HydroQual, Inc.

MEMORANDUM

TO:	M. Schweiger - GE J. Haggard - GE	**DATE:**	September 30, 1997
		RE:	TID Monitoring
FROM:	J. Rhea JRR	**FILE:**	GECO 0500
CC.	J. Connolly		

This memorandum documents the recently collected data from the Thomson Island Dam (TID) monitoring program which indicate that PCB concentrations within TID-west samples are unrepresentative of the average concentration passing the TID. PCB concentrations measured in samples collected from this station consistently exceed those in samples collected in the center channel immediately upstream and downstream of the dam. This bias appears to be responsible for the excess loading observed from the TIP since 1991. The remainder of this memorandum briefly describes the excess loading issue, the different hypotheses explored as possible causes for the excess loading, and presents the objectives, methods, and results of the TID monitoring program.

BACKGROUND

Excess Loading from the TIP

PCB loadings from the Hudson Falls plant site area during the early 1990s, particularly the Allen Mill environs, produced what appeared to be a response in low flow (< 10,000 cfs) PCB loadings from the first quiescent region downstream of the plant sites, the Thompson Island Pool (TIP; HydroQual, 1995). Low flow loadings from this reach of the river (calculated as the difference in PCB transport past the Rogers Island and Thompson Island Dam (TID) monitoring stations using paired flow and PCB data) appeared to increase substantially between summer 1991 and 1992 coincident with the elevated plant site loadings. Summer 1991 loadings from this region of the river were consistent with loadings calculated from the U.S. Geological Service (USGS) data collected during the late 1980s from the Rogers Island and Schuylerville, N.Y. sampling stations (HydroQual, 1995).

The low flow loadings from the TIP, observed after 1991, are in excess of what can be produced via known PCB fate and transport processes (e.g. sediment pore water diffusion), given the PCB concentrations found within TIP sediments in 1991.

Hypotheses for the Observed Excess Load

This excess load described above may have been attributed to a number of possible mechanisms or data inadequacies (General Electric, 1996). Numerous hypotheses have been developed as possible explanations for the excess load including:

- The mass of PCBs entering the TIP are greater than the mass measured at the Rogers Island monitoring station due to either pulsed loadings from the plant site area or because they are part of an unquantified bed load.

- The mass of PCBs passing the Thompson Island Dam (TID) are less than the mass measured at the TID monitoring station.

- Groundwater inflow within the TIP is causing substantial release of PCBs from the sediments into the water column in the TIP.

- There are greater PCB concentrations in the surface sediments of the TIP (as result of the Allen Mill failure (O'Brien & Gere, 1994)) than reflected in surface sediment data, which results in a substantial release of PCBs into the water column of the TIP.

- A substantial mass of PCBs enters the TIP between Rogers Island and the TID from sources outside the TIP such as dredge spoil sites.

- Resuspension of surface sediments introduces a substantial mass of PCBs into the waters of the TIP.

Numerous field sampling and analysis programs have been conducted over the last two years to test the hypotheses presented above (HydroQual, 1996, HydroQual, 1997a, 1997b; O'Brien and Gere, 1996, 1997a, 1997b). The combined results of these efforts indicate that the most likely cause of the mass imbalance observed within the TIP is related to a bias in the data collected from the western shore sampling station at the Thompson Island Dam. The remainder of this memorandum presents the objectives, methods, and results of the TID monitoring program.

Objectives

The principal objective of the TID Monitoring study was to evaluate the representativeness of the TID sampling station for quantifying PCB mass transport out of the TIP.

Approach

The approach for assessing the representativeness of the TID monitoring station was implemented in two phases.

Phase I involved the simultaneous collection of water column samples from the center channel of the river at a location approximately 1000 feet upstream of the dam and from the western wing wall of the dam.

Phase II included sampling from the locations described above, but also included locations from the eastern wing wall of the dam and from stations located immediately downstream of the dam across both the western and eastern channels of the river at Thompson Island.

METHODOLOGY

The sampling and analysis methods generally followed the protocols described within the sampling and analysis plans (O'Brien & Gere, 1997a, 1997b).

Sampling Stations and Collection Procedures

Sampling stations are briefly described in Table 1 and shown on Figure 2. Sampling occurred at stations upstream and downstream of the routine monitoring station located at the western wing wall of the Thompson Island dam and from the eastern wing wall of the dam.

