Disposal Plume Tracking and Assessment at the Rhode Island Sound Disposal Site (RISDS)

John T. Morris

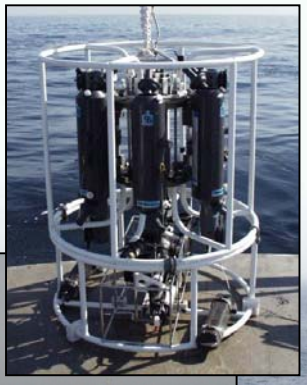
JOHN.T.MORRIS@saic.com

Scott E. McDowell, Ph.D., Thomas J. Fredette, Ph.D., Christopher R. Kincaid, Ph.D., and Natasha C. Pinckard

Key Words: Barge Disposal, Dredged Material, Disposal Site, Sediment Plume, Turbidity, Toxicity

Introduction

- Two Survey Phases – April and September 2004
- Three consecutive disposal plume monitoring events
- Monitor up to 3.5 hours after disposal
- Water samples for Total Suspended Solids (TSS) and Toxicity



Objectives

- Track extent and concentration of the sediment plume during three separate disposal events
- Assess toxicity of sediment plume to marine water column organisms

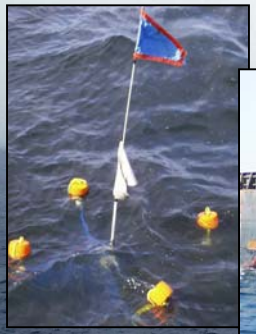
Predictions

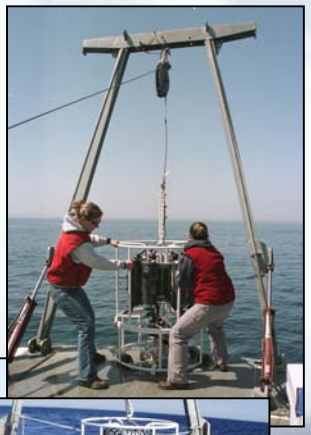
- TSS concentrations at the centroid will decrease to 10 mg/L or less within three hours of disposal
- Water samples from the plume centroid will not exhibit toxicity significantly different from background conditions one-hour after disposal

Methods

Two Elements to Plume Monitoring:

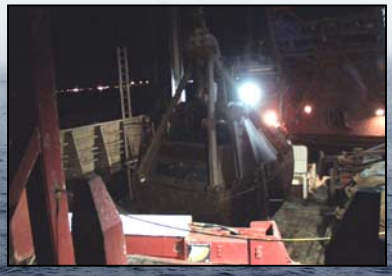
- Barge Sampling
- Plume Monitoring:
  - Water Column Currents
  - Plume Tracking
  - Water Sampling





Barge Sampling

- Completed the night prior to survey
- Grab samples obtained from bow and stern of barge on an hourly basis over loading period (4-6 hours)
- Composited and sub-sampled for:
  Geotech-TOC, H_2O content & Grain Size
  Chemical-Trace Metals & PAHs
- Rinsate collected for Quality Control



Two vessel sampling operation

Vessel One (R/V *Eastern Surveyor*):

- responsible for deploying and tracking the current drogues
- conducted periodic water sampling and vertical CTD/transmissometer/OBS profiling operations

Vessel Two (M/V *Beavertail*):

- responsible for conducting the cross-plume and along-plume vessel-mounted ADCP transects
- deployed and retrieved a bottom-mounted ADCP mooring and OBS sensor string

Water Column Currents

Moored ADCP (upward-looking)

- 300 and 1200 kHz – near disposal location
- High-resolution data of water-column currents

Current Drogues

- Two types of current drogues deployed:
  - Davis Drifter (surface)
  - Holey Sock Current Drogues- (mid-depth and near-bottom)
- Deployed during disposal operations
- Location tracked throughout plume event

