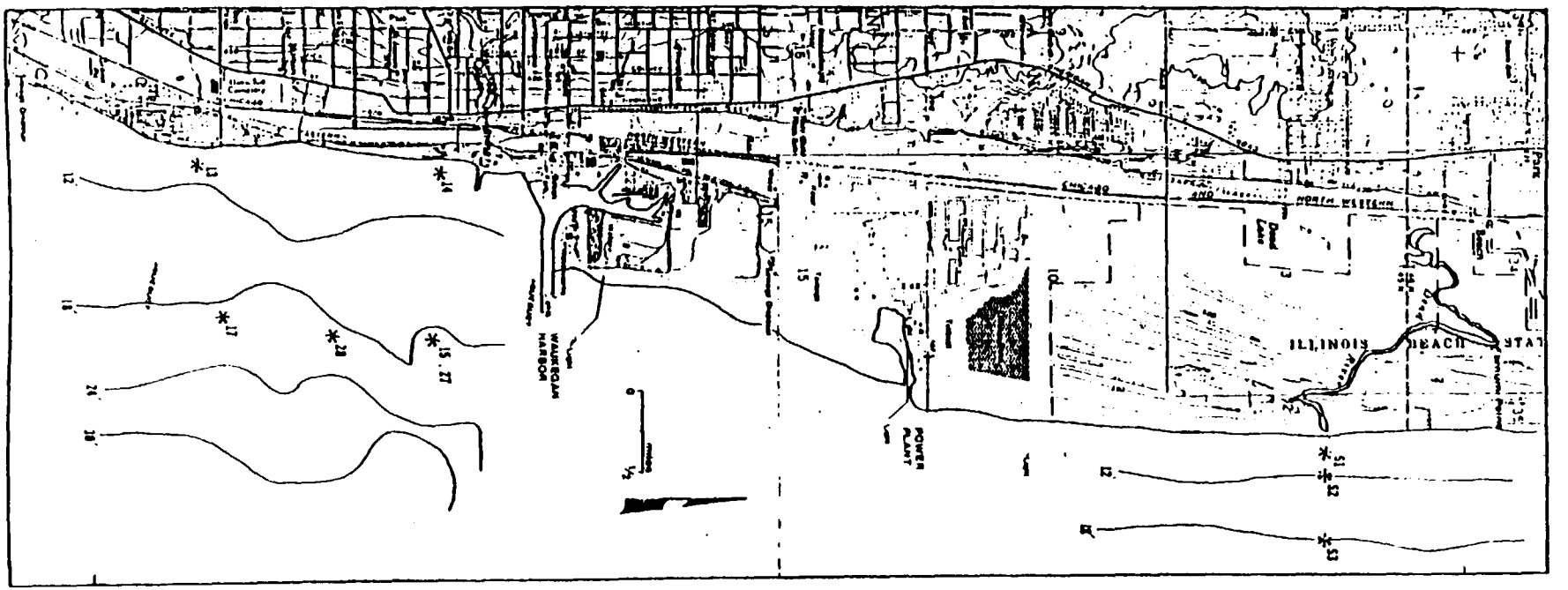


Figure 3-3. Locations of sampling stations near the project area at which studies of water chemistry, plankton, macroinvertebrates, and sediment chemistry have been performed. Numbered stations are those used by Limnetics, Inc. (1974a, 1974b, 1974c, 1974d, 1974e, 1974f). The station sampled by Industrial Bio-test (1971a, 1971b), is located inside the power plant embayment to the north of Waukegan Harbor.

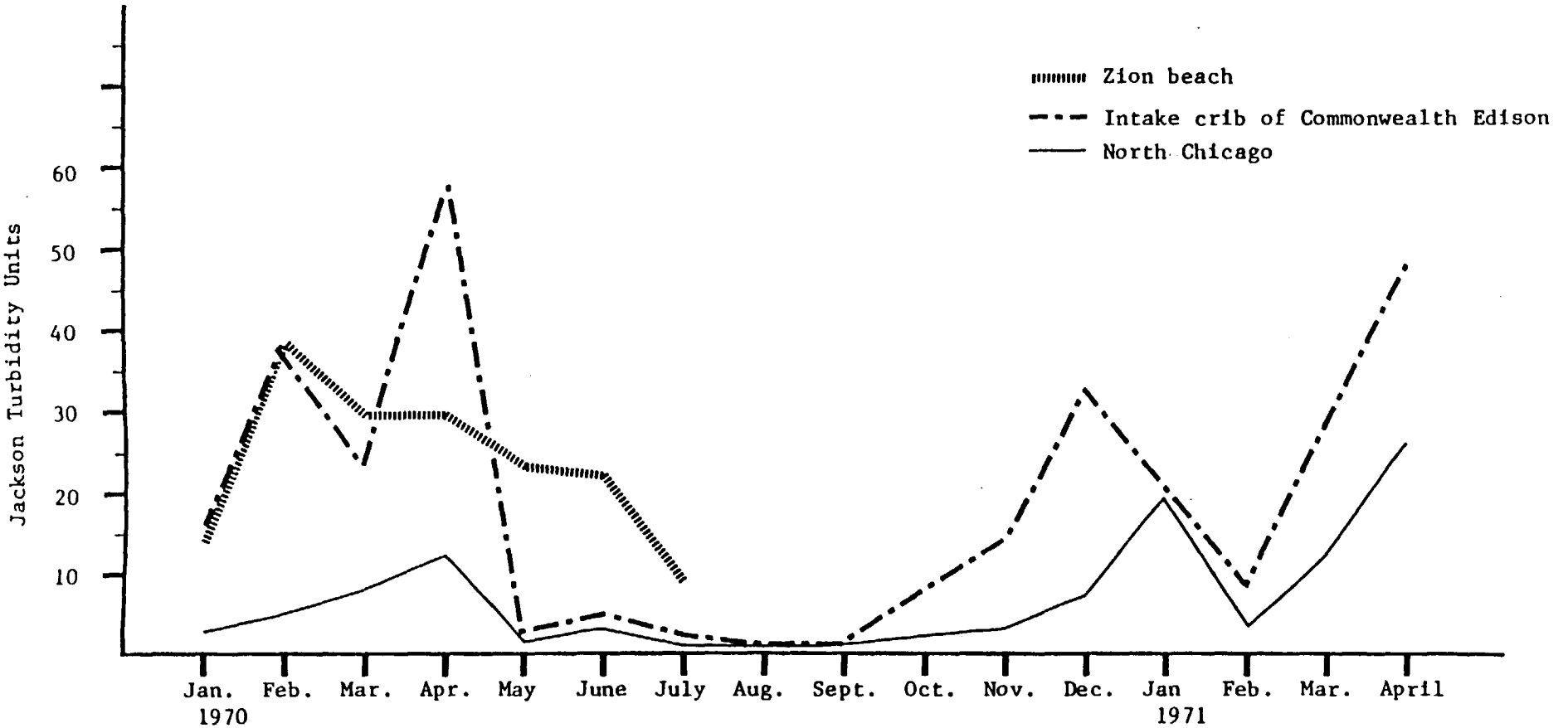


Figure 3-4. Average daily turbidity levels at three locations in the vicinity of Waukegan Harbor; measured from January 1970 through April 1971 Industrial Bio-test 1971.

were 100 mg/l, 120 mg/l, and 44 mg/l, respectively, during the spring and autumn months. Levels of TSS were highest during the spring and the autumn.

Sampling conducted near Waukegan by Industrial Bio-test Laboratories (1971b) found TSS values that exceeded 1 mg/l in only one-fifth of 170 samples collected at three stations located 9.6 km (6 mi) east of Zion, Illinois. The highest TSS value recorded near Zion was 10 mg/l, compared with a high value of 120 mg/l at the intake canal of the Commonwealth Edison Co. coal-fired generating station (Torrey 1976). Harbor water quality typically is poorer than in the open Lake nearshore zone. The generating station intake is located in a harbor immediately north of Waukegan Harbor; thus it is likely that variations of total suspended solids there are representative of the Waukegan Harbor area.

Dissolved oxygen (DO) concentrations usually are near saturation at all depths of Lake Michigan throughout the year except for harbors and certain inshore areas near Chicago (Torrey 1976). In the Waukegan area, as elsewhere, minimum DO concentrations were recorded during the summer and maximum concentrations occurred in the winter (Appendix G; Industrial Bio-test Laboratories 1971). COD and BOD measurements are made to determine the potential effect of oxygen-demanding material on the aquatic environment. COD is a measure of the oxygen equivalent of organic matter that can be oxidized by a strong chemical oxidant under acid conditions. BOD_5 is a measure of the amount of oxygen required by bacteria while these organisms are metabolizing decomposable organic matter over a five day period at 20°C. Thus, COD and BOD_5 are indicative of the amount of organic matter that may consume oxygen while decomposing in the water column.

Although BOD_5 often varies seasonally, this trend is not reflected in the limited data available for the Waukegan area (Appendix G). The results of samples taken at five stations along the western shore of Lake Michigan (USGS 1978, 1979) during the months of April through October did not indicate a seasonal trend in COD (Appendix G). Monthly COD and BOD_5 values recorded over a one-year period (Industrial Bio-test Laboratories 1971b) did not indicate a seasonal pattern at three inshore stations near Waukegan (Appendix G).

Recreational and industrial activities are major sources of oil and grease in surface waters. Levels of these substances often are higher in harbor areas due to commercial or recreational navigation and the relatively restricted flow patterns. Sampling for oil and grease was done at several stations near the US Steel Plant south of Waukegan (Limnetics, Inc. 1974a, 1974b). The levels measured generally were less than 1.0 mg/l in March and July for the inshore stations (Appendix G). Offshore, the level at one station reached a high of 9.0 mg/l. Two offshore stations located between Waukegan and the US Steel Plant had concentrations of 9.0 mg/l and 2.5 mg/l, respectively.

Existing Pollutant Sources

Potentially polluting, nonconsumptive uses of Waukegan Harbor water include commercial and recreational navigation and industrial process use. Commercial navigation serving Huron Cements, Goldbond Building Products, and the Falcon Marine Company could increase turbidity levels in the Harbor due to particulate matter associated with bulk gypsum transfer or operation of dredging equipment. Additionally, boat traffic to and from the recreational marina facilities in the Harbor, especially en route to and from Larsen Marina (inside Slip #3) may increase turbidity by resuspending bottom sediments.

OMC withdraws approximately 1 million gallons of water per day from Slip #3 of Waukegan Harbor and uses it for noncontact, once-through cooling purposes. OMC discharges one portion of the water to the North Ditch Drainage System and another portion directly into Lake Michigan (USEPA 1981). This water, therefore, has no direct water quality influence on the Harbor waters. Withdrawal of turbid, PCB-laden water from the Harbor, however, currently tranfers PCBs to Lake Michigan in substantial quantities. It has been estimated that cooling water discharges transfer several pounds of PCB's to Lake Michigan each year, some of which originates directly from the Harbor (USEPA 1981).

The extensive recreational and commercial boating activities in Waukegan Harbor (Section 3.2.4.1.) are likely to result in periodic increases in turbidity and other related pollutants wherever depths average less than about 10

feet (US Department of Interior 1978). Other ~~less quantifiable~~ pollutant sources to Lake Michigan include permitted discharges for local industry and for the Waukegan sewage treatment plant. Heavy industrial use of the lands surrounding Waukegan Harbor more than likely results in seasonably high surface runoff-borne loads of heavy metals and dust.

The cumulative result of the surrounding industrial setting, recreational boating activity, commercial shipping, and lack of flow-through water movement is a highly turbid Harbor. The fact that periodic maintenance dredging has been conducted in the Harbor (USEPA 1981) indicates considerable sediment deposition from numerous sources.

3.1.7.2. Ultimate Disposal Sites

This section discusses the surface water resources existing around or near the potential ultimate disposal sites which may be used for contaminant transport (by barge) or used as a receiving stream for leachate treatment plant discharges. Special attention also may be required for control of runoff or leachate from the landfill as a result of proximity to surface waters.

Browning-Ferris Industries, Inc. Site, Lake County IL

No natural streams, ponds, or lakes occur on this site. Topographically, the site appears to lie near a surface water divide such that surface water west of the site drains toward the Des Plaines River and surface water east of the site drains toward the Lake Michigan Basin. Surface drainage across the site is reported to be predominantly west and south. The site is not located within the 100-year floodplain. However, standing water apparently has been present in the past near the northern portion of the site, probably due to poor soil drainage.

The nearest surface water is an intermittent stream that passes approximately 0.75 miles southwest of the site and flows west toward the Des Plaines River. This stream is a tributary of the Illinois River, which is located in the Mississippi River watershed. Lake Michigan is approximately 4 miles east of the site.

New Site, Option 1, Lake County IL

This site is located in a flat area with virtually no topographic relief. The site is approximately 3 miles from the Des Plaines River and approximately 1.5 miles from Druce Lake. The area between the site and Druce Lake is low lying and is known to contain marshy areas. It appears that this area is poorly drained.

The nearest intermittent tributary is located 0.75 miles from the site and discharges into a pond about 2 miles from the site. These waters eventually enter Mill Creek, which flows in an easterly direction and discharges into the Des Plaines River. The Des Plaines River is a tributary of the Illinois River and therefore is in the Mississippi River watershed.

New Site, Option 2, Lake County IL

Site 2 is located in an area that shows some topographic relief. The area slopes westward and down towards the Des Plaines River, which flows as close as approximately 0.6 miles to the site. No streams run directly through the site. The nearest tributaries (which are intermittent) are located 0.25 miles from the access road to the site and 0.1 miles from the site. These streams flow south into the Des Plaines River. The site is located 5 miles from Lake Michigan.

Based on the existing natural topography, the site is expected to drain westward into the Des Plaines River, which is a tributary to the Illinois River. Thus the site is in the Mississippi River watershed.

Chemical Waste Management Site, Calumet City IL

The two adjacent fills are both situated approximately 2,000 feet from the Calumet River on the inside of an oxbow bend and just south of Lake Calumet. Thus the Calumet River bounds the site on the east, south, and southwest. To the north, the outlet of Lake Calumet passes within 2,000 feet of the northern most fill site prior to its confluence with the Calumet River. The site is not bounded by a major surface water body on the northwest.

Additionally, a sizeable river-contiguous wetland lies approximately 1,100 feet east of the site and another larger river-contiguous wetland lies approximately 400 feet to the southwest of the site. There are several small man-made ponds or open water/marsh areas inside the oxbow bend that surrounds the site. These ponds appear to be filled by both seepage and flood waters. Water-filled drainage ditches parallel the roads that cross the area, providing a route of surface runoff flow to the Calumet River on the east and south. The Calumet River flows into the Illinois River, a tributary to the Mississippi watershed. The proximity of the site to the Calumet River makes barge transport of PCB-contaminated materials feasible for the majority of the hauling distance.

Assuming but it is unknown if cost effective or feasible —

CECOS International (CERN) Site, Williamsburg OH

Just west of the secured landfill cells, Pleasant Run Creek and its East Branch tributary flow in a southerly direction into the east fork of the Little Miami River. Pleasant Run Creek flows south through the property. The East Branch flows along the southeastern boundary of the site and joins Pleasant Run at the southwestern corner of the site. The site is not located within an established flood-prone area. However, the adjacent streams exhibit flash-flood characteristics.

The site is in a watershed that drains into a reservoir and then into the Ohio River at a point southeast of Cincinnati, Ohio. The proximity of the site to the Ohio River makes barge transport feasible for the majority of the hauling distance, although off-loading into trucks would be required to make final delivery of contaminated materials.

SCA Chemical Waste Services, Inc. Site, Model City NY

This site is located approximately 6.0 miles from the south shore of Lake Ontario in a small watershed that drains into the Lake. It is approximately 4 miles east of the Niagara River and is located between Niagara Falls and Lake Ontario. It would be possible to utilize barges to transport contaminated materials for the majority of the distance to the site, but off-loading into trucks would be required to make the final delivery of the material to the

site. The proximity of the site to international waters indicates that security and isolation from surface water drainageways are important considerations for the design and management of a PCB repository here.

3.1.8. Terrestrial Biota of the Waukegan Coastal Zone

The Waukegan Harbor area lies within the Lake Michigan Dunes Section of the Northeastern Morianal Division of Illinois (White 1978). This is the most recently glaciated area of the State and many rare species of plants are present in Illinois Beach State Park, approximately 1.5 miles north of Waukegan Harbor. The natural communities present in the Harbor area include those characteristic of and limited to the shore of Lake Michigan (beach and foredune communities) and those characteristic of disturbed areas (successional communities and developed land). The scientific names for species of plants and animals mentioned in the text are given in Appendix H.

3.1.8.1. Vegetation

The area to the east of the project site is a public beach, the major part of which is unvegetated, lake-deposited sand. The predominant plants in the beach area are sea rocket, winged pigweed, and cocklebur. Sand-binding plants such as marram grass, common bugseed, and Canada wild rye help to stabilize the dunes and provide substrates on which various insects and spiders live. The more protected foredune areas behind the strand contain species of plants such as beach wormwood, little bluestem grass, silverweed, bearberry, and trailing juniper. Cottonwoods, dogwoods, willows, and other shrubs and trees are present at the western edge of the beach. Successional communities have developed in the disturbed area between the cottonwood-willow band and Seashore Road. Large chunks of concrete and rocks have been piled at this location. Rushes, blue vervain, wild bergamot, and other weedy species are present in most spots around and to the west of these slabs.

Honey locust trees have become established (possibly planted) in the area immediately north of the concession stand at the north end of the beach parking lot. Rushes also are present in wet spots in this area. Squirrel-tail grass and other weeds are common in disturbed sites around the picnic shelter and the parking lot.

Silver maples, oaks, and conifers have been planted adjacent to the North Beach Park parking lot. The southwestern part of the beach has a grass cover and contains weeping willows, cottonwoods, and Scotch pines. Beach Park, located at the west edge of the inlet, also has a grass understory and contains cottonwoods and crabapples.

The areas on the western edge of the project site in the vicinity of the railroad tracks, contain weedy communities typical of disturbed ground. There are thickets of willows, cottonwoods, and wild grape in the moister sites west of the tracks. Prairie cord grass, butterfly weed, black-eyed susans, and other species typical of prairie communities are present in this area.

A marsh community is located to the north of the project site, adjacent to the cooling ponds on the property owned by Commonwealth Edison Co. Some of the species of wildlife that are present in the Waukegan Harbor area undoubtedly feed or rest in this area also.

The center of the OMC vacant property contains spoil piles covered with shrubby and weedy successional vegetation similar to that described previously. A variety of species of coniferous and deciduous trees have been planted on the property for landscaping purposes.

3.1.8.2. Animals

Spiders, tiger beetles, antlions, grasshoppers, termites, digger wasps, and various species of beetles and flies are the typical residents of the beach and foredune areas. Few species of vertebrate animals other than gulls and shorebirds utilize these areas.

Amphibians and Reptiles

Amphibians and reptiles are not likely to be present in the two parks, but may be present in the disturbed areas in the vicinity of the site. Fowler's toad may be associated with the beach community, but no individuals of this species have been observed in Illinois Beach State Park (By telephone, Darrell Johnson, Illinois Beach State Park, to WAPORA, Inc., 21 June 1981)

and it is unlikely that they are present in the Harbor area. The American toad and the eastern hognose snake probably are present in the moist areas to the west and north of North Beach.

Mammals

Because mammals are more mobile than amphibians and reptiles, a few species may be present in the project area at some time during the year. However, the relative scarcity of vegetation and the amount of human activity in the vicinity would tend to cause them to avoid the area except during the early morning and evening. It is likely that prairie deer mice, eastern cottontails, and other small mammals are present in the Waukegan Harbor area, primarily along the northern end of North Beach. Skunks, raccoons, and other predators may visit the area periodically. Muskrats currently use lodges in the marsh on the Commonwealth Edison Co. property (By telephone, Jim Neal, Chicago Ornithological Society, to WAPORA, Inc., 20 July 1981), but these animals are not likely to enter the beach areas in the vicinity of the Harbor.

Birds

The shore of Lake Michigan serves as a natural migration route and resting area for birds. Many species pass through the Waukegan Harbor area during spring and autumn migration periods and stop to rest on the beach at North Beach Park, on the breakwaters, or in the calm water area between the breakwaters. Other species such as the black tern come to the Harbor for the summer after breeding in inland areas. Some species such as gulls also overwinter in the Harbor area. At least 152 species of birds have been observed in the vicinity of Waukegan Harbor (Appendix H). Twenty-seven of these are fish-eating species, 10 of which reside in the Harbor area during the summer or the winter. The status of each species and the counts of winter birds and high counts for some of the more common species are presented in Appendix H.

A breeding colony of common terns, which are classified as endangered in Illinois, is present on the Commonwealth Edison Co. property immediately north of the Harbor area (By telephone, Jim Neal, Chicago Ornithological Society, to WAPORA, Inc., 20 July 1981). Approximately 40 adult black terns and 2

juveniles (a species also classified as endangered in Illinois) were observed during a field visit by WAPORA personnel on 19 July 1981. The adult terns were roosting on the north breakwater at the entrance to the Harbor and presumably were feeding on fish from the Harbor area.

The gulls in the Harbor area generally use North Beach as a day roost (By telephone, Jim Neal, Chicago Ornithological Society, to WAPORA, Inc., 20 July 1981). They roost on the beach overnight and during the early morning and then move out to the Lake after people begin to arrive at the beach.

Because of the number of migrating species and the ease of observation of the birds from the pier that extends for a considerable distance into Lake Michigan, the Harbor is a favorite observation area for local birdwatchers, especially during the spring and autumn migration periods (Sanders and Yaskot 1975). Many species of shorebirds have been observed along the shoreline to the north of the Harbor, up to Illinois Beach State Park (Fawks and Lobick 1975). North Beach may be too disturbed to attract most of these species (Fawks and Lobick 1975).

Of the three habitat types (marshes, shores, and open water) accessible to birds in the Waukegan Harbor area, the open water habitat comprised of the Harbor and of Lake Michigan is by far the most extensive. The species that utilize this habitat type such as ducks, mergansers, and gulls, have the largest populations (Appendix H).

3.1.8.3. Threatened or Endangered Species

<u>Federal Classification</u>

The bald eagle, classified as endangered by the US Department of the Interior (US Fish and Wildlife Service [USFWS] 1980b), has been observed in the Waukegan Harbor area during migration periods. No other species of terrestrial biota currently listed as endangered or threatened is known to be present in the area at any time during the year.

State Classification

Fifteen species of birds and at least five species of plants classified as endangered in Illinois are known or likely to be present in the project area (Stone n.d.). Two species of birds and one species of plant classified as threatened in Illinois also have been observed in the Waukegan Harbor area. These species are listed in Appendix H.

Although the range of the spotted turtle may include some parts of Illinois Beach State Park, and yellow-headed blackbirds have been observed in the marsh to the east of the Commonwealth Edison cooling ponds, neither species has been observed in the Waukegan Harbor area. Both species are classified as endangered in Illinois. Nineteen of the species of birds listed in Appendix H have been included on the Blue List of the National Audubon Society for 1981 (Tate 1981). This is an early warning list of species that are determined to be declining, threatened, or vulnerable on the basis of nominations from knowledgeable observers in all regions of the United States.

3.1.9. Aquatic Biota of the Waukegan Coastal Zone

Many researchers have studied the chemical and biological components of the aquatic habitats of harbors located along the shores of Lake Michigan (Helm 1966; USDOI 1966, 1968; Ayers and Huang 1967; Cook and Powers 1964; Ayers and Rossmann 1967; Willson 1969; all cited in Mozley and Howmiller 1977). Most have reported that the harbors often were severely degraded. Harbors and other partially enclosed areas are very susceptible to environmental degradation because of inputs from adjacent population centers and industrial processes (Mozley and Howmiller 1967). This effect is further compounded by the limited water exchange (dilution) with the open Lake.

The results of research conducted in the shallow inshore waters near Waukegan Harbor were used as the primary sources of documentation for the information in the following sections. For species for which the data from this area were not available or were not comprehensive enough to establish estimates of seasonal and spatial variation in abundance or community composition, the results of studies conducted elsewhere in southern Lake Michigan were used as the bases for the estimations.

3.1.9.1. Fish

Research related to the fish community of Lake Michigan near Waukegan has focused on migrational patterns, habitat preferences, and feeding and spawning behaviors. These factors are important in establishing the transport mechanisms and rates of accumulation of PCBs in fish. Data from studies by Industrial Bio-test Laboratories, Inc. (1971a), Jude et al. (1979), and WAPORA, Inc. (1979) were used extensively. Industrial Bio-test (1971a) reported that, in general, alewife, lake trout, rainbow smelt, bloater, coho salmon, brown trout, lake whitefish, and yellow perch were the most abundant species within the Waukegan-Zion area. Temporal and spatial variations for each of these species are discussed in the following sections. These sections are based upon the detailed literature review on Aquatic Biota of the Waukegan Coastal Zone contained in Appendix I.

