New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-3503

MEMORANDUM

JUL - 9

TO: Distribution

FROM: Frank D. Estabrooks FRANK D ESTABROOKS

SUBJECT: Heavy Metals in Hudson River Sediment Cores

DATE: July 17, 1995

Purpose

The purpose of this technical memo is to present data generated by recent chemical analyses and to initiate a discussion on its importance and future actions.

Background

In July of 1983, sediment core samples were collected from a cove just upstream of the Thompson Island Dam (mile point 188.5) by Dr. Richard Bopp. At that time, he was working for Lamont Doherty Geological Observatory under contract with DEC to investigate sediment and PCB deposition and transport in the Upper Hudson River. In May of 1991, a second core was collected by Dr. Richard Bopp in approximately the same location (mile point 188.6). Shortly after collection, both cores were sub-sectioned. These sub-samples were then dried in a florisil filtered incubator and stored in air-tight aluminum containers.

Both cores were radiodated a short time after collection using cesium 137 isotope tracers. Both cores produced easily interpretable profiles (Figures 1, 2 and 3). Cesium 137 is a radioactive by-product of atmospheric nuclear testing (half life of 33 years). As such cesium 137 radiodating provides us with two historical markers; around 1954 when the first significant levels of global fallout can be detected and 1963 when the Test Ban Treaty was finalized and global fallout peaked.

The cesium analysis also identifies a period of relatively constant concentration (8-20 cm in 188.5 and 24-36 cm in 188.6) which is thought to coincide with the removal of the Fort Edward Dam in 1973.

The top section of core 188.5 is assumed to represent the early 1980s (1983 collection) and the top section of core 188.6 is assumed to represent the early 1990s (1991 collection).