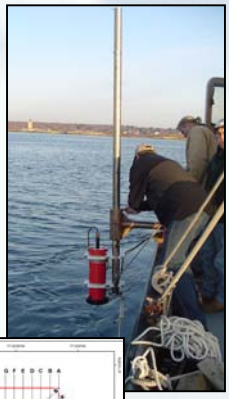
Plume Tracking

Moored OBS

- In-situ turbidity at a fixed location
- Sensors at 13, 18, and 32 m

Real-time ADCP

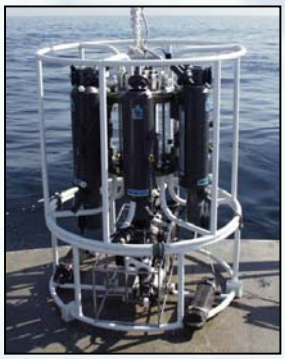
- 600 and 1200 kHz independent vessel-mounted downward looking
- Current (speed & direction) and echo intensity (relative backscatter)
- Occupied 100 m spaced lanes to collect cross-sectional data from plume

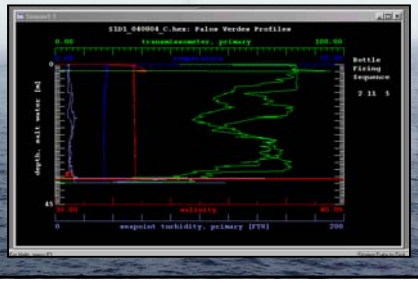


Plume Tracking

Real-time CTD/transmissometer

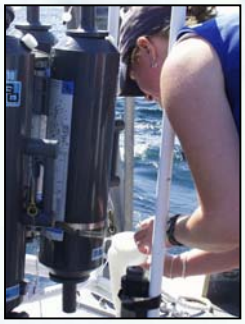
- SBE-32® Carousel Water Sampler controlled by SBE-33 Deck Unit with
  - Niskin Bottles – sample TSS
  - GO-Flow Bottles – sample toxicity
- Used to measure suspended sediment load (turbidity) in the water column
- Seabird Electronics SBE-19® CTD with:
  - Wet-Labs C-Star, 25 cm path length transmissometer
  - Seapoint OBS sensor
- Viewed data real-time
- Profile location guided by current drogues and real-time ADCP





Water Sampling

- Background profiles and water samples collected prior to disposal for TSS and toxicity
- Minimum of 27 water samples collected for TSS at time intervals post disposal
  10, 20, 40, 60,
  90, 120, 150, 210 (minutes)
- Toxicity samples collected at the 40, 60, and 120 minute time intervals for two of the three sample events



Results

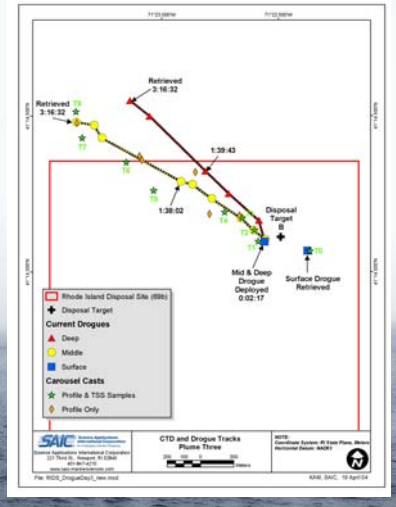
Phase I (April 2004)
- **April 10 (Plume 3)**

Phase II (September 2004)
- **September 2 (Plume 2)**

Water Column Currents – April 10 (Plume 3)

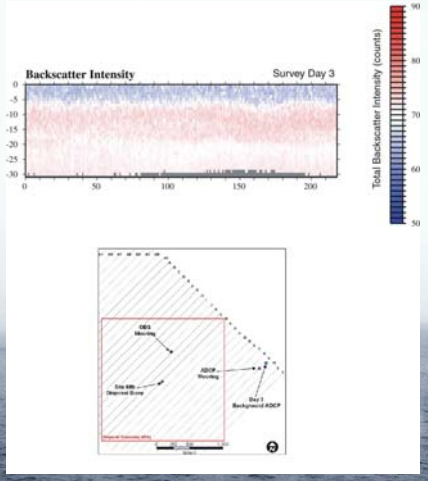
Currents

- Both mid (18 m) and deep-water (32 m) drogues indicated water column current flow in a northwesterly direction
- Currents measured by ADCP in the depth horizon between 16 and 22 m were the strongest and most significant factor affecting plume morphology.
- Deep-water drogue had taken a more northerly track, suggesting that small-scale shear existed in the lower portion of the water column
- Drifter traveled southeast likely due to the minimal southerly current flow and the effects of short period surface waves generated by sustained westerly winds on April 10