Alewife

Based on a review of the literature, Jude et al. (1979) reported that Lake Michigan alewives feed primarily upon zooplankton. Scott and Crossman (1973) reported that inshore adults also feed on benthic macroinvertebrates, usually mysids and ostracods. Field surveys (Jude et al. 1979) have shown that alewives in southeastern Lake Michigan move inshore in spring and offshore again as the Lake warms in early summer. A second peak of inshore movement occurs in summer as adults return to the shallows to spawn. Part of the spring shoreward migration was thought to include alewives that had migrated from the northern portion of Lake Michigan to winter in the southern part of the Lake.

Industrial Bio-test researchers reported, on the basis of a review of literature, that alewives hatch in late July or early August and congregate in large schools along the shoreline (Industrial Bio-test 1971a). They reach a length of 3 to 4 inches by late August. At this time, a movement to deeper offshore water was noted. Industrial Bio-test (1971a) reported that during a sampling study conducted in the Waukegan area between April and December, the greatest number of alewives were taken during the spring in inshore waters. These researchers further concluded that alewives were efficient competitors

for food and habitat on the basis of the absence of rainbow smelt and young perch that usually occupy a similar niche. Vidal (1979) reported that during April field surveys conducted near Waukegan (from 1976 through 1979) continual reductions were found in the number of alewives collected. There also was a corresponding annual increase in the average length and weight.

Lake Trout

Industrial Bio-test (1971a) reported that lake trout captured near Waukegan fed extensively on alewives and sculpins. Alewives were the predominant organisms in their diet until July, after which sculpins made up the greatest proportion of the diet. Hess et al. (1980) reported, however, that alewives were the most frequently observed food item identified in the stomachs of trout captured near Waukegan in August 1980. This may indicate that alewives were present at the same depth as the trout at the time of capture.

Following extensive depredation of lake trout by sea lampreys, 1971 was the first year in which spawning-size fish were numerous in southern Lake Michigan (Industrial Bio-test 1971a). Based on 1971 sampling near Waukegan, Industrial Bio-test (1971a) reported that only a small proportion of the fish were over four years of age (15%) and that there was no evidence of spawning activity in the area. Jude et al. (1979) reported, based on the results of field sampling from 1973 and 1974, that the average life span of lake trout is about eight years; spawning takes place, on the average, when sexual maturity is reached at age seven (Becker 1976). Hess et al. (1980) reported that both the catch per unit of effort and the average size of lake trout have increased continuously from 1977 through 1980. They also reported that older lake trout have become more numerous in the Waukegan area. The average age of the individuals taken in 1980 was 6.5 years. No evidence of successful spawning was found in 1979, in spite of the presence of sexually ripe fish (Hess et al. 1980).

Because of the longevity of lake trout and their feeding preference for alewives, individuals of this species have a tendency to accummulate large body burdens of PCBs (Weininger 1979). Because of this tendency and because of the recently observed increase in average age of the lake trout population

near Waukegan, it is possible that the average body burden of PCBs in the local population may have increased.

Based on a literature review and field sampling in southeastern Lake Michigan, Jude et al. (1979) reported that lake trout abundance peaks in the nearshore zone during autumn spawning activity. Nalco (1978) reported that older lake trout were most commonly present near the Zion area from August to October. During the spring and summer, lake trout are present most frequently at depths of 70 feet or more. During the autumn, individual lake trout may spend three or more weeks at offshore spawning grounds (shoals) that may range up to 100 feet in depth (Industrial Bio-test 1971a). Industrial Bio-test (1971a) reported that lake trout in the Waukegan area originated principally from Illinois or nearby Wisconsin plantings. In the late 1970s, lake trout at Waukegan were found to have originated from distant points around Lake Michigan. Scott and Crossman (1973) reported that lake trout disperse after spawning and may travel more than 100 miles.

Rainbow Smelt

Adult Lake Michigan smelt are reported to be most numerous in the northern portion of the Lake (Becker 1976). Based on a field survey at Waukegan in April 1979, Vidal (1979) found that the smelt were the fourth most numerous fish captured. Hess (1979) reported that the numbers of smelt captured in the Waukegan area are highly variable from year to year. During a 1971 field sampling effort near Waukegan, Industrial Bio-test (1971a) found that smelt were present in the nearshore zone during most of the year, but that they moved offshore in winter. Jude et al. (1976) conducted extensive field surveys and determined that adult smelt moved to deeper waters offshore as summer temperature and light penetration increased. As young-of-the-year smelt developed, they also moved offshore by autumn (October). Jude et al. (1979) reported that spawning occurred along beaches or in tributary streams between March and May, depending on locale and weather. WAPORA, Inc. (1979) reported that smelt occupy the surf zone in the spring prior to moving to deeper waters.

Bloater (Chub)

Based upon a review of the literature and field study at a southeastern Lake Michigan site, Jude et al. (1976) indicated that during summer months bloaters are present in inshore waters only when there are upwellings of cold water. Otherwise, these fish spend little time in the nearshore vicinity, preferring to remain in deeper water where they feed upon plankton and to some extent benthic macroinvertebrates. WAPORA, Inc. (1979) reported that bloaters migrate slowly shoreward from May until June or early July and then gradually return to deeper waters. During sampling in the Waukegan area from April to December of 1971, however, Industrial Bio-test (1971a) captured bloaters in the nearshore zone throughout the sampling period. The greatest numbers were taken from shallow water areas during June when cold water upwellings were frequent.

Coho Salmon

Industrial Bio-test (1971a) reported that the majority of the coho salmon captured near Waukegan were taken close to shore in springtime and that alewives were the predominant food item in the diet of this species. Numerous researchers reported that coho salmon are present in nearshore waters from early spring through early summer, move offshore in summer, and return to nearshore waters during autumn spawning migrations. During field studies at a site in southeastern Lake Michigan, Jude et al. (1979) found that coho salmon were predominantly nocturnal in their nearshore zone activity and that yearling coho inhabited the beach zone from the time of planting in April until June when they moved offshore.

The Waukegan area has been stocked with coho salmon in most years since 1973 (Vidal 1977). However, stocking was recently discontinued after the discovery of PCB contamination in the Harbor. Most Illinois harbors in which coho salmon were planted received higher spawning-run returns of fish than did Waukegan Harbor (Vidal 1979). During the 1979 fall survey, 163 (70.0%) of the coho salmon captured originated from plantings performed by the State of Michigan.

Rainbow Trout

Lake Michigan populations of rainbow trout result primarily from plantings of both spring and autumn spawners (Jude et al. 1979). Industrial Bio-test (1971a) reported that only one rainbow trout was captured near Waukegan during a sampling program carried out from April to December of 1971. By 1977, Vidal (1979) collected over 300 specimens near the mouth of the Waukegan River. The first spawning attempts observed in Illinois occurred in 1978 in a spring tributary near Zion just north of Waukegan. Thus it is evident that the presence of rainbow trout in the Waukegan area is a recent phenomenon.

Brown Trout

Lake Michigan brown trout tend to be most active in shallow coastal waters and to migrate less than the more numerous salmon (Vidal 1979). Becker (1976) indicated that spawning occurs in late autumn when the fish move into tributaries or along shallow, rocky, rubble-filled coastal areas. In recent years, large numbers of spawning brown trout were present in the Waukegan River. Some migration from out-of-state plantings was documented for autumn runs (Vidal 1979).

Lake Whitefish

Industrial Bio-test (1971a) reported that the stomach contents of adult whitefish captured in the Waukegan nearshore zone were comprised principally of amphipods. Young whitefish feed on plankton (Smith 1979). Whitefish spawn nocturnally in shallows during late autumn, remaining in shallow water only until the following spring (Jude et al. 1979). Industrial Bio-test (1971a) reported that there was no evidence of spawning activity in the Waukegan area, and only limited numbers of whitefish were present during 1976 spring and autumn fish surveys near Waukegan (Hess 1979). Because these recent surveys may not necessarily have coincided with the whitefishes' peak of nearshore activity, no conclusions can be drawn from these data concerning the abundance of this species near Waukegan.

Yellow Perch

Young-of-the-year yellow perch are zooplankton feeders; this habit places them in direct competition with alewives. Adult perch are opportunistic, consuming those items that are most abundant at the time of feeding (Jude et al. 1979). Industrial Bio-test (1971a) reported that the primary food items of the 297 adult perch captured near Waukegan were sculpins, smelt, amphipods, chironomid larvae, and leeches.

Jude et al. (1979) and WAPORA (1979) reported that adult Lake Michigan perch are present in deep, offshore water during the spring and that they move into shallow warm-water areas when the water temperature reaches 6 to 7°C. Yellow perch prefer relatively warm water (Becker 1976) and follow the 20°C isotherm in their movements (Scott and Crossman 1973). Yellow perch were reported to be present in several Illinois harbors during winter months (Muench 1980b). They are very common along the Illinois coast; a creel census conducted in the summer of 1979 showed that the bulk of the fish caught in coastal areas were yellow perch (Muench 1980b).

Jude et al. (1979) reported that spawning occurs in southeastern Lake Michigan when inshore temperatures reach 11 to 12°C in late May or early June. Young-of-the-year were most numerous close to shore through July and August, with adult and yearling perch moving into deeper water by October (Jude et al. 1979).

Carp

Few carp have been captured in sampling programs conducted in the Waukegan area. However, Industrial Bio-test (1971a) reported evidence of successful spawning in the beach zone near Waukegan.

Chinook Salmon

Sampling between April and December of 1971 in the Waukegan area (Industrial Bio-test 1971a) resulted in the capture of only 11 chinook salmon. Subsequently, the Waukegan area was stocked with chinook salmon in most years

since 1973 until the PCB contamination problem in the Harbor area became evident (Vidal 1979). However, a spawning run was never established; only in 1976 were adult salmon observed (Vidal 1979). Vidal (1979) indicated that along the Illinois coastline chinook salmon have migrational patterns that are very similar to those of coho salmon. Referring to the autumn surveys conducted along the Illinois coastline from 1976 to the present, Vidal (1979) reported that chinook salmon produce strong runs consistently in several Illinois coastal harbors and that Waukegan Harbor produces comparatively fewer returning adult fish.

3.1.9.2. Benthic Macroinvertebrates

Benthic macroinvertebrates are defined as those visible organisms that inhabit and are a part of the bottom zone of a water body. Benthic macroinvertebrates are considered to be important secondary producers or consumers when assessing potential impacts because the organisms are relatively immobile, and thus the community composition, abundance, and distribution of these organisms is a reflection of aquatic conditions in the recent past. These characteristics of the benthic community are determined by the oxygen content of the waters, sediment composition, the degree and type of pollutants (organic, inorganic), scouring by wave action, and other factors.

In the food web, benthic macrointebrates are secondary consumers of detritus, plankton, and other invertebrates as well as a significant source of food for fish. It is through this food source that PCBs generally are considered to move into fish.

The composition of the macroinvertebrate community near Waukegan, as determined by Limnetics, Inc. (1974), was dominated by aquatic worms, freshwater shrimp, flies, and midges. Snails, clams, sow bugs, and water mites also were present but in lesser numbers. Most of the organisms present are considered by researchers to be either facultative (found in moderately polluted waters and having a wide range of tolerance of organic pollution) or tolerant (capable of thriving under grossly polluted conditions).

Limnetics, Inc. (1974) also calculated diversity and equitability. Diversity is a measure of the species richness and the distribution among species; the greater the diversity, the better the condition of the aquatic population. Equitability is a measure of the component of diversity affected by the distribution of individuals among species. Equal numbers of all species present results in an equitability value of 1.0; values greater than 0.8 are indicative of unpolluted conditions. Limnetics, Inc. (1974) reported that for the shallow locations sampled, diversity ranged from 0.0000 (only one species found) to 2.3875 and that equitability ranged from 0.000 to 0.9284. It should be noted that the use of these indices is hindered by naturally low diversity in Lake Michigan and is further hindered in this case by severe stress from wave action in shallow, unstable areas (Mozley and Howmiller 1977).

3.1.9.3. Plankton

Plankton is the term used to describe the community of suspended, floating or weakly-swimming organisms that live in the open water of lakes and rivers. The two components of plankton are phytoplankton (plants, the primary producers) and zooplankton (animals, the secondary producers and consumers). Plankton are found primarily in the littoral (shallow water) zone and in the limnetic (open water) zone to the depth of effective light penetration. The movement and distribution of plankton largely are determined by physical forces such as temperature, currents, and waves.

Phytoplankton

Phytoplankton occupy a unique position in the ecosystem of Lake Michigan. They represent the transition stage from the physical and chemical aspects to the higher-order biological communities. Thus the phytoplankton community can act as an early warning indicator of changes in the chemical nature of the aquatic ecosystem.

Several intensive studies designed to detect seasonal changes in species composition and abundance were conducted in southern Lake Michigan in the 1960s and 1970s (Tarapchek and Stoermer 1976). Industrial Bio-test (1971a)

sampled phytoplankton communities at several locations near Waukegan and Zion in 1972. The following results were obtained:

- Diatoms were the most predominant group, constituting 60% of the biovolume;
- Blue-green algae constituted 26% of the biovolume; and
- Green algae had the highest species diversity and constituted 31% of the species present.

The inshore locations nearest to Waukegan produced the highest densities of green algae and of all phytoplankton; this was the result of extremely high concentrations of the diatoms Tabellaria floccosa and Fragilaria crotonensis.

Zooplankton

Zooplankton represent an important link in the nutrient cycling and energy flow through an aquatic environment. Zooplankton graze on phytoplankton and serve as a source of food for many invertebrates and fish. The following summary is based on data from Industrial Bio-test (1971a) and Limnetics, Inc. (1974c, 1974d).

A single seasonal maximum was noted; populations were relatively low from January through May, peaked in August, and then declined. Copepods comprised more than 80% of the total zooplankton during the winter and spring. Rotifers accounted for 50% of the total during the early summer. Cladocera were the predominant (50%) organisms during August. The numerically predominant species included Bosmina longirostris, Cyclops bicuspidatus thomasi, Daphnia retrocurva, Diaptomus ashlandi, and Diaptomus minutus.

3.1.9.4. Threatened and Endangered Species

In 1977 the State of Illinois Department of Conservation, in accordance with Section 337 of the Illinois Endangered Species Act, established by Administrative Order the official list of endangered and threatened vetebrate species for Illinois (Appendix H). The order defined a State endangered

species as any species that is in danger of extirpation as a breeding species in Illinois; a State threatened species was defined as any breeding species that is likely to become a State endangered species within the foreseeable future in Illinois.

No endangered fishes have been collected in the Waukegan area. No species of fish classified as endangered or threatened by the US Department of the Interior are known to inhabit the Waukegan area. Three species of fish classified as threatened in Illinois (cisco, longnose sucker, and lake whitefish) were collected in limited numbers in the area in 1971 (Industrial Biotest 1971a). Of these, only the lake whitefish was reported to have occurred in the Waukegan-Zion area in recent years (Hess 1979; NALCO Environmental Services 1978). These studies reported that only limited numbers of lake whitefish were present.

3.2. Man-Made Environment

The man-made environment is composed of those characteristics of the project area that have resulted from human activities. The elements of the man-made environment of significance to this study are land use, population and economics, cultural resources, recreation and tourism, transportation, and government services.

3.2.1. Land Use

3.2.1.1. Waukegan Harbor Vicinity

The existing land use in the City of Waukegan in the vicinity of the project area is largely industrial with a number of commercial, open space and recreational, and other public land uses. ~~With the possible exception of the~~ Commonwealth Edison Co. coal-fired power plant to the north of the Harbor, nearly all of the land uses east of the Eastern, Joliet, and Elgin Railroad line are water-related or water-dependent activities that must be located close to Lake Michigan. These activities include industrial uses that require waterborne transportation; commercial uses that serve boating, fishing, or other recreational activities; and municipal uses such as the public beach,

the wastewater treatment plant, and the water filtration plant which derive their functionality from the Lake.

As indicated in Figure 3-5, nearly the entire Harbor is surrounded with industrial or heavy commercial uses including OMC, Goldbond Building Products, Huron Cements, and the Waukegan Port District. The only remaining open space around the Harbor (the lagoon construction site) is owned by OMC. Other land uses within the project area include Larsen Marine Services, Falcon Marine, the City of Waukegan Water Filtration Plant, the North Shore Sanitary District (NSSD) Wastewater Treatment Plant, and public beach and beach house facilities along the full extent of the publicly owned Lake Michigan shoreline.

There are ten public boat launching ramps at the south end of the Harbor. A boat hoist also is available at Larsen Marine adjacent to Slip #3. Because Waukegan Harbor is the only protected public harbor on the northern Illinois shoreline (public access to Great Lakes Harbor to the south is restricted to boat owners renting moorage space from the US Navy) and a large number of boat launching ramps are available, Waukegan Harbor supports a large amount of recreational boating activity and attracts boaters from throughout Lake County, Illinois and from Kenosha County, Wisconsin.

The City of Waukegan has developed three major land use objectives to be considered in the establishment of a land use plan (City of Waukegan 1980):

- To improve public health and welfare through reductions in air, noise, and water pollution;
- To conserve the natural resources of the area; and
- To protect existing scenic areas and to create new scenic areas.

The City's plans to encourage recreational and open space land use along the Lake Michigan lakefront including the Waukegan Harbor area are consistent with these objectives (By telephone, Bob O'Neill, City of Waukegan, to WAPORA, Inc., 18 August 1981).

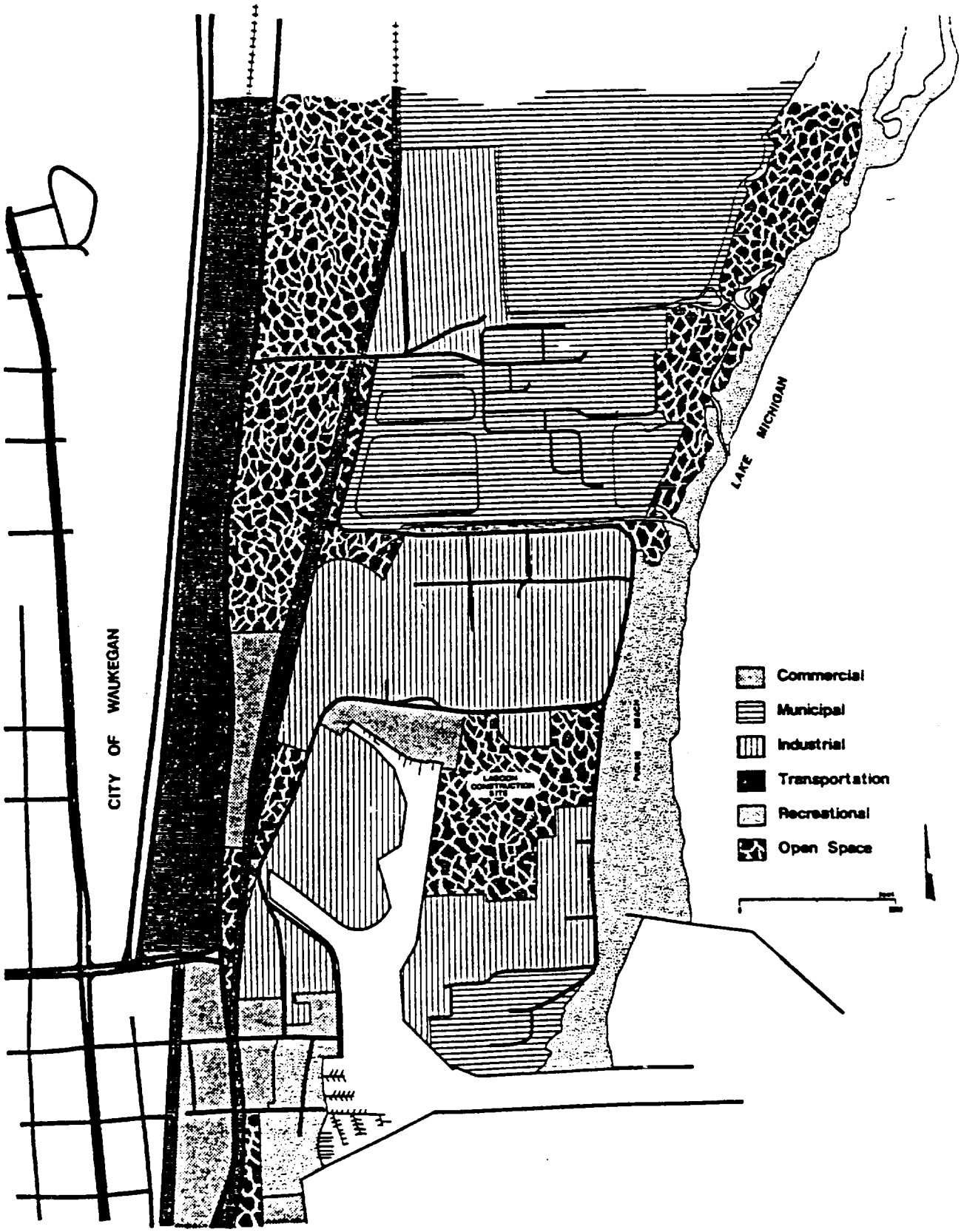


Figure 3-5. Land use in the vicinity of Waukegan Harbor, Waukegan, Illinois

3.2.1.2. Ultimate Disposal Sites

At least six ultimate disposal sites are under consideration for the disposition of the PCB-contaminated materials from Waukegan Harbor and the North Ditch. Four of the identified sites are located in Illinois, three of which are in Lake County. The two remaining sites are fully licensed facilities located in Ohio and New York.

Browning-Ferris Industries, Inc. Site, Lake County IL

This site is situated in the western half of Section 7 of Benton Township in Lake County. Although the area is composed primarily of rural open space, farmland, and wooded areas, dwelling units are located to the west (along Green Bay Road), to the east (single-family dwellings), and to the north (low density, multi-family cluster) of the site. A total of approximately 28 buildings are located within 0.5 miles of the site. Other land uses within a 1- to 2-mile radius of the site include a gravel pit, scattered commercial and industrial uses, and two other existing landfill sites (American Ad-Mixtures and North Shore Sanitary District).

New Site, Option 1, Lake County IL

This site is located in Warren Township of Lake County. The land use within a 0.5-mile radius primarily is rural, composed of farmlands, woodlots, and small ponds. The development pattern becomes more dense farther away from the site. Commercial, industrial, and residential uses are all found within a 2-mile radius of the site including two industrial parks and small subdivisions around Gages Lake.

New Site, Option 2, Lake County IL

This site also is located in Warren Township of Lake County. Land use near the site includes scattered farmsteads and industrial uses as well as the St. Sava Monastery. In all, approximately 38 structures are located within a 0.5-mile radius of the site. Additional institutional, residential, and commercial/industrial uses are apparent within a 2-mile radius of the site

including parts of four communities: Park City, Gurnee, Wildwood, and Libertyville.

Chemical Waste Management Co. Site, Calumet City IL

There is a residence in middle of site

The Chemical Waste Management site is located adjacent to the Little Calumet River in the Hyde Park South Township of Cook County. The area is primarily industrial and includes excellent rail access (Chicago, South Shore, and South Bend; New York Central; and Baltimore and Ohio Railroads) as well as a harbor on Lake Calumet. The Calumet Expressway lies directly west of the site. Approximately 90 structures are located within a 0.5-mile radius of the site; most are used for industrial purposes. Residential, commercial, open space, and additional industrial uses lie within 2 miles of the site including several forest preserves and the communities of Thornton and Calumet City.

CECOS International (CERN) Site, Williamsburg OH

No specific land use information currently is available for the CECOS International site in Williamsburg, Ohio. A review of USGS topographic maps indicates that approximately 67 structures lie within 0.5 miles of this site. However, the area in the vicinity of the site generally can be characterized as rural.

SCA Chemical Waste Services, Inc. Site, Model City NY

No information currently is available for this site.

3.2.2. Population and Economics

3.2.2.1. Population

The City of Waukegan is the most populated municipality in Lake County. The official 1980 Census figure is 67,653 (US Bureau of the Census 1981). From 1970 to 1980, population growth in Waukegan (3.2%) was markedly slower than in Lake County as a whole (15.1%) for the 10-year period. Population projections for the City of Waukegan for the year 2000 range from 87,269 to

111,301 (City of Waukegan 1980). The most probable projection is 93,000. Currently, all of the residential development in Waukegan is located outside of the Harbor area. This development trend is expected to continue because no land in the Harbor area is zoned residential and there is little land suitable for residential development in the area.

3.2.2.2. Employment

The Waukegan Harbor area is the major industrial center in the City of Waukegan and is an important component of the industrial district located along the shore of Lake Michigan between North Chicago and Waukegan. Companies first began to locate in the Harbor area during the early 1900s. Currently, the fifteen publicly- and privately-owned establishments located in the Harbor area employ 12% of the persons employed in Waukegan. The total number of jobs in the Harbor area is approximately 3,500 (Appendix J). Employment ranged from 3 at Waukegan Architectural, Inc. to approximately 3,100 at OMC (including the Johnson Outboards Division), the largest employer in the City of Waukegan. Other industries located in the Harbor area include manufacturing, transportation, and marine-related services (Appendix J).

