Removal and Encapsulation of PCB–Contaminated Hudson River Bed Materials

For New York State Departments of Transportation and Environmental Conservation

1977 - 1979

MALCOLM PIRNIE, INC.

PCB ENCAPSULATION SITE

Town of Moreau, New York
July 1979

View of completed fill eight months after final seeding. Side slopes of fill are one vertical on four horizontal. Paved drains for surface runoff control and ground water intercepted from off-site are visible (right and foreground). Redish tint of water is due to oxidation of iron in the ground water.

PCB ENCAPSULATION SITE

Town of Moreau, New York
October 1977

Initial placement of PCB-contaminated debris and sediment (black material, left)on top of 18-inch clay liner; 4-ft interior clay dike (right foreground) and observation well (center foreground) are also visible. Existing dike (right) was incorporated into final fill. During the periods September-December 1977 and April-June and October 1978, 200,000 cu yd of dredged material was placed at the site.

Technical details of the site and the program for dredging PCB-contaminated material from the Hudson River at Fort Edward, New York are contained in the paper following the site photographs.

PCB ENCAPSULATION SITE

Town of Moreau, New York
July 1978

Placement of an 18-inch thickness of clay cover on top of contaminated material at final grade; typical depths of dredged material varied from 15 to 25 ft.

Standing water (left foreground) is evidence of 8 million gallons of water that had accumulated to a depth of 13 ft over the clay liner. This water accumulation occurred due to the site's over-winter exposure to 66 inches of precipitation on the surface of the fill prior to placement of the clay cover. A final dressing of 12 inches of soil was placed over the clay cover.