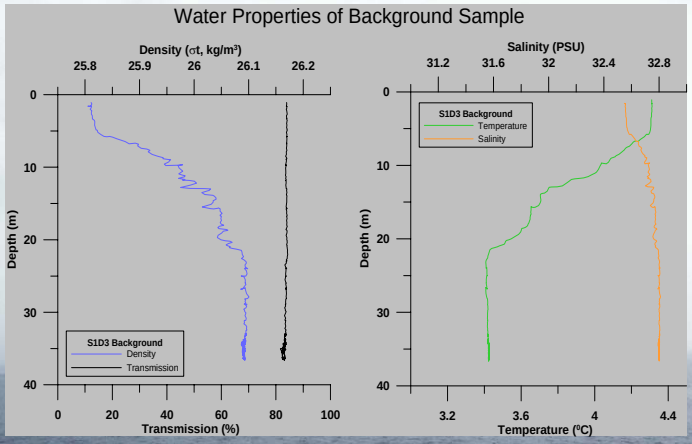


ADCP Background Data

- Raw backscatter intensity data displayed a minor increase in acoustic backscatter intensity at mid depth.
- One dB = two counts
- The highest backscatter values reached 75 counts at a depth horizon of 12 to 15 m

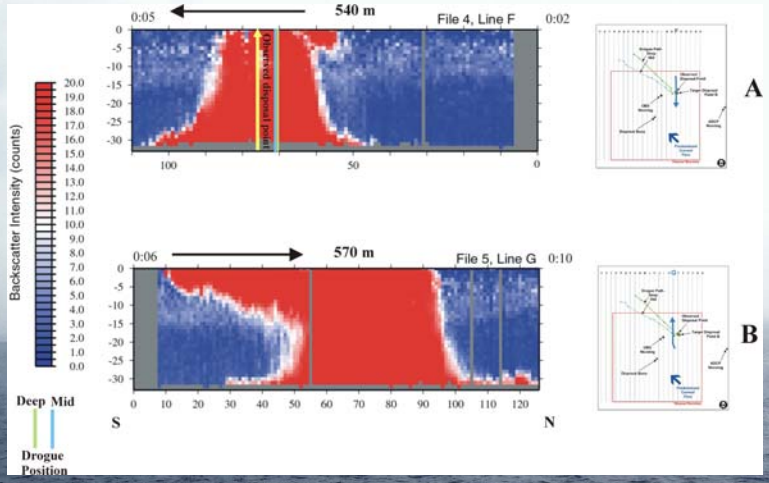


CTD/Transmissometer Background Profiles

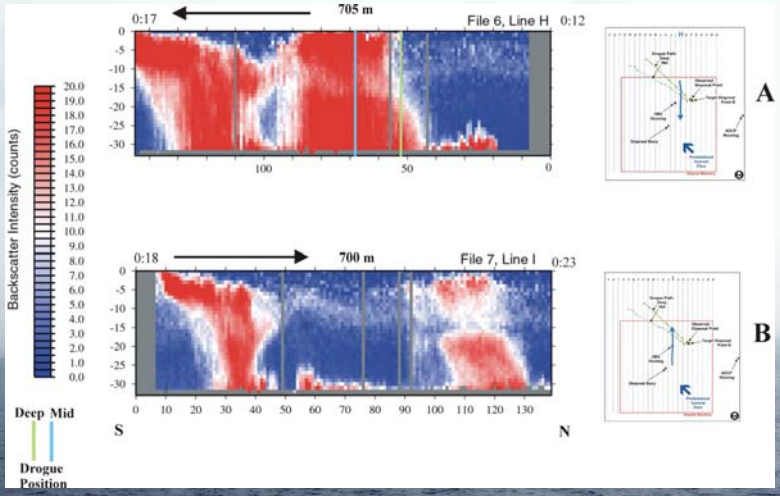


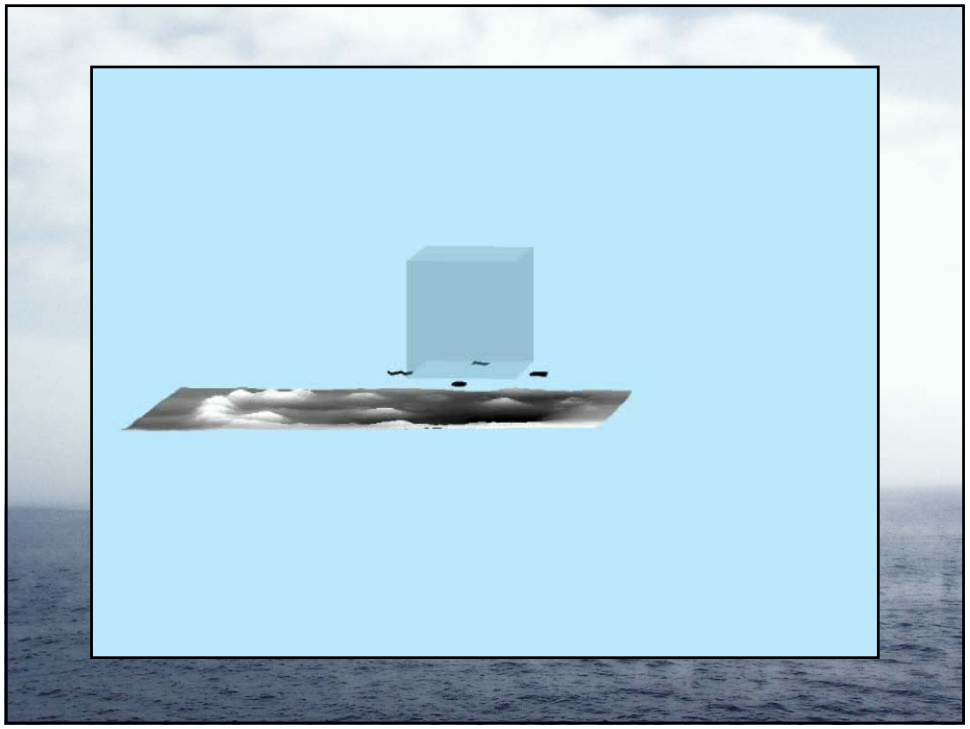
- Salinity and percent transmittance showed minimal change with depth, but both density and temperature exhibited evidence of water column stratification