A cursory survey of the employers in the Harbor area indicates that much of the economic activity either is water-dependent or water-related. The Outboard Marine Corporation (manufacture of marine engines and related machinery), Larsen Marine (marine sales and services), Falcon Marine (marine contractor), Waukegan Port District (transportation services), the Waukegan Yacht Club (recreation), and the Waukegan Water Filtration Plant (public water supply) depend upon the Harbor and Lake Michigan for their operations. Huron Cements and Goldbond Building Products, both of which are Divisions of National Gypsum, Larsen Marine, Falcon Marine, the Waukegan Port District and the Waukegan Yacht Club depend upon a working harbor for their operations.

The Waukegan Port District operates the Waukegan Harbor. The Port District's gross revenues during 1980 totalled $286,950 (By telephone, Bruce Lawson, Deputy Director, Waukegan Port District, to WAPORA, Inc., 20 October

1981). The sources of these revenues are shown below:

Gasoline sales	$13,000
Land leases	64,000
Slip rental	78,000
Dry moorings	35,000
Wet moorings	8,200
Slip hopping	14,000
Parking lot fees	16,000
Boat launching	31,000
Charter Boat permits	6,500
Temporary docks	7,800
Interest	7,500
Micellaneous	5,950
Total	$286,950

During 1980 there were approximately 43 commercial ship dockings at Waukegan Harbor (By telephone, Bruce Lawson, Deputy Director, Waukegan Port District and Susan Du Bois, Goldbond Building Products to WAPORA, Inc., 19 October 1981). Shipping activity in the Harbor varied widely from 1969 to 1980. The number of tons of cargo hauled over the 11-year period ranged from 588,866 in 1971 to 282,500 in 1980 (USCOE n.d. and Waukegan Port District 1981). The decline in shipping activity during 1980 reflects the nature of the Port District's commercial clients. The Port District currently serves two commercial clients: Huron Cements and Goldbond Building Products. Huron Cements is located on the northwest side of the Harbor between Slip #3 and Slip #1. Goldbond Building Products is located south of Slip #1 (Figure 1-2). During 1980, 282,500 tons of bulk cement and gypsum rock were hauled into the Harbor for these two clients, respectively. Because Huron Cements and Goldbond both supply building materials for the construction industry in the Chicago metropolitan area, their need for raw materials is directly related to the level of construction activty taking place. During 1980 and 1981, construction activity in the Chicago area was relatively slow and shipping activity at Waukegan Harbor likewise declined (By telephone, Jim Woodly, Huron Cements to WAPORA, Inc., 20 October 1981). At the current level of business, Goldbond and Huron Cements have sufficient capacity to stockpile raw materials for approximately one month if given sufficient advance notification (By telephone Jim Woodly, Huron Cements to WAPORA, Inc., 20 October 1981 and Susan Du Bois, Goldbond Building Products to WAPORA Inc., 19 October 1981). Huron Cements and Goldbond both dock at Slip #1 to unload cargo. Depending upon the size of

the ship, Goldbond's ships either back out of the Harbor or back around into Slip #3 to swing the bow around. Huron Cements' ships back around into Slip #3 and leave the Harbor bow first.

The Port District currently leases land to Huron Cements, Goldbond, the Waukegan Yacht Club, and Falcon Marine. The Waukegan Yacht Club operations are located on the west side of the Harbor by the boat mooring area (Figure 1-2).

Do they have agreements with owners?

Falcon Marine is located on the east side of the Harbor adjacent to the Waukegan Water Filtration Plant. Falcon Marine docks between four and eight barges along the seawall by the proposed lagoon site. The barges are between 30 and 42 feet wide and 100 to 120 feet long (By telephone, Gerry Lapish, Falcon Marine to WAPORA, Inc., 20 October 1981).

3.2.2.3. Unemployment

Unemployment in the City of Waukegan was high during 1980. The unemployment rate of 9.8% was higher than the Lake County rate of 6.9%, the State rate of 8.3%, and the national rate of 7.1% (By telephone, Francis Williams, Illinois Department of Labor, to WAPORA, Inc., 18 August 1981; By telephone George Erhart, US Bureau of Labor Statistics, to WAPORA, Inc., 18 August 1981). This rate may reflect the concentration of Waukegan employment in manufacturing industries that have experienced slow growth during recent years. This is a national trend which is most visible in older industrial areas in the northern states.

3.2.2.4. Future Economic Development

Industrial activity in the Waukegan Harbor area is expected to remain stable with little expansion. Two buildings located in the southern portion of the Harbor area are scheduled to be demolished when the new dock facilities are constructed to the south of the southernmost breakwater and outside of the existing Harbor (By telephone, Bob O'Neill, City of Waukegan to WAPORA, Inc., 18 August 1981). The value of land in the Harbor area for recreation and open space uses will increase. Planned industrial growth will be directed

[illegible] is this current?

to the west of the Harbor area. The projected 1995 employment range is 34,425 to 37,150 (City of Waukegan 1980). Employment is expected to remain concentrated in manufacturing industries. Increases in the retail, transportation and utilities, and miscellaneous services sectors also are expected.

3.2.3. Transportation Facilities

3.2.3.1. Port Facilities

The Waukegan Harbor is a 14-acre interior basin with a 200-foot-wide, 19-foot-deep channel. The Harbor facilities are maintained and operated by the Waukegan Port District and are used for both recreational and industrial purposes. The Harbor is open from 15 April to 15 November. The Harbor facilities provide the Waukegan area with access to world markets. The majority of the Harbor traffic, however, consists of pleasure boats (By telephone, Victor White, Waukegan Port District, to WAPORA, Inc., 24 August 1981). There are more than two hundred 20- to 40-foot pleasure boats moored in the Harbor. An expansion of the Harbor is underway and will add 750 public mooring slips. The new boat basin is being constructed by adding a new breakwater to the south of the existing south breakwater. Construction is scheduled to be completed by 1983.

3.2.3.2. Highway Facilities

The road network near Waukegan is comprised of publicly and privately owned roads. Interstate Highway 94 is located approximately 6 miles west of Waukegan Harbor and the nearest interchange is at Grand Avenue (Route 132).

The City of Waukegan has established a truck route system and has designated eight full truck routes in the system:

- 10th Street
- Belvidere Street
- Grand Avenue

Should be referenced or used in mitigation section

- Route 41
- Green Bay Road
- Sheridan Road, except the stretch between Grand Avenue and Greenwood Avenue
- Amstuts Highway
- Greenwood Avenue, east of Sheridan Road.

This is will need to be defined into footpath

A full truck route is defined by Illinois Statutes hauling laws. The weight limits for a full truck route are 18,000 pounds per axle or 32,000 pounds on a tandem (By telephone, Corporal Burleson, City of Waukegan, Traffic Division, to WAPORA, Inc., 28 August 1981). The truck routes are heavily traveled, but substantial additional capacity is available (By telephone, Corporal Burleson, City of Waukegan, Traffic Division, to WAPORA, Inc., 28 August 1981).

3.2.3.3. Railroad Facilities

The Chicago and North Western Transportation Company (C&NW) and the Elgin, Joliet, and Eastern Railroad Company (EJ&E) operate freight lines in the western portion of the Harbor area. In general, operations on both sets of tracks are light and therefore do not interfere with automobile traffic patterns.

The C&NW operates an engine yard in the Waukegan area. There are approximately six total daily operations. There are bridges over the tracks at Grand Avenue, Washington Street, and Route 120. The only grade-level C&NW crossing is at Greenwood Avenue (By telephone, John Havirla, C&NW Yardmaster, to WAPORA, Inc., 26 August 1981).

Two daily trains cross the EJ&E tracks, once between 8:00 a.m. and 10:00 a.m. and once between 11:00 a.m. and 1:30 p.m. There are an average of ten cars per train (By telephone, Bob Massey, EJ&E, to WAPORA, Inc., 28 August 1981). There are grade-level crossings located at Madison Street, Clayton Street, and Derringer Road. The present level of operations is markedly lower than that of early 1980 when there were 15 trains a day, each averaging 103 cars in length (By telephone, Bob Massey, EJ&E, to WAPORA, Inc., 28 August 1981).

3.2.3.4. Regulations Governing the Transport of Hazardous Wastes

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Currently, there are few regulations governing the transport of hazardous materials. The Interstate Commerce Commission and the Illinois Commerce Commission can issue a Certification of Authority to a carrier to transport and haul commodities including PCBs. A carrier that is not certified by either of these two commissions must obtain a waste hauler's permit from IEPA. IEPA has the authority to issue Special Waste Hauler's Permits for the transport of PCB-contaminated waste (as defined under the Toxic Substances Control Act) within Illinois (USEPA 1981).

we should handle as though it were haz. was.

Under the Resource Conservation and Recovery Act (P.L. 94-580) standards applicable to transporters of hazardous wastes were promulgated (40 CFR Part 263). These standards are in agreement with the regulations of the US Department of Transportation (DOT) concerning the transportation of hazardous waste as stated in the Hazardous Materials Transportation Act (40 CFR 171-177; USEPA 1981). Because DOT does not specify PCBs as a hazardous substance for the purposes of regulation, specific permits for transportation of PCBs are not required. However, extensive new regulations have been proposed (Federal Register 34560-34707, 22 May 1980) which represent the combined efforts of DOT and USEPA to update current regulations. These regulations will not become final for an indeterminate period of time (USEPA 1981). PCBs are listed in the table of hazardous substances in the proposed regulations. Information on transportation of PCBs including packaging requirements also is provided in these regulations (USEPA 1981).

3.2.4. Recreation and Tourism

Many types of recreation facilities and opportunities are available at Waukegan Harbor. The Illinois Department of Conservation, Division of Fisheries and Wildlife, has estimated that Waukegan Harbor and offshore areas experience the heaviest fishing pressure of any area along the Illinois coastline of Lake Michigan (Muench 1981). Although the majority of the recreational uses of the Harbor are related to fishing, a substantial amount of pleasure boating, sailing, picnicking, and other waterrelated activities also take place.

3.2.4.1. Boating

The 10 public boat launching ramps at the Harbor open for use on 1 April each year. However, the gas dock does not open until 15 April. The 117 slips and 41 mooring cans are open by 1 May. There also are 75 dry parking spaces for boats. The boats must be out of their moorings by 1 November. Demand for the boat moorings is quite high and the current waiting list contains more than 600 applications.

A considerable amount of boat-launching activity occurs at the Harbor. During the period April 1980 through 31 July 1980, 5,110 boat launching tickets were sold (a $3 fee is charged). During the same period in 1981, 5,755 tickets were sold. This does not account, however, for the approximately 450 season-pass holders who have unlimited boat launching privileges (By telephone, Sally Houghton, Waukegan Port District, to WAPORA, Inc., 5 August 1981).

Larsen Marine Services, Inc., is located adjacent to Slip #3 at the north end of Waukegan Harbor and is the largest lakefront yacht dealer in the Chicago metropolitan area. Because Waukegan Harbor is the only protected public harbor along the northern Illinois shoreline, a large amount of recreational boating activity is concentrated there. Larsen Marine is the only marine sales and services company located directly on Waukegan Harbor. The company provides yacht brokerage for new and used power boats and sailboats and offers complete marine repair services. A crane operated boat hoist is also available for removal and storage of all size classes of boats. These services are of considerable importance to recreational boaters in the region because there are no similar commercial facilities on the northern Illinois coastline.

3.2.4.2. Fishing

Currently, 35 licensed charter boats operate out of Waukegan Harbor. The licenses are issued by the Illinois Department of Conservation and the number of licenses issued is limited to 35. Of this total, 27 are members of the Waukegan Charter Boat Association and the remainder operate independently.

The Charter Boat Association estimates that its 27 boats have between 12,000 to 15,000 paying clients per season (By telephone, Bobbie Stirnichuk, Waukegan Charter Boat Association, to WAPORA, Inc., 5 August 1981).

This boating activity results in substantial fishing pressure. According to Muench (1981) the "...intensity of boat fishing is related to the quality and location of nearby public boat ramps." There are 14 public boat access points along the Illinois shoreline to serve the entire metropolitan region. Although Waukegan is 40 miles north of Chicago, the major population center of the region, the Waukegan area experiences the greatest fishing pressure along the entire Illinois shoreline of Lake Michigan. This estimation is based on a 1979 sport fishing creel survey conducted along the Illinois portion of Lake Michigan by the Illinois Department of Conservation (Muench 1981).

The results of the creel survey indicated that the heaviest pier/breakwater fishing pressure was experienced at Waukegan Harbor and that the heaviest boat fishing pressure was experienced offshore from Waukegan Harbor (Appendix K). The survey personnel estimated that a total of 222,918 angler hours were expended for pier/breakwater fishing along the Illinois shoreline. At Waukegan Harbor, the 1979 estimate of angler hours was 45,974, or 21% of the total (Appendix K). However, the average number of fish caught per hour at Waukegan Harbor was the second lowest rate of the 14 sites listed.

The estimates for the trolling fishery also indicated that more angler hours were expended at Waukegan Harbor than at any of the other locations (Appendix L). Of the total 601,426 estimated angler hours spent trolling, 184,554 (31%) were allocated to Waukegan Harbor. As for the pier/breakwater fishery, the number of fish caught per hour was relatively low; of the 14 locations listed by Muench (1981), only 3 had lower catch-per-hour figures. The majority of the fish caught by both pier/breakwater and trolling fishing were coho salmon. Half of all the coho caught from the pier/breakwater fishery were from Waukegan Harbor. The Waukegan Harbor trolling fishery accounted for 34% of all the coho salmon caught along the Illinois shoreline in 1979.

Although significant fishing activity took place on the Waukegan breakwater and from boats in 1979, relatively little shore fishing occurred at Waukegan Harbor (Appendix K). Of the 285,374 angler hours estimated for the 1979 shore fishery, only 1,179 (0.4%) were allocated to Waukegan Harbor.

Although the majority of fish caught were yellow perch (79% of the total catch), "...perch fishing was generally better in north and south Cook County than in Lake County" (Muench 1981). Coho salmon were the second most abundant caught fish with an estimated catch of 90,000 (Muench 1981). The creel survey identified Waukegan as the most successful boat fishing area for coho with a total catch higher than the second- and third-ranked areas added together. The 1979 chinook salmon catch was estimated to be 28,000 fish, two-thirds of which were taken by boat fishermen. Waukegan Harbor recorded the second-highest chinook catch.

Waukegan Harbor and nearby offshore areas were found to be relatively productive for trout fishing. According to Muench (1981), "...the best area for boat fishing for rainbows is Waukegan... areas of outstanding lake trout catches were off Dawes Park (Evanston) and Waukegan ... (and) nearly all the brown trout reported in the boat fishery came from Lake County, mainly from Spring Bluff and Waukegan."

Muench (1981) estimated that the Lake Michigan sport fishery generates at least $9,200,000 in purchases annually, mostly in northeastern Illinois. This estimate is based on 1,760,000 angler-hours which involve 368,000 trips (at 4.8 hours per average trip). The estimate assumes an average value for an angler-day trip of $25 (Talhelm 1979).

A total of 371,789 angler hours were estimated for the Waukegan Harbor fishery (Muench 1981). At 4.8 hours per average trip, 371,789 angler hours involved a total of 77,456 angler-day trips. If the average value of each trip is assumed to be $25, approximately $1,936,401 in purchases were generated by the total Waukegan Harbor fishery in 1979.

3.2.4.3. Other Recreational Activities

In addition to fishing, a substantial number of people use the Waukegan Harbor for sailing, picnicking, or sightseeing. The beach to the north and east of the Harbor is used for swimming, sunbathing, volleyball, and public events. Recreational facilities in the Harbor area in addition to the boat mooring and public launching areas include the Waukegan Yacht Club, the Warren G. Sivert Park, and the south breakwater. The Yacht Club owns a clubhouse adjacent to the Harbor and currently has 350 members (By telephone, Michael Urban, Waukegan Yacht Club, to WAPORA, Inc., 5 August 1981). The Yacht Club sponsors several events during the year that bring large numbers of people into the Harbor. The biggest of these is the annual Chicago to Waukegan sailboat race which is held in July. Over 300 boats participated in this race in 1981. The Warren G. Sivert Park is a small park immediately west of the boat mooring area. There also is a small concession stand in this area that sells food, beverages, ice, and fishing supplies. Public restrooms and picnic tables are available at the Park.

The south breakwater is used for sight-seeing, walking, sunbathing, and birdwatching as well as for fishing. The long breakwater ends at the lighthouse that marks the entrance to the Harbor.

The public beach to the north and east of the Harbor (Figure 3-5) is manned during the summer by lifeguards and is supervised by a beach director and security director (By telephone, Paul Seveska, City of Waukegan, to WAPORA, Inc., 5 August 1981). There are three picnic pavilions with grills and a bathhouse with washrooms and showers. There also is a concession stand at the north end of the beach and a snack bar at the south end. The use of the beach is free to Waukegan residents; nonresidents must pay a $2 fee.

The City also sponsors five festivals each year at the beach that include food, music, games, and fireworks. The City expects between 70,000 and 80,000 people to attend festivals in 1981. Because there are only 250 public parking spaces available at the beach, the City has an informal arrangement with OMC to use the vacant area across from the beach for parking for the festivals. Approximately 2,500 cars can be accommodated in this area.

The old foundry property

3.2.5. Sewer and Utility Lines

3.2.5.1. Storm and Sanitary Sewers

The North Shore Sanitary District (NSSD) and the City of Waukegan provide storm and sanitary sewers in the project area. The system in the vicinity of the North Ditch consists of a 54-inch diameter gravity sanitary sewer, a 48-inch diameter gravity combined sewer, and a 54-inch diameter force main. These sewers are located parallel to each other in an east-west direction just north of the south property line of the NSSD Waukegan treatment plant which parallels the North Ditch (By telephone, Leonard Latz, City of Waukegan, Engineering Department, to WAPORA, Inc., 28 August 1981; by telephone, Pat Wells, NSSD, to WAPORA, Inc., 24 August 1981). There is a sanitary sewer traversing the vacant lot owned by OMC in the vicinity of the proposed lagoon construction site. Another sewer runs north from the water filtration facilities near the Harbor mouth along the beach to the NSSD treatment plant. This sewer was installed in 1978 to carry filter-backwash solids away for treatment and disposal.

3.2.5.2. Water Lines

There are no water mains in the immediate vicinity of the North Ditch. There is a 24-inch water main in the right-of-way of Seahorse Drive. Individual service lines extend from this main (By telephone, Leonart Latz, City of Waukegan, Engineering Department, to WAPORA, Inc., 28 August 1981).

3.2.5.3. Natural Gas Lines

The North Shore Gas Co. provides natural gas to the project area. The system consists of a 12-inch diameter gas main located along the private road that extends from the northwest corner of the OMC property east and south to Seahorse Drive. The main continues along the north-south section of Seahorse Drive to the Waukegan Water Filtration Plant. Two vault regulators are located south of the east-west section of Seahorse Drive on the vacant OMC property (By telephone, Steve Duncan, North Shore Gas Co. to WAPORA, Inc., 24 August 1981).

3.2.5.4. Electrical Lines

The Commonwealth Edison Co. provides electrical service to the project area. Underground and overhead facilities are located in the vicinity of the North Ditch. Underground facilities are located in the Harbor itself and on the vacant parcel of land owned by OMC.

3.2.5.5. Telephone Lines

The Illinois Bell Telephone Co. provides telephone service to the project area. Most of the telephone cables are located in street rights-of-way. Service cables extend to individual properties (By telephone, Dick Parker, Illinois Bell Telephone Co., to WAPORA, Inc., 25 August 1981).

3.2.6. Cultural Resources

A variety of cultural resource sites and activities are located in the City of Waukegan including two community theaters, a center for performing arts, a municipal band and symphony orchestra, and a historic district. None of these, however, are located within the Harbor area. No landmarks on the National Register of Historic Places are located in the Harbor area and no historical or archaeological sites are known to exist there (By telephone, Miss Booth, Waukegan Historical Society, to WAPORA, Inc., 18 August 1981). The State Historic Preservation Officer (SHPO) has been contacted for confirmation of this information (Appendix L).

Five sites of local significance are located in the Harbor area (By telephone, Miss Booth, Waukegan Historical Society, to WAPORA, Inc., 18 August 1981):

- A memorial shelter at Leisure Park
- A memorial boardwalk
- A bandshell that was constructed through the efforts of the Waukegan Exchange Club
- A historical marker that commemorates five explorers who were present in the Waukegan area during the 1670s

- A beach pavilion presented to the people of Waukegan in July 1940. The bricks used in the front pillars came from the old Waukegan lighthouse which was razed in 1938.

4.0. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

The environmental consequences of the alternatives detailed in Section 2.0. are discussed in this section. The discussions are divided into two main areas: the natural environment (Section 4.1.) and the man-made environment (Section 4.2.).

The five alternatives that are addressed are consecutively more comprehensive, beginning with Alternative #1 (the No Action Alternative) and ending with Alternative #5 (the most comprehensive alternative). In addition, a specific alternative will include all the components of the previously addressed alternative as well as some new components. For example, Alternative #4 includes all the components of Alternative #3 plus the excavation of the Crescent and Oval Lagoons. Consequently, the impacts discussed for Alternative #4 will include all impacts discussed for Alternative #3 and any additional impacts expected from excavation of the Crescent and Oval Lagoons.

The generic impacts from the transportation and ultimate disposal of the contaminated material are discussed under Alternative #2 because this is the first alternative which includes these project components. For all the other alternatives (#3, #4 and #5) requiring these project components, the reader is referred to the discussion presented under Alternative #2.

4.1. Natural Environment

This section discusses the environmental consequences of each of the five alternatives. The consequences are discussed by resource and include air quality, noise, topography and geology, soils, groundwater, surface water, terrestrial biota, and aquatic biota.

4.1.1. Air Quality

4.1.1.1. Alternative #1

The short-term air quality impacts of this alternative should be minimal. All impacts occurring from dredging, excavation, construction and truck

traffic will be avoided. However, long-term adverse air quality impacts could take place as a result of the continual release of PCBs to the air.

M+H report

It has been estimated (USEPA 1981a) that the present volatilization rate of PCBs from Waukegan Harbor is approximately 40 pounds per year. The primary long-term impact that could arise from the volatilization would be the ongoing risk to the public associated with continuous exposure to PCBs over a long period of time.

$\frac{40}{365} =$ x area

4.1.1.2. Alternative #2

The dredging of Waukegan Harbor, especially Slip #3, would increase PCB concentrations in the air. Health risks would be greatest for the workers involved in the dredging operations with local air concentrations of PCBs probably in excess of the recommended NIOSH 8-hour standard of 1 ug/m^3, but probably well below the 500 ug/m^3 OSHA standard. The more stringent NIOSH standard is for continuous occupational exposure and is based on a time-weighted average (TWA) concentration for up to a 10-hour workday or 40 hour workweek. The OSHA standard is based on intermittent or short-term exposure to PCBs.

what's this? compare with TLV booklet

The greatest public exposure to increased PCB levels from the dredging operations probably would occur at the nearby public beach. PCB levels in the air near the beach probably would increase, but are not expected to exceed safe levels because the emission source would be very localized and temporary.

The dredging operations would require a dewatering lagoon on vacant OMC property adjacent to the Harbor. Because the dewatering lagoon would be temporary, no long-term effects are anticipated. However, short-term effects may result from volatilization of PCBs during the excavation and operation of the lagoon, and fugitive dust would be generated at the construction site and along the roads leading to and from the site.

dust & overburdens

The area affected by fugitive dust would depend upon local wind direction and velocity. Normally, the wind blows from the lake towards the land during the day. Therefore, the areas west of the site may be most vulnerable to

dust, while the surrounding areas to the north and south may experience occasional dust impacts as the wind shifts in those directions.

Sensitive receptors west of the lagoon site include National Gypsum Company and Larsen Marine (Figure 1-2). The public beach is not expected to be significantly affected by fugitive dust on the basis of past data concerning daytime wind conditions. The Harbor, boat launching and breakwater areas south of the site also are sensitive receptors, and could be affected by fugitive dust generated during construction of the dewatering lagoon.

The operation phase of the lagoon can be divided into three separate steps. In the first step (Phase 1), it is anticipated that the Slip #3 muck sediments (7,300 yd^3) would be dredged over a period of six days and placed in the lagoon. It is estimated that the lagoon water would contain approximately 100 ppb of dissolved PCBs (USEPA 1981a). The lagoon water would be continuously mixed with fresh dredged material which releases PCB to the water to replace PCBs lost by volatilization. When finished, the lagoon should contain 7,300 yd^3 of muck sediments and 71,000 yd^3 of water with an average exposed surface water area of 210,000 ft^2 (..... m^2).