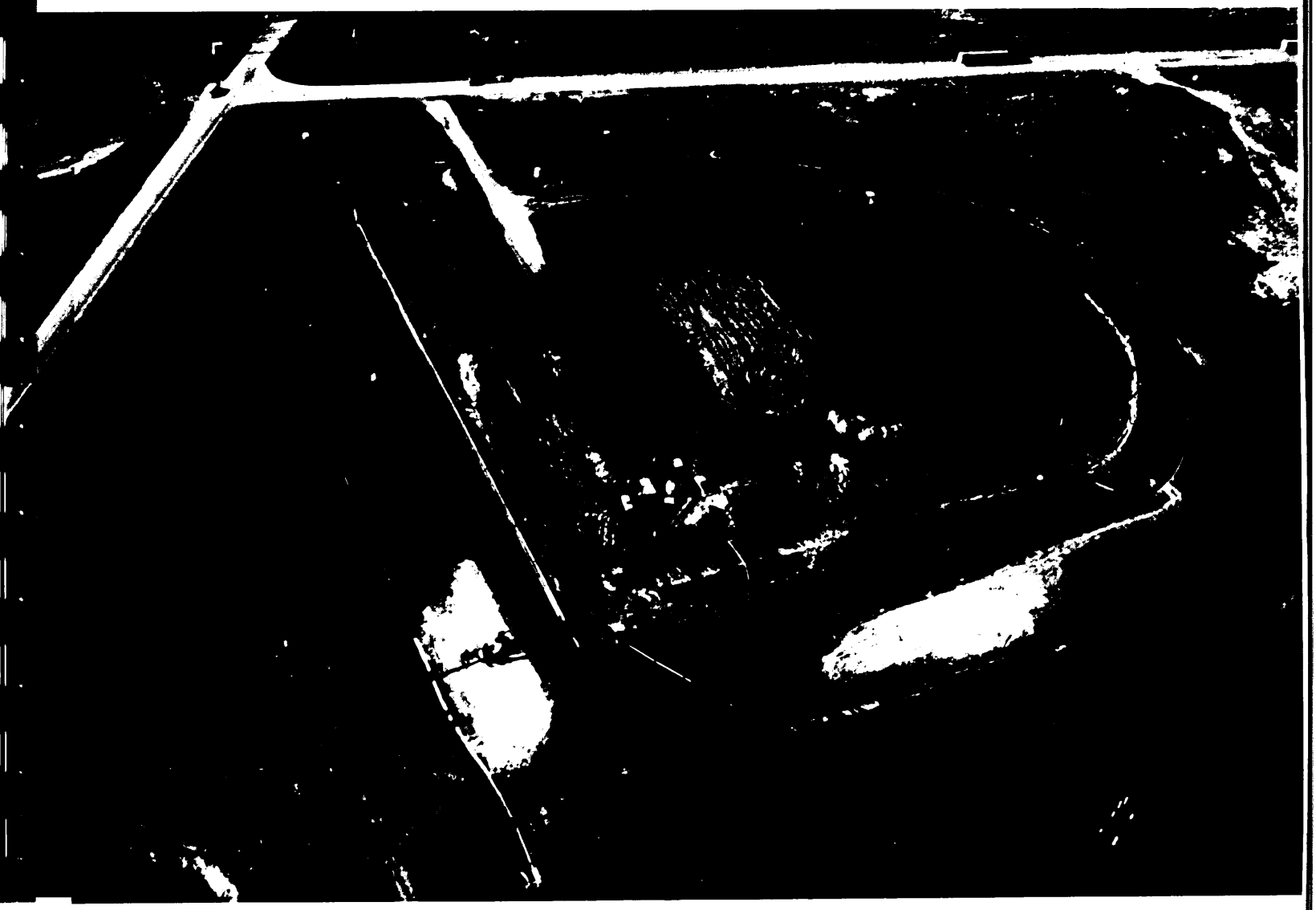

Photo by NYSDEC

PCB ENCAPSULATION SITE

Town of Moreau, New York
October 1978

Placement of the final dredged material. Clay cover and dressing had already been placed on side slopes, which show growth from seeding in fall of 1978. Wellpoint system header and pump used to remove trapped interior water from side slopes are visible on left and foreground perimeter at top of side slopes. Two light areas on side slopes are surface repairs necessitated by uplift pressure of the trapped water on the clay cover. Dewatering is continuing in the fall of 1979 at rates of 2-3 gpm.

PCB levels in drained water are at or below 1 ppb PCB and are acceptable for discharge to the river; 13 grams of PCB will be discharged.

REMOVAL AND DISPOSAL OF PCB-CONTAMINATED RIVER BED MATERIALS

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INTRODUCTION

This paper describes recent work, performed for the New York State Departments of Environmental Conservation (DEC) and Transportation (DOT), to remove and dispose of PCB-contaminated river debris and sediments from the upper Hudson River near Fort Edward, N.Y. The purpose of these efforts was two-fold:

1. To remove debris and sediment blocking the Fort Edward Terminal Channel of the Champlain Canal section of the New York State Barge Canal System.
2. To serve as a demonstration project for some aspects of removal, handling, and containment of PCB-contaminated river materials.

The project operations will be discussed in the following order: background, site design and preparation, removal and disposal operations, monitoring, future PCB disposal sites, and conclusions.

BACKGROUND

The Village of Fort Edward is located in Washington County, N.Y., approximately 45 miles north of Albany (Figure 1). The upper Hudson River at this point has a drainage area of 2,818 sq miles. Recent activities in this area of the Hudson began in the spring of 1974 after the removal of a 20-ft high timber crib dam, which was in poor structural condition and presented a hazard to the population living downstream.

After the dam was removed, some 850,000 cu yd of debris and sediment which had accumulated behind the dam for over 100 years was scoured from the deposits above the dam and deposited in the river channel within a distance of about a mile downstream. Various remedial measures, including removal of the debris, were undertaken during 1974-75 by the State of New York. All these efforts, however, were carried out with no knowledge of PCB contamination.(1)

In late 1975-76, field investigations were undertaken to determine the extent of PCB contamination in the river system. The presence of this substance had resulted from discharge of PCB-contaminated wastes over many years at two locations in the former pool of the Fort Edward dam. Sampling indicated that remnant deposits on the western bank of the river had PCB levels of approximately 10 ug/g, whereas those on the eastern side (where the PCB outfall points were located) had PCB levels on the order of 100 to 5,600 ug/g. High levels of Cd and Pb were also present.

