General Electric Company
Albany, New York

**Sampling and Analysis Plan**

# Hudson River PCB DNAPL Transport and Water Column Monitoring Study

August 1996

Prepared by:

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# 1. INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared by HydroQual, Inc. and O'Brien & Gere Engineers, Inc. on behalf of the General Electric Company (General Electric). This SAP describes sampling and analysis procedures to be used during the PCB dense non-aqueous phase liquid (DNAPL) transport and water column monitoring study to be conducted on the Hudson River. These studies are being performed to supplement the results of the 1995 River Monitoring Test (O'Brien & Gere, 1996a), and have been designed to evaluate the hypothesis that PCB DNAPL transport or sampling bias at routine monitoring stations produces the PCB fate and transport anomalies observed in the river.

## 1.1 Background

DNAPL PCBs are present within fractured bedrock underlying the General Electric Hudson Falls Plant site (O'Brien & Gere, 1996b). This material is believed to have migrated through bed rock fractures and accumulated in waterways within the 150 year old Allen Mill (O'Brien & Gere, 1994a). Collapse of a wooden gate structure within the mill is believed to have resulted in the transport of PCB DNAPL into the Hudson River during September 1991 and until flow through the waterways was controlled in January 1993 (O'Brien & Gere, 1994a). While these sources have been controlled by remedial measures (O'Brien & Gere, 1996b), PCB DNAPL from the plant site may be entering the river directly through fractures in the river bed. Such DNAPL activity was observed in 1994 following partial river bed dewatering conducted in association with the construction of a new dam near the Hudson Falls plant site (O'Brien & Gere, 1996b) as well as during visual inspections of the dry river bed conducted by General Electric during the summer of 1996.

The PCB DNAPL loadings described above may be responsible, at least in part, for some of the PCB fate and transport anomalies observed in the upper Hudson River over the last several years (O'Brien & Gere, 1993a, 1994b; HydroQual, 1995). Of particular

interest is the increase in summer low flow loadings observed from the Thompson Island Pool following the Allen Mill loading event of 1991 (HydroQual, 1995). These loadings are in excess of those expected from molecular diffusion based upon 1991 sediment pore water PCB measurements. The temporal correspondence of mill loadings and the increase in PCB loadings from the Thompson Island Pool suggest the mill loadings as the causative factor. For this hypothesis to be true, PCBs must have passed the Fort Edward sampling station undetected and then been deposited within the pool. This could have occurred if a large mass of PCB entered the river between sampling events, as is believed to have occurred during the initial stages of the September 1991 mill loading event. This also could have occurred (and may still be occurring) if PCBs from the plant site environs are transported as part of the bed load and pass under the sampling devices as described below.

Alternatively, some of the fate and transport anomalies observed in the river may be due to inaccuracies associated with the current monitoring program. Presently, water column monitoring consists of:

- grab samples collected weekly from the western shore of the river from the canoe carry station (HRM 198.6; Figure 1)[1],

- vertically stratified composite samples collected weekly from the eastern and western channel of the river at Fort Edward and combined into a single composite sample (HRM 194.2; Figure 1), and

[1]Since the fall of 1995 startup of the new hydroelectric facility on the western shore of the river at HRM 197, samples collected from the canoe carry station on the western shore have not accurately represented average river conditions. Discharge of water from the facility hydraulically isolates the canoe carry station from potential PCB loadings from the plant site area along the eastern shore. This station will not be considered in the transect study described herein and probably should be dropped from the current monitoring program.

- grab samples collected weekly from the western wing wall of Thompson Island Dam (HRM 188.5; Figure 1).

Due to their density (1.38 g/cc), PCB DNAPL loadings from the Allen Mill or plant site area may be transported downstream along the sediment/water interface as part of the bed load. Water column monitoring at the Fort Edward station does not include collection of water from the bottom 1 foot (estimated) of the water column and, therefore, does not include any bed load DNAPL. Additionally, if PCB loadings are not equally distributed across the channels at Fort Edward, the single sampling points may not account for it. Within Thompson Island Pool, any unmeasured PCB may subsequently become progressively mixed or dissolved in the water column or incorporated into the surface sediments where it would be subjected to other fate determining processes. Similarly, a sampling bias at the single point station at Thompson Island Dam may also be misinterpreted as a PCB flux across the Thompson Island Pool.

## 1.2 Objectives

The principal objective of the DNAPL transport and water column monitoring study is to test the hypothesis that PCB fate and transport anomalies observed in the upper Hudson River are due to either 1) DNAPL PCB loadings from the Hudson Falls Plant site environs or 2) sampling biases at the current river monitoring stations. The specific objectives include:

- evaluate the fate of PCB DNAPL loadings to the river from the Allen Mill and Hudson Falls Plant site,

- assess the potential for PCBs to be transported as part of the bed load into Thompson Island Pool, and

- evaluate the ability of the current monitoring program to quantify upstream PCB loads.

## 1.3 Approach

PCB DNAPL Transport Study

The PCB DNAPL transport study has been designed to simulate the fate and transport of PCB DNAPL within the Hudson River using traceable fluorescent resin particles. The study will include:

- the injection of particles possessing a density similar to that of Aroclor 1242 into the river from the new Adirondack Hydro Development Corporation (AHDC) Hydroelectric Plant,

- the collection of water column and bed load particle samples at or near current water column monitoring stations, and

- the analysis of water column and bed load particle samples for fluorescent resin particle concentration, PCB concentration, total solids, and total organic carbon (TOC).

Water Column PCB Monitoring Study

The water column PCB monitoring study has been designed to evaluate the ability of current monitoring program to quantify PCB loadings which pass Fort Edward and Thompson Island Dam. The study will include:

- collection of discrete and temporally composited water column samples across two transects perpendicular to river flow located upstream of current routine monitoring stations at Fort Edward and Thompson Island Dam,

- collection of temporally composited samples from the current routine monitoring stations over the same period as transect samples are collected, and

- analysis of water column samples for PCB and total suspended solids (TSS) concentration.

## 2. METHODOLOGY

### 2.1 PCB DNAPL Transport Study

#### 2.1.1 Fluorescent Resin Particles

The fluorescent resin particles to be used for the PCB DNAPL transport study are manufactured by Day-Glo Color Corporation of Cleveland, Ohio. The particles are used as colorants for a variety of industrial and commercial applications and have a density of 1.20 g/cm$^3$. The density of PCB DNAPLS recovered from monitoring wells on the Hudson Falls plant site have ranged from 1.26 - 1.38. The particles consist of a polyamide ester resin and a zinc based fluorescent dye colorant. A material safety data sheet for the particles is contained in Appendix A.

The particles are produced by serial grinding a block of fluorescent resin material to form a powder. A sample of the product of the first grinding was obtained from Day-Glo. This material was sieved and the settling velocities of the different size fractions were

| Particle Diameter ($\mu$m) | Settling Velocity Trials | Mean Settling Velocity (cm/sec) | Standard Deviation |
|---|---|---|---|
| >2380 | 6 | 5.27 | 0.86 |
| 1168-2380 | 6 | 4.35 | 0.48 |
| 247 - 1168 | 6 | 2.46 | 0.51 |
| 143 - 247 | 6 | 0.62 | 0.14 |
| <143 | 3 | 0.33 | 0.05 |

For this study, a particle size between 143 and 247 $\mu$m having a mean settling velocity of 0.62 cm/sec was selected. This decision was based upon an empirical study involving the addition of a small volume of PCB oil to 1 liter of Hudson River water. The oil was obtained from one of the wells at the Hudson Falls plant site. Vigorous shaking of the water and oil mixture produced PCB oil droplets visually estimated to be between 100 and 200 $\mu$m in diameter. A spherical PCB oil droplet of this size in 1 L of water would produce a PCB concentration in the 1 to 2 $\mu$g/L range. This concentration is similar to that observed in the river during the Allen Mill PCB loading events of 1991 and 1992.