Sample collection procedures are briefly described in Table 1. Generally, where water column depth permitted, the samples consisted of vertically integrated composites made up of discrete aliquots collected from three depth intervals (0.2, 0.5 and 0.8 times the total depth) using a stainless steel Kemmerer Bottle sampler. Where water depth restricted the use of the Kemmerer bottle, grab samples were collected using a stainless steel beaker. Several of the sampling rounds also consisted of temporal composites consisting of discrete aliquots collected over a several hour period and composited. Finally, the sampling occurred from upstream to downstream with the timing corresponding to the estimated time of travel of a parcel of water between the stations.

Analytical Testing

Water column samples were analyzed for PCBs and TSS by Northeast Analytical, Inc. in Schenectady, N.Y. A select number of samples were also analyzed for total solids, total organic carbon, particulate organic carbon, and chlorophyll a. PCBs were quantified using a gas chromatograph/DB-1 capillary column system standardized using the U.S. Environmental Protection Agency Green Bay Mass Balance protocols (Green Bay protocols; Northeast Analytical, 1990). Samples collected prior to September 1, 1997 have been corrected for calibration errors and coelution biases

associated with the Green Bay protocols (HydroQual, 1997c). Samples collected after September 1, 1997 have been adjusted for coelution biases only as NEA corrected calibration errors in the Green Bay protocols for samples collected after September 1, 1997 (O'Brien & Gere, 1997c).

RESULTS AND DISCUSSION

The Thompson Island Dam monitoring program data are presented in Tables 1 and 2 and Figures 1, 2, and 3. Sampling stations are described in Table 1 and those within the TID region are shown in Figure 2.

Phase I

Phase 1 results indicate that the routine shoreline sampling station at TID-west consistently yielded PCB concentrations in excess of those observed from the center channel station. Eleven pairs of samples were collected from the center channel of the river and TID-west between September 1996 and September 1997 (Table 1). In all pairs, the samples from the TID-west station contained higher PCB concentrations (Figure 1). The difference between the samples ranged from 20 to 177 ng/L representing between a 29 and 186% increase, respectively (Table 2). The increase observed between the two stations does not appear to be the result of resuspension of contaminated sediments since there does not appear to be any correlation between the changes in suspended solids concentrations and the changes in PCB concentrations (Figure 1). Moreover, preliminary evaluation of the PCB congener patterns suggest that the increase in PCBs between the two stations is consistent with a surface sediment pore water source.

The increase in PCB levels between the two stations suggested that either 1) the sampling station at TID-west was biased and yields PCB concentrations unrepresentative of PCB mass transport from the pool, or 2) the sediments between the center channel station located approximately 1000 feet upstream of the dam and the dam were contributing, on average approximately 50% of the total PCB load observed over the entire TIP (Table 2). Phase 2 of the monitoring program was conducted to provide further insights into these questions.

Phase 2

Phase 2 water column monitoring confirmed that the TID-west station yields PCB concentrations unrepresentative of the average concentrations passing the TID. Water column samples were collected from numerous locations both upstream and downstream of the TID during four sampling events in August and September, 1997 (Table 1). As discussed above, during these events, samples from the TID-west

station contained higher PCB concentrations than those collected upstream at the center channel station (Table 1 and Figure 2). PCB concentrations in samples collected from the eastern wing wall of the TID (TID-east) were generally consistent with samples collected at TID-west. That is, they were elevated compared to center channel samples collected upstream of the dam (Table 1 and Figure 2). In contrast, water column samples collected downstream of the dam in both the western and eastern channels were consistent with center channel samples collected upstream of the dam, and were significantly lower than concentrations at the wing walls of the dam. PCBs in samples downstream of the dam within the western and eastern channels were, on average, 38% and 29% lower than in samples collected from the dam, respectively. These data clearly indicate that the routine samples collected from the TID-west station are not representative of average concentrations passing the TID.