In April 1976 a flood with an approximate recurrence of 100 years occurred. This event caused the scour of an additional 250,000 cu yd from unprotected areas of the former pool. Deposits in the Fort Edward Terminal Channel (Plate I) as a result of the April 1976 flood averaged 20 ug/g PCB, a relatively low level because the material had been scoured primarily from the less contaminated western bank.(2)

The need to remove this new material blocking the navigation channel presented an opportunity to demonstrate certain aspects of removal and containment of river debris which, although not classified as hazardous, could be disposed of in a site which essentially met chemical landfill requirements. Foundation permeability was modified by the placement of a clay liner.(3)

The project generated valuable information on several important aspects of contaminated material handling and disposal. These findings will be used in preparing final design and dredging administration procedures for the proposed "hot spot" dredging program in the 40-mile river reach between Fort Edward and Albany, where bed and bank sediments are contaminated by some 400,000 lb of PCB. In addition, approximately 700,000 lb of PCB is located in or adjacent to the study area in numerous landfills, dumps, and dredge spoil areas.

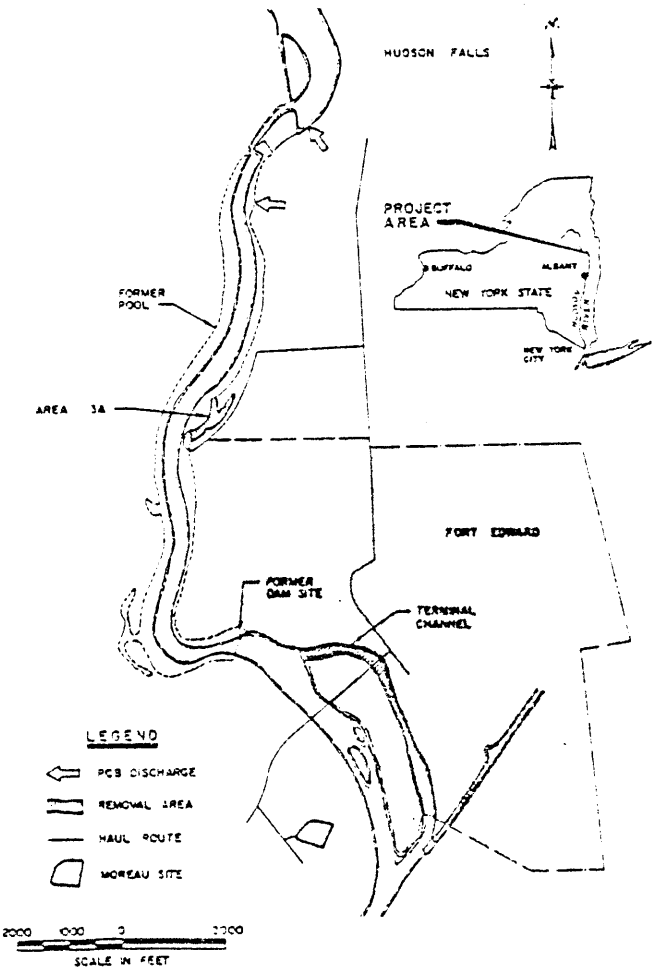


FIG. 1 PROJECT AREA

SITE DESIGN AND PREPARATION

The disposal site occupies some ten acres in the Town of Moreau, Saratoga County, N.Y. (Plate II). Subsurface characteristics of the site were evaluated by means of four borings (30 ft depth), a continuous trench approximately 4 ft deep by 500 ft in length, and about 50 shallow auger holes 3 to 4 ft in depth. The hydraulic conductivities of the site were evaluated using 40 infiltrometers. The following site description was developed based on these investigations.

The western one-third of the site is underlain by 10 to 40 ft of glacial lake clays, and the remainder by brown silty fine sand. Hydraulic conductivities of the underlying materials are on the order of 10^{-3} to 10^{-7} cm/sec.

Because of the variety of subsurface deposits, it was determined to cover the entire bottom with an 18-inch thick layer of compacted clay, which has a hydraulic conductivity on the order of 1×10^{-6} cm/sec (specified), to 1×10^{-7} cm/sec (measured). Before the liner was placed, the site surface was drained, organic material was removed, and a 4-ft high interior clay dike was constructed along the southerly and easterly perimeters (Plate III). The northerly and westerly perimeters of the site were established on existing debris from previous channel dredging programs.