317901

FIGURE 1

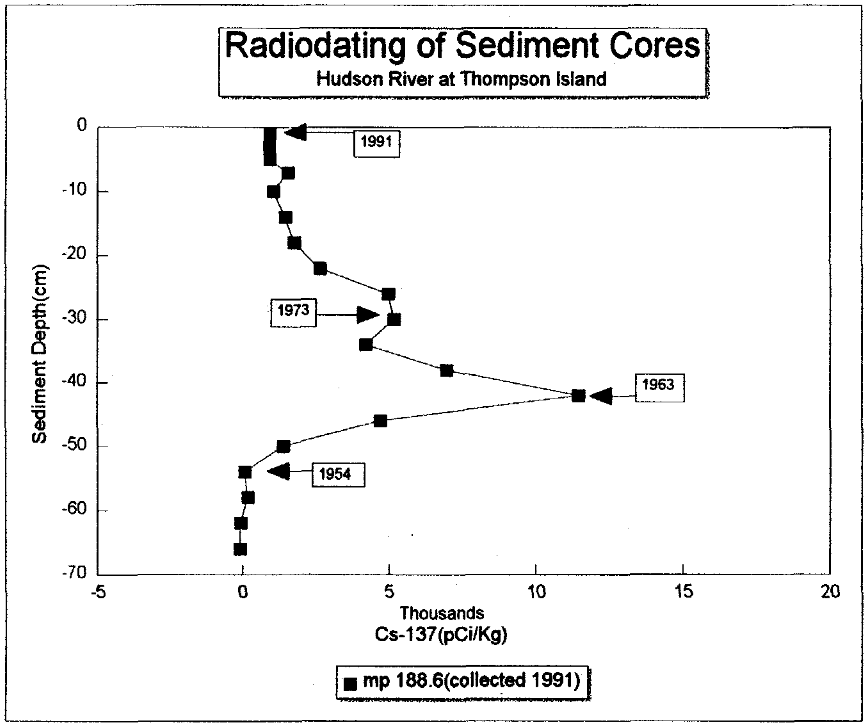
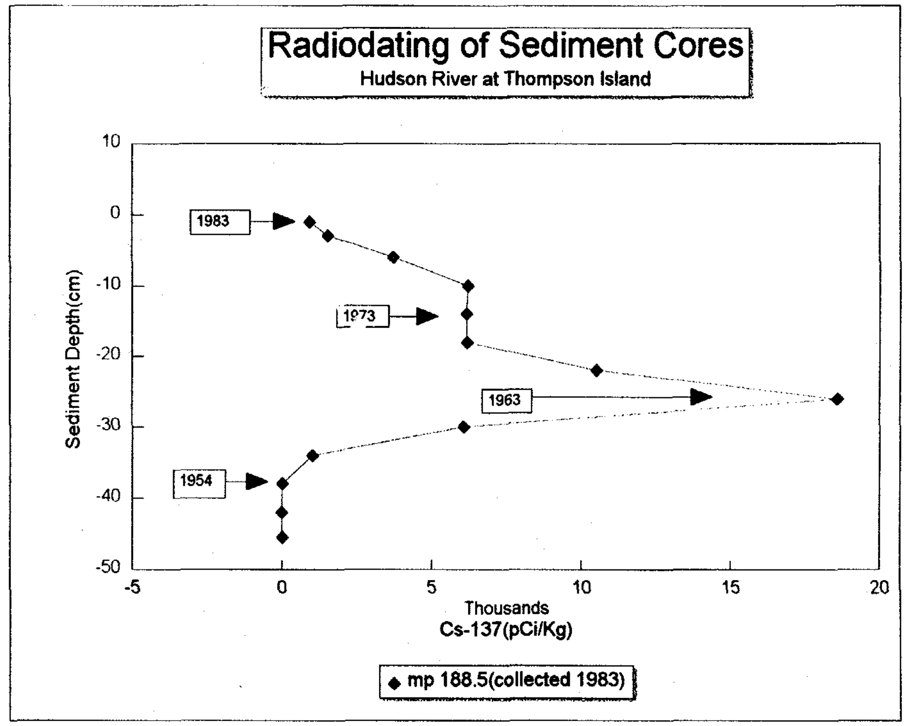
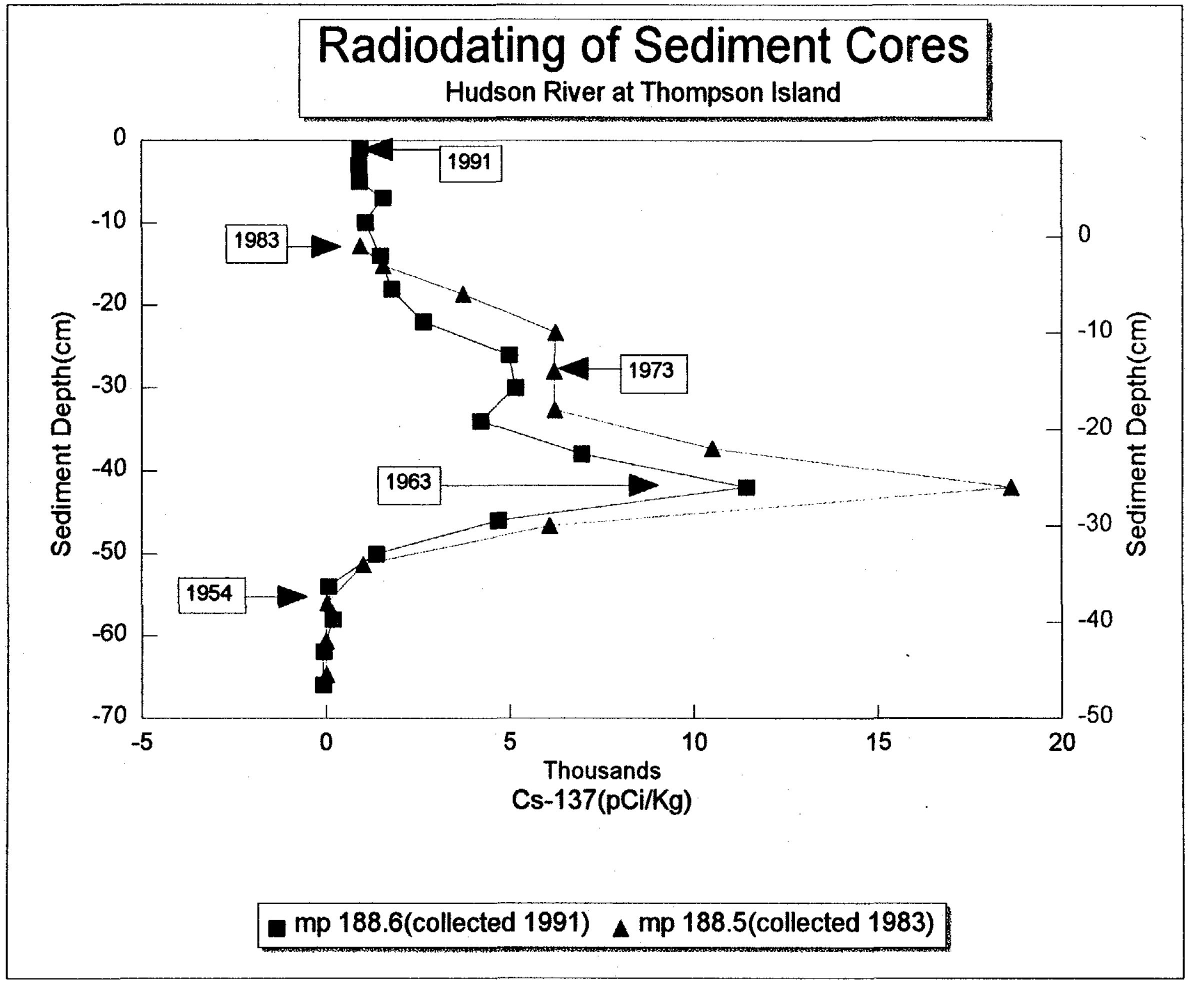