Water column monitoring downstream of TID at Fort Miller, N.Y[1]. provides further evidence that the routine TID-west station produces biased high PCB concentrations. Samples from the Fort Miller station contained PCB concentrations more consistent with both the lower measurements at the stations downstream of the TID and our understanding of PCB dynamics in the river (Table 1). The sediments within the river reach between TID and Fort Miller contains PCBs at levels which should produce water column PCB loadings through diffusive mechanisms during low flow conditions. The monitoring conducted on August 13, 1997 (Table 1) show a 28% (16 ng/l) increase in PCB concentrations compared to the samples collected downstream of the TID. In contrast, PCBs in samples from this station represent a 16% (14 ng/L) decrease in PCB concentrations when compared to the TID-west station. The latter observation is inconsistent with our understanding of sediment PCB distribution in this reach of the river and sediment-water partitioning.

Possible Mechanism for the Observed Bias at TID-west

The observed bias at TID-west may be the result of incomplete lateral mixing of a localized sediment source. The region immediately upstream of the TID along the east and west shoreline consists of emergent aquatic vegetation beds which may be hydraulically isolated from the main stream of the river. As such, PCB concentration in these waters would be elevated in comparison to PCBs in center channel samples as the mass flux from the sediments attributable to diffusive mechanisms would be integrated into a smaller volume of water. However, shear forces along the boundaries of these water masses may promote the transport of waters containing higher PCB concentrations within a thin band along the shorelines. This thin band of water may be what is sampled from the shoreline locations at the TID and sampled by the EPA

[1]The Fort Miller sampling station is located approximately two miles downstream of the TID and there are not any significant tributaries between the two sampling stations.

during their transect and flow averaged sampling studies of 1993 (USEPA, 1992, 1997). Further studies are required to generate the data necessary to substantiate this mechanism. Nonetheless, it is apparent that the routine sampling station located at the western wing wall of the TID produces PCB concentrations which are not representative of the average PCB concentration across the TID.

RECOMMENDATIONS

To provide further information regarding the representativeness of the TID monitoring station we recommend the following:

- continue routine sampling from the center channel upstream of TID, the routine TID-west station, and stations immediately downstream of the dam,

- include in the routine sampling program an additional station at the east wing wall of the western channel dam from Thompson Island,

- collect samples from the western shore region immediately upstream of the TID to confirm the presence of a water mass with elevated PCB concentrations, and

- routinely collect water samples for PCB analysis from the Schuylerville sampling stations.

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GENERAL ELECTRIC COMPANY
Hudson River Project
Table 1. Thompson Island Dam Monitoring Results