ADCP Data

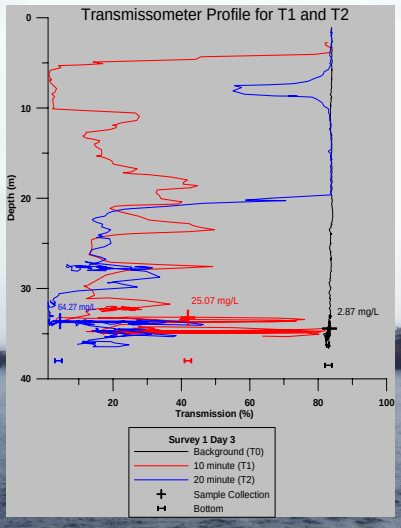


ADCP Data

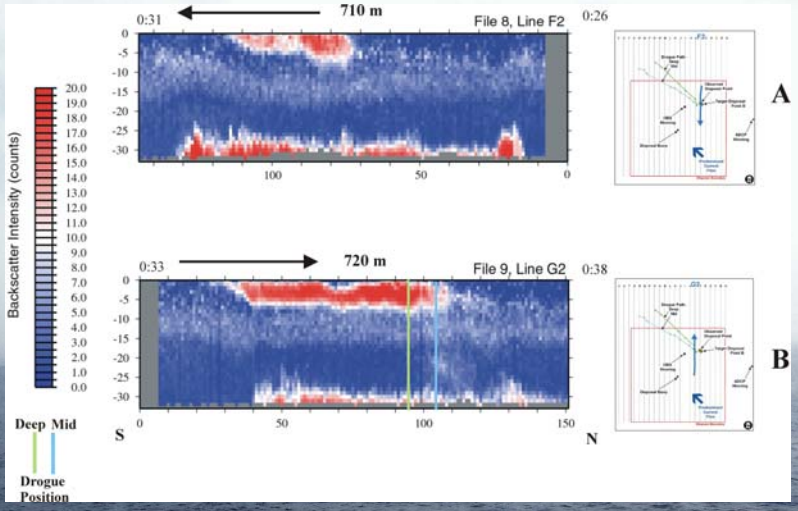




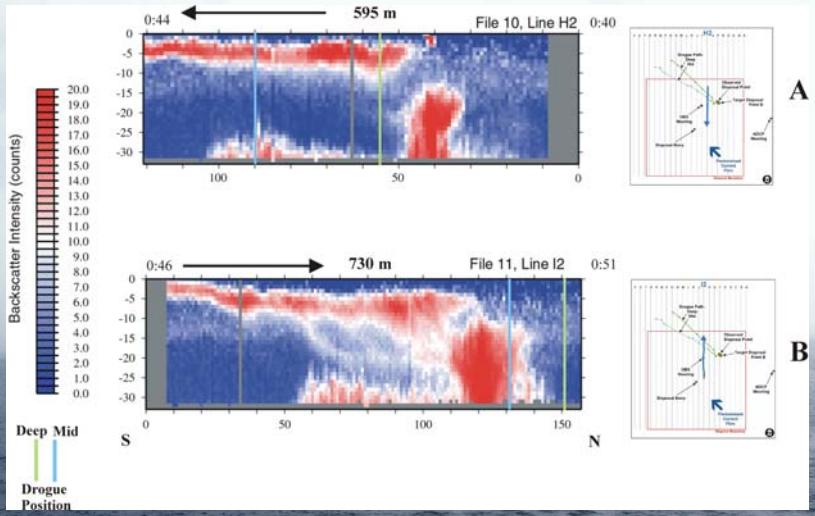
CTD/Transmissometer Profiles