### 2.1.2 Particle Injection

The particles will be injected in a slurry form into the fish bypass line of AHDC's hydroelectric plant. Approximately 20 pounds of the 143 - 247 $\mu$m sized particles will be slurried at a 2 percent concentration using Hudson River water. A surfactant (Triton X-100) will be added to the slurry at a concentration of 0.5% (wt./vol.) to wet the particles and retard agglomeration during injection. A material safety data sheet for Triton X-100 is contained in Appendix B. The fish bypass line discharges directly into the river within the turbine discharge zone. Injection at this location will facilitate particle mixing. The particle slurry will be pumped using a peristaltic pump over a 1 hour injection period. At

the turbine discharge zone. Injection at this location will facilitate particle mixing. The particle slurry will be pumped using a peristaltic pump over a 1 hour injection period. At a river flow rate of 2,500 cfs, this injection rate will produce an average particle concentration in the river of approximately 35 ug/L or 7 particles/L.

$\frac{35\ ug/L}{7\ part/L} = 5\ ug/part$

### 2.1.3 *In Situ* Particle Filtration

Natural water borne particulates and fluorescent resin particles will be collected by passive water column filtration devices deployed within the river downstream of the particle injection point. These data will be used to evaluate the fate of the injected particles.

**Sample Locations**

Water column particulate and fluorescent resin particle samples will be collected from the Hudson River at three locations including (Figure 1):

- approximately 300 feet upstream of the north end of Rogers Island (HRM 195),
- beneath the Route 197 Bridge in Fort Edward at the routine monitoring station location (HRM 194.2), and
- approximately 500 feet upstream of the Thompson Island Dam (HRM 189).

Two in-situ particle filtration set ups (described below) will be deployed at each of the sampling stations along the main channel flow path to facilitate the collection of representative samples. One sampler will be deployed in the eastern and one in the western channel at the Fort Edward (HRM 194.2) station.

Sample Collection Procedures

Water borne particulate and fluorescent resin particle samples will be collected from the river within 100 $\mu$m nylon mesh bags mounted on metal frames (Figure 2). Three bags will be fitted to each frame. One bag each will be located at or near the air/water interface, at mid channel depth (if water depth permits), and at the sediment/water interface. The mouth of the bags will be formed by a 0.1 sq. ft. rectangular plastic support and oriented upstream to capture particles transported by the natural flow of the river. The sampler will be anchored on the river bottom by concrete blocks. Once daily for three days following fluorescent particle injection, the mesh bags and the captured particles will be collected and new bags will be mounted on the samplers. The filtration devices located in the eastern and western channel of the Fort Edward Station will be removed each night due to concerns over boater safety.

The bags and entrained particles will be transferred to a 1 quart glass jar, labeled, and transported to HydroQual's facilities in Mahwah, N.J. to be prepared for shipment to laboratories for testing.

### 2.1.4 Thompson Island Pool Sediment Traps

Settling particle samples will be collected from within the Thompson Island Pool and analyzed for fluorescent particle concentration. These data will be used to assess the fate of particles passing the upstream sampling stations as suspended material.

Sampling Locations

A cluster of three sediment traps will be deployed within four quiescent regions within the Thompson Island Pool (Figure 1). These locations include:

- the southern tip of the unnamed island within the western channel of the river adjacent to Rogers Island,
- the southern tip of Rogers Island,
- a backwater region along the western shore immediately downstream of the H-7 site (HRM 193), and
- the southern tip of Griffin Island.

**Sample Collection Procedures**

The sediment traps will be constructed from 5-gallon plastic pails weighted with approximately 20 pounds of cured concrete. The pails will be fitted with a plastic cover containing a 4 inch hole in the center. The traps will be deployed for one week beginning the day of particle injection. Upon retrieval, excess water from the traps will be decanted into the river and the sediments will be quantitatively transferred from the pails into labeled glass containers and transported to HydroQual's facilities in Mahwah, N.J. Water will be evaporated from the samples and the residual solids will be retained for fluorescent particle analysis.

### 2.1.5 River Flow Velocity Measurement

River flow velocity within one foot of each of the particle filtration devices will be measured using a Marsh-McBirney Model 201 flow velocity meter. These flow velocity measurements will allow approximation of the volume of water filtered by each of the mesh bags. Flow will be measured approximately hourly adjacent to the devices located upstream of Roger's Island (HRM 195) and at the Fort Edward monitoring station (HRM

194.2) and at least three times daily adjacent to devices deployed at the Thompson Island Dam station (HRM 189).

### 2.1.6 Particle Analysis

The trapped particulate samples will be analyzed for fluorescent particles, PCBs, total solids, and TOC. Direct counts of fluorescent particles will be conducted by SpectraScan, a small optical consulting firm affiliated with the University of Southern California, Department of Biological Sciences. The analysis includes the mounting of particle samples on specially treated glass slides and direct counting under an epifluorescent microscope. The fluorescent particle analysis protocol is contained in Appendix C. Congener specific PCB and TOC analysis will be performed by Northeast Analytical, Inc. of Schenectady, N.Y. using Methods NEA608CAP (O'Brien & Gere, 1993b) and EPA Method 415.1, respectively.

### 2.1.7 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) measures for the PCB DNAPL study will follow the quality assurance project plan (QAPP) developed for the Hudson River Project (O'Brien & Gere, 1993b). QA/QC sampling will consist of:

- the analysis of blind duplicates for PCBs, fluorescent particles, and TOC at a rate of 1/10,
- the analysis of blind field blanks and matrix spikes at a rate of 1/10 for fluorescent particle analysis, and
- the analysis of matrix spikes at a rate of 1/20 for PCB analysis.

A summary of the samples to be collected during the study is contained in Table 1.

## 2.2 Water Column Monitoring Study

The Water Column Monitoring Study consists of the collection of temporally composited water column samples across two transects located upstream of current water column monitoring stations at Fort Edward and Thompson Island Dam, and the monitoring stations themselves. These samples will be analyzed for TSS and PCB and the data will be used to evaluate the adequacy of the current monitoring to quantifying water column PCB transport within the river. Timing of the Thompson Island Dam samples will be determined based on time-of-travel estimates for the flows measured the day of sampling in an attempt to sample a single mass of water as it passes the two stations.

### 2.2.1. Hydrologic Profile Construction

Before sampling begins, flow profiles of each transect will be constructed. These profiles will be located in the approximate locations utilized during the 1995 River Monitoring Test for the Fort Edward and Thompson Island Dam transects. Buoys will be placed at the sampling locations along each transect. Water depths will be measured across the transects to generate a bathymetric profile. River velocities will be measured using a Marsh-McBirney Model 201 velocity meter. These data will be used in conjunction with PCB concentration data to calculate PCB mass loadings within the individual parcels along each transect in a manner consistent with the procedures used during the 1995 River Monitoring Test (O'Brien & Gere, 1996a; Figure 3).

### 2.2.2 Sample Locations

Samples will be collected from six stations along each of two transects located upstream of Rogers Island and the Thompson Island Dam (Figure 1). Two samples will be

collected at each sampling station, one near the surface of the water column (approximately 0.2 times the total depth), and one near the bottom of the water column (approximately 0.8 times the total depth) and composited. These water column composites will be collected hourly for eight hours and combined to form 1-eight hour composite for each station. To summarize, transect sample collection will include:

- two transects,
- six stations per transect, and
- six composite samples from each transect.