Sample Date	Sample Location*	Water Depth (ft)	Sampling Method +	Total PCBs (ng/L)	TSS (mg/L)	TS (mg/L)	TOC (mg/L)	POC (mg/L)	Chlorophyll a (µg/L)
09/18/96	TIP-18C	10.5	VC	53.6	2.8	---	---	---	---
09/18/96	TID-WEST	1.0	G	141.6	5.6	---	---	---	---
10/29/96	TIP-18C	10.0	VC	49.7	2.3	---	---	---	---
10/29/96	TID-WEST	1.0	G	101.9	2.4	---	---	---	---
06/04/97	TIP-18C	7.0	VC	84.2	1.9	---	---	---	---
06/04/97	TID-WEST	1.0	G	112.9	2.0	---	---	---	---
06/17/97	TIP-18C	10.0	VC	94.7	1.7	---	---	---	---
06/17/97	TID-WEST	1.0	G	271.9	4.2	---	---	---	---
06/30/97	TIP-18C	5.0	VC	175.1	2.2	---	---	---	---
06/30/97	TID-WEST	1.0	G	271.0	2.6	---	---	---	---
07/14/97	TIP-18C	5.0	VC	91.8	0.0	---	---	---	---
07/14/97	TID-WEST	1.0	G	189.9	0.0	---	---	---	---
07/28/97	TIP-18C	6.0	VC	66.7	1.3	---	---	---	---
07/28/97	TID-WEST	1.0	G	115.7	1.3	---	---	---	---
08/13/97	TIP-18C	6.0	VC,TC	49.6	2.1	76	6.1	0.26	0.3
08/13/97	TID-WEST	1.0	G,TC	90.2	1.9	76	6.1	0.18	0.3
08/13/97	TID-EAST	1.0	G,TC	80.8	1.9	70	5.7	0.21	1.1
08/13/97	TID-PRE	7.0	VC,TC	57.7	1.6	62	7.5	0.21	0.3
08/13/97	TID-PRW	5.0	VC,TC	57.7	2.1	96	5.2	0.18	0.4
08/13/97	FM	3.0	VC,TC	76.0	1.9	69	5.7	0.22	0.3
08/14/97	SCH	12.0	VC,TC	74.2	2.1	88	8.0	0.11	0.3
09/09/97 a	TIP-18C	8.0	VC,TC	63.8	2.0	---	---	---	---
09/09/97 a	TID-WEST	2.7	G,TC	107.0	1.8	---	---	---	---
09/09/97 a	TID-EAST	---	G,TC	97.9	2.0	---	---	---	---
09/09/97 a	TID-PRW-1	2.2	VC,TC	69.2	1.8	---	---	---	---
09/09/97 a	TID-PRW-2	11.4	VC,TC	60.3	2.2	---	---	---	---
09/09/97 a	TID-PRW-3	2.8	VC,TC	63.7	2.2	---	---	---	---
09/09/97 a	TID-PRE-1	3.1	VC,TC	70.4	2.2	---	---	---	---
09/09/97 a	TID-PRE-2	3.8	VC,TC	66.2	2.4	---	---	---	---
09/09/97 a	TID-PRE-3	6.1	VC,TC	63.0	2.3	---	---	---	---
09/09/97 b	TIP-18C	8.5	VC,TC	69.6	2.1	---	---	---	---
09/09/97 b	TID-WEST	---	G,TC	90.4	2.0	---	---	---	---
09/09/97 b	TID-EAST	---	G,TC	83.5	2.2	---	---	---	---
09/09/97 b	TID-PRW-1	---	VC,TC	55.3	1.9	---	---	---	---
09/09/97 b	TID-PRW-2	---	VC,TC	70.3	2.1	---	---	---	---
09/09/97 b	TID-PRW-3	---	VC,TC	64.3	2.2	---	---	---	---
09/09/97 b	TID-PRE-1	3.5	VC,TC	68.5	2.0	---	---	---	---
09/09/97 b	TID-PRE-2	4.5	VC,TC	70.5	2.2	---	---	---	---
09/09/97 b	TID-PRE-3	6.5	VC,TC	62.2	2.2	---	---	---	---
09/10/97	TIP-18C	9.3	VC,TC	52.5	2.1	---	---	---	---
09/10/97	TID-WEST	2.7	G,TC	93.7	1.7	---	---	---	---
09/10/97	TID-EAST	---	G,TC	85.7	2.0	---	---	---	---
09/10/97	TID-PRW-1	3.5	VC,TC	67.0	2.1	---	---	---	---
09/10/97	TID-PRW-2	11.5	VC,TC	56.0	2.3	---	---	---	---
09/10/97	TID-PRW-3	2.7	VC,TC	55.0	2.2	---	---	---	---
09/10/97	TID-PRE-1	4.0	VC,TC	59.2	1.9	---	---	---	---
09/10/97	TID-PRE-2	4.3	VC,TC	61.6	1.9	---	---	---	---
09/10/97	TID-PRE-3	5.5	VC,TC	60.2	2.2	---	---	---	---

***Description of Sample Locations**

TIP-18C	Center channel, approximately 1000 ft upstream of Thompson Island Dam
TID-EAST	Eastern wingwall of Thompson Island Dam
TID-WEST	Western wingwall of Thompson Island Dam
TID-PRE	Center of eastern channel, approximately 200 ft downstream of Thompson Island Dam
TID-PRE-1	Approximately 45 ft from western shore and 200 ft downstream of Thompson Island Dam
TID-PRE-2	Center of eastern channel, approximately 200 ft downstream of Thompson Island Dam
TID-PRE-3	Approximately 225 ft from western shore and 200 ft downstream of Thompson Island Dam
TID-PRW	Center of western channel, approximately 200 ft downstream of Thompson Island Dam
TID-PRW-1	Approximately 350 ft from eastern shore and 200 ft downstream of Thompson Island Dam
TID-PRW-2	Center of western channel, approximately 200 ft downstream of Thompson Island Dam
TID-PRW-3	Approximately 80 ft from eastern shore and 200 ft downstream of Thompson Island Dam
FM	Lock 6 Dam in Fort Miller, NY
SCH	Route 29 Bridge in Schuylerville, NY

+Description of Sample Types

G	Grab
VC	Vertical Composite
TC	Time Composite

Table 2. Paired center channel and TID-west total PCB concentrations.