General Electric (GE) has conducted PCB volatilization tank tests on contaminated water and sediment samples. Based on data derived from the tank tests, it is possible to estimate the PCB volatilization rate from the dewatering lagoon. The expected worst case meteorological situation for the determination of the impact on the North Beach would be high temperature and low wind speed. Therefore, GE data was obtained for a temperature of 20°C and a wind speed of 3.62 mph ~~are assumed to apply~~. For these conditions, the Aroclor 1242 volatilization rate from a saturated solution (assumed by Mason & Hanger to be 200 ppb) was estimated at 4 $mg/m^2/hr$.

If the volatilization rate is assumed proportional to the estimated concentration of PCBs in the lagoon water (100 ppb), the following volatilization rate is predicted (assuming a water surface area of 210,000 ft^2 [USEPA 1981a]):

$$\frac{100\ ppb}{200\ ppb} \times \frac{4mg}{m^2/hr} \times \frac{0.092m^2}{ft^2} \times 210{,}000\ ft^2 \times \frac{1b}{453{,}600\ mg} = 0.086\ lb/hr\ (0.0108g/sec)$$

how does this rate compare to current harbor rate?

This volatilization rate is expected to last for the minimum six-day period it will take to dredge Slip #3. Based on a simplified dispersion analysis, the average 8-hour ambient PCB level at the public beach is estimated to be 3 ug/m^3 (Appendix M).

Although this level is greater than the NIOSH recommended 8-hour level of 1 ug/m^3, it is well below the 500 ug/m^3 OSHA standard. In addition, the predicted level is not expected to represent any significant health hazard because of the following:

- The approach taken is very conservative
- The methodology assumes that worst case wind speed and direction will occur during the entire six days of dredging
- The NIOSH level was recommended for a population exposed to 1 ug/m^3 for 8-hour intervals during extended working periods. The population using the beach will vary almost daily and ~~very~~ few of the same people will continuously be exposed
- The dredging would take place, if possible, during the spring or fall when few people use the beach or during periods of low beach use during the summer (cloudy weekdays). ~~Further, the public beach can be closed during dredging operations, if necessary.~~

delete

During the second step in the operation of the lagoon, the water treatment plant would be tested to insure that the water returned to the Harbor contains less than 1 ppb of PCB. This period of time is assumed to be five days (USEPA 1981a). At this point, the dredging of Slip #3 would be complete and the lagoon should contain 71,000 yd^3 of water containing 100 ppb of PCB. The emissions during this step are assumed to be approximately the same as in the first step because the same PCB concentration in the water column is anticipated. The actual emissions would probably be lower because the water is not as strongly agitated as during the dredging phase.

During the third step (~~Plan~~ phase 2), 38,000 yd^3 of sediment would be dredged and placed in the lagoon. The concentration of PCB in the water may vary anywhere from 1 to 100 ppb due to the lower PCB concentration in these sediments. The average concentration is assumed to be 30 ppb (USEPA 1981a) with the surface area of the water estimated to be 280,000 ft^2. The volatilization

4
5
40

rate during this period (approximately 40 days) is:

$$\frac{30 \text{ ppb}}{200 \text{ ppb}} \times \frac{4 \text{ mg}}{m^2/\text{hr}} \frac{0.0929 \text{ } m^2}{ft^2} \times 280{,}000 \text{ } ft^2 \times \frac{\text{lb}}{453{,}6000 \text{ mg}} = 0.034 \text{ lb/hr}$$

Using the same dispersion characteristics utilized for the first step of the operation of the lagoon (Appendix M), the 8-hour concentration at the public beach would be:

$$\frac{0.034}{0.086} \times 8 \text{ ug/m}^3 = \underline{3.4 \text{ ug/m}^3}$$

After the dredging operations are completed, the contents of the lagoon must be excavated. This process consists of first draining the lagoon prior to the actual excavation. The water cap over the sediment during draining is estimated to have a concentration of 10 ppb of PCB with an exposed area of 200,000 ft^2 (USEPA 1981a). Using the same methodology previously described, the volatilization rate during this phase is as follows:

$$\frac{10 \text{ ppb}}{200 \text{ ppb}} \times \frac{4 \text{ mg}}{m^2/\text{hr}} \times \frac{0.0929 \text{ } m^2}{ft^2} \times 200{,}000 \text{ } ft^2 \times \frac{\text{lb}}{453{,}600 \text{ mg}} = 0.0082 \text{ lb/hr}$$

The 8-hour concentration at the public beach would be:

$$\frac{0.0082}{0.086} \times 8 \text{ ug/m}^3 = 0.1 \text{ ug/m}^3$$

This concentration is below the NIOSH recommended level of 1 ug/m^3.

During the actual excavation process, the amount of PCBs volatilized depends both upon the concentration of PCBs in the exposed sediments and on the area of exposed sediments. When it is necessary to excavate the more contaminated sediments, the area exposed at any one time should be as small as possible. It has been estimated that 1,450 lbs/month (48.3 lbs/day) of PCB would be volatilized from sandy sediment containing 10,000 ppm of PCB covering an area of 280,000 ft^2 (USEPA 1981a). If this material were capped with

uncontaminated material and excavated only 200 ft^2 at a time, the volatilization rate would be:

$$\frac{48.3 \text{ lbs}}{\text{day}} \times \frac{\text{day}}{24 \text{ hr}} \times \frac{200 \text{ ft}}{280{,}000 \text{ ft}^2} = 0.0014 \text{ lb/hr}$$

The 8-hour concentration at the public beach then would be:

$$\frac{0.0014}{0.086} \times 8 \text{ug/m}^3 = 0.13 \text{ ug/m}^3$$

This also is below the NIOSH recommended level of 1 ug/m^3. However, this phase of the project has the largest potential (if not handled properly) to pose a health problem because the 8-hour ambient concentration would increase proportional to the amount of sediment exposed at any one time.

The transport of the contaminated material to the ultimate disposal site is a short-term activity and no long-term irreversible air quality impacts are expected. The mode of transport is currently unknown; however, assuming proper precautions are taken (that is, covering the material) volatilization is expected to be negligible.

delete

During the transfer of the contaminated material from the hauling mode into the ultimate disposal site location (currently unknown), some PCB volatilization is expected. Due to the lack of data, the ~~volatilization rates and~~ ultimate air concentrations cannot be determined. It should be noted, however, that the fewer times the material is handled (and consequently mixed with the air), the lower the potential ambient PCB concentrations will be.

When the disposal site has been filled it must be properly capped and vented. These precautions are required by the Federal regulations concerning hazardous waste landfill sites; therefore, it is assumed that there would be no irreversible air quality impacts from the disposal of the contaminated material in an approved landfill.

correct?

4.1.1.3. Alternative #3

we have good idea here; it's parking lot!

The impacts discussed for Alternative #2 also apply to Alternative #3. Although it is clear that the North Ditch is heavily contaminated with PCBs, any estimate of the extent of contamination can only be made to an order of magnitude based on the information available (USEPA 1981b). In addition, the rate of volatilization is proportional to the concentration of PCBs in the sediments with the area of contaminated sediments exposed at any one time. Therefore, no quantitative estimate of the volatilization rate during the construction of the North Ditch stormwater diversion can be made.

4.1.1.4. Alternative #4

The impacts discussed for Alternative #3 also apply to Alternative #4. In addition, some volatilization is expected from the excavation of the Crescent and Oval Lagoons. Because insufficient data are available, no determination of PCB air concentrations can be performed. However, the overall impact of this alternative would be greater than the previously discussed alternatives because more highly contaminated soils would be removed and consequently a greater volatilization rate could be expected.

4.1.1.5. Alternative #5

The impacts, discussed for Alternative #4 also apply to Alternative #5. The Parking Lot removal options vary from removing 40,000 yd^3 to 100,000 yd^3 of contaminated material. Because the concentrations of PCBs and the final construction plans are unknown, it is not possible to determine the potential volatilization rate, and resultant ambient PCB concentrations. This alternative, however, would have a greater impact than Alternative #4 because a greater amount of contaminated material would be removed. — speculation

4.1.2. Noise

4.1.2.1. Alternative #1

The No Action Alternative would not result in any increased noise levels over those that currently exist at the Waukegan Harbor site (Section 3.1.3).

4.1.2.2. Alternative #2

This alternative has three main noise-producing activities associated with it: construction; dredging; and transportation. The construction activities generally would impact the area surrounding the vacant OMC lot where the temporary storage and dewatering lagoon is planned and the area surrounding the final disposal site (assuming that this site requires development or some type of modification). The areas adjacent to Slips #2 and #3 would be impacted by noise generated during the proposed dredging activities. Transportation-related noise would impact areas along the corridors used for transporting clay to the lagoon site and for transporting contaminated material to the final disposal site.

Community noise levels are commonly described as a 24-hour average noise level (L_{eq}). The L_{eq} is adjusted to represent noise levels during day and night time conditions which is then expressed as L_{dn}. In determining L_{eq} or L_{dn} from activities such as construction, dredging, and hauling, several factors must be addressed. These include distance from the noise source, characteristics of the noise source (that is, type of equipment used), number of equipment pieces, number of the pieces working simultaneously, duration of working shifts, barriers located between noise source and receptor (for example, buildings, topographic relief, structures), and background noise levels. Most of the data required to determine L_{eq} and L_{dn} for the activities proposed under this alternative are not available.

The proposed lagoon construction activities would utilize heavy equipment such as trucks, bulldozers, compactors, generators, backhoes and other earth moving equipment. Noise levels for various pieces of construction equipment measured in decibels (dBA) at a distance of 50 feet are presented in Table 4-1. Because the construction period is relatively short-term, no irreversible impacts are expected.

Increases in noise levels at the final disposal site would be dependent on the activities needed to make the site acceptable for disposal of the contaminated materials. These may vary from complete site development to minor site modifications. It is not possible to determine the increases in

Table 4-1. Measured noise levels of construction equipment (USEPA 1971).

Equipment	Noise Level (in dBa at 50 feet)	Equipment Noise Sources[a] (in order of importance)
Earthmoving		
Front-end loaders	79	E C F I H
Backhoes	85	I C F I H
Dozers	80	E C F I H
Tractors	80	E C F I W
Scrapers	88	E C F I W
Graders	85	E C F I W
Trucks	91	E C F I T
Pavers	89	E C F I
Stationary		
Pumps	76	E C
Generators	78	E C
Compressors	81	E C H I
Impact		
Pile drivers	101	W P E
Jackhammers	88	P W E C
Rock drills	98	W E P
Pleumatic tools	86	P W E C
Other		
Saws	78	W
Vibrators	76	W E C

[a] Sources:

C - Engine Casing
E - Engine Exhaust
F - Cooling Fan
H - Hydraulics
I - Engine Intake
P - Pneumatic Exhaust
T - Power Transmission Systems, Gearing
W - Tool-Work Interaction

noise levels that would occur, because of the lack of data regarding the disposal site. However, those sites that are currently under consideration are used at present as disposal sites or are located in sparsely developed or undeveloped areas. Therefore, it is anticipated that there would be no significant noise impacts at the final disposal site.

Because the mode of transporting contaminated material is unknown at this time, it is not possible to determine potential transportation-related impacts. However, of the three available modes (truck, barge, train), barging would most likely have the least noise impacts.

4.1.2.3. Alternative #3

The impacts discussed for Alternative #2 are the same for this alternative. In addition, the construction of a North Ditch stormwater diversion would create an increase in noise levels north in the vicinity of the North Ditch. Noise associated with this activity would be caused by earth-moving and other construction equipment. No significant impacts are expected from this additional activity.

4.1.2.4. Alternative #4

The impacts discussed for Alternative #3 are the same for this alternative. In addition, this alternative includes the excavation of contaminated materials from the Crescent and Oval Lagoons which would require the use of earthmoving and hauling equipment. This alternative would increase the noise levels north of the OMC plant near the excavation sites and along the corridor of the final disposal site. However, no significant impacts are anticipated.

4.1.2.5. Alternative #5

The impacts discussed for Alternative #4 are the same for this alternative. In addition, this alternative requires the removal of contaminated material from the Parking Lot north of the OMC plant. This activity also would require earthmoving and hauling equipment which would increase noise levels around the Parking Lot area. Only short-term nuisance impacts are expected to occur, however.

4.1.3. Topography and Geology

4.1.3.1. Alternative #1

If no action is taken to abate PCB contamination in the Harbor, routine dredging of the channel and boat basin for navigational purposes would be suspended indefinitely. Two major industries, Gold Bond and Huron Cement, rely on deep draft shipping for the import of raw materials and the export of building materials. Sedimentation of the Harbor channel that restricted deep draft shipping access would seriously threaten the continued economic viability of Waukegan Harbor as a commercial port.

4.1.3.2. Alternative #2

In this alternative, the proposed dredging under ~~Plans~~ Phase 1 and 2 would be accomplished and the temporary dewatering lagoon constructed. Both the topography and the geology of the Harbor area would be modified by these activities.

Approximately 47,800 yd^3 of PCB-contaminated bottom sediment would be removed from the inner Harbor by dredging. This would entail the deepening of the Harbor by 12 feet or more. The thickness of the contaminated sand and muck to be removed varies throughout the projected dredging area, but these materials cover the bottom of the entire inner Harbor. Thus, water depths throughout the inner Harbor would be increased by the proposed dredging.

The removal of the muck and contaminated sand layers from Slip #3 would expose a hard, clayey silt or sand over the dredged area. Because the sand layer is believed to be considerably less contaminated with PCBs than the muck, only the upper portions of the sand layer would be removed. Thus the proposed dredging operation would result in a change in the composition of the inner Harbor bottom from its present mucky state to a firm bottom of sand and hard, clayey silt.

The construction of the proposed lagoon would produce widespread and noticeable changes in the topography of the proposed site. The present topography of the lagoon site generally is low and flat, but is modified locally by spoil piles. The existing low areas near the Harbor would be filled to build up the floor of the lagoon above the present grade. A dike would be constructed to retain the contents of the lagoon; this structure would be as high as 21 feet above grade and would surround the 5-acre body of water inside the lagoon. Pads for buildings and other structures and footings for roadways also would be constructed. These activities would modify the existing topography to a lesser extent. At the conclusion of the project, the lagoon would be removed and the site restored. No adverse impacts are expected from this alternative.

The transportation of the contaminated material to the final disposal site would not have any adverse impacts on topography or geology. However. Although the location of the final disposal site is unknown, topographical and geological impacts would occur and may be assumed to be similar to the impacts resulting from the construction of the temporary storage lagoon. The site would require clay liners, dikes, and access roads. These physical changes are not expected to create any adverse environmental impacts, but may have an annoying aesthetic impact on adjacent areas.

4.1.3.3. Alternative #3

In this alternative, the impacts for Alternative #2 would occur, and a stormwater diversion would be constructed as a bypass drainage route around the North Ditch. The diversion, however, would result in little or no alteration to the existing topography and geological features. Therefore, no additional adverse topographical or geological impacts are expected.

4.1.3.4. Alternative #4

In this alternative, the actions and associated impacts of Alternative #3 would occur. In addition, much of the PCB-contaminated material would be excavated from the North Ditch Drainage System. Most of this excavation would be accomplished within a high-density slurry wall or cofferdam that would

extend 25 to 30 feet beneath the surface of the ground. The total extent of the contamination in the vicinity of the North Ditch is currently unknown and would be determined by a detailed sampling program prior to the excavation operation. However, it is known that removal of material in a belt approximately 60 feet wide and 25 feet deep may be required. The present plans include backfilling of this excavated area with clean, uncontaminated materials and cutting off the base of the slurry wall or cofferdam. Alternatively, the cofferdam, if used, might be removed entirely. Complete backfilling and grading of the excavated site would produce negligible or no permanent changes in the topography of the area. Portions of the cofferdam or slurry wall left in the ground would cause local disruption of the lateral movement of groundwater. This effect is discussed further in Section 4.1.5.4.

4.1.3.5. Alternative #5

In this alternative, the actions and associated impacts of Alternative #4 would occur. In addition, contaminated soils in and around the Parking Lot would be excavated. Slurry walls and wellpoints would be used to protect nearby structures and to dewater the affected soils. The preliminary engineering plans call for backfilling of the excavated area; thus no significant modification to the existing topography would result. If the backfill is composed of material similar to that excavated, there would be no significant change in the geological character of the excavated area. If parts of slurry walls are left in the ground, the lateral movement of the groundwater may be disrupted. This impact is discussed further in Section 4.1.5.5.

4.1.4. Soils

4.1.4.1. Alternative #1

Under the No Action Alternative, all contaminated soils which exist in the project area would be considered a long-term potential health hazard and development or routine construction activities such as sewer replacement would be precluded. The areas of contamination would essentially be hazardous waste disposal sites and would render the contaminated area off-limits to development for an indefinite period.

not really

unless cleaned up

4.1.4.2. Alternative #2

Because this alternative does not involve the removal of contaminated North Ditch Drainage System soils from the project area, the impacts outlined above for Alternative #1 also would occur. In addition, at the dewatering lagoon and landfill sites, the soils under and around these areas would become compacted due to construction and hauling activities. Surface runoff would increase and local groundwater recharge would decrease because of the impervious surfaces created by the haul roads and the temporary storage lagoon and the landfill. These are not considered to be adverse impacts for these sites.

4.1.4.3. Alternative #3

The impacts on soils for this alternative would be nearly identical to those described for Alternative #2. Stormwater would leave the area more rapidly and the water table may be reduced locally, resulting in drier surficial soils. The drier surface soils may become warmer during the summer and possibly result in temporary increases in the volatilization of PCBs. However, because the greatest concentrations are found several feet below the surface and the tendency of the PCB concentrations is to move downward, it is not anticipated that this would be a serious concern (Mason and Hanger 1981).

4.1.4.4. Alternative #4

Under this alternative, at least half of the contaminated soils would be removed and securely disposed. Consequently, the contamination of soils would no longer restrict development in the project area. The sizeable area taken up by the landfilling of contaminated materials, however, would preclude several acres of soil elsewhere from use as productive agricultural land, wildlife habitat, or for urban land uses. Therefore, although use restrictions would be removed in the project area, the same or an additional amount of land would be lost elsewhere. Other impacts would remain the same as described for Alternative #3.

4.1.4.5. Alternative #5

The impacts of Alternative #5 would be similar to those of Alternative #4, but on a broader scale. An additional adverse impact may occur under this alternative if not enough deep contaminated soils are removed to make the Parking Lot area suitable for future development other than as a parking lot. For this reason, it is best to remove the maximum amount possible of the Parking Lot contamination. Other impacts would remain the same as described for Alternative #4.

4.1.5. Groundwater

4.1.5.1. Alternative #1

Under the No Action Alternative, no changes in groundwater recharge or movement would occur. The present flux of PCBs from the saturated soils beneath the North Ditch Drainage System into the surface water, and resulting from local groundwater flows, would continue (Section 1.2.2.). The lakeward migration and dispersion of the enclave of PCB contamination beneath the Parking Lot also would continue.

4.1.5.2. Alternative #2

No adverse effects are expected to occur on the local groundwater as a consequence of the proposed dredging operation. The surface of the local water table is generally in equilibrium with the surface of the water in Lake Michigan. Short-term fluctuations in the elevation of the water in the Lake may cause water to move either into or out from the water table at the site. The effects of these changes, however, would be felt only in a narrow zone along the shoreline. Because of their transitory nature, these effects would have a negligible influence on the main body of groundwater beneath the Harbor front. Dredging of the inner Harbor would cause a temporary increase in the content of suspended PCBs in the Harbor water. However, because of the equilibrium that exists between the Harbor water and the groundwater, very little of this material is likely to enter the groundwater adjacent to the Harbor.

The major effect on the groundwater beneath the proposed lagoon site would be the limitation of the amount of surface recharge that can occur at the site. The liners, underdrain system, and leachate collection system would intercept any water moving downward from the surface. Thus, rain water and surface flow, which normally infiltrate the soils of the area and percolate downward to the water table, would be collected and removed by the structures of the lagoon. There essentially would be no recharge from the surface under the lagoon. The area beneath the lagoon and the lined portions of the dikes, a total of approximately 3.5 acres, would not receive surface recharge. Because the local groundwater table and the water of the Lake and the Harbor are in equilibrium, this local decrease in recharge would have a negligible effect on the dynamics of the water table at the site.

appears not to agree w/ acres on p. 10

A major concern associated with the operation of the dewatering lagoon is the potential for leakage or seepage of PCB-contaminated water from the lagoon into the underlying soils and ultimately into the groundwater. The possibility of leakage through cracks, gaps, or other anomalies in the clay liner is recognized by the design engineers (USEPA 1981). The operational plan calls for a ~~trial flooding~~ testing of the lagoon with clean water for a period of at least one week, during which time the leachate collection system would be monitored to detect the presence of any water that penetrates the liner. If a leak or leaks is detected, the lagoon would be drained and the lining repaired.

The time required for water to penetrate the clay liner by seepage alone, assuming that no cracks or other breaks exist in the liner, can be calculated ~~from expected parameters~~ as follows:

$$V = \frac{KI}{n}$$ where:

V = the velocity of flow in ft/day

K = the coefficient of permeability in cm/sec

$I = \frac{h}{l}$, with h = the hydraulic head to base of liner and l = the liner thickness in feet

n = the porosity of the clay

Given:

- The difference in elevation between the deepest part of the lagoon and the base of the portal of the water intake tower (607-591 feet) is 16 feet
- The thickness of the clay liner is 3 feet
- The maximum hydraulic head to the base of the liner is 19 feet
- The designed coefficient of permeability is 1×10^{-7} cm/sec
- The porosity of the liner is: Case 1) 50% (soft glacial clay); Case 2) 37% (stiff glacial clay)

Then:

$$V = \frac{(1 \times 10^{-7} \text{ cm/sec}) \dfrac{(19 \text{ ft})}{(3 \text{ ft})}}{0.50}$$

$$= \frac{(2.834 \times 10^{-4} \text{ ft/day})\ (6.33)}{0.50}$$

$$= 3.59 \times 10^{-3} \text{ ft/day in Case 1, where porosity} = 50\%$$

or:

$$= 4.85 \times 10^{-3} \text{ ft/day in Case 2, where porosity} = 37\%$$

The time required to penetrate 3 feet of clay would be:

$$\text{(Case 1)} = 3 \times \frac{1 \text{ ft}}{3.59 \times 10^{-3} \text{ ft/day}} = 835 \text{ days} = 2.3 \text{ years}$$

or

$$\text{(Case 2)} = 3 \times \frac{1 \text{ ft}}{4.85 \times 10^{-3} \text{ ft/day}} = 618 \text{ days} = 1.7 \text{ years}$$

Thus, the clay liner can be expected to contain water in the lagoon for periods of more than one year under maximum head conditions, assuming complete integrity of the liner. Periods of maximum head are expected to be very short. The period of operation of the lagoon is not expected to exceed one

year. During most of this period, the hydraulic head probably would be approximately half the maximum value. Thus, the permeability of the clay liner should be sufficient to contain the contaminated water for longer than the expected period of residence of the dredged spoil.

The above values are based upon the assumption that the clay liner would be uniform in texture, density, and bulk properties, and that no local inclusions of sandy clay or gravel would provide percolation paths through the liner. A very high level of quality control and inspection would be required during the construction of the liner if these conditions are to be achieved.

Penetration of the clay liner on the dike walls by the impounded water would require even longer periods, due both to the lower heads over most of the dike and the presence of a greater thickness of clay liner. The potential for penetration through fissures is greater for the dikes than for the bottom of the lagoon because of the possibility of partial or complete drying or mechanical failure of the sloping surface of the dike. If penetration occurred, piping in the soil underlying the liner might occur causing a threat to the integrity of the dike. This may pose a serious concern, particularly during times of elevated head conditions.

The integrity of the dike liner also may be threatened by internal wave action during periods of strong winds and by the effects of ice during the winter. The plastic mesh fabric that is intended to cover the inner sides of the dike would aid in stabilizing the soil against the effects of gravity and surface runoff; however, additional protection such as gravel armor may be required if adverse wind or ice conditions are experienced during the life of the lagoon.

Groundwater impacts at the ultimate disposal site may be assumed to be similar to the impacts resulting from lagoon construction. However, because the applicable rules and regulations require proper safety systems to protect the groundwater at disposal sites, no adverse impacts are expected. These regulations call for specific landfill liners, leachate and runoff collection systems, monitoring programs, and leachate and runoff treatment systems. Adverse groundwater impacts may occur if there is a major breach in the liner

and contaminated leachate seeps through. In addition, the area covered by the landfill will reduce the overall groundwater recharge area.

Because this alternative does not include an action for the North Ditch Drainage System, the movement of PCBs into the surface waters as a result of local groundwater flows would continue.

Rivers Key → reduce recharge to local aquifer and eliminate sediment trans. fate

4.1.5.3. Alternative #3

In this alternative, the actions and impacts associated with Harbor dredging and lagoon construction would occur. In addition, stormwater would be diverted from the North Ditch Drainage System to ~~halt~~ reduce recharge ~~and flow~~ of the groundwater. This would reduce the present flux of PCBs into the surface waters~~, to a negligible amount and halt the lakeward migration and dispersion of the PCB enclave beneath the Parking Lot.~~

4.1.5.4. Alternative #4

would reduce PCBs in ground H2O

In this alternative, the actions and related impacts of Alternative #3 would occur. In addition, much of the PCB-contaminated material would be excavated from the North Ditch area. The local groundwater table would be disrupted temporarily by the effects of the proposed dewatering wellpoints.