Sampling locations along each transect will be identified by anchoring buoys at the desired stations, as described in Section 2.2.1. Stations along each transect will be accessed by boat for sampling.

Concurrently with the transect sampling, samples will be collected from the routine monitoring stations located at Fort Edward (HRM 194.2) and Thompson Island Dam (HRM 188.5). One temporal composite sample will be collected from each of the following locations:

- the eastern channel of Rogers Island at the Fort Edward station,
- the western channel of Rogers Island at the Fort Edward station,
- the western wing wall of the Thompson Island Dam, and
- the eastern wing wall of the Thompson Island Dam.

Each hour for the eight hour transect sampling period, aliquots of vertically integrated samples will be collected from the two Fort Edward stations and grab samples will be collected from the Thompson Island Dam stations. These aliquots will be combined to form one temporal composite from each station. Additionally, at both the eastern and western

channel station at Fort Edward, discrete hourly samples consisting of vertically stratified composites will be collected for analysis.

### 2.2.3 Sample Collection Procedures

**Transect Sampling**

Samples will be collected at each transect station (water depth permitting) with a Kemmerer Bottle sampler. The areas where water depths are too shallow to permit use of a Kemmerer bottle, a grab sample will be collected with a glass or stainless steel vessel. Composites will be formed by discharging a portion of the contents of the Kemmerer Bottle directly into a sample container. The sample containers will be pre-marked in approximately one-eighth increments to guide preparation of the composite. Dedicated sampling equipment will be used for each transect. Sampling equipment will not be decontaminated between stations due to the close proximity of the sampling stations, expected low-level concentrations of PCBs, and field logistics. However, the sampling equipment will be rinsed several times with river water prior to sampling at each station.

**Routine Water Column Monitoring Stations**

Water sampling procedures at the routine water monitoring stations will be similar to those employed for the Post Construction Remnant Deposit Monitoring Program (PCRDMP; O'Brien & Gere, 1992a). The only differences being the collection of: 1) temporal composites, and 2) separate samples from the eastern and western channel of Rogers Island and the eastern and western wing wall of Thompson Island Dam.

Sample Preparation and Handling

Upon collection, the samples will be placed in appropriate containers. PCB and TSS samples will be chilled to approximately four degrees C. The PCB and TSS samples will be transported to Northeast Analytical, Inc. (NEA) for analysis. Each sample will be assigned a unique sample designation, identifying sample location, and date and time of sample collection.

### 2.2.4 Analytical Testing

Analytical methods for PCBs and TSS will be the same as those used in the PCRDMP and will be performed by NorthEast Analytical, Inc. of Schenectady, N.Y. PCBs will be analyzed by capillary column using method NEA608CAP and TSS will be analyzed by USEPA Method 160.2. Copies of the methods are provided in the PCRDMP QAPP (O'Brien & Gere, 1992b).

### 2.2.5 Quality Assurance/Quality Control

QA/QC issues are addressed in the QAPP developed for the PCRDMP (O'Brien & Gere 1992b). QA/QC samples will consist of collection of matrix spike, blind duplicate, and equipment blank samples. PCB QA/QC will include one matrix spike and one duplicate sample at each of the two transects and one equipment blank at each transect as well as each of the routine monitoring station locations. Duplicate TSS samples will be collected at a rate of 1/transect.

### 2.3 Health and Safety

Health and safety issues and procedures are addressed in the Health and Safety Plan developed for the PCRDMP (O'Brien & Gere 1992c) as modified in the Sampling and Analysis Plan for the River Monitoring Test (O'Brien & Gere, 1995).

## 3. PROJECT ORGANIZATION, SCHEDULE, AND DELIVERABLES

### 3.1 Project Organization

A project organization chart is presented in Figure 4. HydroQual will be responsible for overall project management and the execution of the PCB DNAPL transport study. O'Brien & Gere will provide technical support for the PCB DNAPL transport study and will be responsible for the execution of the water column monitoring study. PCB, TOC, and TSS analysis will be performed by Northeast Analytical. Fluorescent resin particle analysis will be performed by SpectraScan.

### 3.2 Project Schedule

A project schedule is contained in Figure 5. The PCB DNAPL transport and water column monitoring study will be conducted simultaneously the third week of September 1996. Analytical testing results should be available approximately 4 weeks following sample collection with data evaluation and reporting complete six weeks following receipt of data from the laboratories.

### 3.3 Project Deliverables

Project deliverables for the PCB DNAPL transport and water column monitoring study will include separate non-interpretive data summary reports containing a description of the objectives, methods, and raw data results.

## 4. REFERENCES

HydroQual, 1995. Anomalous PCB Load Associated with the Thompson Island Pool: Possible Explanations and Suggested Research. HydroQual, Inc. October 31, 1995.

O'Brien & Gere, 1996a. Hudson River Project River Monitoring Test Data Summary Report. O'Brien & Gere Engineers, Inc. January, 1996.

O'Brien & Gere, 1996. Hudson Falls, Operable Unit 3, Interim Remedial Measures Report. O'Brien & Gere Engineers, Inc. July 1996.

O'Brien & Gere, 1995. Hudson River Project, River Monitoring Test, Sampling and Analysis Plan. O'Brien & Gere Engineers, Inc. August , 1995.

O'Brien & Gere, 1994a. Bakers Falls Operable Unit 3, Remedial Investigation Report: Syracuse, N.Y. O'Brien & Gere Engineers, Inc., January 1994.

O'Brien & Gere, 1994b. Fort Edward Dam PCB Remnant Containment 1993 Post-Construction Monitoring Program Report. Syracuse, NY: O'Brien & Gere Engineers, Inc., May 1994.

O'Brien & Gere, 1993a Fort Edward Dam PCB Remnant Containment, 1992 Post-Construction Monitoring Program Report. O'Brien & Gere Engineers, Inc., August 1993

O'Brien & Gere, 1993b. Hudson River Project, Sampling and Analysis Program, Quality Assurance Project Plan. O'Brien & Gere Engineers, Inc., May, 1993.

O'Brien & Gere, 1992a. Fort Edward Dam PCB Remnant Deposit Containment, Post-Construction Monitoring Program, Field Sampling Plan. O'Brien & Gere Engineers, Inc., June 1992.

O'Brien & Gere, 1992b. Fort Edward Dam PCB Remnant Deposit Containment, Post-Construction Monitoring Program, Quality Assurance Project Plan. O'Brien & Gere Engineers, Inc., June 1992.

O'Brien & Gere, 1992c. Fort Edward Dam PCB Remnant Deposit Containment, Post-Construction Monitoring Program, Health and Safety Plan. O'Brien & Gere Engineers, Inc., June 1992.