Date	Center Channel (ng/L)	TID-west (ng/L)	Difference (ng/L)	% Difference
9/18/96	54	142	88	163
10/29/96	50	102	52	104
6/4/97	84	113	29	35
6/17/97	95	272	177	186
6/30/97	175	271	96	55
7/14/97	92	190	98	107
7/28/97	67	116	49	73
8/13/97	50	90	40	80
9/9/97a	64	107	43	67
9/9/97b	70	90	20	29
9/10/97	52	94	42	81
Statistics:				
number	11	11	11	11
maximum	175	272	177	186
minimum	50	90	20	29
mean	78	144	67	89
std. dev.	36	69	45	49

Figure 1. Center Channel and TID-west PCB and TSS Results

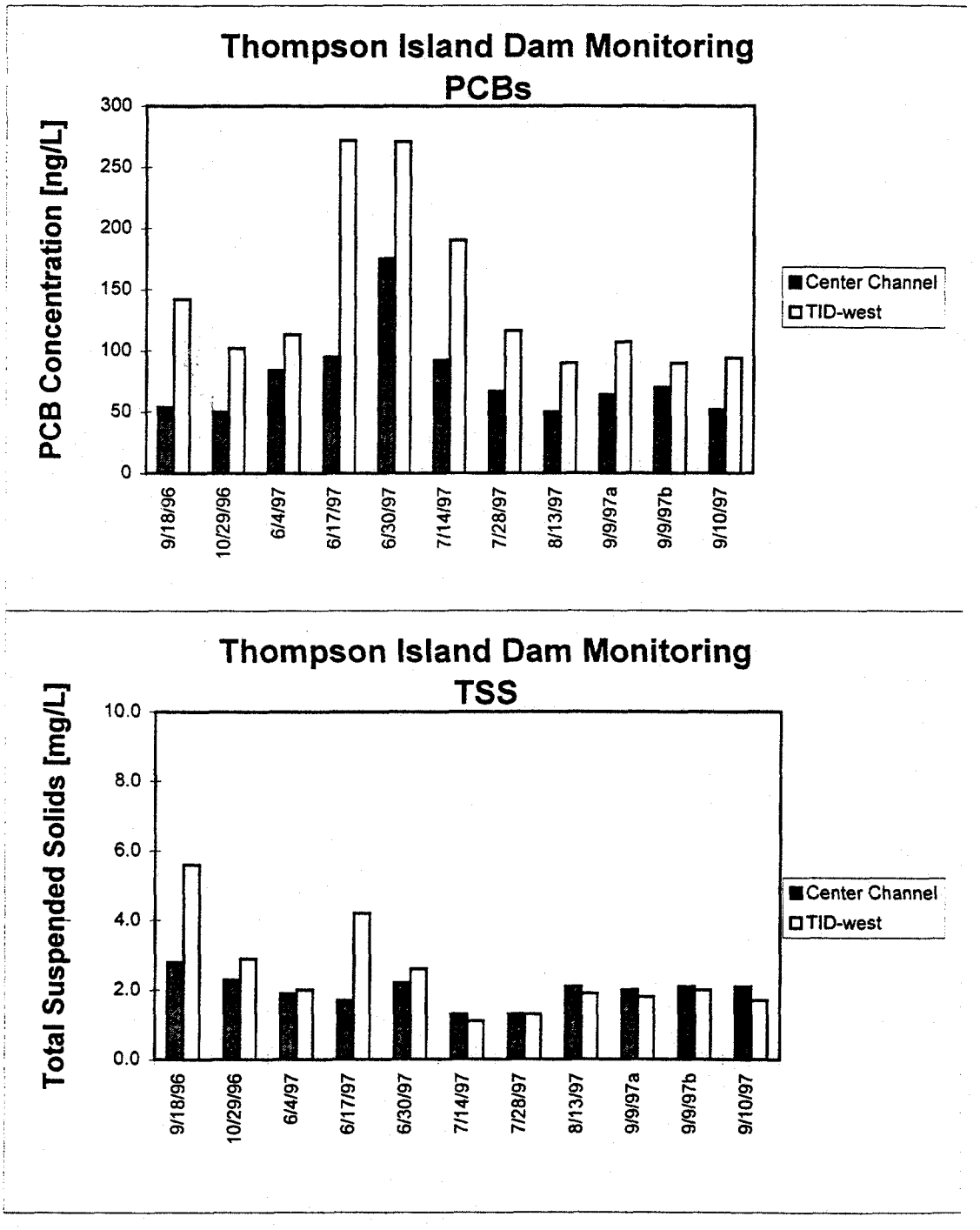
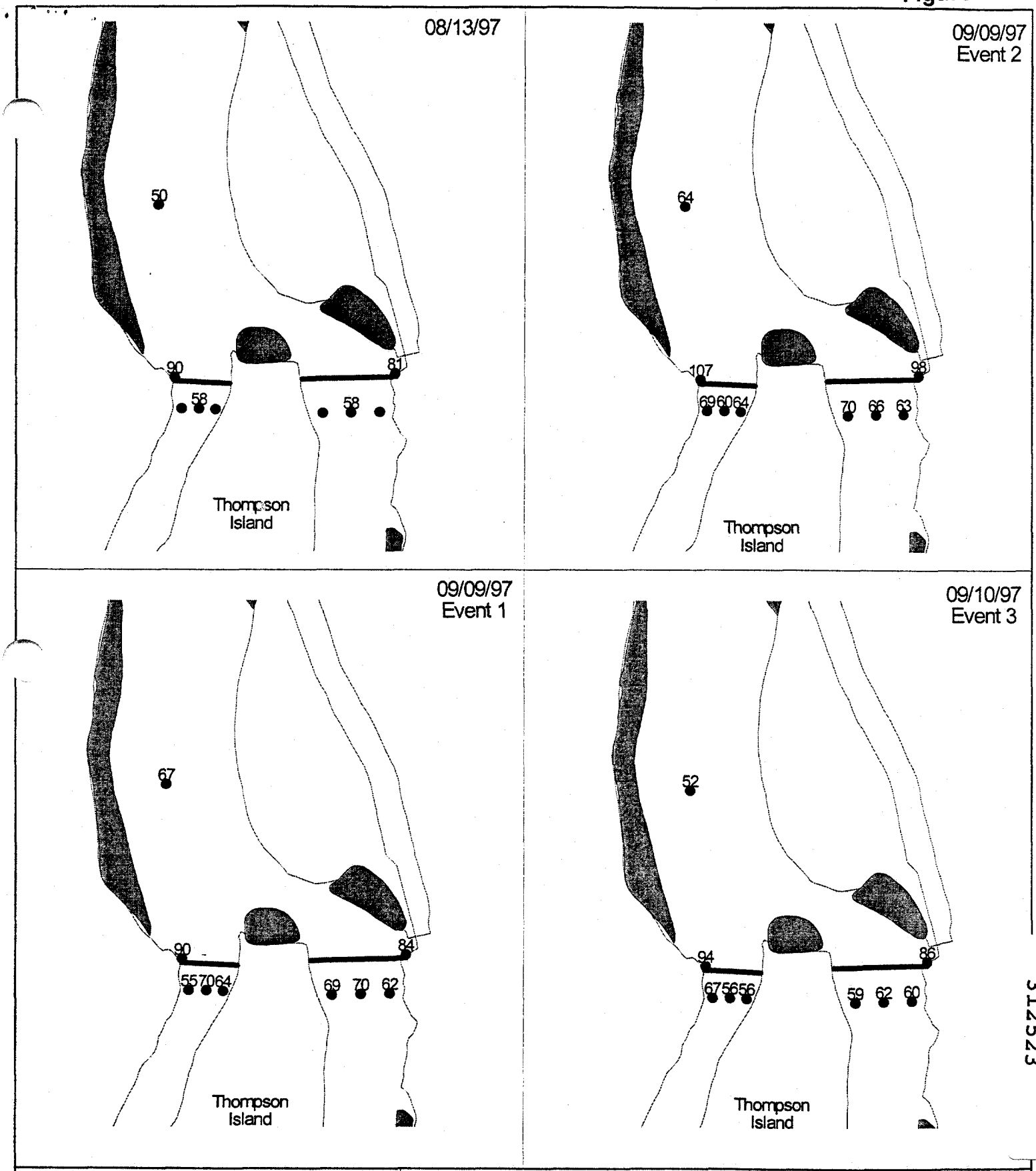


Figure 2



The General Electric Company Thompson Island Dam Monitoring Study

Total PCB Concentrations

HydroQual, Inc. October, 1997

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