The clay liner was extended up the existing slope to provide a barrier to migration from the existing deposits, and an exterior trench drain of crushed stone and perforated pipe wrapped in filter cloth was installed to intercept ground water flow. The side slopes of the disposal site had a maximum horizontal:vertical slope of 4:1 (Figure 2). A system of paved surface drains was provided to intercept surface runoff (Plate IV) and an 18-inch thick clay cover was placed over the deposited debris. The final slope dressing consisted of 12 inches of material suitable for turf establishment, followed by seeding and mulching. The permeability of the compacted clay liner was determined by infiltrometer.

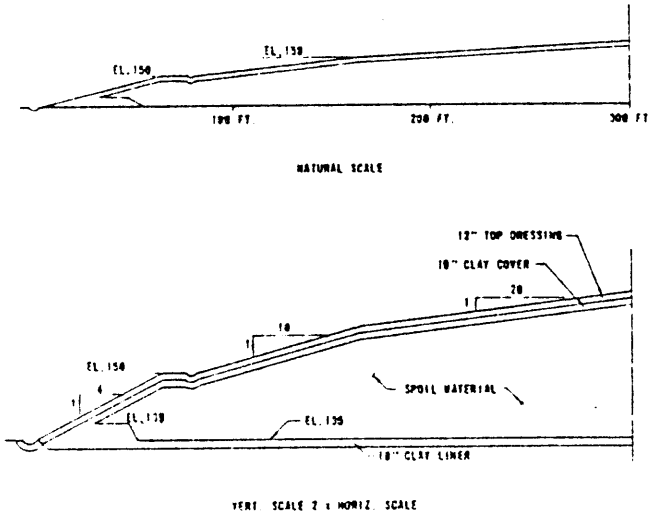


FIG. 2 TYPICAL SECTIONS — MOREAU SITE

REMOVAL AND DISPOSAL OPERATIONS

Approximately 180,000 cu yd of debris and sediment was removed from the east channel during two periods: September-December 1977 and April-June 1978. During October 1978, an additional 14,000 cu yd of material was removed from the remnant pool deposited in Area 3A (Figure 1).

The terminal channel deposits averaged 20 ug/g PCB, whereas deposits from Area 3A had an average PCB concentration of 1,000 ug/g, and thus required a more careful handling operation.[4] The general excavation procedure consisted of removal of material by dragline from the terminal channel and deposit in a windrow to allow for drainage and storage of material. After a few hours the material became well drained and was easily handled.

The Area 3A deposits, located above normal water level, were removed with conventional power shovels and generally loaded directly into trucks, although some stockpiling was done. Special care was taken to clean loose material from trucks, and loads were covered to prevent contaminated material from being tracked onto highways. At the Moreau site, the dredged material was placed on lifts on the order of 1-3 ft to a total depth of approximately 15 ft.

Material removed from the east channel was a mixture composed predominantly of quartz sand, shale fragments, coal, and wood debris of various sizes, ranging up to lengths of several feet. Material removed from Area 3A was predominantly quartz sand with shale fragments. River deposits also contained a variety of oils, greases, and other industrial and municipal pollution products.

During dredging the agitation of the bed deposits by the dragline excavation generated an oily floating scum which drifted away from the area being excavated. To resolve this problem a conventional oil boom (Plate V) was deployed, trapping the scum, which was removed manually, along with wood debris. PCB levels in the floating scum reached as high as 4,000 ug/g dry weight, which necessitated some care in handling. Additional aspects of the scum removal and total PCB losses during removal are discussed in this report's monitoring section.

In-Site Water Buildup

The original project timetable called for completion of disposal operations and installation of the clay cover before winter of 1977-78. However, delays caused by very heavy rains and the early onslaught of winter prevented closing all but the 4:1 slopes of the site. Disposal operations resumed in the spring, and concluded in the fall with the addition of material from Area 3A.

During the period when the site was exposed (August 1977 - November 1978), precipitation measured 66.5 inches, a value some 30 percent above normal for that period. A buildup of water over the interior clay dikes caused surface slumping of the finished clay cover in two areas on the 4:1 slopes. Repair of the slope required that the site be partially dewatered.