# TABLES

## Table 1. Field Sampling Program Summary

| Activity | Task | Approximate location | Number of samples | Analysis/purpose |
|---|---|---|---|---|
| **PCB DNAPL Transport** | *In Situ* particle filtration | Two particle filtration devices at each of the following locations:<br>- 300 ft. upstream of Rogers Island;<br>- beneath Rt. 197 Bridge (east and west channels);<br>- 500 ft. upstream of Thompson Island Dam | 54 (1) | Fluorescent particle concentration, congener specific PCBs, total organic carbon, total solids |
| | Sediment Traps | Three sediment traps located at each of the following locations:<br>- Southern tip of unnamed island within the western channel adjacent to Rogers Island;<br>- Southern tip of Rogers Island;<br>- Adjacent to east shore, immediately downstream of the H-7 site<br>- Southern tip of Griffin Island | 12 (2) | Fluorescent particle concentration, congener specific PCBs, total organic carbon, total solids |
| | River flow velocity | Adjacent to each particle filtration device | (3) | Used to estimate volume of water passing through sampling devices |
| **Water column monitoring** | Hydrologic profiles | Fort Edward transect;<br>Thompson Island Dam transect | -- | Developed to estimate volume of water passing each sampling location |
| | Transect sampling | Fort Edward transect;<br>Thompson Island Dam transect; | 12 (4) | Congener specific PCBs, total suspended solids |
| | Routine PCRDMP monitoring station sampling | Fenimore Bridge;<br>Rt. 197 Bridge (east and west channels);<br>Thompson Island Dam (east and west wing walls) | 21 (5) | Congener specific PCBs, total suspended solids |

(1) - number of samples based on two collection devices per transect, three collection bags per device sampled daily for three days. Does not include QA/QC samples (blind duplicates and equipment blanks at 10%, matrix spike at 20%)
(2) - number of samples based on three sediment traps per location. Does not include QA/QC samples (blind duplicates and equipment blanks at 10%, matrix spike at 20%)
(3) - performed periodically throughout study
(4) - Based on 6 composite samples per transect. Does not include QA/QC samples (blind duplicates and equipment blanks at 10%, matrix spike at 20%)
(5) - Based on one 8-hr composite sample at Fenimore Bridge, two 8-hr. composite samples from the Route 197 Bridge (east and west channels), and two 8-hr. composite samples from Thompson Island Dam (east and west wing walls). Also includes 8 discrete vertically stratified composite samples collected hourly from both the eastern and western channel of the river from the Route 197 bridge. Does not include QA/QC samples (blind duplicates and equipment blanks at 10%, matrix spike at 20%)