FIGURE 2



317902

FIGURE 3



317903

During the last several years, Division of Water staff have been working with personnel from the Bureau of Hazardous Waste Facility Permitting (DHSR) on aspects of the site closure plan dealing with characterizing the contamination of the Hudson River/Feeder Tow Canal by discharges from the Ciba Geigy/Hercules Main Plant in Glens Falls, New York. The RCRA Facility Investigation (RFI) Phase I report on the adjacent surface water sediments has been completed. This investigation identified high concentrations of cadmium (up to 250 ppm), chromium (up to 14,100 ppm), copper (up to 870 ppm), lead (up to 12,300 ppm), mercury (up to 31 ppm), nickel (up to 324 ppm) and zinc (up to 1,180 ppm) between the plant site and the Bakers Falls Dam. These results would probably necessitate additional sediment analyses in downstream reaches because previous studies (M. Brown, et. al. 1988) had identified lead and cadmium at levels of concern in the Thompson Island Pool.

In the Spring of 1995, the means to analyze some of the archived (previously collected) sediment samples materialized. Six heavy metals (cadmium, chromium, copper, lead, nickel and zinc) were selected for analysis. It was hoped that these results would help characterize the downstream spatial and vertical distribution of the metals identified in the phase I report.

Results

The results of the analytical work are presented in Tables 1 and 2. Figures 4 through 9 graphically display this data by sediment depth, with estimated deposition date indicated.

Observations

The analytical results show concentrations that are significantly above levels identified by Persuad (Table 3) and Long and Morgan (Table 4) as causing significant biological impacts. Some of these concentrations are also likely to cause these sediments to be characterized as hazardous waste (Table 5).

These analytical results are also supported by previous analyses at Lamont Doherty Geological Observatory (Table 6).

Dr. Richard Bopp has reported in a May 30, 1995 memo that Steve Chillrud of Lamont has traced the dominant cadmium signal in sediments from near Kingston back to its Ciba-Geigy/Hercules source. He also speculates that it may be possible to trace this signal to New York Harbor sediments.

Analytical results of core samples collected from the Hudson River at Troy (mile point 143.4) (Table 7) show elevated levels at deeper depths.

At a depth of 36 cm in core 188.5, there was a documented (R. Bopp memo, May 30, 1995) change in sediment type; from a homogeneous compact grey mud (0-35 cm) to sand. The very low metal results suggest pre-industrial background conditions, possibly separated from recent deposition by a dredge boundary.

TABLE 1

Hudson River at Fort Edward
Sediment Core 188.5, Collected 1983 (PPM)

Subsection (cm)	Cd	Cr	Cu	Pb	Ni	Zn	Loss on Ignition (%)
0-2	21	317	38	247	16	153	6.9
2-4	39	493	52	541	16	188	5.8
4-8	80	1240	108	1600	22	456	12.4
8-12	163	1640	157	2330	22	636	15.8
12-16	148	1310	135	1700	29	549	15.8
16-20	110	1050	119	1120	28	552	20.7
20-24	181	1590	152	1760	30	1050	17.4
24-28	72	1300	109	1360	32	1050	13.6
28-32	30	1160	90	704	42	711	14.0
32-36	3	549	43	215	24	288	3.9
36-40	0.2	11	6	11	5	34	.5
Duplicate of 32-36	4	571	45	226	24	303	

TABLE 2

Hudson River at Fort Edward
Sediment Core 188.6, Collected 1991 (PPM)