The proposed slurry wall would be cut off at its base after construction is completed. If a cofferdam is used in this phase of the project, portions of it may be left in the ground. These structures would act as low-permeability to impermeable barriers to the lateral movement of groundwater over most of their vertical surfaces, but would allow passage of water below the cutoff zone. The overall impact of this local disruption in the flow of groundwater is not regarded as ~~negative~~ significant ~~because the cessation of groundwater flows would halt the movement of PCBs into the surface waters of the North Ditch.~~

reduce flows, reduce volumes to the Lake via ground H2O

4.1.5.5. Alternative #5

In this alternative, the actions and associated impacts of Alternative #4 would occur. In addition, contaminated soils in and around the Parking Lot

This would eliminate ground H_2O as a source of PCB to Lake MI

would be excavated. This excavation would be accomplished with the aid of slurry walls and wellpoints to stabilize the walls of the excavation and to dewater the materials. The overall effect on the groundwater of the area would be a significantly decreased concentration of PCB contaminants. However, it is extremely doubtful that this resource could be developed as a useable water supply in the forseeable future. The water table would be disrupted by the excavation operation, but would be restored in a relatively short time period after backfilling with clean materials. Any remnants of slurry walls or cofferdams left in the ground would cause local disruption of the lateral movement of groundwater within a limited area.

4.1.6. Surface Water

4.1.6.1. Alternative #1

Should the No Action Alternative option be exercised, impacts to the surface water would occur as described quantitatively in Section 1.2. Waukegan Harbor would remain a relatively turbid body of water which constantly flushes PCBs into Lake Michigan. The intermittently-flowing North Ditch Drainage System would continue to contain high levels of PCBs in its waters as well. As explained in Section 2.1., these adverse surface water characteristics would be maintained for 10 or more years.

part Dual - arg we can use?

Surface water uses of the Harbor will be impaired due to the restrictions on navigational dredging which must be imposed to prevent increased PCB dispersal into Lake Michigan. Waukegan Harbor would continue to accumulate organic sediment in the inner area; in the outer Harbor area and Harbor mouth sand will be deposited, eventually preventing the passage of deep-draft boats and barges.

The Waukegan Water Treatment Plant currently maintains a back-up or emergency water intake crib in the Harbor mouth area. This intake is reported to be utilized for a maximum of a few days in the rare years when the principal offshore crib (over 1 mile offshore) is iced up or when repairs are being made. If no abatement actions are taken, the treatment plant must diligently monitor for PCBs in the drinking water to assure that PCBs are not detected in

the finished water. The Director of the Waukegan Water Treatment Plant has stated that PCBs are removed from potable water supplies to levels below laboratory detection limits. These practices must continue indefinitely unless PCB contamination in both Waukegan Harbor and the North Ditch Drainage System are abated.

An additional, undetected impact potentially may be occuring with respect to drinking water supplies for adjacent communities. Several cities and villages including Zion, Winthrop Harbor, North Chicago, Lake Bluff and Lake Forest obtain their municipal water supplies from Lake Michigan and maintain water intakes within a 10 mile radius of Waukegan Harbor. Section 3.1.7.1. contains a discussion of the potential for longshore Lake Michigan current fields to transport undispersed, PCB-contaminated solids over a 10 to 20 mile range or more. Under the No Action Alternative, there will remain a potential that under certain hydrologic conditions storm-driven currents could transport significant amounts of PCBs into the vicinities of public water supply intakes north and south of Waukegan. Because finished water is not tested for PCBs on a frequent basis, testing during the occasional periods when storm-driven currents containing elevated levels of PCBs are passing by public water supply intakes would be coincidental. Thus, it cannot be determined if water taken from the Lake on those occasions when storm-driven currents are transporting elevated levels of PCBs along the nearshore zone is being treated to below the 1 ppb Federal standard. Some indication of this potential has been provided by a modeling study of the pollution of coastal waters near Chicago by plumes of polluted water originating from the Indiana Harbor Canal (Argonne National Laboratories 1977) . In that study, unequivocal evidence was presented for the northward transport of relatively undiluted oily waste originating from the Harbor Canal, over 3.5 miles up the Lake Michigan coast, and into the South Water Filtration Plant intake.

4.1.6.2. Alternative #2

The recommended option under this project alternative is to implement Plans 1 and 2 of the dredging as per the schedule requirements discussed in Section 2.4.2. The benefits derived from this action would include a nearly 100% long-term reduction in the average annual rate of movement to the Lake of

PCBs now in the Harbor. The dredging of the Harbor under the option of implementing Plans 1, 2, and 3 provides no significant additional reduction in the PCB load to the Lake. The modeling studies which have allowed these comparative benefits to be assessed are described in the following paragraphs.

Modeling of Dredging Option

Dredging the Harbor bottom sediments has been recommended as a part of an action plan to abate PCB contamination in the project area. The dredging ~~alternatives~~ are as follows:

- Dredge all areas where the bottom sediment PCB concentration is in excess of 500 ppm (~~Plan~~ 1)
- In addition, dredge all areas where the bottom sediment PCB concentration is between 50 and 500 ppm (~~Plan~~ 2)
- Dredge all areas where the bottom sediment PCB concentration is between 10 and 50 ppm. (~~Plan~~ 3)

Figure 4-1 depicts the areas of the Harbor affected by the dredging alternatives. ~~Plan~~ 1 involves essentially the dredging of Slip #3, ~~Plan~~ 2, in addition to Slip #3, includes the dredging of the upper half of the N-S section of the Harbor; ~~Plan~~ 3 also includes the dredging of the Slip #1 and the central basin of the Harbor.

In order to evaluate the effectiveness of the foregoing alternatives, the water quality model of Waukegan Harbor developed by HydroQual (USEPA 1981) was used. The model of Waukegan Harbor is a mathematical representation of dilution, dispersion, flow, and other physical-chemical processes and conditions governing the spatial and temporal distributions of PCBs and other selected water quality constituents. The Waukegan Harbor model was calibrated with available data collected in Waukegan including chlorides, dye, and suspended solids to assess the dispersional and transport characteristics of the Harbor area and the interaction of the water column with PCB laden bottom sediments. The model was also calibrated to observed water column PCB concentrations and, therefore, the flux to Lake Michigan. ~~Thus, although an approximation,~~ the model can be used to assess the effect of changes in bottom sediment PCB

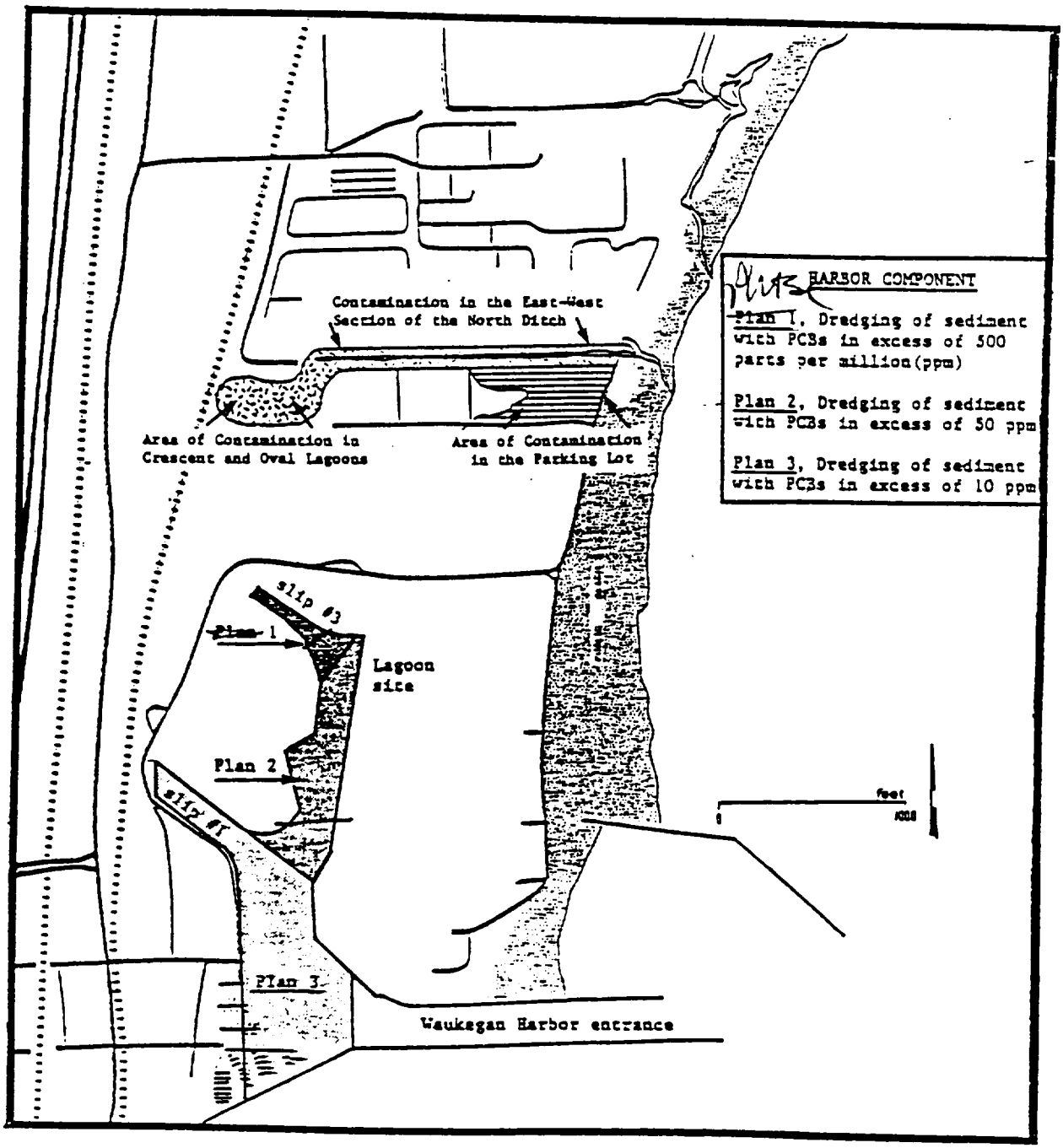

Figure 4-1. Map of the project area showing removal components for PCB contaminated materials. Map features are derived from color aerial photography by the U.S. Environmental Protection Agency: May 1978.

what about fish tissue samples?

levels, as a result of dredging, on water column PCB concentrations and Harbor losses to Lake Michigan. (A similar model was developed for the North Ditch area of PCB movement.)

Based on the modeling framework, two scenarios were examined: (1) the long-term impact of dredging on conditions in Waukegan Harbor and Lake Michigan; and (2) the short-term impact on Waukegan Harbor and Lake Michigan during the dredging operations. Each type is discussed in the following paragraphs.

Long-term Impact to Lake Michigan due to Dredging

Under this scenario, it is assumed that dredging operations have been completed and that any transient effects due to dredging operations have subsided. The purpose of this analysis therefore is to assess the ultimate impact of removal of PCB laden sediments on Harbor water column concentrations and the resultant bioaccumulation impact on fish in Waukegan Harbor. The change in flux to Lake Michigan is also assessed.

Move revised 4-1

The segments of the Waukegan Harbor model which are affected by each of the foregoing dredging alternatives are depicted in Figure 4-1. In each case the bottom sediment PCB concentration of the shaded segments was programmed into the model as the final sediment PCB concentration (10, 50, 100 and 500 ug/g) that would result after dredging operations are complete.

Three major sets of simultations were run sequentially (starting with ~~Plan~~ 1) with the Waukegan Harbor model, one for each of the dredging alternatives. In turn, it was assumed in program runs that for each dredging alternative the final sediment PCB concentration after dredging was either 10, 50, 100, or 500 ug/g. In all, twelve combinations were investigated. The combinations comprised the three dredging alternatives and the four resulting sediment PCB concentrations.

On the basis of the modeling analysis the following observations are made:

important

- It appears that the most effective dredging procedure from the standpoint of reducing water column PCB concentration and flux to Lake Michigan is Plan 1 (the dredging of Slip #3). Slip #3 appears to be principally responsible for currently observed conditions of water column contamination and flux to Lake Michigan. As a result, remedial action in this area will be the most effective means of abating these impacts.

- The surficial sedimentary PCB concentrations remaining after the Slip #3 dredging will be more significant in terms of reducing the water column PCB concentration and PCB flux to Lake Michigan than the spatial extent of additional dredging. This conclusion is verified in Figure 4-2 which depicts the calculated Waukegan Harbor water column PCB concentration and resulting flux to Lake Michigan for various residual sediment PCB levels under dredging Plan 1 (Slip #3) as compared to present conditions. The results indicate that if residual sediment PCB levels of either 10, 50, or 100 ug/g can be attained in Slip #3, a substantial reduction from present conditions in both water column PCB and flux to Lake Michigan will result. Total water column PCBs will be reduced throughout the Harbor by more than an order of magnitude (from the 0.3 - 1.0 ug/l range to approximately 0.01 ug/l). The steady state flux to Lake Michigan from the Harbor would be reduced from the present rate of 8.8 lbs/yr to approximately zero. Transient storm induced events, however, would probably still contribute some discharge of PCBs to the Lake but at levels less than 2 lbs/yr.

- If residual bottom sediment PCB concentrations in Slip #3 can be reduced to only 500 ug/g by dredging, water column PCB concentrations will be reduced to approximately 0.05 ug/l for most of the Harbor area. There will continue to be a steady state flux of PCBs to Lake Michigan of about 0.9 lbs/yr, in addition to less than 2.2 lbs/yr from storm induced flushing.

- The most effective dredging plans from the standpoint of the Waukegan Harbor fishery are those which will reduce water column PCB levels to the 0.01 to 0.02 ug/l range, ultimately reducing fish burdens to near USFDA action levels. This would require that, at a minimum, residual sediment PCB levels of 10 to 100 ug/l be attained in Slip #3. If residual sediment levels of 500 ug/g remain, water column concentrations in Waukegan Harbor will be approximately 0.05 ug/l, with resultant whole-fish body burdens remaining in the 20 to 40 ug/g (wet weight) range.

leaves me

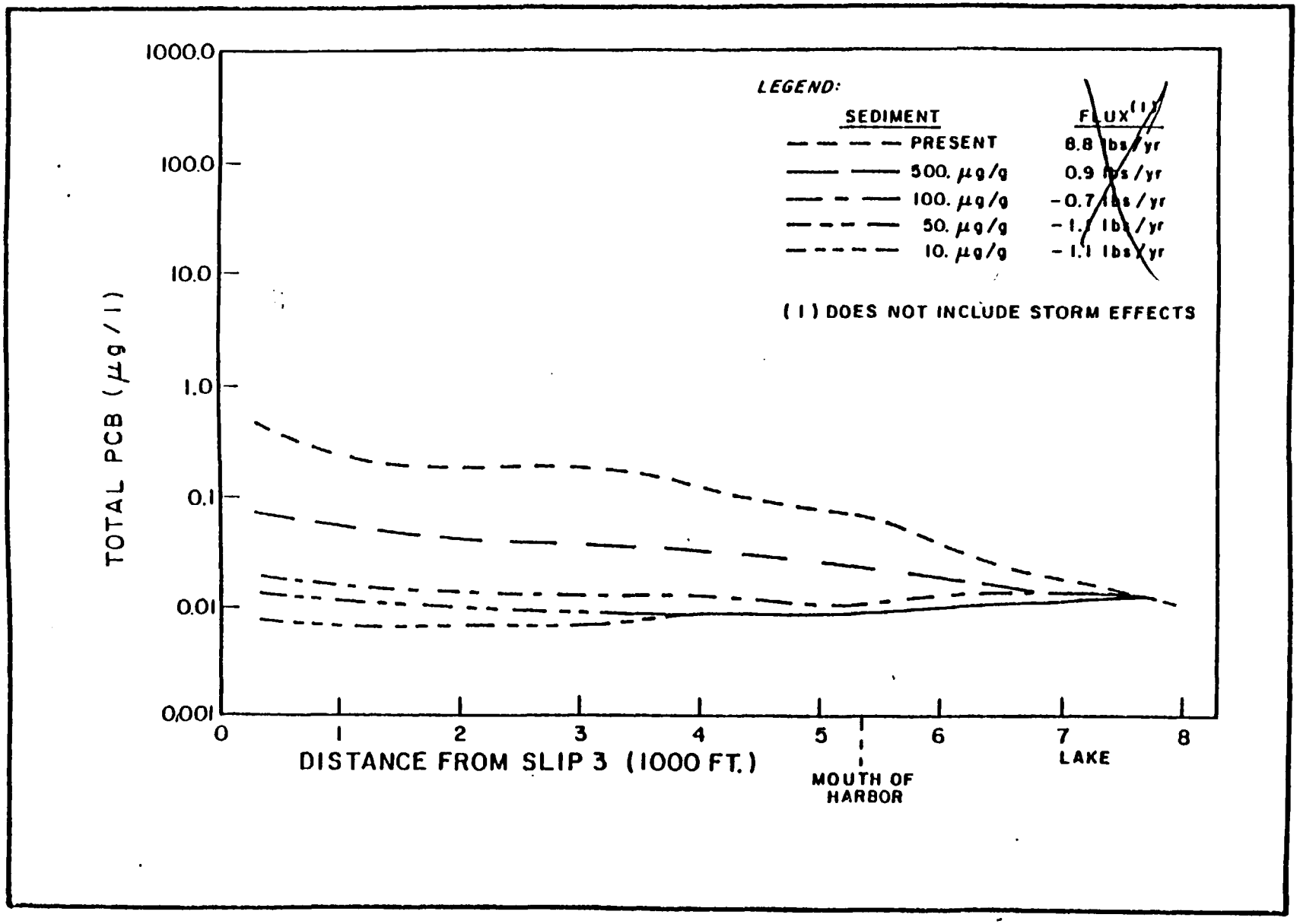

Figure 4-2. Estimates of the of the impact of dredging operations on water column PCB concentrations in Waukegan Harbor. Based on modeling simulations by HydroQual, Inc. (USEPA 1981).

- Although the majority of the positive impacts which will be achieved by the recommended dredging program are associated with dredging Plan 1 (Slip #3), it should be recognized that there are other factors operative in the Harbor such as localized, transient turbulent effects and man induced sediment motions that are not included in the analysis.

Short/term Impacts of Dredging

During implementation of the recommended dredging option there would be potential short-term impacts associated with the resuspension and mobilization of PCB contamination caused by the dredge. During the screening of optional dredging techniques, the recommendation was made to utilize a pneumatic or hydraulic dredge to minimize ~~many of the~~ potential short-term impacts. The additional mitigative technique of a double-walled silt curtain is recommended for use during the dredging program to ~~prevent~~ transport of PCBs lakeward and to exclude fish from entering the area of dredging.

The usefulness ~~effectiveness~~ of silt curtains as a turbidity barrier in Waukegan Harbor was established in a dredging project carried out in 1979. A small area adjacent to the public boat launching ramps was dredged with a clamshell dredge and a single-wall silt curtain was used to minimize turbidity in adjacent Harbor areas. Monitoring conducted by USEPA, which included aerial photos and water quality sampling, indicated that the silt curtain effectively prevented the movement of suspended solids out of the dredging area. No problems with the deployment or operation of the silt curtains during the dredging operation were noted (Environmental Reseach Group 1979).

The performance of the silt curtains recommended for use during the dredging also has been evaluated by the use of mathematical modeling studies. This has been done to test the mitigative abilities of the proposed system and to determine if PCB losses to the Lake can be kept to a minimum. The modeling results are discussed in the following paragraphs.

Modeling Assessment of Short-term Dredging Impacts to Lake Michigan

According to the recommended dredging plan, the bottom sediments of Slip #3 will be dredged first by means of either a hydraulic or pneumatic dredge.

Before dredging begins, all water withdrawals from the Harbor will stop, and a double-walled silt curtain will be placed between Slip #3 and the rest of the Harbor in order to minimize the spreading of the roiled sediments resulting from the dredging. The bottom of the double silt curtain will be sunk into the muck layers and there will be a maximum 2 ft-wide gap between the end of the curtain and the bank on both sides.

US. EPA ~~It is~~ estimated that during the dredging of Slip #3 the total PCB concentration in the water column within Slip #3 may vary between 500 and 5,000 ppb depending on the distance from the dredge. The latter figure represents being the worst case situation. ~~(personal communication, Jack Braun, USEPA, to WAPORA, Inc., 1981)~~. In the model simulation of the dredging operations by HydroQual (USEPA 1981), it was estimated that the worst case total PCB concentration most likely to occur at the location of the silt curtain is about 500 ppb. It was assumed for the purpose of modeling silt curtain effectiveness that when the dredge is operating on the highly contaminated sediments of the inner part of Slip #3 the high total PCB concentration (5,000 ppb) might occur in that area of the slip only and the roiled sediments would settle quickly. Based on this assumption, the concentration at the silt curtain would be attenuated to about 500 ppb. Also, when the dredge is operating in the southeastern portion of Slip #3 where sediments are less heavily contaminated, the total concentration of PCBs in sediments at the silt curtain may be assumed as 500 ppb. Therefore, for purposes of a model simulation, Slip #3 was considered to have a total water column PCB concentration of 500 ug/l during dredging operations.

The open cross-sectional area at a location between Slip #3 and the rest of the Harbor was calculated to represent, in the model only, the 2 ft-wide gaps on the side of the silt curtains. The industrial water withdrawal of about 3 million gallons per day (mgd) was assumed to be stopped and the discharge from the dewatering lagoon (1,500 gallons per minute [gpm] or 3.3 cfs) was included with a 1 ug/l total PCB concentration. Based on these assumptions, the calculated resulting flux of PCBs through the silt curtain into the Harbor would be about 0.13 lb/d of dredging or about 1 pound of PCBs per week.

I thought HQ said movement during dredging would be worst conditions ?

PCB Discharges Resulting From the Operation of the Dewatering Lagoon

Following the construction of the dewatering lagoon and before dredging commences, the lagoon will be filled with water to test its structural integrity. The water from the lagoon will be discharged before the dredging operations begin and cracks or anamolies in the clay liner will be sealed. The slurried sediment from the first phase of the dredging operations will be conducted to the empty lagoon and allowed to settle. A supernatant liquid will be displaced from the lagoon during the second phase of the dredging and will be treated for PCB removal by polymer addition, sedimentation, and carbon filtration. The effluent water of the treatment process will be returned to the Harbor at a total PCB concentration of less than 1 ug/l. It is estimated that the majority of the effluent water will be discharged at a steady flow rate of 1,500 gpm, which will decline at the latter stages of the operations. The dredging and treatment operations will overlap to a certain extent, with the treatment process most likely continuing after all dredging has finished.

The short-term impacts of the treatment process on surface water quality were modeled by HydroQual (USEPA 1981) to determine the resultant lakeward movement of PCBs. The modeling assumed that about 95% of the sediments in the areas affected by ~~Plans~~ Phase 1 and 2 are dredged to achieve a final sediment concentration of less than 50 ug/l and that these dredged sediments are slurried by water to 15% by volume. Based on these assumptions, the volume of the water to be treated would be 320,000 yd^3. Assuming also that 90% of this volume will be discharged at 1,500 gpm, the duration of the 1,500 gpm effluent discharge was estimated to be about 1 month. The PCB load to the Harbor from the effluent during this month would be about 0.02 lb/d from treatment system. The total mass of PCBs discharged to the Harbor would be less than 1 pound.

The recommended schedule for implementing dredging Plans 1 and 2 provides for a "phased" program whereby Plan 1 is completed in the fall of 1983 and Plan 2 in the spring of 1984. All the material and water removed during dredging Plan 1 would go directly to a storage lagoon, where it would be held ~~and covered~~ for the winter. No water would be decanted from the dredge spoils in that lagoon until the package treatment plant has been constructed in the spring of 1984. Then, as the spoils and water removed from the Harbor during

implementation of Plan 2 are pumped into the storage lagoon, the displaced water would be decanted and treated to remove sediment-bound and dissolved PCBs prior to discharge back into the Harbor. Although the dissolved chemical constituents of that water (other than PCBs) may have concentrated slightly due to evaporative concentration over the winter, no adverse impacts are anticipated from the discharge of the treated, supernatant lagoon water. The amount of PCBs which would be discharged back into the Harbor from the treatment plant is discussed in the following paragraphs.

This was discussed

Short-Term Water Quality Impacts Due to Lagoon Construction

The construction of the storage and dewatering lagoon could have several short-term water quality impacts for which preventative and mitigative measures are available. Soil erosion on the lagoon site is a concern because of the potential for stormwater to carry sediment into the Harbor or into Lake Michigan. Erosion can result when earthmoving or excavation in construction projects takes place in areas exhibiting substantial topographic relief. The proposed site for the dewatering lagoon is generally level and the slopes of the lagoon would be sodded and seeded to minimize erosion.