# FIGURES

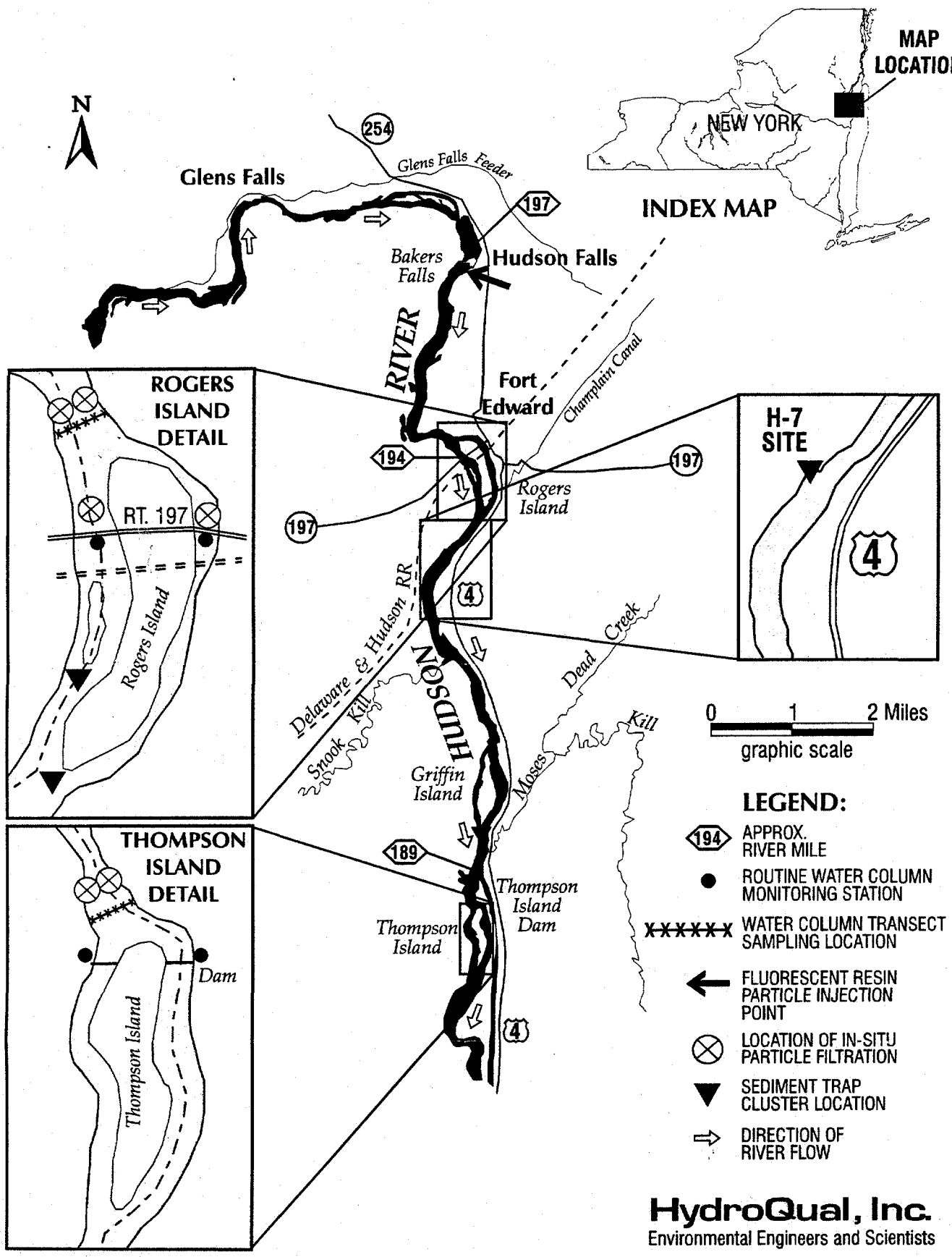


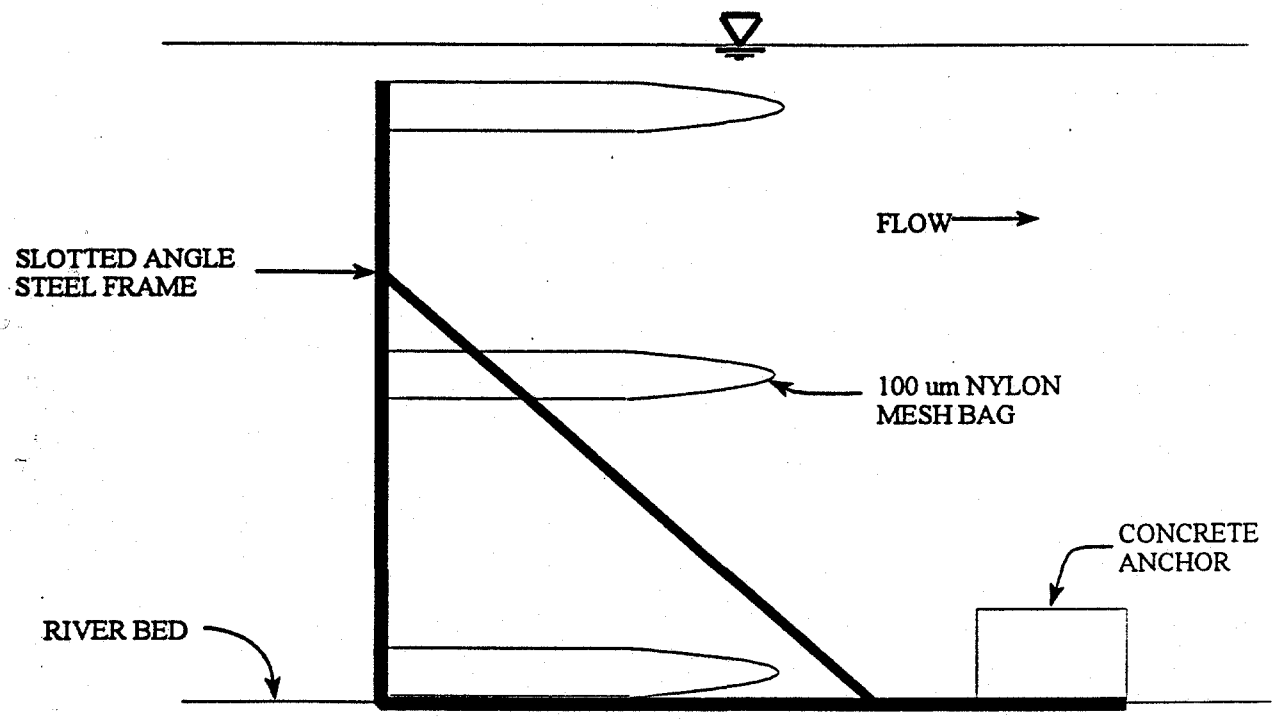

FIGURE 1. WATER COLUMN TRANSECTS, FLOURESCENT RESIN PARTICLE INJECTION POINT AND SAMPLING LOCATIONS

I:\DIV52\PROJECTS\612205\DWG\PARTRAP.FIG

DATE: AUGUST 6, 1996

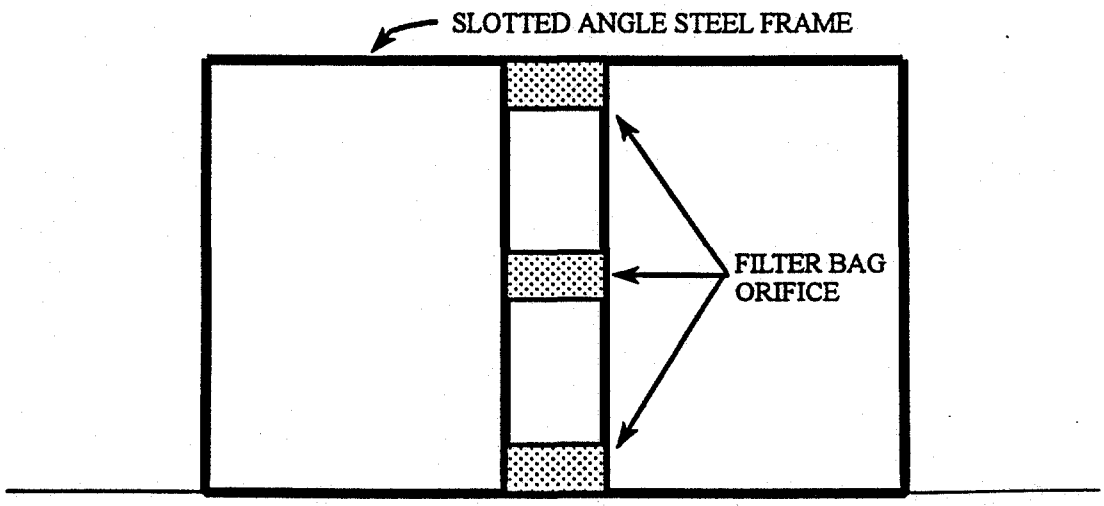
FIGURE 2

# GENERAL ELECTRIC COMPANY
# HUDSON RIVER PCB DNAPL TRANSPORT
# SCHEMATIC OF IN-SITU FILTERING APPARATUS




SIDE ELEVATION VIEW

NOT TO SCALE




FRONT ELEVATION VIEW

NOT TO SCALE

FILE NO. 0612.205-01F

O'BRIEN & GERE ENGINEERS INC.

DATE: AUGUST 6, 1996

I:\DIV52\PROJECTS\612205\DWG\FIG3

FILE NO. 0612.205-02F

# GENERAL ELECTRIC COMPANY
# HUDSON RIVER DNAPL TRANSPORT AND WATER COLUMN MONITORING STUDY
# TRANSECT MASS LOADING PROFILE

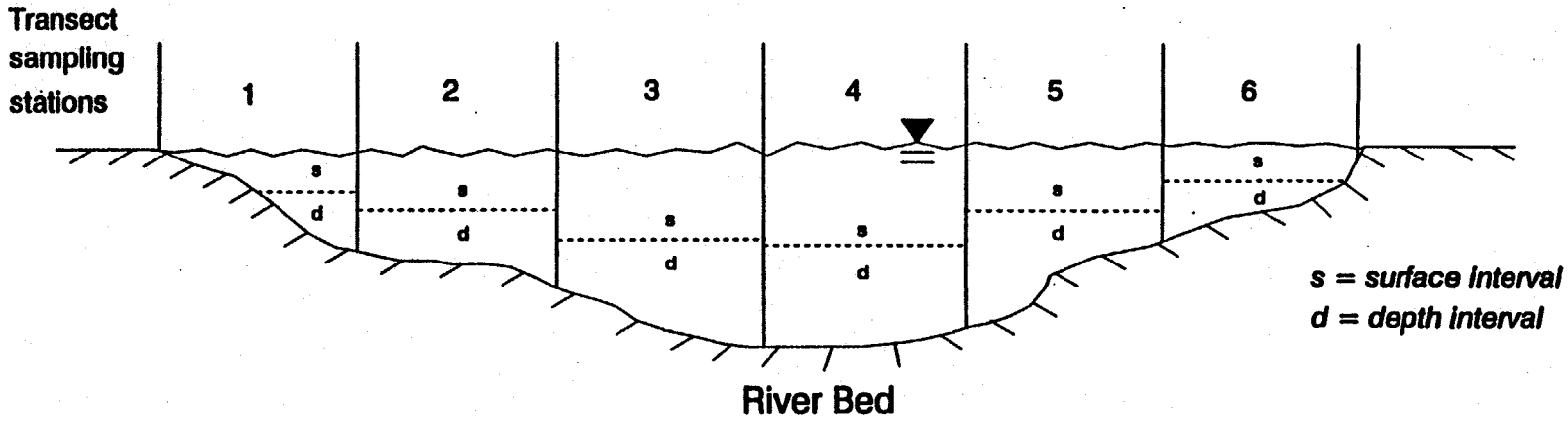



FIGURE 3

O'BRIEN & GERE ENGINEERS INC.