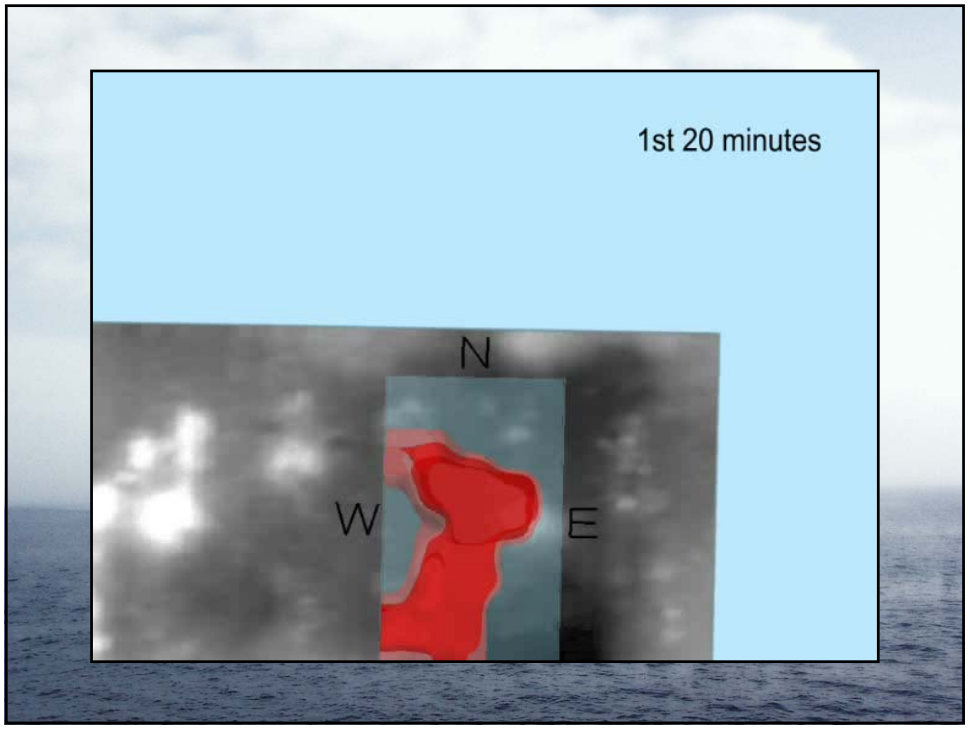


ADCP Data

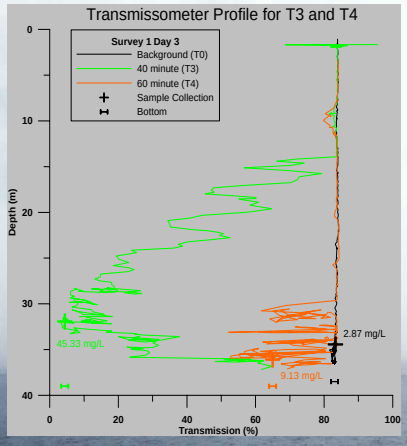


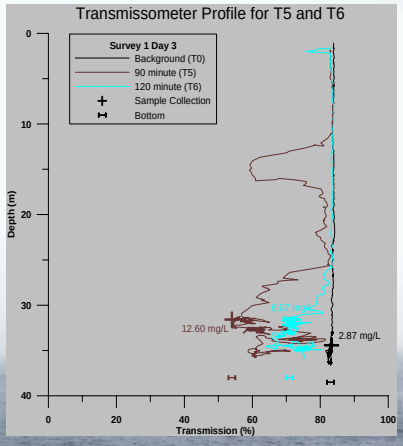
ADCP Data



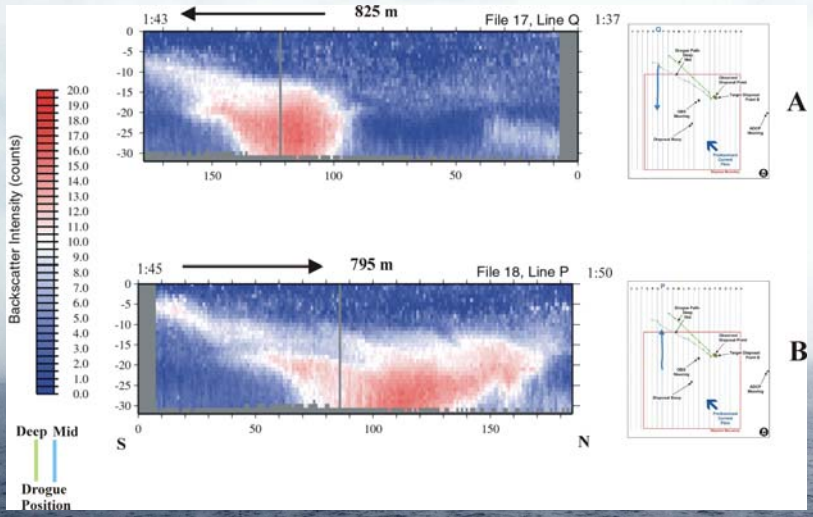


CTD/Transmissometer Profiles