The proposed lagoon site was formerly the site of a foundry (USEPA 1981) and there is a possibility that site clearing would reveal demolition rubble that contains scrap metal and foundry sand as well as unknown soluble materials. The construction crews should be informed of this possibility in advance and be prepared to transport such materials to a suitable disposal facility.

may, as is expected

Water Quality Impacts due to Landfilling

The disposal of approximately 50,000 yd^3 of Harbor sediments in an approved landfill may have short-term adverse impacts unless proper site management and truck maintenance practices are carried out. The trucks used must not be allowed to spill or track contaminated materials between the storage lagoon and the landfill site(s). Tire and truck washing facilities must be available at both ends of the hauling route and wash water from the cleaning must be collected and treated if it is determined to be contaminated.

most likely it will be - assumed

At the landfill site, construction and grading during the fill activities must be planned so that erosion of the contaminated materials cannot move PCBs offsite and into surface drainage channels. Because clay would make up a large portion of the hauled material, the handling would be messy and difficult if it is raining, increasing the possibility of PCBs being washed into ditches near the site. Therefore, contaminated material detention basins should be available for all runoff from the unloading areas and from where earthmoving equipment is stored.

4.1.6.3. Alternative #3

Under Alternative #3, nearly 100% of the existing rate of PCB movement into the surface waters of the Harbor and into Lake Michigan would be abated. All of the impacts discussed for Alternative #2 also would occur for Alternative #3. The same mitigative measures are recommended. Additionally, Alternative #3 includes construction of a North Ditch Drainage System stormwater diversion. Runoff water which collects in the newly-installed storm sewer would not be discharged into Lake Michigan until it is tested and, if necessary, treated for removal of PCBs.

The long-term beneficial impact of the stormwater diversion as portrayed in Alternative #3 would be comparable to the benefits described for the conceptual alternative called Diversion of Overland Flow (Section 2.2.3.2.). The impact on surface water of completing a stormwater diversion would be to eliminate much of the movement of PCBs to the Lake. Additionally, the migration and dispersion of PCB contamination, a process that is estimated to bring high concentrations of PCBs into contact with the Lake in approximately 60 years, also would be halted under this Alternative.

4.1.6.4. Alternative #4

The surface water impacts of Alternative #4 are almost identical in all respects to those associated with Alternative #3 and the same mitigative measures are proposed. During excavation of the Crescent and Oval Lagoons, wellpoints would be placed inside the surrounding structural slurry walls to permit conventional excavation machinery to operate. The volumes of water

would also reduce loadings to groundwater

removed would be intermittent and small. The water would be treated to achieve removal of PCBs down to a concentration not to exceed 1 ppb before its discharge to the surface water. The specific means of treating this water has not yet been proposed, however, and therefore the specific short-term impacts of the discharged water have not been assessed. The long-term beneficial impact of excavation of the Crescent and Oval Lagoon soil would be a nearly complete reduction in the long-term annual average PCB load to the Lake.

4.1.6.5. Alternative #5

Using the present data base on Parking Lot contamination, it is not possible to ascertain whether partial removal would halt the potential for future groundwater transport of PCBs to the Lake as efficiently as total removal. The surface water impacts of implementing Alternative #5 would be identical to those identified for Alternative #4 with the caveat that the groundwater transport of PCBs has unquantifiable impacts depending on the completeness of excavation that can be achieved in the Parking Lot.

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4.1.7. Terrestrial Biota

4.1.7.1. Alternative #1

The No Action Alternative would result in a continued increase in the concentrations of PCBs in the fish-eating birds, waterfowl, shorebirds, and other species of terrestrial animals that live and feed in the vicinity of Waukegan Harbor and in nearby parts of Lake Michigan. The PCB masses would remain in the area for many years and the PCB loading to the Lake would increase during the period required for the complete dispersal of PCBs from the contaminated areas into the Lake. The concentrations of PCBs would increase in the individual animals that routinely or periodically ingest highly contaminated food items. The individuals that reside in the area during a significant part of the year such as gulls, terns, and diving ducks, would be most affected. Migratory species that rest and feed in the area for a short period of time during the spring and the autumn would be less likely to accumulate large burdens of PCBs, although the body burden of an individual bird would increase after each annual visit. Because these birds also might

ingest PCB-contaminated food items in other parts of their ranges, the total body burden of an individual bird of a relatively long-lived species could be sustained or increase to a level that would affect its reproductive potential, the viability of its young, or its own health.

PCBs are known to accumulate in fatty tissues, and migratory birds develop additional fat deposits in their bodies as an energy reserve prior to migration. When fatty deposits containing PCBs are metabolized (broken down chemically into several components with a corresponding release of energy for use as fuel), the PCBs are released into the bloodstream and can have various toxic effects on the individual organisms or their offspring. Rapid releases into the bloodstream could occur due to acute, short-term stresses such as flight from a predator or from severe weather conditions or due to continuous, longer-term stresses such as those associated with migration and reproduction, when large amounts of energy are required.

Effects on Birds

The most severe effects would occur on fish-eating, resident birds. Approximately 27 of the 152 species of birds that have been observed in the Waukegan Harbor area are fish-eating species. Some of these species such as gulls also will scavenge (consume dead fish or other animals). Ten of the fish-eating species are known to reside in the vicinity of Waukegan Harbor, and two of these resident species are classified as threatened by the State of Illinois (the common tern and the black tern). PCB levels could increase in an individual animal both through biomagnification by individual organisms (such as water fleas or Daphnia which are known to concentrate the similar compound DDT from 0.5 ppb in the surrounding water to 50 ppm in their bodies) and subsequent amplification through food chains to a top predator such as a gull, or through long-term accumulation in an individual animal by periodic ingestion of PCBs at low levels and subsequent storage of the chemical in fat deposits.

The studies that have documented the effects of PCBs on populations of birds have been performed almost exclusively on fish-eating species such as the herring gull. Populations of herring gulls, common terns, and double-

crested cormorants in the Great Lakes area have been shown to be decreasing as a result of PCB contamination (Gilbertson 1975). The reasons for these declines include (Gilbertson 1975):

- Egg loss due to mechanical breakage as a result of extremely thin eggshells;
- Death of the chick as an embyro, death when fully developed but unhatched, death during the act of pipping (making a whole in the eggshell), or death after hatching;
- Large numbers of deformed chicks; and
- Unusual incubation behavior of adults (that may lead to egg breakage).

DDT is known to interfere with the production of steroid hormones and the functioning of an enzyme (carbonic anhydrase) that is necessary for the production of the calcium carbonate structure of eggshells. The shells produced by affected birds are thin and easily broken. Thus the young are likely to die before hatching, and the lack of viable young leads to a decrease in the population of that species. Because of the similarities between the chemical properties and effects on biota of DDT and PCBs and their co presence, it is possible that comparable processes occur as a result of contamination with PCBs.

Experimental studies with birds have shown that ingestion of PCBs can cause a liver enzyme imbalance that may result in embryo death and crossed-bill deformity in young birds (Gilbertson 1975). A similar deformity has been observed in many colonies of fish-eating birds in the Great Lakes region (Gilbertson 1975). Friend and Trainer (1970) reported that mallard ducklings fed PCBs in increasing concentrations for ten days suffered no apparent toxic effects, but did have a significantly higher mortality rate than a control group of ducklings when both were injected with duck hepatitis virus five days after exposure to PCBs. In a Lake Ontario study conducted by Norstrum et al. (1978), alewives and smelt (the most important food items in the diets of herring gulls in the Great Lakes) each had an average PCB concentrations of 2.21 milligrams per kilogram (mg/kg) wet weight. Considering the large populations of alewives, smelt, and herring gulls reported in the Waukegan Harbor vicinity, it is likely that the populations of herring gulls and other fish-

eating birds in the area are highly contaminated. However, no studies are known to have been performed on herring gulls or on any other species of birds in the area to measure PCB concentrations in tissues of adults or embryos or in eggshells.

Species of waterfowl that eat fish such as the diving ducks that spend part of the winter in the vicinity of Waukegan Harbor and the dabbling ducks that feed on aquatic plants and invertebrates also may be affected by the ingestion of PCB-contaminated organisms. Dabbling ducks may be attracted to the stabilization ponds of the North Shore Sanitary District Waste Treatment Plant because of their lake-like appearance or to feed on the algae and macroinvertebrates that may be present there at certain times of the year. These ponds are on the north side of the access road directly across from the Oval Lagoon. Consequently ducks or other species of migratory birds occassionally may rest or feed on or in the Oval Lagoon. Shorebirds also may feed on the exposed areas of the Lagoon, especially in the spring. These species also could be present along parts of the East-West Section of the North Ditch, particularly at the point where the Ditch enters Lake Michigan.

Effects on Other Terrestrial Species

Few terrestrial animals other than birds would be affected by the existing PCB contamination in the project area. Some mammals, reptiles, and amphibians may be present in the area, but both the number of species and the number of individuals of each species is likely to be low because of the lack of suitable habitat and food as a consequence of the industrial character of the area. The species other than birds that are most likely to come into contact with PCBs are those that would scavenge dead fish from the beach, come into contact with the discharge from the North Ditch, or feed on vegetation in the vicinity of the Crescent and Oval Lagoons.

Soil invertebrates and microorganisms in the project area undoubtedly are contaminated with PCBs and would be further affected by the dispersal of PCBs in the soils of the project area. Because the extent of this contamination will not be known until detailed surveys are performed and because little is known about the relationships of contaminated organisms such as these to the

general ecosystem of an area, no further discussion of these organisms is presented in this EIS.

If no action is taken, additional vegetation would become established in some parts of the project area and the existing plant communities would become more developed and diversified. The number and diversity of habitats for animals would increase, thus encouraging more use of the area by terrestrial animals. Over time, more species and more individuals would become exposed to the contamination and would transfer it to food chains in other areas in the vicinity of Waukegan and elsewhere.

In summary, the continued dispersal of PCBs in the project area would constitute a chronic stress on both the terrestrial and related aquatic communities in the project area for an unknown period. The long-term effects of a relatively stable chemical stressor such as PCBs, especially in a situation where the dispersal of the contaminant is more than offset by a continual fresh input, is not yet known (National Science Foundation 1975). Species vary in their tolerance to chronic "contamination stress," and many would be more susceptible to toxic effects from man-made compounds when stress from these sources is combined with stresses from other natural or man-made sources such as migration or synergistic effects from simultaneous accumulation of DDT. The major long-term effects of contaminant-induced changes in behavior or reproduction would become evident at the population or community level (National Science Foundation 1975). Little knowledge currently exists on the ability of species, populations, or communities to resist and recover from such stresses. Because PCBs are man-made compounds, few organisms have evolved that have the capacity to break them down into harmless constituents such as carbon dioxide and water-soluble compounds (Section 2.2.5.4.).

The final sink for PCBs on a global basis is believed to be the sediments and bottom waters of the polar oceans (De Santo 1978), and thus the dispersal and volatilization of PCBs from the project area may affect ecosystems around the world for many years if no action is taken to prevent their spread.

4.1.7.2. Alternative #2

The proposed dredging of Waukegan Harbor under this alternative would affect terrestrial biota. Populations of gulls and terns that currently reside and feed in the vicinity of the Harbor would be disturbed by increased noise and activity levels and may move to another area along the shoreline of Lake Michigan during the times of the day when disturbances would occur. However, because none of these species breeds in the immediate vicinity of the Harbor, no long-term displacement of populations is anticipated.

Some species of birds or other animals could come into contact with the contaminated sediments and water in the Harbor and dewatering lagoon, particularly during non-working hours (gulls) and autumn migration periods (waterfowl and shorebirds). Some species of terrestrial animals (particularly birds) also could come into contact with the contaminated sediments during transport of these materials to the ultimate disposal site and the contamination could be passed into other terrestrial food chains. Some species of terrestrial animals and plants could come into contact with the contaminated sediments at the ultimate disposal site and the contaminants could be spread through other terrestrial food chains.

None of the above effects is considered to be of major importance in comparison to the benefits to be gained, and most would not occur if appropriate mitigative measures are implemented.

4.1.7.3. Alternative #3

The potential impacts identified for Alternative #2 also could occur with this alternative. In addition, other animals could be disturbed or affected by those aspects of the North Ditch Drainage System Bypass construction that would alter or remove their habitats and affect their normal daily and seasonal activities. However, such changes would be expected to effect relatively few species and individuals and would be far outweighed by the benefits to be gained from removal of the contaminated material. Shorebirds, gulls, and possibly other species could be attracted to the excavated areas along the North Ditch.

4.1.7.4. Alternative #4

The potential impacts identified for Alternative #3 also could occur with this alternative. In addition, the larger amount of excavated area could prove to attract more birds and result in more opportunities for contamination of terrestrial food chains. However, these impacts are not considered to be of major importance in comparison with the benefits to be gained.

4.1.7.5. Alternative #5

The potential impacts identified for Alternative #4 also could occur with this alternative. In addition, the excavation of the Parking Lot would provide more opportunities for disturbance of wildlife and contamination of terrestrial food chains. However, these impacts are not considered to be of major importance in comparison with the benefits to be gained.

4.1.8. Aquatic Biota

4.1.8.1. Alternative #1

It has been estimated that approximately 60% of the PCBs found in the surface waters of Waukegan Harbor are "dissolved" while approximately 40% of the PCBs found in Lake Michigan's waters are dissolved (USEPA 1981). This difference in the proportion of PCBs present in the dissolved phase relative to the absorbed-to-organic-matter phase explains one of the strongest biological impacts associated with the No Action Alternative. As a consequence of the high levels of dissolved PCBs present in Waukegan Harbor, fish in this environment accumulate PCBs more rapidly and to much higher total body burdens than fish not entering the Harbor.

Additionally, the reservoir of detritus-bound PCBs on the surficial sediments of the areas specified for dredging in Plans 1 and 2 is a very strong vector of PCB bioaccumulation to fish. Macroinvertebrates and plankton which feed on detritus or "muck" are important food organisms for fish. The high sediment PCB content in and just outside the Harbor contribute to excessive PCB accumulations in fish through these consumptive steps (often

referred to as "the food chain"). Bottom-feeding fish such as carp appear to be more directly affected by surficial sediment PCB levels as evidenced by the very high body burdens reached by this species in highly contaminated harbor areas (USEPA 1981).

Mathematical modeling studies have been conducted to depict and verify the relative levels of PCB accumulation in fish dwelling inside Waukegan Harbor. The development and results of this modeling are presented in Section 1.4. in order to provide an understanding of the level of abatement that is needed to eliminate the adverse impacts of the existing situation.

Failure to abate the PCB contamination in the project area will result in the following long-term adverse impacts on fish inside and around the Harbor:

- All native Harbor fish and any Lake Michigan fish which enter the Harbor for several weeks at a time will accumulate extraordinary PCB body burdens (USEPA 1981). This situation will exist for a duration of at least 10 years. Perch, coho salmon, carp, and spawning chinook salmon will be the most important fish to be affected because of their nature and predominance.

- Benthic macroinvertebrates and plankton will be inhibited or excluded due to the chronic toxic affects of PCBs on those organisms. McNaught (1980) has reported that dissolved concentrations of PCBs as low as 10 mg/l (0.01 ppm) can be chronically toxic to some plankton species, based upon experimental findings.

The long-term adverse impact to Lake Michigan fishes has been described at length in Section 2.1.2. An additional aspect of the long-term adverse impact of the No Action Alternative derives from the experimental observation that PCB degradation products are more toxic to some plankton species than the parent PCB isomers (McNaught 1980). The same acceleration in toxic effects can be expected for other aquatic organisms as PCBs in Waukegan Harbor degrade and the breakdown products move into the aquatic environment and fish.

4.1.8.2. Alternative #2

The dredging and disposal of contaminated Waukegan Harbor sediments under this alternative will eliminate the adverse impacts of the No Action alterna-

tive on aquatic biota. Changes in the Harbor water column PCB concentrations and reduced PCB accumulations in fish will be the two principal long-term beneficial impacts of dredging. These benefits were calculated through the use of a mathematical model as described in Section 1.4.

It is presumed that no short- or long-term adverse impacts to aquatic biota would occur near the landfill disposal sites for Harbor sediments. The licensing process for the site(s) should preclude any opportunity for surface water contamination by PCBs. Possible short-term adverse impacts of the dredging programs would include the following:

- The area inside the silt curtains used to detain roiled sediments would become turbid during dredging and would very likely become anoxic in the pre-dawn hours following a day of dredging in organic "muck" sediments. The sediment oxygen demand of highly organic muck sediments has been measured in-situ in the 1 to 3 grams of oxygen per day per square meter ($gO_2/d/m^2$) of sediment range when sediments were not disturbed by stirring (USEPA 1976). Sediment oxygen demand also has been measured in-situ as high as 9.5 $gO_2/d/m^2$ in Lake Erie when the measurement chambers were stirred (USEPA 1972). Therefore, indications are that "disturbances" of polluted bottom sediments, especially if they have great quantities of reduced compounds dissolved in the interstitial waters, can elevate the expression of sediment oxygen demand by as much as one order of magnitude. Diurnal rhythms of respiration/photosynthesis in freshwater algae are such that the lowest oxygen levels occur in pre-dawn hours. Consequently, almost all respiring organisms inside the silt curtains would be driven out or may die during early morning hours after dredging.

will or be able to mitigate

- Because dredging is scheduled for fall and spring seasons, there is a good chance that spawning fish may be present in the Harbor during the dredging activities. Chinook making fall runs may be able to swim around or leap over the silt curtains into a highly PCB-laden body of water.

4.1.8.3. Alternative #3 does this need to be so qualified

Alternative #3 would have short- and long-term impacts identical to those of Alternative #2. However, the current flux of PCBs into the Lake would be reduced to a negligible level. The added benefit to the community of near-shore zone aquatic organisms of halting the movement of PCBs from the North Ditch Drainage System to the Lake has not been estimated specifically. It is

estimated, however, that the present flux of PCBs out of the North Ditch Drainage System is at least 5 kg/year (USEPA 1981). In addition, if current groundwater flow rates continue in the future, it is estimated that the PCB enclave beneath the Parking Lot will migrate and disperse lakeward at a rate that will bring it into contact with Lake Michigan in approximately 60 years. At that time, it is estimated that up to 10 g/day of PCBs could be released to Lake Michigan during storm events (USEPA 1980). Thus, the diversion of stormwater would benefit nearshore zone aquatic organisms by reducing the present movement of PCBs from the North Ditch Drainage System into the Lake.

4.1.8.4. Alternative #4

The impacts of Alternative #4 on the aquatic biota of the nearshore zone of Lake Michigan and Waukegan Harbor would be the same as those described for Alternative #3.

4.1.8.5. Alternative #5

The impacts of Alternative #5 on the aquatic biota of the nearshore zone of Lake Michigan and Waukegan Harbor would be the same as those described for Alternative #3.

4.2. Man-Made Environment

The positive and negative environmental impacts of the five alternatives on the man-made environment are discussed below. The components of the man-made environment that are addressed include: land use, economics and population, transportation, recreation and tourism, sewer and utility lines, and cultural resources.

4.2.1. Land Use

4.2.1.1. Alternative #1

If no action is taken to abate PCB contamination in the North Ditch Drainage System, the area essentially can be considered a hazardous waste

disposal site. This precludes the development of the Parking Lot area for anything other than its present use. No construction or development activities could take place in the North Ditch Drainage System in the future which disrupts or exposes the PCB contamination.

4.2.1.2. Alternative #2

two to five

The use of the vacant OMC property for a dewatering lagoon would preclude OMC from utilizing this site for years necessary to dredge Waukegan Harbor and dispose of the sediments. The dewatering lagoon would be removed when the project is completed, and the site would be available for development. Other land uses in the Harbor area would not be impacted under Alternative #2.

There are potential, irreversible impacts on land use associated with the ultimate disposal site. If a site is chosen that currently is not used for solid or hazardous waste disposal, a permanent land use change would take place. The magnitude and nature of this impact would depend on the existing use of the ultimate disposal site.

Short-term construction impacts from the establishment of the ultimate disposal site also would occur. The severity of the impacts would depend largely on the adjacent land uses. The primary, construction-related impacts of development of the ultimate disposal site include noise, fugitive dust emissions, and erosion. Noise impacts would depend on the presence of sensitive receptors in proximity to the ultimate disposal site. Fugitive dust and erosion impacts could result from site preparation activities (clearing and grading) prior to construction. In addition to the impacts associated with construction of the ultimate disposal site, noise impacts also could result from its operation.

The ultimate disposal site also could adversely impact surrounding land uses. Losses in property values could be expected and the use of property in adjacent areas could be adversely affected. It is possible that land use patterns could be permanently changed by the ultimate disposal site.

Because this alternative does not include actions to remove the PCB contamination in the North Ditch Drainage System, the impacts described under Alternative #1 also would occur under this alternative.

4.2.1.3. Alternative #3

Impacts on land use associated with Alternative #3 would be nearly the same as those for Alternative #2. The impacts associated with the ultimate disposal site would increase, however, because a greater volume of PCB-contaminated material must be disposed of.

4.2.1.4. Alternative #4

The land use impacts associated with the temporary dewatering lagoon and the landfill also would take place under this alternative. The removal of PCB contamination from the Crescent and Oval Lagoons would no longer restrict development activities in this area.

4.2.1.5. Alternative #5

The impacts on land use associated with Alternative #5 are similar to those for Alternative #4. However, the removal of PCB contamination in the Parking Lot would allow the development of this area for other uses. Under Alternative #5, there would be no restrictions on development or land use activities because of PCB contamination.

4.2.2. Economics and Population

4.2.2.1. Alternative #1

Economics

Under the No Action Alternative, it is possible that dredging of the navigation channel could be postponed indefinitely. At the request of the USEPA, the COE has agreed not to dredge the navigation channel until PCB-contaminated Harbor sediments are removed in order to mimimize PCB transport into Lake Michigan.

If routine channel dredging did not take place, deep draft shipping activity would eventually cease as a result of sedimentation at the Harbor mouth. Huron Cements, Goldbond Building Products, Larsen Marine, Falcon Marine, the Waukegan Port District and the Waukegan Yacht Club depend on a working harbor for their operations (Appendix K). The sedimentation of the Harbor mouth is resulting in immediate impacts on Huron Cements and Goldbond. Both operations import bulk cement and gypsum rock on deep-draft barges. The Harbor channel has been maintained in the past to 19 feet. Because of the cessation of Harbor dredgings, soundings are now made of the Harbor channel immediately prior to the entrance of a loaded barge into the Harbor. At present, bulk cement barges are entering the Harbor with approximately one-third less tonnage than if routine maintenance dredging were being carried out (By telephone, Bruce Lawson, Deputy Director, Waukegan Port District, to WAPORA, Inc., 3 November 1981). The lack of normal Harbor depths is estimated to result in 10 more dockings per year based on a 1980 shipping volume of 148,500 tons of bulk cement (By telephone, Bruce Lawson, Deputy Director, Waukegan Port District, to WAPORA, Inc., 3 November 1981). It costs approximately $400 per hour to operate the cement barges. The additional operating costs for cement barges serving Huron Cements and Goldbond resulting from the lack of full draft Harbor access is estimated at $120,000 in 1981 (By telephone, Bruce Lawson, Deputy Director, Waukegan Port District, to WAPORA, Inc., 3 November 1981). In addition, if channel depths decreased further as a result of sedimentation, deep-draft barges would eventually be prohibited from entering the Harbor. This potentiality would seriously threaten the ability of Huron Cements and Goldbond to remain in business.

Although the economic contribution to the overall economy of the area of the Harbor industries that are dependent on a working harbor for their operations has not been quantified, the impacts associated with a further curtailment in use of the Harbor would be substantial. Such a curtailment would be expected if no action were taken to abate PCB contamination in the Harbor because of the potential hazards associated with Harbor maintenance activities.

Population

The economic impacts associated with the No Action Alternative would likely result in population losses in the Waukegan area because of diminished job opportunities.

4.2.2.2. Alternative #2

Economics

There would be short-term economic impacts associated with the implementation of Alternative #2. There also could be long-term economic impacts pending the outcome of the litigation, and at the ultimate disposal site.

Larsen Marine Services, Inc. would be impacted Phase during the dredging of Waukegan Harbor if the recommended features of ~~Plan~~ 1 and ~~Plan~~ 2 were implemented. The estimated economic impact on Larsen Marine is shown in Table 4-2.

If Plan 1 Harbor dredging took place during the first two weeks of September, maintenance operations would be impacted resulting in an estimated loss of $39,500. If Harbor dredging took place during the second two weeks of September, maintenance operations and boat hauling for winter storage operations would be impacted causing an estimated loss of $55,000. Income lost from boat maintenance activities may be recovered and income lost from winter boat storage probably would be recovered. Maintenance customers could, however, go to Kenosha (17 miles north of Waukegan Harbor) or to a Chicago area harbor. Winter storage customers would not be expected to be lost in the long term. Impacts which also could occur but cannot be quantified include unsatisfied customers and strenuous working conditions for Larsen Marine employees. The dredging of Slip #3 would benefit Larsen Marine in that it would eliminate the need for the eventual dredging of the Slip to maintain adequate depths for sailboat moorage.