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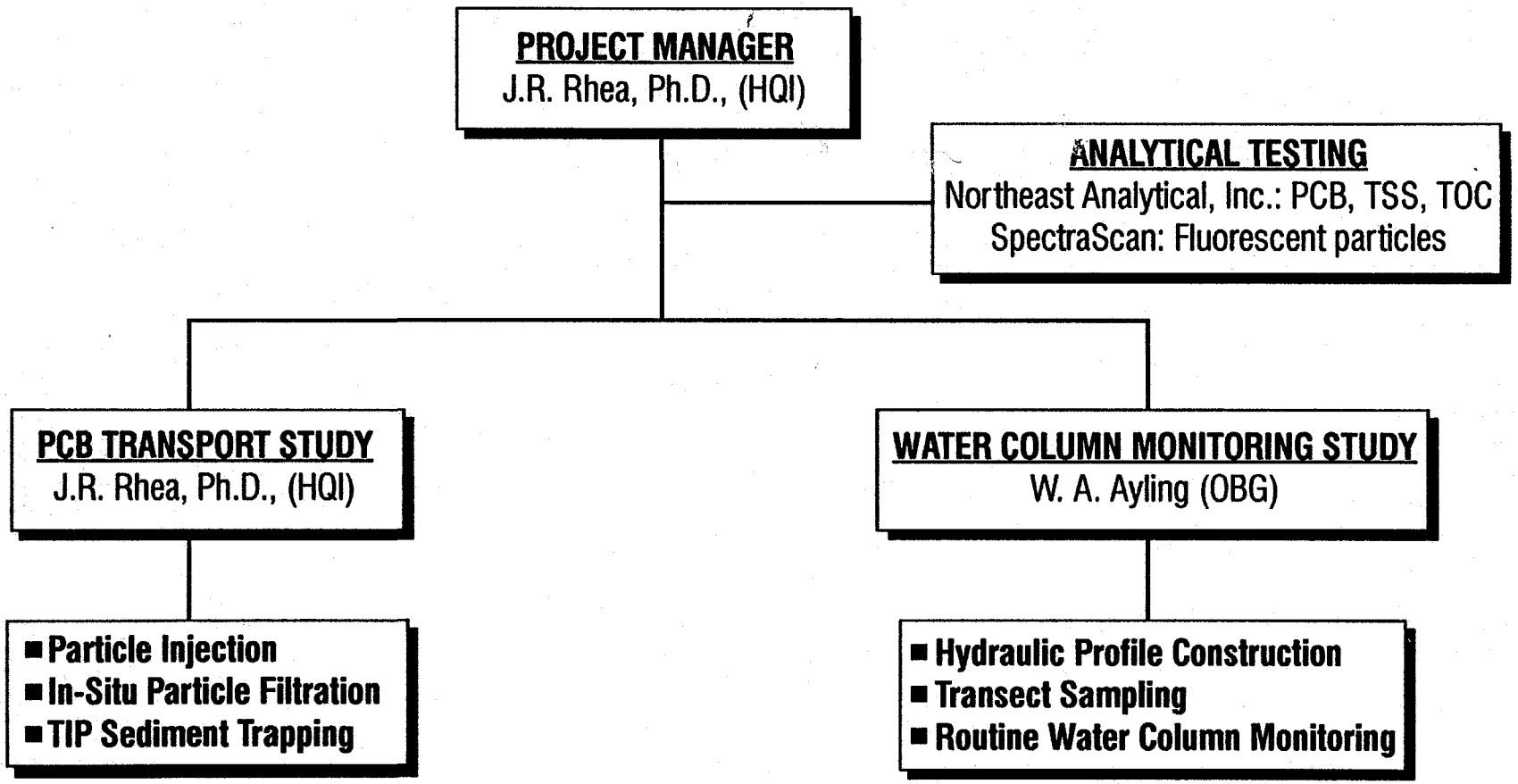
Figure 4

# GENERAL ELECTRIC COMPANY

## Hudson River PCB DNAPL Transport and Water Column Monitoring Study
## Organizational Chart






August 6, 1996

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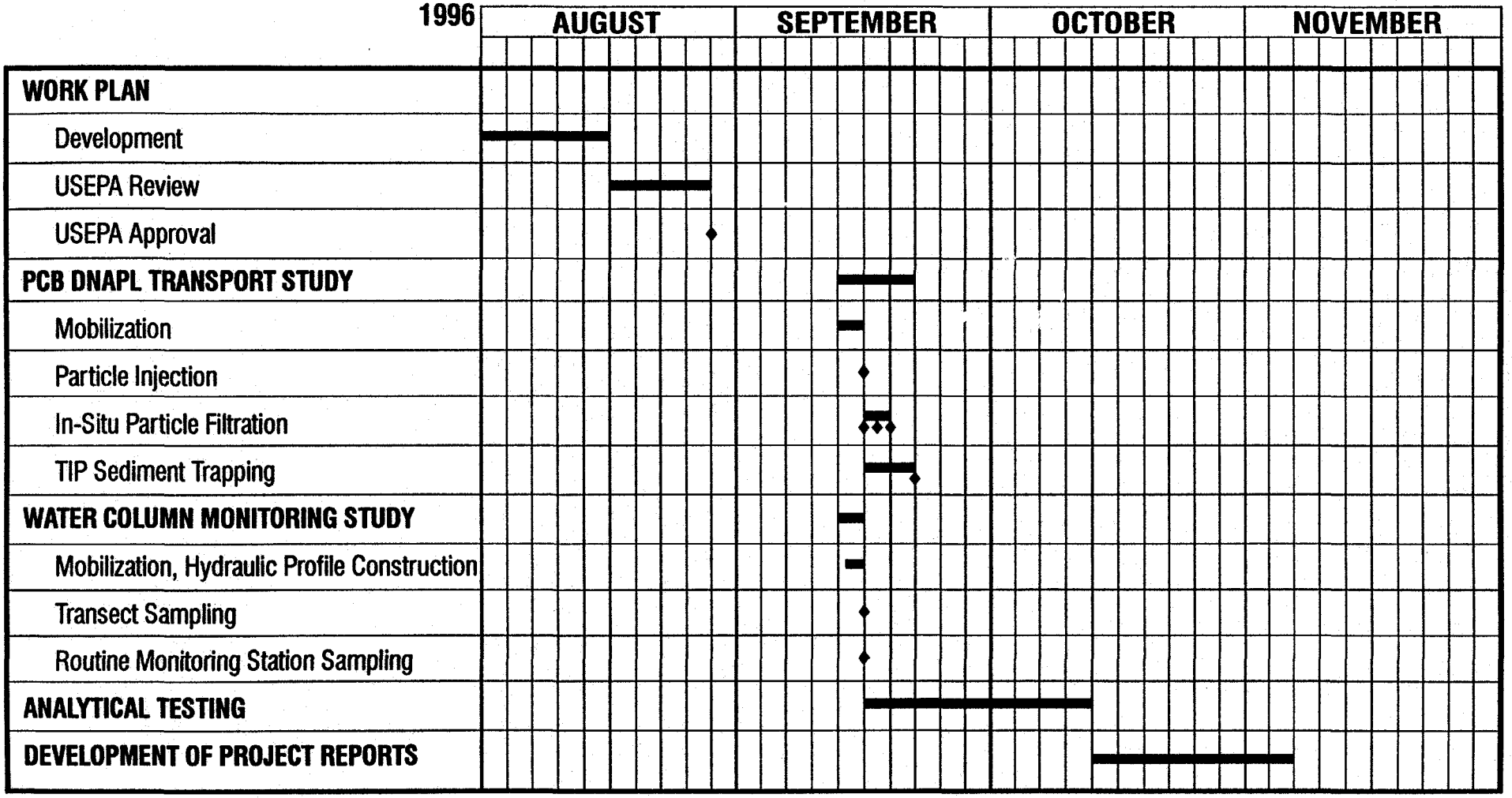
Figure 5

# GENERAL ELECTRIC COMPANY

## PCB DNAPL Transport and Water Column Monitoring Study

## Project Schedule




August 6, 1996

HydroQual, Inc.

O'Brien & Gere Engineers, Inc.

# APPENDIX A

# MATERIAL SAFETY DATA SHEET FOR DAY-GLO FLUORESCENT PARTICLES

# MATERIAL SAFETY DATA SHEET

Printed : 02/20/95

Revised : 02/20/95

## SECTION I - PRODUCT IDENTIFICATION

Manufacturer: DAY-GLO COLOR CORP
ENVIRONMENTAL HEALTH & SAFETY
4515 ST CLAIR AVENUE
CLEVELAND OH 44103

Information Phone: 216-391-7070
Emergency Phone: 800-424-9300

Product Class: SYNTHETIC ORGANIC COLORANT
Trade Name : SATURN YELLOW ZQ PIGMENT
Product Code : ZQ-17N
C.A.S. Number: MIXTURE
Prepared By : SCOTT A. FLEMING
Title : REGULATORY CHEMIST

Hazard Ratings: Health - 1
none -> extreme Fire - 1
0 ---> 4 Reactivity - 0

## SECTION II - HAZARDOUS INGREDIENTS

| Ingredients | CAS # | Weight % | Exposure Limits ACGIH/TLV | Exposure Limits OSHA/PEL | VP mm HG |
|---|---|---|---|---|---|

(No hazardous ingredients known at this time.)