Subsection (cm)	Cd	Cr	Cu	Pb	Ni	Zn
0-2	3	154	31	69	21	188
2-4	3	109	25	53	17	147
4-8	4	126	37	67	24	190
8-12	7	197	49	104	27	245
12-16	7	172	41	121	21	225
16-20	20	438	81	342	27	366
20-24	41	706	90	914	25	577
24-28	NA	NA	NA	NA	NA	NA
28-32	193	1730	170	2450	29	675
32-36	NA	NA	NA	NA	NA	NA
40-44	115	1440	121	1560	33	1100

FIGURE 4

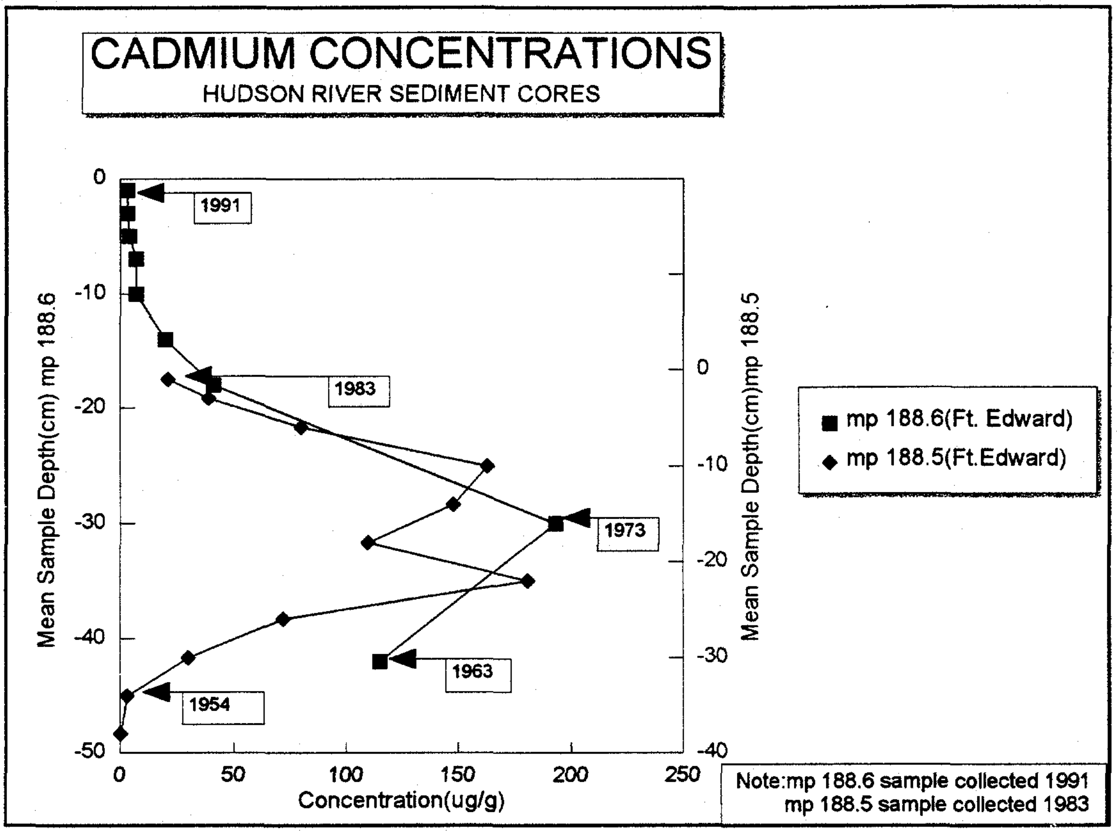


FIGURE 5

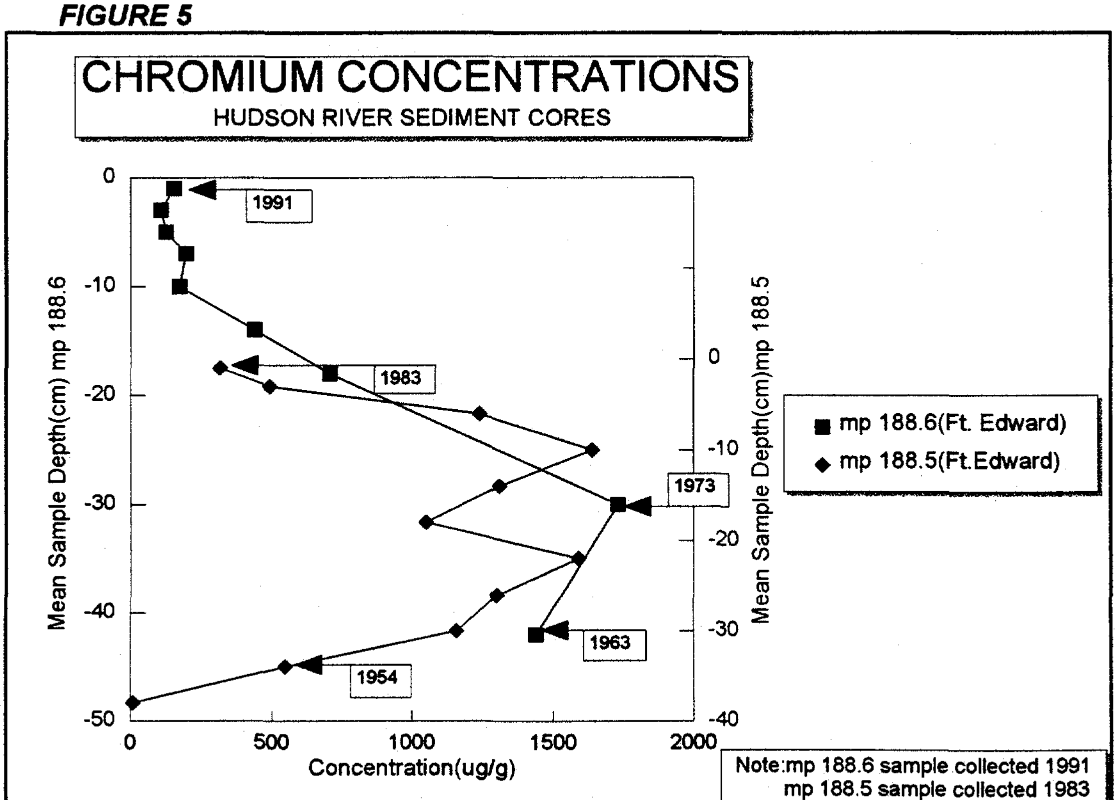


FIGURE 6

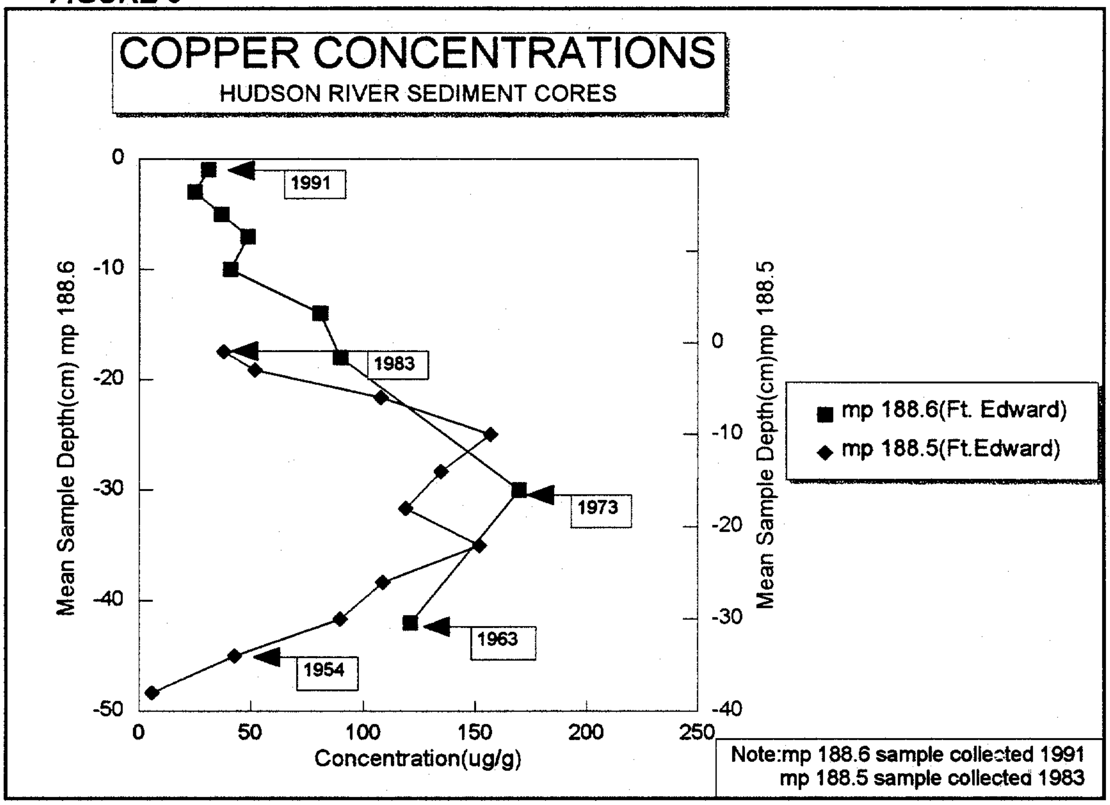


FIGURE 7

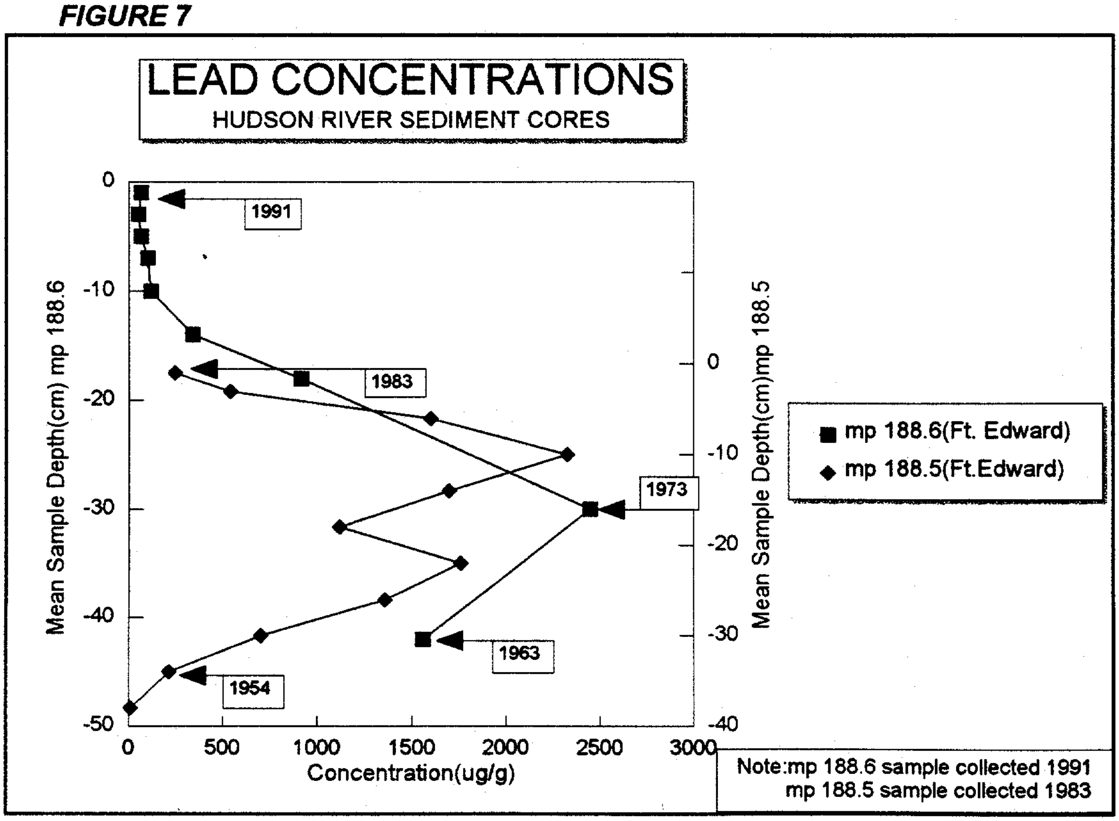


FIGURE 8

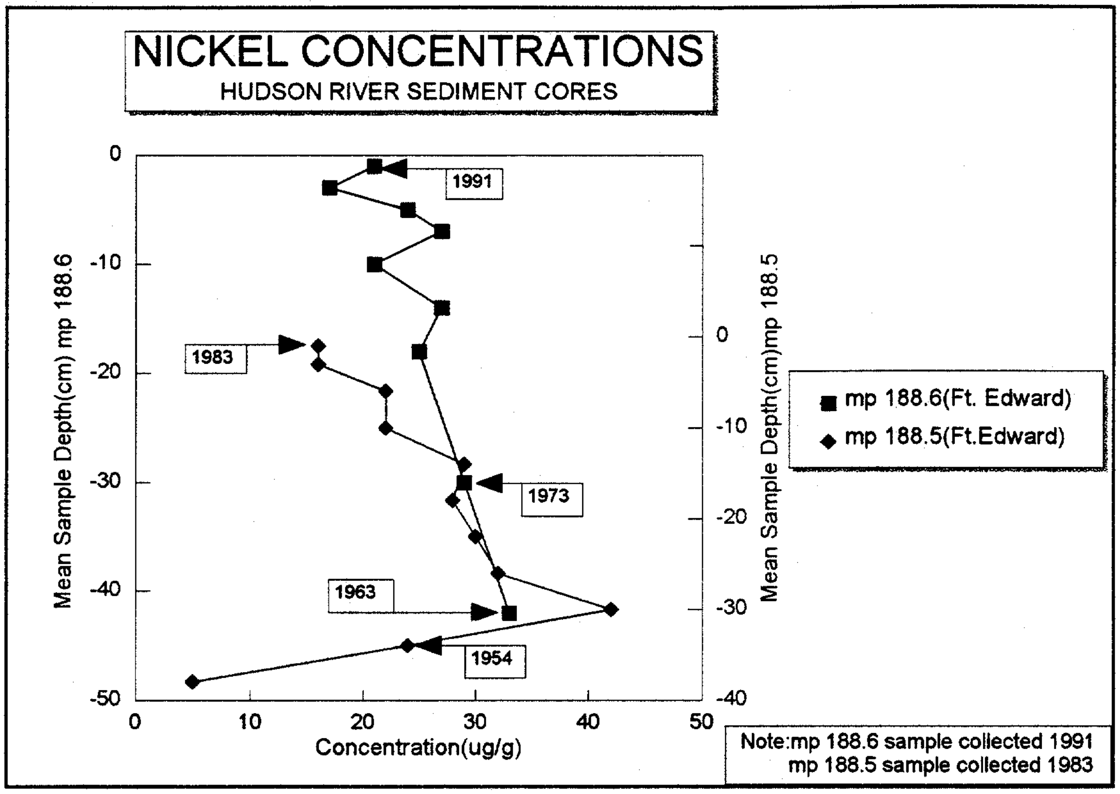


FIGURE 9

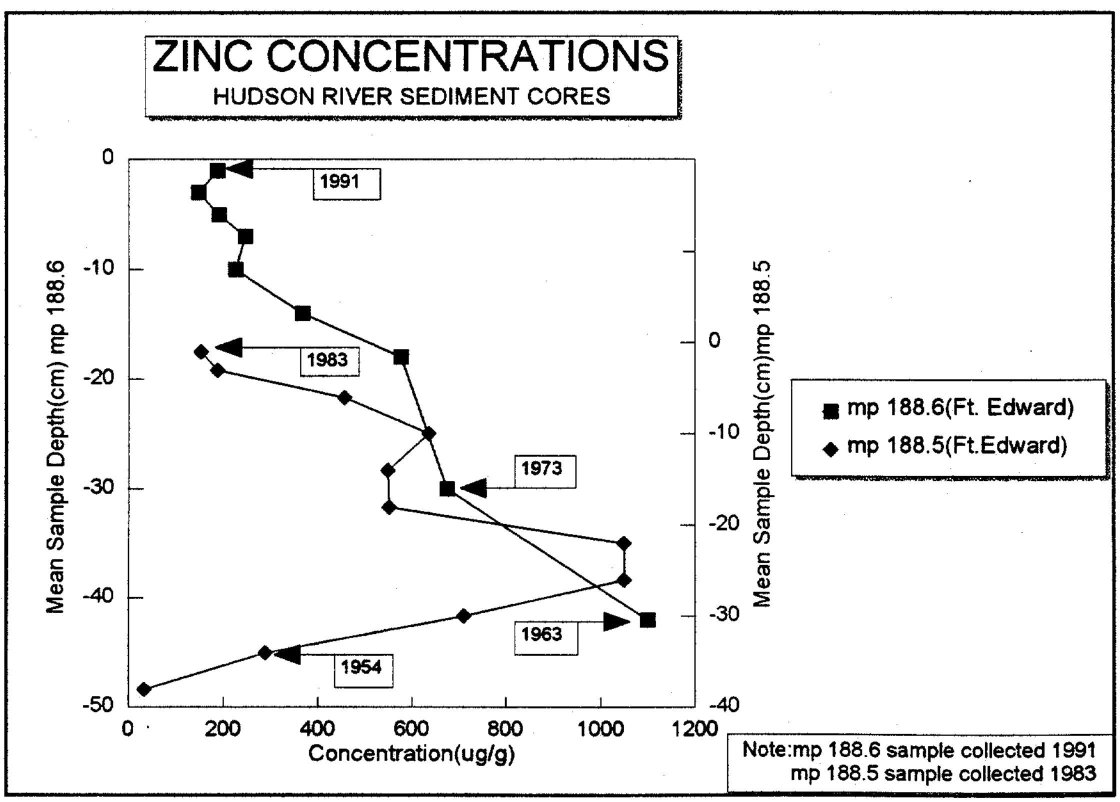


TABLE 3

Persaud et. al. (1992)
Sediment Quality Guidelines (PPM)

METAL	NO EFFECT LEVEL	LOWEST EFFECT LEVEL	SEVERE EFFECT LEVEL
Cadmium	-	0.6	33
Chromium	-	26	110
Copper	-	16	110