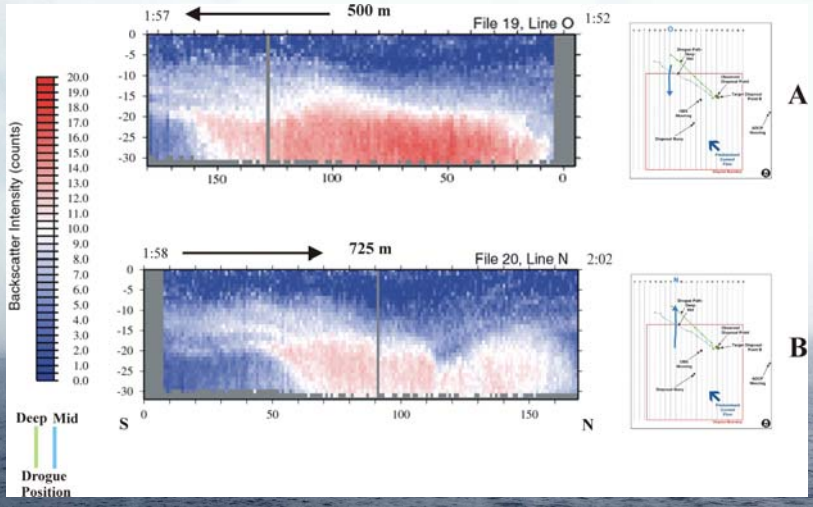




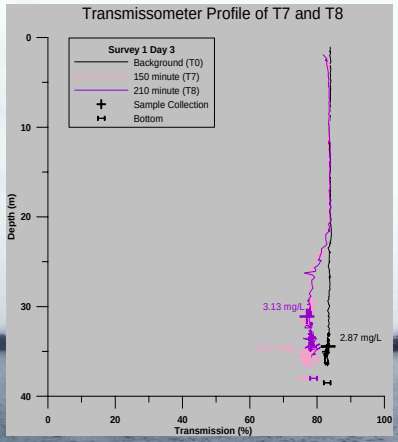
ADCP Data



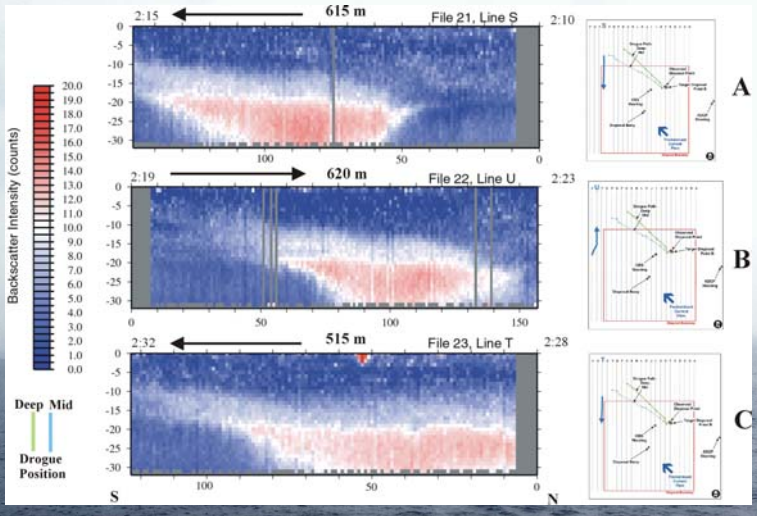
ADCP Data



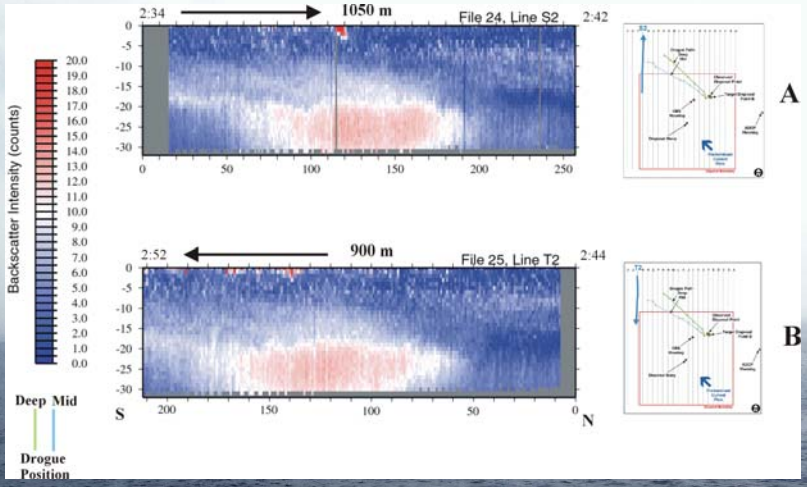