If Plan 2 Harbor dredging took place during the period from 15 April to 30 May, boat launching operations would be impacted resulting in an estimated

Table 4-2. Estimated economic loss incurred by Larsen Marine Services, Inc. under Alternative #2. Data obtained from Larsen Marine Services, Inc., 3 September 1981.

	CAUSE FOR ECONOMIC LOSS				
	Income	Wages	Over-time Wages	Total Loss	Percentage of Annual Revenues
Plan 1					
1 Sept.-15 Sept.	$24,000	$ 8,000	$ 7,500	$ 39,500	1.0
15 Sept.-1 Oct.	$30,000	$10,000	$15,000	$ 55,000	1.4
Plan 2					
15 April-30 May	$60,000	$20,000	$30,000	$110,000	2.8
30 May-15 June	$45,000	$15,000	$22,500	$ 82,500	2.1

TOTAL ANNUAL REVENUES $4,000,000+

loss of $110,000. If Harbor dredging took place during the period from 1 June to 15 July, boat launching operations still would be impacted, causing an estimated loss of $82,500. During both periods, income loss for wages and overtime wages could not be recovered. The income lost for boat launching possibly could be recovered, however, because there are no other boat hoists in Waukegan Harbor.

Other impacts that could occur but cannot be quantified include unsatisfied customers and strenuous working conditions for Larsen Marine employees. Boat owners would not be able to launch boats from Larsen Marine during dredging operations. Local opposition would result if the boat hoist was not usable from 15 April to 30 May. Less opposition would result if the boat hoist was not usable from 1 June to 15 July.

The estimated impacts on Larsen Marine Services, Inc. associated with Harbor dredging were calculated on the assumption the Plan 1 dredging could be accomplished in two weeks and Plan 2 dredging could be accomplished in six weeks. Because the dredging has to be carefully carried out, however, it is possible that the implementation of Plan 1 could take up to one month and the implementation of Plan 2 could take up to two months. The economic impacts on Larsen Marine Services, Inc. would increase commensurately.

Huron Cement and Goldbond operations could be impacted under Plan 2 of Alternative #2. This would occur if a shipment of raw materials were to be delivered during the dredging operation. Currently, when barge deliveries are made the barge pulls into Slip #1 nose first, unloads, and backs around the Huron Cement's property into the Plan 2 dredging area. This type of operation would not be feasible during Plan 2 Harbor dredging.

OMC also would suffer economic losses if Alternative #2 were implemented and the outcome of the litigation were not in its favor. The economic losses cannot be quantified at this time.

The short-term, beneficial impacts associated with Alternative #2 would occur during the lagoon construction phase, the dredging phase, the lagoon operation phase, and the disposal phase. Construction jobs created by the

project would reduce unemployment for the period of time that these phases occurred. Employment levels would return to previous levels at the conclusion of the project.

The economic impacts that would occur at the ultimate disposal site would be long-term. There would be an adverse impact on the land value of the site and on the value of the land immediately surrounding the disposal site. Land values would decrease in both cases. Although the impact would be minimal, there would be a beneficial impact on local levels of unemployment in the community in which the disposal site is located.

Population

Short-term population growth might occur as a result of construction jobs created by Alternative #2. Population growth in the vicinity of the ultimate disposal site would be impacted adversely. The construction of the disposal site would preclude residential development and other ancillary land uses at the site as well as restrict residential development of the land immediately surrounding the site.

4.2.2.3. Alternative #3

The economic and population impacts associated with Alternative #3 essentially are the same as those for Alternative #2.

4.2.2.4. Alternative #4

The economic and population impacts associated with Alternative #4 essentially are the same as those for Alternative #2.

4.2.2.5. Alternative #5

The economic and population impacts associated with Alternative #5 essentially are the same as those for Alternative #2.

4.2.3. Transportation Facilities

4.2.3.1. Alternative #1 can't we come up with a dollar amount ↓?

Shipping traffic may be prohibited from entering Waukegan Harbor if routine channel dredging cannot take place. No other impacts on transportation facilities are anticipated to result from the No Action Alternative.

4.2.3.2. Alternative #2

Impacts to transportation facilities under this alternative would be both construction-related and disposal-related. Construction-related impacts would concern highway facilities. Disposal-related impacts could concern highway, railroad, or port facilities.

Construction-related impacts on highway facilities would occur when the 200,000 yd^3. of clay and sand are hauled to the lagoon construction site. Based on the construction time, truck loading, and truck traffic estimated for lagoon construction (WAPORA 1981), roadway congestion and roadway damage could occur. Because the source of the sand and clay has not been identified, specific impacts on roadways cannot be assessed. The established full truck routes within the City of Waukegan have sufficient capacity to accommodate the estimated truck traffic (By telephone, Corporal Burleson, City of Waukegan, Traffic Division, to WAPORA, Inc., 28 August 1981), ~~but roadway congestion and damage remain possible.~~

Disposal-related transportation impacts would depend upon the mode of transportation (truck, rail, barge) chosen to facilitate disposal of PCB-contaminated materials. If trucks are used to haul PCB-contaminated materials to a disposal site, there would be increased congestion on the roads used to access the site. Road damage also could occur. If railroad cars are used to haul PCB-contaminated materials, there could be automobile traffic congestion at grade-level crossings. Congestion also could occur if the materials had to be transferred to a truck for final transport to the disposal site. This impact also could occur if barges were used to haul PCB-contaminated materials.

All three modes of transporting PCB-contaminated materials pose the danger of potential spills. If trucks are used, spills could occur during a traffic accident (either with another vehicle or due to loss of control and possible roll-over) or could be caused by leaks. Spills caused by traffic-related accidents would more than likely result in large volumes of local contamination, whereas a leak could deposit contaminated materials along the entire truck route. A spill could occur during an accidental derailment or collision if railroad cars were used. There is also the possibility of leakage. Transport of PCB-contaminated materials by barge poses similar problems. A puncture to the hull or an accidental collision could cause a spill or leakage.

An additional hazard posed by truck transport is off-site migration of PCB-contamination from materials adhering to the tires and truck under carriages and falling off. This phenomenon of off-site migration is one that often is observed around construction sites where heavy equipment is utilized. Normally (that is, when uncontaminated material is being moved) this causes a short-term nuisance problem and may potentially increase off-site sediment transport. Impacts from off-site transport of PCB-contaminated sedimentary materials may, however, be much more severe and long-term. If the concentrations of contaminants are high, local heath problems may result from direct contact or dust inhalation. In addition, the contamination will be difficult (if not impossible) to retrieve because PCBs exist in the environment for a long time.

There would be no impacts on transportation facilities at the ultimate disposal site.

4.2.3.3. Alternative #3

The impacts associated with Alternative #3 essentially are the same as those for Alternative #2. The disposal-related impacts also would be similar, except that the level of roadway congestion and damage would be greater. The possibility of accidental spills or leakage also would be increased.

4.2.3.4. Alternative #4

The impacts associated with Alternative #4 essentially are the same as those for Alternative #2 with the exceptions noted under Alternative #3.

4.2.3.5. Alternative #5

The impacts associated with Alternative #5 essentially are the same as those identified for Alternative #2 with the exceptions noted under Alternative #3.

4.2.4. Recreation and Tourism

4.2.4.1. Alternative #1

The major recreation-related impact associated with the No Action Alternative could be a decrease in the breakwater and shore fishery. According to Muench (1981) it is estimated that 45,974 angler hours of breakwater fishing and 1,179 angler hours of shore fishing were expended at Waukegan Harbor in 1979 (Section 3.2.4.2.). In 1981, signs were posted on the breakwater alerting fishermen to the possible health effects of eating fish caught in Waukegan Harbor. Although no data are available, it is likely that breakwater and shore fishing activity has decreased since the signs were posted.

Muench (1981) also determined that there is a substantial trolling fishery off of Waukegan Harbor (Section 3.2.4.2.). The impact of the No Action Alternative on the substantial trolling fishery largely depends on the perception people have of the health effects of eating fish taken from Lake Michigan near Waukegan Harbor. Because of the signs posted on the breakwater alerting people of the possible health hazards of eating fish caught in Waukegan Harbor, it is likely that the majority of the people who fish offshore from the Harbor have some awareness of the PCB contamination present in the Harbor. Boat launching activity has increased from 1980 to 1981, however, and the charter operators have had no problems in filling their boats. It appears that people do not perceive that there could be a health hazard in eating fish caught several miles from Waukegan Harbor. How the No Action

Alternative might change people's perceptions is uncertain, but it is possible that a reduction in the trolling fishery could occur. No other recreation-related impacts associated with the No Action Alternative are apparent.

4.2.4.2. Alternative #2

The major impact associated with Alternative #2 would result from the construction and operation of the dewatering lagoon. The site of the dewatering lagoon is across from the Waukegan Public Beach which can be considered as a sensitive noise receptor. The noise produced by construction equipment could impact the use of the public beach. Traffic congestion associated with construction of the dewatering lagoon also could inconvenience public access to the beach.

what about OMC's parking lot?

In addition, the City of Waukegan uses the site proposed for the dewatering lagoon as a parking area its public festivals. The City expects between 70,000 and 80,000 people to attend its festivals in 1981 (By telephone, Paul Sveska, City of Waukegan, to WAPORA, Inc., 5 August 1981). If the vacant lot were unavailable for parking for the City's summer festivals, a shuttle system between the downtown area and the beach would have to be arranged because no alternative parking facilities are available.

Of the impacts listed above, noise and traffic congestion can be regarded as negative short-term impacts that could be reduced with proper mitigative measures. The loss of a large parking area adjacent to the beach is a short-term impact that would diminish the City of Waukegan's ability to use the beach for large public festivals.

The removal of PCB-contaminated Harbor sediments would have a positive impact on the recreational fishery. Increased breakwater fishing activity could be expected as could an increasing trolling fishery. Increased demand for charter fishing space also could be expected.

4.2.4.3. Alternative #3

The impacts associated with Alternative #3 would be similar to the impacts associated with Alternative #2.

4.2.5.3. Alternative #3

Impacts on sewer and utility lines associated with Alternative #3 would be the same as for Alternative #2 except that JULIE services would have to be used in the vicinity of the North Ditch.

4.2.5.4. Alternative #4

Impacts to sewer and utility lines associated with Alternative #4 would be the same as those for Alternatives #2 and #3. The precise locations of utilities could be determined by JULIE during the construction of the North Ditch bypass.

4.2.5.5. Alternative #5

Impacts to sewer and utility lines associated with Alternative #5 would be the same as those for Alternatives #2 and #3.

4.2.6. Cultural Resources

4.2.6.1. Alternative #1

Impacts to cultural resources under the No Action Alternative would be related to the social undesirability of the presence of PCB-contaminated waste materials. Visitation and upkeep of cultural resources would be jeopardized by the long-range effects of the dispersal of PCBs from the project area (Section 2.1.2.).

4.2.6.2 Alternative #2

There would be no adverse impacts to cultural resources in the Waukegan Harbor area under this alternative. It is possible that the removal and disposal of PCB-contaminated sediments would enhance the desirability for acquisition and retention of cultural resources in the Harbor Area.

4.2.4.4. Alternative #4

The impacts associated with Alternative #4 would be similar to the impacts associated with Alternative #2.

4.2.4.5. Alternative #5

The impacts associated with Alternative #5 would be similar to the impacts associated with Alternative #2.

4.2.5. Sewer and Utility Lines

4.2.5.1. Alternative #1

The No Action Alternative is not expected to have any adverse impacts on sewers or other utility lines located near the project area.

4.2.5.2. Alternative #2

Impacts on sewer and utility lines associated with Alternative #3 dredging operations would be short-term impacts. Although it appears that underwater electrical cables are the only utilities present in the Harbor, the joint utility locating information for excavators (JULIE) would have to be contacted before construction or dredging could begin. There is a charge for this service. Utility lines would have to be avoided or temporarily relocated during the construction and dredging phases. JULIE also would have to be contacted when the ultimate disposal site is identified.

An 8-inch sanitary sewer traverses the proposed site of the dewatering lagoon but it is not expected to be directly impacted by construction of the lagoon. As a precaution, a sanitary sewer force main would be placed parallel to the existing pipe. This force main would only be utilized if the existing sanitary sewer should fail.

Will we need this?

Impacts could occur at the ultimate disposal site. Depending upon the disposal site selected and the recommendations of the State Historic Preservation Officer, an archaeological survey could be required.

4.2.6.3. Alternative #3

The impacts associated with this alternative would be the same as those for Alternative #2.

4.2.6.4. Alternative #4

The impacts associated with this alternative are the same as those for Alternative #2.

4.2.6.5. Alternative #5

The impacts associated with this alternative are the same as those for Alternative #2.

dredge and by-pass mitigation of removal of dock pilings

5.0. EIS RECOMMENDED ACTION

The preceding chapters of this EIS have discussed the purpose and need for action in the project area, alternatives for abating the PCB problem, the affected natural and man-made environments, and the environmental consequences of the five alternatives selected for analysis. Based on this information, it is apparent that the presence of a large amount of uncontained PCBs in the Waukegan Harbor and in the North Ditch Drainage System area represent an immediate and long-term threat to Lake Michigan water quality, fish populations, and public health.

Harbor

The benefits of an abatement action for Waukegan Harbor outweigh the costs that will be associated with the cleanup effort. This conclusion is ~~primarily~~ based on the ~~direct impacts on~~ aquatic organisms resulting from PCB contamination in the Harbor (Section 1.5.1.), on the long-term potential for continuous exposure and redistribution of contaminated materials within the Harbor, on the estimated rate of movement of PCBs out of the Harbor (Section 1.2.2.), and on the potential impacts on human health from consumption of contaminated fish (Section 1.5.3.). This conclusion is supported by the analysis of the environmental consequences associated with recommended methods for removal and disposal of contaminated Harbor sediments (Section 4.0.). As documented in the Environmental Assessment the adverse impacts that are associated with the dredging elements of the project do not appear to be significant. For these reasons, Alternative 3 - Dredging and Disposal of Waukegan Harbor Sediments, plus by pass construction is recommended unconditionally.

North Ditch

The magnitude of PCB contamination in the Parking Lot, an area at the east end of the North Ditch Drainage System, has not been determined with acceptable precision. Although it is currently estimated that the Parking Lot holds roughly 30% of the total estimated mass of PCBs in the North Ditch Drainage System, the singularly large PCB concentrations which have been measured in a limited number of soil borings beneath the Parking Lot indicate that a much greater mass of contamination could be present there. Therefore, a comparison between the magnitude of PCB contamination in the Parking Lot and the contamination in the Crescent and Oval Lagoon area, based on current information, does not provide a clear indication of the abatement action priority in the North Ditch Drainage System.

The available information does demonstrate, ~~however,~~ that ~~for both of the areas the~~ horizontal movement of PCB masses and the discharge of PCBs into surface water result directly from groundwater recharge and flow in the water table aquifer of the North Ditch Drainage System. By diverting stormwater runoff from the drainage courses of the North Ditch Drainage System, groundwater recharge and horizontal flow would be minimized. The result of a complete stormwater diversion would be to ~~halt~~ slow the present flux of PCBs out of the Crescent and Oval Lagoon enclaves of PCB contamination. It also would ~~halt~~ slow the net lakeward (easterly) migration and dispersion of PCBs in the Parking Lot enclave of contamination. (At present there is no flux of PCBs out of the Parking Lot soils and into the surface waters. The enclave is, however, migrating and dispersing as a result of non-reversing groundwater flows [Section 1.2.2.]).

use ground water

A complete stormwater diversion in the North Ditch Drainage System would prevent recharge into the groundwater of stormwater from the area west of the OMC properties and runoff from the roof drains, paved areas, and other surfaces in the immediate vicinity of the drainageway. Such a diversion would halt the present flux of PCBs into the surface waters and would protect the public beach to the east of the Parking Lot from becoming severely contaminated in the future. [There are three optional means for stormwater diversion:]

This is wrong through sediment & effort

- [Retain the East-West segment of the North Ditch as a drainageway but limit groundwater recharge and channel erosion by installing an impervious sluiceway or collection sewer directly into the present water course.]

- [Divert the runoff from the area west of the OMC property into Waukegan Harbor after the dredging program is finished. This would not be a total diversion as it would not eliminate groundwater recharge from stormwater in the immediate vicinity of the contamination.]

- Construct two storm sewers parallel to, but not in place of the present drainageway to collect and bypass all stormwater runoff from the area. This diversion option would require the excavation of some contaminated soils (Section 2.0.) and would be the preparatory step for the excavation of all dewatered, highly contaminated soils in the Crescent and Oval Lagoon areas. Depending on the engineering design employed, the storm sewers could be extended eastward to the northside of the Parking Lot area to halt the eastward migration and dispersion of PCBs in the east end of the Ditch.

should be this

it only stops sediment transport and surface runoff

Each of the above options would reduce the present flux of PCBs from the North Ditch by halting the horizontal groundwater flow. To the extent that groundwater flows produce dispersion of the PCB enclaves, this process also will be nullified by altering the groundwater recharge and flow mechanism that currently exists. The horizontal component of PCB movement in the North Ditch would essentially cease. Because the horizontal movement of groundwater is responsible for the present flux of PCBs to the Lake from the North Ditch, the implementation of an action that would limit stormwater flow (and hence groundwater flow) in the North Ditch is recommended unconditionally. None of the three diversion options directly involves the extensive excavation of PCB-contaminated soils. (The parallel bypass option requires that a relatively small amount of material (7,000 cubic yards) be excavated to install the bypass storm sewers.)

There is a possibility by better design...

When ~~a~~ The by-pass diversion is completed, high concentrations of relatively stationary PCBs would remain in the area. (There is insufficient evidence, however, concerning the extent of the contamination in the North Ditch Drainage System and the costs of implementing Alternatives #4 or #5 to unconditionally recommend the implementation of these components of the project at this time. Although it is apparent that halting the groundwater flow through the area would put an end to the present flux and migration of PCBs to the Lake, there is insufficient evidence on the long-term implications of leaving PCBs in the North Ditch Drainage System to conclude that excavation and secure landfill disposal of PCB contaminated soils is an imperative part of an overall abatement project. The need for such a removal program is primarily contingent upon the need to avert adverse impacts associated with possible accidental human contact with PCBs at the North Ditch or during a future construction project in the area of contamination. Further information on the projected migration rate of the PCB enclaves and on the public health impact of leaving a large mass of PCBs in the soils of the North Ditch Drainage System, when compared to updated abatement cost estimates, will allow a final determination of the need for excavation of these contaminated soils.

wrong

NO

The preferred option for the diversion of stormwater is dependent on the extent of excavation of contaminated soils that is to be implemented. If extensive excavation of PCB-contaminated soils is not found to be necessary,

the diversion of stormwater into the Harbor or the construction of an impervious sluiceway in the North Ditch ~~appear to be~~ is feasible methods for ~~halting~~ reducing groundwater recharge. If excavation of the major areas of contamination is to be implemented, however, the construction of a new sewer system parallel to the North Ditch drainageway is the recommended option.

In summary, as more information becomes available on the extent of contamination in the North Ditch Drainage System, the long-term threat that the contamination poses, and the costs of abatement, the need for and benefits of implementing Alternatives #4 and #5 will be evaluated. Following this evaluation, a single course of action which should be followed will be recommended. Thus, at the present time, the dredging and disposal of contaminated Harbor sediments and the implementation of a stormwater diversion to limit groundwater recharge and flow in the North Ditch Drainage System are recommended unconditionally.

The following sections summarize the alternatives that are available for PCB abatement and the approximate cost estimates developed to date. These sections also describe the mitigative measures that will be used to lessen the adverse impacts associated with the alternatives.

5.1. Alternatives Available for PCB Abatement

The range of conceptual alternatives available for the abatement of the PCB problem in Waukegan Harbor and the North Ditch Drainage System are detailed in Section 2.0. These conceptual alternatives range from no action to complete removal of all PCB-contaminated material in the project area including transport and ultimate disposal of this material. The range of alternatives was screened down to those alternatives which could effectively and feasibly abate the PCB problem with the greatest environmental, social, and technical acceptability. As a result, a number of alternatives were ~~screened out~~ eliminated early in the selection process.

The need for further information on the magnitude of contamination and additional engineering plans for abatement of the North Ditch Drainage System contamination, including the Crescent and Oval Lagoons and the Parking Lot,

has prevented a single alternative from being selected for this area. Two related but separate areas of PCB contamination exist in the North Ditch Drainage System. The alternatives that were considered for abatement of PCB contamination in the Crescent and Oval Lagoons and in the Parking Lot include:

- Excavation of contaminated soils;
- Dredging of soils;
- In-place, secure disposal; and
- Diversion of stormwater.

This is a quasi-natural alternative

Engineering, environmental, and cost factors dictate that some method of stormwater bypass be utilized initially. Because the extent of contamination has not yet been precisely determined, it was decided to consider three action alternatives for the North Ditch Drainage System that provide incrementally greater levels of excavation and removal, depending on the magnitude of the PCB problem. The three action alternatives represent combinations of diversion, excavation, and disposal activities for both of the contaminated areas in the North Ditch Drainage System. Depending on the final alternative selected; varying levels of stormwater bypass, excavation, and slurry wall construction; dewatering and treatment; and transport and ultimate disposal will be required. Between 7,000 and 179,000 yd^3 of contaminated materal may need to be removed and transported to an ultimate disposal site.

Under any of the recommended alternatives for the Harbor and for the North Ditch Drainage System, the transport and ultimate disposal of contaminated material is required. Ultimate disposal options include landfill disposal, incineration, chemical treatment, and biochemical degredation. Although landfilling only provides secure storage rather than destruction of PCBs, it is the only economically and technologically feasible method of disposal currently available for PCB-laden soils materials.

A number of existing licensed and unlicensed landfill sites as well as several potentially suitable but undeveloped landfill sites were screened as ~~potential~~ ultimate disposal sites for the contaminated materials from the project area. No single site is recommended in the EIS because the detailed

engineering and cost proposals have not yet been submitted through the bidding process and because a public hearing must first be held on the granting of the Federal and state permits for landfill disposal of PCBs. The disposal site(s) that is selected through the bidding process will be required to fulfill all applicable Federal and state licensing and permitting procedures, thus ensuring one or more secure and environmentally acceptable ultimate disposal sites for the contaminated material.

This means we may add to address the final

The uncertainty regarding selection of ultimate disposal site options prevents a particular transport mode from being selected at this time. Truck, barge, and rail all have certain advantages and disadvantages which could support the selection of one mode over another. However, the selection of a transport mode and route will be made in conjunction with the selection of a final disposal site and after an evaluation of the issues associated with the transport of PCB-contaminated materials to a particular site (safety, potential environmental impacts, costs, reliability). Proper precautions including a spill prevention and containment plan will be developed to reduce the potential for accidents and spillage and consequent impacts.

Because only certain ~~of the~~ project components can be selected and unconditionally recommended for implementation, the project alternatives represent combinations of these recommended components with other potentially viable components that provide cumulatively greater levels of PCB abatement. These alternatives are defined as follows, based on those components that appear to be most appropriate for the abatement of contamination in the different areas:

- Alternative #1 - No Action
- Alternative #2 - Dredging and Disposal of Waukegan Harbor Sediments
- Alternative #3 - Dredging and Disposal of Waukegan Harbor Sediments and Construction of the North Ditch Drainage System Stormwater Diversion
- Alternative #4 - Dredging and Disposal of Waukegan Harbor Sediments, Construction of the North Ditch Drainage System Stormwater Diversion, and Excavation of the Crescent and Oval Lagoons

- Alternative #5 - Dredging and Disposal of Waukegan Harbor Sediments, Construction of the North Ditch Drainage System Stormwater Diversion, Excavation of the Crescent and Oval Lagoons, and Removal of Contaminated Soils from the Parking Lot.

As discussed in the introduction to this section, the dredging and secure landfill disposal of contaminated Harbor sediments and action to limit groundwater recharge in the North Ditch Drainage System (Alternative #3) are recommended unconditionally. Both Alternatives #4 and #5 include these recommended actions and also provide for the excavation of contaminated soils in cumulatively greater degrees from the North Ditch Drainage System. The recommendation of one of the latter alternatives will be made when more detailed information is available on the extent of the contamination in the North Ditch Drainage System, the benefits of excavation of contaminated soils, and the cost of the project components for this area of contamination.

5.2. Costs of Alternatives

Final cost estimates have not yet been developed for all of the various project components because the magnitude of abatement activities required is uncertain. However, USEPA has developed approximate cost estimates by component in order to project fiscal year financial appropriation requirements (Table 5-1). These figures represent cost estimates for the most likely courses of action based on data available prior to the preparation of this EIS.

These approximate cost estimates by component result in the following cost estimates by project alternative:

- Alternative #1 - 0
- Alternative #2 - $17.1 million (Plans 1 and 2)
- Alternative #3 - $21.6 million
- Alternative #4 - $31.7 million
- Alternative #5 - $46.3 million (depending on volume of contaminated material to be excavated and removed).