Lead	-	31	250
Nickel	-	16	75
Zinc	-	120	820

TABLE 4

Long and Morgan (1990)
Sediment Apparent Effects Thresholds

Metal	Effects Range-Low[1]	Effects Range-Median[2]
Cadmium	5	9
Chromium	80	145
Copper	70	390
Lead	35	110
Nickel	30	50
Zinc	120	270

[1] 10 percentile concentration of observed biological effects.
[2] Median concentration of observed biological effects.

TABLE 5

Metal	Concentrations (PPM) at which Sediments would be Expected to Fail Hazardous Waste Determination
Cadmium	130[1] - 400[2] $\mu g/g$
Chromum	650[1] - 2000[2] $\mu g/g$
Lead	650[1] - 2000[2] $\mu g/g$
Mercury	26[1] - 180[2] $\mu g/g$

[1] Based on 15% availability (conservative estimate)
[2] Based on 5% availability (standard estimate)

TABLE 6

Previous Results (PPM)
Analyzed at Lamont Doherty

Sample	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
188.5 0-2 cm	18	NA	35	278	44	199
188.5 12-16 cm	157	NA	163	1793	63	607
188.5 24-28 cm	79	NA	117	1314	60	1045
188.5 36-40 cm	2.7	NA	13	38	20	89

TABLE 7

Hudson River at Troy
Sediment Core 143.4, (PPM)

Subsection (cm)	Cd	Cr	Cu	Pb	Ni	Zn	Est. Deposition Date
0-2	2	67	65	63	28	207	1992
0-10	7	170	104	162	31	404	1977
20-30	17	305	134	316	31	438	1974-1975
40-50	20	421	199	344	37	596	1972

188.6 were submitted for dioxin and furan analysis (EPA method 1613A). The respective toxic equivalence as 2,3,7,8-TCDD are 11.0, 309.5 and 325.7 ppt. While the concentration in the surface sample would be expected in an industrialized area, the other two samples are elevated. And while the dioxins show the classic multiple source combustion percent abundance pattern (OCDD domination), the