Based on the assumptions of: (1) a 10-acre effective drainage area at the site, (2) about 5 percent of runoff leaving the site during the winter months, and (3) dredge spoil at or near field capacity when placed, some 7.8 to 8.2 million gallons infiltrated into the site. Leakage via an

existing 4-inch gravity drain and through seeps in the two slope slippage locations removed on the order of .5 to .8 million gallons, leaving a net volume of about 7.5 million gallons in September 1978. The water level in the fill was at a depth of 13 ft over the clay liner and 9 ft over the top of the interior clay dike. At a measured PCB concentration of 1 ppb, 0.03 lb, or 13 grams, of PCB was contained in the water to be removed from the fill and discharged to the river.

Alternative measures for dewatering the site were evaluated during August 1978 and dewatering was begun in September. The program selected was the installation of a well point dewatering system which permitted the immediate removal of water at the easterly and southerly perimeter of the fill. The well points allowed early repair of the slope area and made it possible to construct a trench drain in the vicinity of the slope repair areas.

At the end of November 1978 the clay cover was in place, slope repairs were completed, and the well point system had been removed. Some 1.1 million gallons of water had been moved for a net drawdown of 3 ft. The installation of the final clay cover and turf establishment material was completed December 20, 1978. Water removal continued through the winter and spring by means of a one-inch diameter siphon hose with flows of 3 to 7 gpm.

In situ hydraulic conductivity of the dredged spoils was evaluated, based on dewatering results, as being on the order of 7 to 11 ft per day. Preconstruction estimates based on grain size analysis and preliminary laboratory results were one to two orders of magnitude higher. Differences are attributed to the presence of new quantities of fines generated during the disposal process.(5)

Total costs incurred for the dredging/disposal projects amounted to approximately $1,300,000. Approximately 32,000 lb of PCB is contained at the Moreau site.

MONITORING

Water Quality

Dredging operations in the Fort Edward Terminal Maintenance Channel were monitored by NYSDEC from July through November 1977. A total of eight stations were established over a river reach of approximately two miles which bracketed the dredging activities. Sampling was initiated approximately three weeks before actual dredging took place, and consisted of collections for total and volatile suspended solids, turbidity, PCB and heavy metals. River flow measurements were also recorded in order to compute mass transport.(6) The water retained on the clay liner of the Moreau site was also sampled periodically.

Survey data show that the river flow remained relatively stable during July, August, and September. In October 1977, there was considerable rainfall which raised river flows and retarded work in the river and at the dredged spoil disposal site. Despite a wide range in analytical results, particularly for PCB analysis, the monitoring data on volatile and total suspended solids, turbidity, and PCB indicated that although in-river dredging activities produced a localized disturbance on water quality, the parameters measured returned to upstream values well within the two-mile sector of river monitored.

The finer dredged materials were generally lost during dredging operations, and were detected in the downstream water column sampling. Based on these results, mechanical dredging, as anticipated, was concluded to have a localized impact on water quality; however, under stable low-flow conditions, this impact is generally confined to the near field (less than one mile). Translocation of PCB-bearing materials during high river flows, on the other hand, is substantially higher, usually by several orders of magnitude and distance. PCB losses are summarized in Table 1.

TABLE 1

PCB BALANCE IN REMOVAL/DISPOSAL SYSTEM
WATER LOSSES

	Estimated PCB		Measured PCB	
	Concentration	Total Mass	Concentration	Total Mass
Channel Deposits	30 ug/g	10,500 lb	20 ug/g	6,400 lb
Removal Losses in River				
- Mass	-	300 lb	-	*130 lb
- As Percent of in situ PCB	-	3%	-	2%
- Surface Scum	-	-	4,000 ug/g	**<50 lb
Disposal Site				
- Interior Water	3 ug/l	-	<1-2 ug/l	-

*As measured transport in water column approximately 200 ft downstream of area being dredged.

**Does not represent actual loss; almost all this material was collected on the oil boom and deposited at the Moreau site.

Air Quality

In the summer and fall of 1978, during the excavation operations at Area 3A (where PCB concentrations ranged as high as 5,600 ug/g and averaged 1,000 ug/g), permit conditions required continual water spraying of the area for dust control purposes both at the excavation site and at the contained disposal site in the Town of Moreau.