## SECTION III - PHYSICAL DATA

Boiling Range: None
Evap. Rate: Non Volatile
Volatiles vol % 00.00 Wgt% 00.00
Appearance: Colored powder
V.O.C.: See Section IX

Vapor Density: Non Volatile
Liquid Density: Heavier than Water.
Wgt per gallon: 10.00 Pounds.

## SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Class: NA Flash Point: None F LEL: None UEL: None

**-EXTINGUISHING MEDIA:**

Based on the NFPA quide, use dry chemical, water or other extinguising agent suitable for Class A fires. For large fires, use water spray or fog, thoroughly drenching the burning material.

**-SPECIAL FIREFIGHTING PROCEDURES:**

Clear area of personnel. Approach upwind. Wear self-contained breathing apparatus.

**-UNUSUAL FIRE & EXPLOSION HAZARDS:**

Improper handling may lead to dust cloud formation which, as with any organic compound, may be an explosion hazard.

## SECTION V - HEALTH HAZARD AND PERSONAL PROTECTION INFORMATION

-FIRST AID:

EYES: Flush with water for at least 15 min. while holding eyelids open.

SKIN: Practice good industrial hygiene, wash with soap and water.

INGESTION: Give water, do not induce vomiting. Call a physician.

INHALATION: Remove to fresh air. Treat symptoms. Call a physician.

-TOXICOLOGY INFORMATION:

No toxicity studies have been conducted on this product.

-PRIMARY ROUTE(S) OF EXPOSURE:

EYE CONTACT: May cause slight irritation

SKIN CONTACT: May cause slight irritation

INHALATION: Treat as a nuisance dust. Avoid breathing.

-SYMPTOMS OF EXPOSURE:

A review of available data does not identify any symptoms from exposure.

-CHRONIC:

CARCINOGENICITY: NTP? (N) IARC MONOGRAPHS? (N) OSHA REGULATED? (N)

Long term exposure may result in dermatitis for sensitive individuals.

-AGGRAVATION OF EXISTING CONDITIONS:

Respiratory allergies and diseases may be aggravated in extreme exposures.

-RESPIRATORY PROTECTION:

A dust mask or NIOSH approved respirator with a dust filter.

-VENTILATION:

General ventilation for comfort conditioning is usually enough to maintain the dust within the nuisance limit of 5 mg/cu.m.

-PROTECTIVE EQUIPMENT:

GLOVES: Required only for sensitive individuals.

EYE PROTECTION: Glasses or goggles are recommended.

RESPIRATORY PROTECTION: Use a NIOSH approved dust respirator.

## SECTION VI - REACTIVITY DATA

STABLITY: [ ] Unstable [x] Stable

HAZARDOUS POLYMERIZATION: [ ] May occur [x] Will not occur

-INCOMPATABILITY:

Avoid contact with strong oxidizers (eg. chlorine, peroxides, chromate, nitirc acid, perchlorates, concentrated oxygen, permanganates) which can generate heat, fires, explosions and the release of toxic fumes.

## SECTION VI - REACTIVITY DATA (cont.)

-CONDITIONS TO AVOID:
Avoid excessive dust in vicinity of electrical or other spark generating equipment. Avoid extreme heat.

-HAZARDOUS DECOMPOSTION PRODUCTS:
The fumes and smoke released contain oxides of carbon and nitrogen which are highly toxic. Do not breath smoke or fumes. Wear suitable protective equipment.

## SECTION VII - SPILL OR LEAK PROCEDURES

-SPILL CONTAINMENT AND RECOVERY:
This product is not defined as a hazardous waste under EPA 40 CFR 261. Sweep up & dispose of as any dust or dirt.

-DISPOSAL:
Same as above.

## SECTION VIII - REGULATORY INFORMATION

-FEDERAL REGULATIONS:
OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200: See Section II for hazardous ingredients as defined.

-CERCLA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (TITLE III)
This is not a regulated material under 40 CFR 117, 302. Notification of spills not required.

-

-SECTIONS 311 AND 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS:
Our hazard evaluation has found this product to be non-hazardous.

-SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372):
See Section X.

-TOXIC SUBSTANCES CONTROL ACT (TSCA):
All components in this product are listed, or are excluded from listing, on the U.S. Toxic Substances Control Act (TSCA) 8(b) Inventory.

-FEDERAL WATER POLLUTION CONTROL ACT,CLEAN WATER ACT,40CFR401.15:
This product contains no ingredients regulated by this Act.

-CLEAN AIR ACT, 40 CFR 60, SECTION 111, 40 CFR 61, SECTION 112:
This product contains no ingredients regulated by this Act.

-STATE REGULATIONS:
MICHIGAN CRITICAL MATERIALS: This product does not contain ingredients listed on the Michigan Critical Register.

-CONEG-COALITION OF NORTHEAST GOVERNORS:
This product is in compliance with the CONEG (Conference of Northeast Governors) requirements thru 1/1/1994 (ie total cadmium, chromium, lead and mercury less than 100 ppm). The detection limits of the test method used (in ppm) indicated by < and also the analytical test results for the pigment are as follows:

| | | | |
|---|---|---|---|
| ANTIMONY | (Sb) <4 | ARSENIC | (As) <4 |
| BARIUM | (Ba) <0.50 | CADMIUM | (Cd) <0.25 |
| CHROMIUM | (Cr) <0.50 | COPPER | (Cu) 1.3 |
| LEAD | (Pb) <1.0 | MERCURY | (Hg) <0.05 |

(cont.)

## SECTION VIII - REGULATORY INFORMATION (cont.)

**-CONEG-COALITION OF NORTHEAST GOVERNORS: (cont.)**

| | | | |
|---|---|---|---|
| NICKEL | (Ni) <0.75 | SELENIUM | (Se) <4 |
| SILVER | (Ag) <0.50 | ZINC | (Zn) 38,500 |

In other words Zinc and Copper were the only element found in our pigments.

**-TRANSPORTATION-49 CFR 172-101:**

This product is not regulated by DOT.

**-FDA-21 CFR:**

DAY-GLO Color Corp.'s products are not listed by the FDA for use under 21 CFR, since potential applications are so numerous that specific applications must be submitted to the FDA for inclusion in the 21 CFR FDA listing.

**-CLEAN AIR ACT AMMENDMENTS OF 1990**

No DAY-GLO product contains an ozone depleting substance (ODS) nor are any of our products manufactured with them.

## SECTION IX - PRECAUTIONARY & LABEL INFORMATION

**-HMIS LABEL STATEMENT:**

ZQ-17N SATURN YELLOW PIGMENT

HEALTH - 1 FLAMMABILITY - 1 REACTIVITY - 0

PRECAUTIONS: Can cause respiratory irritation. Avoid breathing dust. Use & store with adequate ventilation. Dust explosion hazard with ignition source.

FIRST AID: EYES: Flush with water for 15 minutes. SKIN: Wash with soap and water. INGESTION: Give water, do not induce vomiting. Call a physician.

FIRE FIGHTING USE: Water spray, dry chemical, foam or CO2 (Toxic fumes emitted on burning).

SPILL CONTROL: Sweep up & dispose according to local, state and federal regulations.

| CONTAINS: | CAS NO. OR NJ TSRN: |
|---|---|
| RESIN | 80100023-5027-P |
| ALBERTA YELLOW | 80100023-5004-P |
| C>14 ALCOHOL | 71750-71-5 |

TARGET ORGANS: NO ORGANS AFFECTED.