CTD/Transmissometer Profile



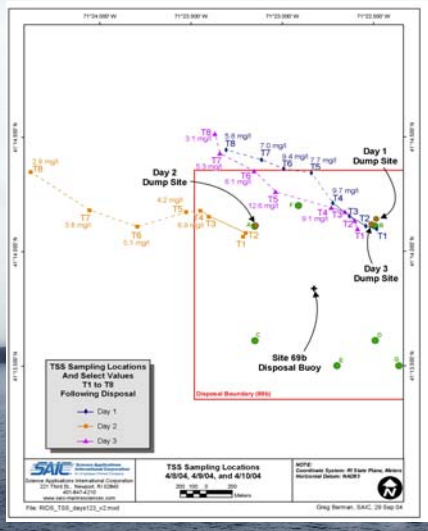
ADCP Data



ADCP Data



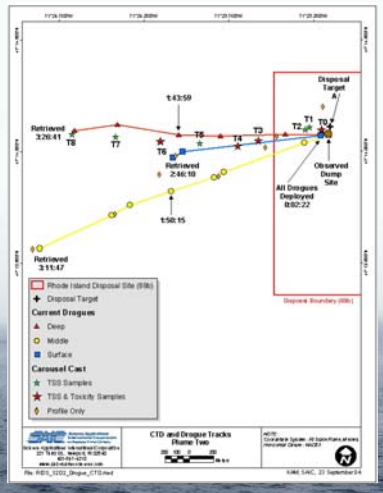
Plume Centroids



Water Column Currents – September 2 (Plume 2)