Five ambient air samples were collected over a five-hour composite period in mid-September 1978, in the area of high-level PCB excavation. These samples ranged from 7,000 to 10,000 nanograms of Arochlor (A-1016) per cubic meter. Data from other air monitoring stations in the vicinity were reviewed but no noticeable increase in PCB levels was detected off-site during the excavation period.

At the Moreau disposal site, ambient air samples were taken during mid-August prior to the introduction of high PCB level material. Sampling was done over a six-hour period when air temperatures were 75-85°F with calm to light breezes. PCB analyses indicated all samples contained less than 50 nanograms of A-1016 per cubic meter. Samples were collected over a five-hour period on two separate occasions in October following placement of the highly PCB-contaminated material at the Moreau contained disposal site. Temperatures ranged from 55 to 65°F and wind conditions were light except for one instance of brisk southerly breezes. The PCB analyses from this set of sampling ranged from 7,000 to 15,000 nanograms of A-1016 per cubic meter.

Table 2 summarizes results of air quality sampling.

TABLE 2

AIR QUALITY MONITORING DATA

Location/ Date	No. of Samples	Composite Sampling Period	A-1016 Measured (ng/m^3)
Excavation Area 3A - Sept. 1978	5	5-hr	7,000-10,000
Moreau Disposal Site - Aug. 1978	1	6-hr	< 50
- Oct. 1978	2	5-hr	7,000-15,000
Threshold Limit Value (TLV)* - A-1254			50,000
- A-1242			100,000

*OSHA 29 CFR 1910.1000

Site Water Levels

Observations in seven 4-inch PVC wells located within the fill area continue on a regular basis. Three observation wells are located in the interior underdrain, one of which serves as a siphon intake. A comparison of drawdown versus removal via dewatering and leakage indicates that no large leakage is occurring through the cover. Data are not yet sufficient to make a quantitative estimate.

FUTURE PCB DISPOSAL SITE

During feasibility studies for the Upper Hudson River PCB Removal Program, 100,000 acres of land along a 40-mile reach of the river were screened for sites that would meet chemical landfill criteria. Forty-two sites containing 3,200 acres were identified in this preliminary screening, but after further on-site investigations and engineering studies a single 250-acre location was selected as the most suitable site.(7)

The typical site section used in preliminary engineering studies is shown in Figure 3.(8) The most important aspect of the proposed site involves the drainage of hydraulically transported materials prior to placement of the clay cover and top dressing. A more elaborate upper and lower drainage system than that required at the Moreau site is indicated in the proposed cross sections.

CONCLUSIONS

Considerable experience was gained during the removal and disposal into a secure site of 194,000 cu yd of PCB-contaminated river debris and sediments, 14,000 cu yd of this material containing relatively high levels from remnant deposits in a PCB-contaminated region. This project demonstrates that reasonable construction practices will limit losses of PCB into the air and water environments to acceptable values.(9)

Delay in placement of an impervious cover resulted in the accumulation of water over the compacted clay liner, a condition which demonstrated the liner's essential integrity. Hydrostatic pressures generated by this accumulation caused the clay cover to slip on two areas of the 4:1 side slopes. No movement of the dredged material occurred, however, and replacement of the cover material was readily accomplished after dewatering of the slope areas.

Water level observations made subsequent to placement of the clay cover indicate that no extensive leakage is occurring through the cover, although data are not yet sufficient to make a quantitative estimate.