furan pattern is quite different because of the significant presence of tetrachlorinated congeners. This may be indicative of a PCB related source.

The environmental and regulatory significance of these concentrations of dioxin and furan is unknown but further attention is probably warranted.

Discussion

These analytical results identify sediments that are highly contaminated but presently isolated from the water column by a layer of cleaner sediment at these locations. Since much of the downstream transport of these contaminants appears to be associated with the removal of the Fort Edward Dam, the depositional "hot spots" for these metals are likely to be identical to those for the PCBs. Therefore, as a minimum, these results should become a part of the discussion in the PCB dredging project.

Other possible directions:

- Include the data as part of the Hudson River Reassessment RI/FS Project
- Identify the source(s) for these metals.
- Study the downstream distribution (spatial and vertical) of the contamination, including the potential for flood plain deposition.
- Initiate a biological impact study/modeling to define the current impacts and/or potential threat due to flood and scour events.

Additional Work Required

- Because of resource limitations, no mercury analyses were completed on these samples. The concentrations identified upstream (up to 31 ppm) suggests that some analytical work be planned.

Distribution
N.G. Kaul
Al Bromberg
George Hansen
Bob Bode
Mike O'Toole
Steve Hammond
Bill Ports ✓
Norm Nosenchuck
Steve Kaminski
Victor Valaitis
Wiley Lavigne
Peter Mack
Ron Sloan