These figures are subject to significant fluctuations depending on the specific components selected for the abatement action, the mode of transport, the location of the ultimate disposal site, and the volume of material removed. Consequently, the estimates of cost should be used merely as an approximate basis of comparison between project alternatives.

Table 5-1. Waukegan Harbor and North Ditch Drainage System components and costs (Personal communication, Tony Rutter, USEPA, to WAPORA, Inc., July 1981).

Federal Fiscal Year	Project Area/Component	Estimated Cost
	Waukegan Harbor	
1983	Construct Lagoon	$ 4.5 million
1983-84	Dredge to 50 ppm	$ 7.0 million
1984	Dispose of Dredged Sediment*	$ 4.5 million
1985	Lagoon Site Restoration	$ 1.1 million
		$17.1 million
	North Ditch Drainage System	
1983-84	Construct Bypass	$ 4.5 million
1984	Remove and Dispose of Contaminated Sediment (Crescent and Oval Lagoons, Bypass Excavation)*	$10.1 million
		$14.6 million
	Parking Lot	
1985	Removal and Disposal of Contaminated Material*	$14.6 million
	Total Cost	$46.3 million

*Landfill transport and disposal costs are likely to be substantially higher if a Lake County IL site can not be utilized.

5.3. Impacts of Alternatives

5.3.1. Mitigation of Adverse Impacts

As discussed in Chapted 4.0., certain impacts will occur as a result of implementing any of the action alternatives. The adverse impacts associated with these alternatives can be largely minimized through appropriate mitigative techniques. Such measures are discussed below for each action alternative.

5.3.1.1. Alternative #1 - No Action

Because Alternative #1 represents no action (that is, no abatement of the existing PCB contamination problem in Waukegan Harbor and the North Ditch Drainage System), no impacts would occur which would require mitigation in addition to those recommendations already in effect for consumption of contaminated fish. The existing PCB-contaminated sediments and soils would remain in the project area with the resultant effects on water quality, aquatic and terrestrial biota, and humans. In effect, Alternatives #2 through #5 represent various means of mitigating this problem.

5.3.1.2. Alternative #2 - Dredging and Disposal of Waukegan Harbor Sediments

This recommended component of all of the action alternatives requires extensive mitigatie measures to prevent adverse impacts. This is due largely to the encompassing nature of this action which requires dredging, dewatering and treatment, excavation, transport, and ultimate disposal of the sediments.

need more about method of dredging

Waukegan Harbor Dredging

The recommendation to use either a hydraulic or pneumatic dredge minimizes many of the resuspension problems associated with the dredging of PCB-contaminated sediments. In addition, a double-wall silt curtain will be deployed before, during, and for several days after dredging takes place. The method of deployment for the silt curtain is shown schematically in Figure 5-1 for the implementation of Plan 1 (duration of up to one month). The same

method of deployment will be used north of Slip #1, between the Johnson Outboard Plant #1 and Huron Cements property, during the implementation of Plan 2 of the dredging.

Deployment of double-wall silt curtains should minimize PCB transport-lakeward and keep concentrations in the water column outside the area of dredging to an acceptable level during both phases of the dredging. Silt curtains are not recommended for use where currents approach 0.5 m/sec because they may billow or "sail," causing excessive roiling of sediments if the anchor weights are pulled out of the muck sediments (Barnard 1973). Therefore, it will be necessary to coordinate the use of the silt curtains in the implementation of dredging Plan 2 with commercial shipping operations in and out of Slip #1. Transport ships enter Slip #1 bow first and back out when leaving, pointing the stern to the north (where the silt curtains will be). If stern-thrusters on the ships are turned on at the time a ship is backing down on the silt curtain, damage to or "sailing" of the curtains would result in leakage of the highly contaminated water behind the curtain into the central Harbor. Even with the double-wall silt curtains, PCBs may move toward the Lake. As a result, total suspended solids (TSS) and turbidity will be monitored throughout the Harbor during dredging as an indicator of PCB mobilization and movement. Based on these results, additional measures including silt curtain readjustment and/or the use of precipitant/ absorbent slurries (polymers, alum, or activated carbon) may be required.

Dissolved oxygen concentrations throughout the Harbor also will be measured during dredging as an indicator of any stress that may develop on spawning fish observed to be present in the vicinity of the dredging operations. It may be advisable to retain the use of an electric "boom-shocker" device mounted on a boat for use in driving and removing fish from the areas to be dredged on an as-needed basis. Some chinook salmon die-offs have been observed in Waukegan Harbor and the appearance of dying fish, concurrent with autumn dredging operations, would be a matter of public concern that should be taken into consideration by Illinois Conservation Department personnel who may be observing the operations. Close coordination between USEPA and the Department should be maintained during autumn dredging so that additional mitigative steps can be developed if needed.

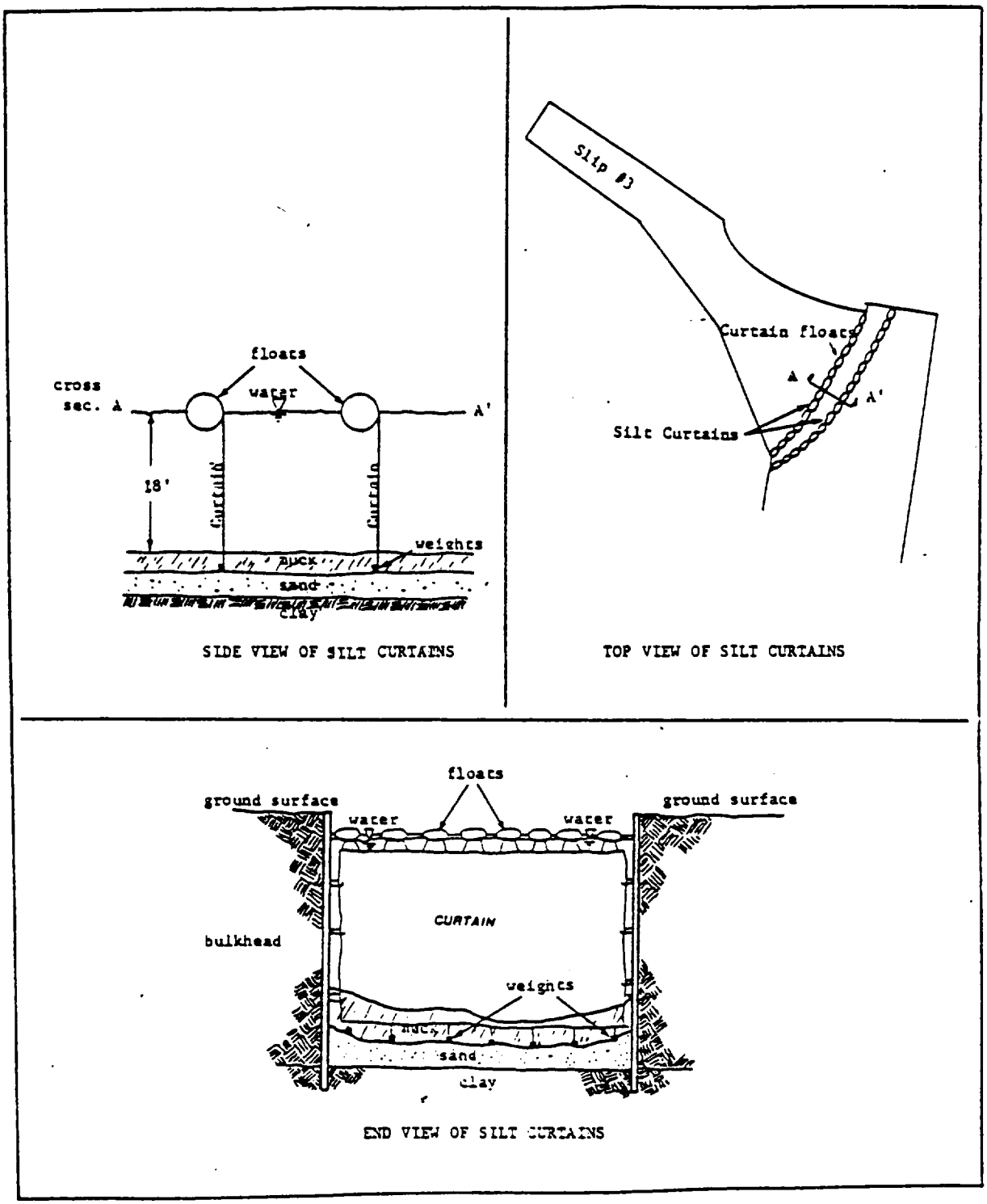

Figure 5-1. . Three views of the planned deployment of silt curtains to minimize the movement of suspended and dissolved PCBs during implementation of the dredging Plans. (Views are for Plan 1, in Slip #3).

The dredging activity in Waukegan Harbor, especially in Slip #3 where PCB concentrations are highest, will result in increased volatilization of PCBs unless properly controlled. Measures that will be used to mitigate volatilization impacts include:

- Protective clothing including respirators and protective gloves will be available for the equipment operators and other personnel at the dredging site.

- The operations will be halted during unfavorable meteorological conditions (for example, high ambient temperatures with winds blowing from the Harbor to the beach).

- The contaminated sediments inside the Lagoon will be covered with water until removed for disposal.

- The exposed sediment will also be treated with a dust control agent.

- The dredging will be performed only during non-beach use periods such as early spring or late autumn or even during cloudy or rainy days, and not during heavily-used beach periods (such as sunny summer weekends or holidays).

- The most contaminated materials will be placed as far as possible from the public beach.

- The most contaminated materials will be placed in a pocket of the proposed lagoon and covered with less contaminated material to minimize volatilization (USEPA 1981).

- Muck from Waukegan Harbor that is relatively uncontaminated will be used to form a cap on the settled, heavily contaminated sediments. This will lower the concentration of PCBs in the exposed sediment and thus reduce the volatilization rate.

The effectiveness of these mitigative measures will be determined by the regular use of several high-volume air samplers strategically placed in the area of dredging activity.

Lagoon Construction and Operation

Dewatering lagoon impacts are associated with lagoon construction and the various phases of operation including dewatering, storage, and excavation for disposal. Construction activities will alter the topography of the site, compact the soils around and under the lagoon, increase surface water runoff,

really!

and reduce local groundwater storage. As a result, proper excavation techniques must be used to minimize adverse impacts. After construction is completed, the area outside the lagoon will be graded so that runoff can be collected and detained prior to movement into the surface water. In addition, typical construction impacts such as fugitive dust emissions, vehicle and equipment emissions, and construction noise also can be expected. Proper equipment maintenance, noise suppression devices, daytime working hours, and dust control plans should adequately minimize these impacts.

Perhaps the most potentially adverse impact of lagoon operation would be leakage or seepage of PCB-contaminated water into the underlying soils and ultimately into the groundwater. To avoid this potentiality, the lagoon will be flooded with clean water prior to the start-up of dredging operations. If leaks are detected, the lining will be repaired in advance of dredging.

The clay material for the liner will be placed into position carefully, and compacted so as to minimize the possibility of occurrence of zones of poorly-compacted aggregates. The liner will consist of a blanket of clay over the bottom of the lagoon and the inner sides of the dikes. The thickness of the liner will be a uniform 3 feet over the bottom and a uniform 4 feet on the sides. During the trial flooding period, this clay should expand, sealing any small cracks. Larger cracks or other features that provide channels through the liner for the water, may have to be sealed by application of bentonite. The operational plan requires that the integrity of the liner be demonstrated prior to the introduction of contaminated dredged spoil into the lagoon.

The integrity of the dike liner also may be threatened by wave action during periods of strong winds and by the effects of ice during the winter. The plastic mesh fabric that will cover the inner sides of the dike will aid in stabilizing the soil against the effects of gravity and surface runoff; however, additional protection such as gravel armor may be required if adverse wind or ice conditions are experienced during the use of the lagoon.

The exposure of PCB-contaminated materials in the lagoon will increase volatilization, although probably at a lower rate than during dredging. Consequently, many of the same mitigative measures can be applied to this component of Alternative #2 for air quality. The use of measures such as

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covering the exposed materials with plastic sheeting or tarpaulins also will prevent birds from being exposed to the PCB-contaminated sediments and water. Non-avian terrestrial animals could be discouraged from coming into contact with these materials through the use of fences.

Transport of Contaminated Materials

The transport of PCB-contaminated material from the project area to the ultimate disposal site provides the opportunity for non-localized impacts. For instance, truck transport allows for: PCB volatilization during loading and unloading operations and during transport (if not covered); off-site migration of contaminated material that adheres to truck tires and undercarriages and falls off in transit; air and noise emissions; traffic congestion; and potential spills off-site. Other transport mode options (rail and barge) provide similar opportunities for off-site impacts and migration of PCBs.

Noise and air emission control devices can be installed to control these impacts and use of proper transportation routes and scheduling can eliminate congestion problems. PCB migration off-site, however, requires that more extensive measures be employed. Cleaning pits (wheel cleaners) will be located at or near the site and all exiting vehicles will be required to drive through these facilities. Each pit will be designed so that it collects the sediment-laden runoff, separates the fines from the water, and sends the water to the treatment system for treatment. The collected sediments (after dewatering) will be taken to the final disposal site. Because personnel involved in operating this process may be exposed to high concentrations of airborne contaminants proper safety equipment will be provided to assure them adequate protection.

Proper precautions will be taken to control the likelihood of spills and to provide a cleanup procedure should a spill occur. The cautionary methods will be designed, drafted, and be available in a form similar to a Spill Prevention Control and Countermeasure (SPCC) plan (as required for many pollutants and described in 40 CFR Part 151). In addition, rules and regulations

controlling the transport of toxic materials promulgated by the USDOT, USEPA, Illinois Department of Transportation (IDOT), and Illinois Institute of Natural Resources (IINR) will be reviewed and applied to this program.

TAI to prepare an SPCC plan

General areas of concern for spill prevention may include, but are not limited to: Could place in appendix

- Proposed route structural integrity
- Traffic volumes
- Route patrol
- Awareness by local communities
- Training of personnel

A general awareness of the potential hazards by the personnel and local communities involved will result in a more efficient and effective response action should a spill occur.

In the event of a spill, a system will be in place to allow for a quick response. The items that will be included in the emergency spill response plan include:

- A proper communication system description;
- Notification of all affected parties;
- Emergency dispatch team with proper equipment; and
- Alternative routes to be used during a spill.

With proper planning and praparation, the risk of a spill can be greatly reduced and spills that do occur can be cleaned up efficiently and effectively.

Ultimate Disposal

Although no specific ultimate disposal site has been selected, there are certain characteristic impacts common to all such sites that require mitiga-

tion. Some of these impacts will be mitigated through existing licensing procedures, while others may require special provisions. Air contamination at the ultimate disposal site can be caused by two sources: volatilization from the surface and gas production within the landfill. Mitigative measures to control surface volatilization include the capping of the surface with a natural or synthetic cover. The final cover material chosen for the site should be receptive to local climatic conditions and allow the site to function properly (for example, if dewatering is planned, the cover must not interfere with this activity).

The landfill should be properly vented so that any gas produced can be captured and treated. This can be accomplished by strategically placing relief vents with control valves. The gases released should be sampled and analyzed for PCB content. If PCBs are present, the gases should be collected and treated prior to discharge to the atmosphere. Treatment systems could be comprised of individual units connected to each vent (for example, carbon adsorption filters) or all the vents could be interconnected with a vacuum system that would collect the gases and send them through a common treatment system (for example, a carbon adsorption column).

Many of the impacts associated with the ultimate disosal site will be similar to those associated with the dewatering lagoon, and consequently similar mitigative measures will be required. These include the proper use and testing of liners, control of leachate and surface water runoff, monitoring programs, and water treatment systems.

Noise impacts associated with the construction and operation of the ultimate disposal site will be minimized, if necessary, by limiting the transport of materials and the operation of the facility to daytime periods during the work week. Depending on the site that is selected, a berm or noise barrier may be required to shield sensitive receptors (residential areas, schools, churches, etc.) from excessive noise levels. The berm or noise barrier should be high enough to lower noise levels at the "worst case" noise receptor to below 65 decibels.

Land use impacts are difficult to mitigate after an ultimate disposal site is selected. For this reason, the site selection process will include an evaluation of the impact the disposal site will have on the conversion of prime farmland to other uses, decreases in property values on adjacent lands, possible changes in land use and growth patterns, and the compatibility of the hazardous waste disposal site with adjacent land uses.

5.3.1.3. Alternative #3 - Dredging and Disposal of Waukegan Harbor Sediments and Construction of the North Ditch Drainage System Stormwater Diversion

All of the mitigative measures identified for Alternative #2 also would be required under this alternative. For the most part, only the magnitude and range of the impacts would change between Alternative #2 and Alternative #3. Consequently, the implementation of the mitigative measures becomes even more important. Widespread use of many of the mitigative measures required for the dredging of the Harbor, the construction of the lagoon, and the transport and disposal of the contaminated material also will be applied during the North Ditch Drainage System stormwater diversion activities.

5.3.1.4. Alternative #4 - Dredging and Disposal of Waukegan Harbor Sediments, Construction of the North Ditch Drainage System Stormwater Diversion, and Excavation of the Crescent and Oval Lagoons

The mitigative measures required for Alternative #4 are very similar to those discussed for Alternative #2. Although many of the measures will be applied to different areas (North Ditch and Crescent and Oval Lagoons) and involve different types of activities (excavation and sewer construction), the basic mitigative techniques remain the same.

5.3.1.5. Alternative #5 - Dredging and Disposal of Waukegan Harbor Sediments, Construction of the North Ditch Drainage System Stormwater Diversion, Excavation of the Crescent and Oval Lagoons, and Removal of Contaminated Soils from the Parking Lot

No significantly different mitigative measures are required under this alternative as compared with any of the other action alternatives.

5.3.2. Unavoidable Adverse Impacts

Through the use of the mitigative techniques described in Section 5.3.1., few serious unavoidable adverse impacts should occur under any of the alternatives. Those impacts that cannot be avoided through some type of mitigative action are listed below. Some of the unavoidable impacts are more severe than others. The order of the list, however, is not intended to indicate the relative significance of the particular impact.

- Use of the vacant OMC property for a dewatering lagoon would preclude the development of this site for industrial use for the duration of the project.

- Noise, exhaust, and fugitive dust emissions would result from construction activities, excavation, and transport. Material transport also may result in traffic congestion on highways or at railroad crossings.

- Topographic alteration associated with lagoon construction and the resultant aesthetic impact would occur. The construction activities also would result in soil compaction near and under the lagoon which would reduce groundwater recharge.

- Dredging activities would disrupt aquatic biota in the inner Harbor and may even result in some fish kills. Resuspension and adsorption of PCBs during dredging may also serve to move PCBs outside of the Harbor into Lake Michigan.

- Terrestrial habitat would be disrupted during lagoon construction. Both aquatic and terrestrial animal species may be forced away from normal habitat, feeding, and activity areas during construction and dredging activities.

- PCB exposure to the atmosphere during dredging, dewatering, storage, excavation, transport, and disposal actvities would result in PCB volatilization.

- Excavation activities in and near the North Ditch Drainage System may require relocation of utility lines.

- Land at the ultimate disposal site would no longer be suitable for other productive uses. Adjacent land uses may be reduced in value due to the proximity of the disposal site.

- Harbor dredging would reduce Harbor access and would result in a loss of revenue to several Harbor-related businesses.

- The City of Waukegan would be unable to use the vacant OMC property for parking during its public festivals.

In addition, the potential for a spill of PCB-contaminated material represents perhaps the most serious of all the unavoidable adverse impacts. Even the most specific spill prevention and control plan cannot ensure total protection from PCB movement into the environment during a spill.

5.3.3. Irretrievable and Irreversible Resource Commitments

The resources that would be committed through the implementation of the various alternatives discussed in Section 2.5. have been described in Sections 4.1. and 4.2. These resources would include:

- Fossil fuel, electrical energy, and human labor for construction and operation;
- Tax dollars for construction and operation expenditures;
- Chemicals for treatment plant operation;
- Some unsalvageable construction materials; and
- Possible loss of prime farmland at the location of the ultimate disposal site.

These alternatives would consume a significant amount of these resources with no feasible means of recovery. It is possible, however, that some tax dollars expended for this project will be recovered. The US has sued OMC as the discharger of PCBs to recover the costs of cleanup. This case is expected to be heard in the beginning of 1982. Therefore, nonrecoverable resources would be foregone for the provision of the proposed cleanup and disposal of PCB contamination at the Harbor and North Ditch site.

Accidents that could occur from system construction, operation, and hauling could cause irreversible bodily damage or death and damage or destroy equipment and other resources. Unmitigated failure of the storage lagoon and ultimate disposal site could contaminate local groundwater and increase PCB concentrations in the ambient atmosphere. These may result in immediate or future adverse human health effects.

5.3.4 Relationship Between Short-term Uses of Man's Environment and Maintenance and Enhancement of Long-term Productivity

The short-term disruption and commitment of resources associated with the removal and disposal of PCB-contaminated material is necessary to mitigate water and air pollution and to minimize the threat to Lake Michigan water quality, aquatic organisms, and human health posed by the presence of large quantities of uncontained PCBs. Adverse environmental impacts and resource requirements, however, will be offset by water and air quality improvements. Long-term, significant environmental benefits will be derived from short-term, minimal environmental costs.

5.4. Recommended Course of Action

Public health and fish data for the Harbor and Lake Michigan indicate that an abatement action is required to reduce the extent of PCB contamination. The implementation of Alternative ~~#2~~ 3, Dredging and Disposal of Contaminated Harbor Sediments, is unconditionally recommended and is considered an important step in reducing the threat associated with uncontained PCBs in the project area. Similarly, it is unconditionally recommended that some form of stormwater diversion be implemented to reduce the recharge and horizontal movement of groundwater in the North Ditch Drainage System. The complete diversion of stormwater from the North Ditch Drainage System will halt the migration of PCB ~~masses~~ toward the surface water and will reduce or eliminate the existing rate of PCB movement toward Lake Michigan. However, the environmental analysis of the other action alternatives and the available data on the extent of PCB contamination in the North Ditch Drainage System does not provide a clear indication of a preferable alternative for the complete abatement of PCB contamination in this portion of the project area.

surface water

All of the action alternatives have similar environmental impacts, many of which can be mitigated. Relatively few serious unavoidable adverse impacts are associated with any alternative. The only major difference between alternatives lies in the magnitude and range of the impacts and, consequently, the extent of mitigation required to control or eliminate these impacts.

Based on this environmental analysis, data regarding the magnitude and extent of the PCB problem, and limited cost data for each alternative, it appears that the selection of a specific course of action to be followed by USEPA to effectively abate PCB contamination (that is, Alternative #3 plus some combination of the recommended components for the removal and disposal of PCB-contaminated soils in the North Ditch Drainage System) rests primarily on a comparison between the amount of abatement to be derived for any particular action versus the costs associated with that action. It is apparent that any adverse environmental impacts resulting from an abatement action in the Harbor are outweighed by the public health benefits. The recommended action for the entire cleanup project rests on the need to determine what level of PCB removal, both in the Harbor and the North Ditch Drainage System, will effectively and economically remove the direct and potential threats associated with large uncontained quantities of PCBs in the Waukegan Harbor and adjacent areas.

7.0. GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ADI	Acceptable daily intake
AQCR	Air Quality Control Region
BFI	Browning - Ferris Industries, Inc.
BOD; BOD_5	Biochemical oxygen demand; 5-day
BP	Before Present
CEQ	Council on Environmental Quality
CFS	Cubic feet per second
CL	Low plasticity silty clay
CL-CH	Moderately plastic silty clay
C & NW	Chicago North Western Transportation Company
CO	Carbon Monoxide
COD	Chemical oxygen demand
COE	US Army Corps of Engineers
CPM	Critical Path Method
DO	Dissolved oxygen
DOT	US Department of Transportation
E	East
EA	Environmental Assessment
EHRC	Environmental Health Resource Center
EIS	Environmental Impact Statement
EJE	Elgin Joliet & Eastern Railroad Company

ESE	East-Southeast
FDA	US Food and Drug Administration
FNSI	"Finding of No Significant Impact"
Ft^2	Square Feet
GE	General Electric
$gO_2/d/m^2$	Grams of oxygen per day per square meter
GPM	gallons per minute
g(w)	grams wet weight
IDOT	Illinois Department of Transportation
IEPA	Illinois Environmental Protection Agency
IINR	Illinois Department of Natural Resources
IJC	International Joint Commission
JTU	Jackson Turbidity Units
JULIE	Joint Utility Locating Information for Excavators
km	Kilometers
L_{eq}; L_{dn}	24-hour average noise level; day and night noise levels
lbs	pounds
lb/d	pounds per day
lb/yr	pounds per year
m	meters
m/sec	meters per second
$m_{eq}/100g$	milliequivalents per 100 grams
mg	milligrams
mg/kg	milligrams per kilogram
mg/yr	milligrams per year
ML	Silt layer