Physical characteristics of dredged spoil in

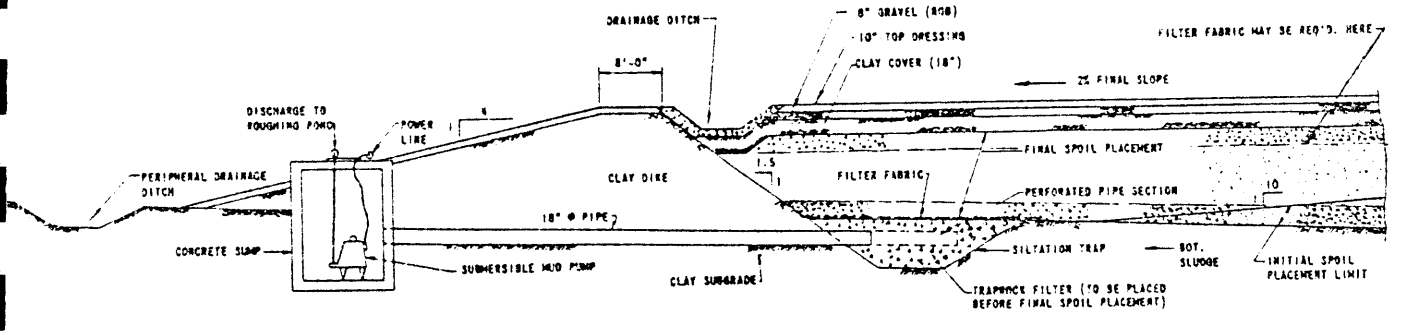
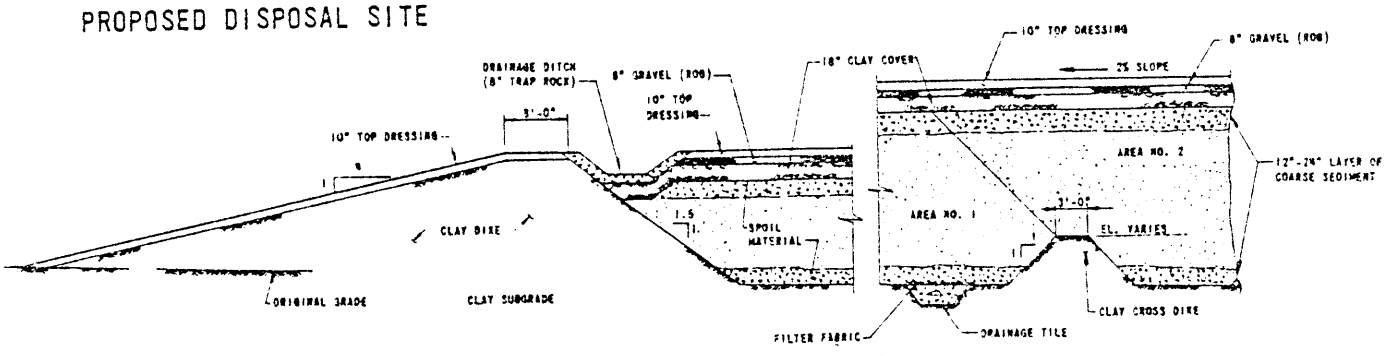


FIGURE 3 - TYPICAL SECTION
PROPOSED DISPOSAL SITE



the disposal area varied significantly from the in-situ conditions prior to dredging. The possibility that this situation may recur in other sites should be considered in the design of any removal and containment program.

ACKNOWLEDGMENTS

We wish to acknowledge the cooperation of NYSDOT, Mr. Joseph Stellato, Director of Waterways Maintenance, and Mr. Victor Griffin, Resident Engineer; Mr. William Miner and Dr. James Tofflemire of NYSDEC, who were responsible for sample collection, analysis, and interpretation.

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PLATES

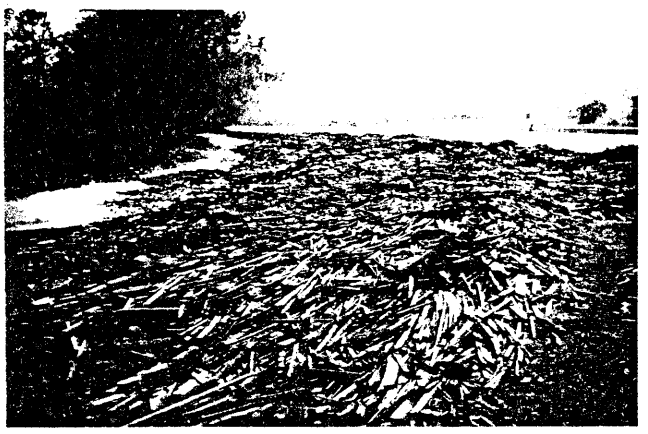

PLATE I. Debris blocking Terminal (East) Channel, Fort Edward, N.Y.: a view looking upstream.