COATING V.O.C. : NONE
MATERIAL V.O.C.: NONE

**-OTHER PRECAUTIONS:**

None

## SECTION X - ADDITIONAL REGULATORY INFORMATION

-SARA TITLE III SECTION 313:

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right To Know Act of 1986 and of 40 CFR 372:

| CAS# | Chemical Name | Percent by Weight |
|---|---|---|
| | None | |

-PROP 65 (CARCINOGEN):

WARNING: This product contains a chemical known to the state of California to cause cancer.

| CAS# | Chemical Name |
|---|---|
| | None |

-PROP 65 (TERATOGENIC):

WARNING: This product contains a chemical known to the state of California to cause birth defects or other reproductive harm.

| CAS# | Chemical Name |
|---|---|
| | None |

-PROP 65 (BOTH CARCINOGEN AND TERATOGENIC):

WARNING: This product may contain a chemical known to the state of California to cause cancer or birth defects or other reproductive harm

| CAS# | Chemical Name |
|---|---|
| | None |

## SECTION X - ADDITIONAL REGULATORY INFORMATION (cont.)

**DISCLAIMER:**

The information contained herein is believed to be accurate, but is not warranted. Nothing contained herein constitutes a specification nor is it intended to warrant suitability for the intended use.

# APPENDIX B

# MATERIAL SAFETY DATA SHEET FOR TRITON X-100 SURFACTANT

## 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: TRITON(R) X-100
FORMULA:
FORMULA WT: .00
CAS NO.: 09002-93-1
NIOSH/RTECS NO.: MD0907700
COMMON SYNONYMS: ALKYLARYL POLYETHER ALCOHOL; OCTYL PHENOL ETHOXYLATE
PRODUCT CODES: X198,4171
EFFECTIVE: 11/26/86
REVISION #02

PRECAUTIONARY LABELLING

BAKER SAF-T-DATA(TM) SYSTEM

| | | | |
|---|---|---|---|
| HEALTH | - | 1 | SLIGHT |
| FLAMMABILITY | - | 0 | NONE |
| REACTIVITY | - | 1 | SLIGHT |
| CONTACT | - | 2 | MODERATE |

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT

PRECAUTIONARY LABEL STATEMENTS

WARNING
CAUSES IRRITATION
AVOID CONTACT WITH EYES, SKIN, CLOTHING.
KEEP IN TIGHTLY CLOSED CONTAINER. WASH THOROUGHLY AFTER HANDLING.

SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

## 2 - HAZARDOUS COMPONENTS

| COMPONENT | % | CAS NO. |
|---|---|---|
| TRITON(R) X-100 | 90-100 | 9002-93-1 |

## 3 - PHYSICAL DATA

BOILING POINT: 270 C ( 518 F)
MELTING POINT: 23 C ( 73 F)
SPECIFIC GRAVITY: 1.04 (H2O=1)
VAPOR PRESSURE(MM HG): 0
VAPOR DENSITY(AIR=1): 21.0
EVAPORATION RATE: 1 (BUTYL ACETATE=1)

SOLUBILITY(H2O): COMPLETE (IN ALL PROPORTIONS) % VOLATILES BY VOLUME: 0

APPEARANCE & ODOR: VISCOUS, COLORLESS LIQUID.

---

4 - FIRE AND EXPLOSION HAZARD DATA

---

FLASH POINT (CLOSED CUP 148 C ( 299 F) NFPA 704M RATING: 1-0-0

FLAMMABLE LIMITS: UPPER - N/A % LOWER - N/A %

FIRE EXTINGUISHING MEDIA
USE EXTINGUISHING MEDIA APPROPRIATE FOR SURROUNDING FIRE.

---

5 - HEALTH HAZARD DATA

---

TOXICITY: LD50 (ORAL-RAT)(MG/KG) - 1800

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE
CONTACT WITH SKIN OR EYES MAY CAUSE SEVERE IRRITATION OR BURNS.

TARGET ORGANS
EYES, SKIN

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
NONE IDENTIFIED

ROUTES OF ENTRY
EYE CONTACT, SKIN CONTACT

EMERGENCY AND FIRST AID PROCEDURES
CALL A PHYSICIAN.
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT 15 MINUTES. FLUSH SKIN WITH WATER.

---

6 - REACTIVITY DATA

---

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT

INCOMPATIBLES: STRONG OXIDIZING AGENTS, STRONG REDUCING AGENTS, COPPER

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7 - SPILL AND DISPOSAL PROCEDURES

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STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE
WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING.



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STOP LEAK IF YOU CAN DO SO WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP WITH SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL AND PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH SPILL AREA WITH WATER.

DISPOSAL PROCEDURE
DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

---

## 8 - PROTECTIVE EQUIPMENT

---

| | |
|---|---|
| VENTILATION: | USE ADEQUATE GENERAL OR LOCAL EXHAUST VENTILATION TO KEEP VAPOR AND MIST LEVELS AS LOW AS POSSIBLE. |
| RESPIRATORY PROTECTION: | NONE REQUIRED WHERE ADEQUATE VENTILATION CONDITIONS EXIST. IF AIRBORNE CONCENTRATION IS HIGH, USE AN APPROPRIATE RESPIRATOR OR DUST MASK. |
| EYE/SKIN PROTECTION: | SAFETY GOGGLES, UNIFORM, APRON, RUBBER GLOVES ARE RECOMMENDED. |

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## 9 - STORAGE AND HANDLING PRECAUTIONS

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SAF-T-DATA(TM) STORAGE COLOR CODE: ORANGE (GENERAL STORAGE)

SPECIAL PRECAUTIONS
KEEP CONTAINER TIGHTLY CLOSED. SUITABLE FOR ANY GENERAL CHEMICAL STORAGE AREA.

A PRECIPITATE MAY FORM ON PROLONGED STORAGE. HEAT TO 40-50 C WITH AGITATION TO RENDER A HOMOGENEOUS SOLUTION.

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## 10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

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DOMESTIC (D.O.T.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME CHEMICALS, N.O.S. (NON-REGULATED)

# APPENDIX C

# SPECTRASCAN'S EPIFLUORESCENT PARTICLE COUNTING PROTOCOLS

**SpectraScan**
**Environmental and Optical Consulting**

# HUDSON RIVER PCB DNAPL TRANSPORT STUDY

## FLUORESCENT PARTICLE COUNTING PROTOCOL

A quantitative assessment of fluorescent particles in sediment samples is performed as follows:

### Particle Mounting

1) A known amount of dry sediment (M) is added to 100 ml of particle free water ($V_t$),

2) the suspension is thoroughly mixed with a vortex mixer,

3) a subsample ($V_f$) of the sediment suspension is placed on a 4.8 cm Millipore filtration funnel which is then filled with particle free water containing a dilute detergent solution to prevent particle aggregation,

4) the dilute sediment suspension is then filtered through a Whatman GF/C glass fiber filter,

5) the filter is then placed on a small glass plate containing a gelatin-glycerol based optical embedding medium to fix the particles to the filter, and

6) a thin glass coverslip is placed over the filter.

### Particle Counting:

1) The mounted filter is scanned at low magnification (e.g., x 2.6) using a Zeiss epiflurescence microscope equipped with UV and visible excitation lamps[1],

2) fluorescent particles are manually counted on a calibrated grid of known area at 20-30 different locations on the filter to estimate an average number of particles per grid area,

[1]Optimal excitation for the particles is 490 nm, the emission at that excitation wavelength is 575 nm (yellowish color) which can be differentiated from natural sediment minerals and organic particulates. No significant background from natural sediments was observed in test Hudson sediment samples.

3) the total number of particles filtered ($N_t$) is calculated as the average number of particles ($N_g$) per unit grid area ($A_g$) times the total filter area, ($A_f$):

$$N_t = \frac{N_g}{A_g} * A_f$$

4) the number of particles per mass of sediment (C) is calculated as:

$$C = \frac{N_t}{\frac{M}{V_t} * V_f}$$

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