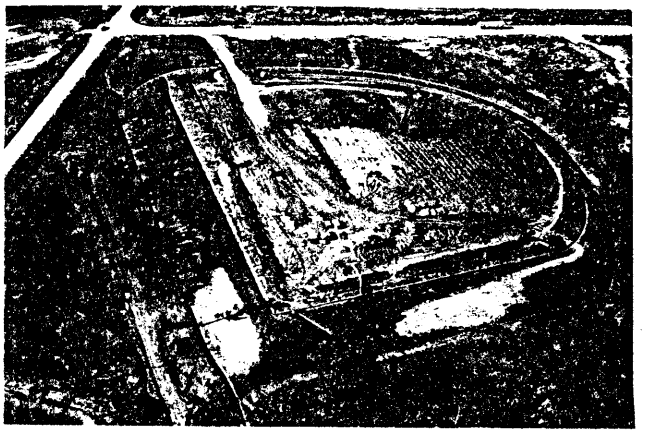

PLATE II. Moreau Disposal Site, Fall 1978, showing placement of material from Area 3A, prior to placement of clay cover. Light areas on 4:1 slopes in foreground are slope repair areas.

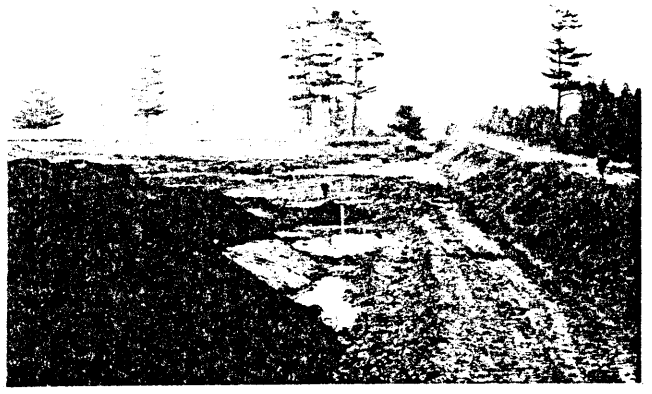

PLATE III. Placement of dredged spoil. In foreground, left to right: spoil material; monitoring well; interior clay dike.

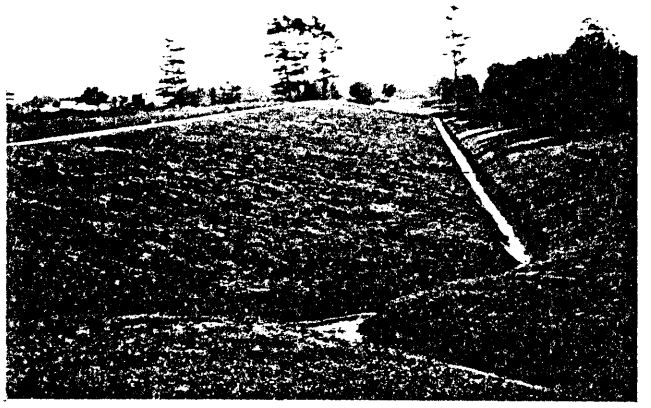

PLATE IV. Completed side slopes with asphaltic concrete paved drains.

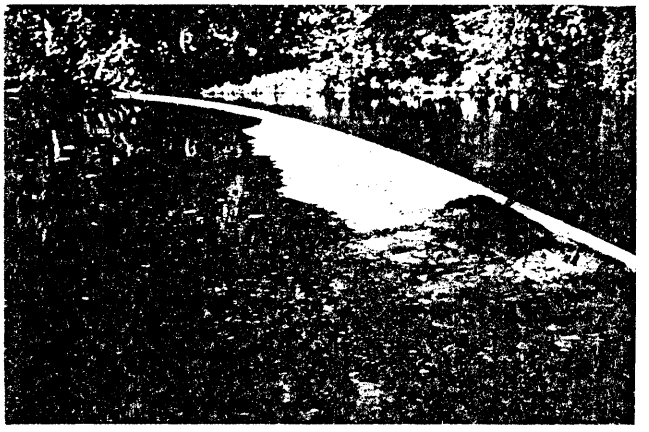

PLATE V. Oil boom used to collect highly contaminated floating debris.