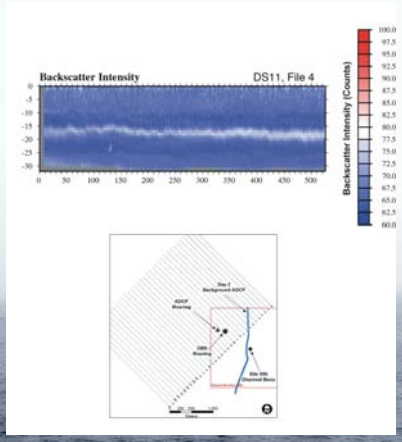
Currents

- The surface drifter displayed a slower speed relative to the mid and deep-water drogues, drifting west-southwest
- Both drogues tracked along a general westerly heading.
- Ten minutes into survey operations the mid (15 m) and deep-water (32 m) drogues began to track away from each other.
- Currents recorded by the ADCP indicated multi-layer flow within the water column, with the mean currents moving in a westerly direction.
- Water column currents were the strongest and most consistent within the depth interval between 10 and 15 m.

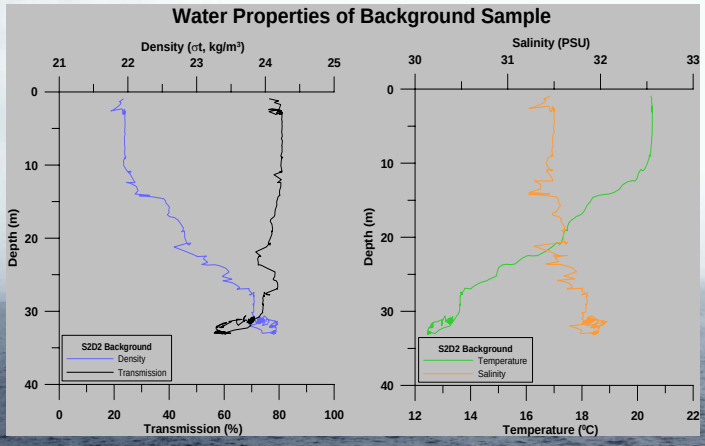


ADCP Background Data

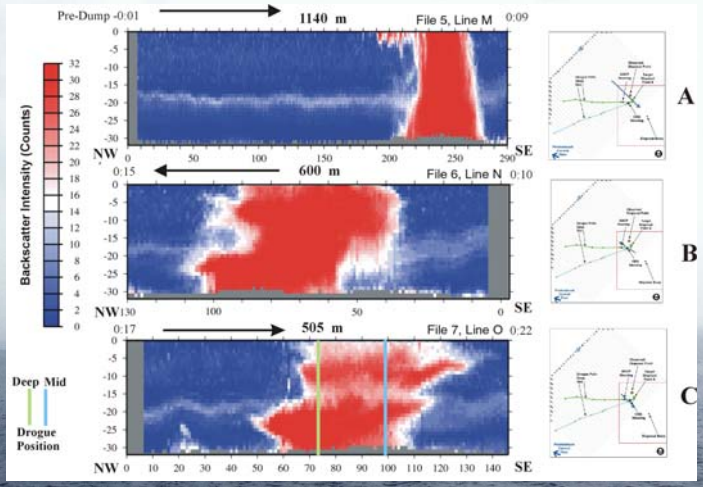
- Background data showed higher backscatter values (75 to 80 counts) at mid-depth (15 to 20 m water depth).
- One dB = two counts
- Due to the predominance of flow to the west-southwest, a northwest-southeast survey transect orientation was chosen prior to survey operations.



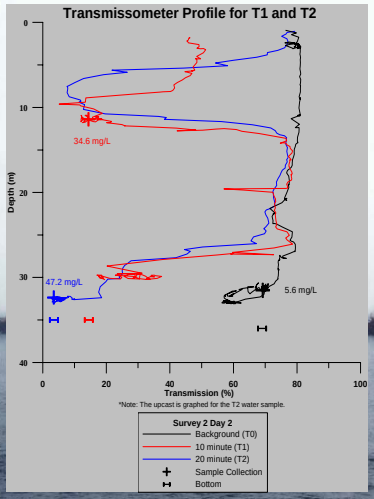
CTD/Transmissometer Background Profiles



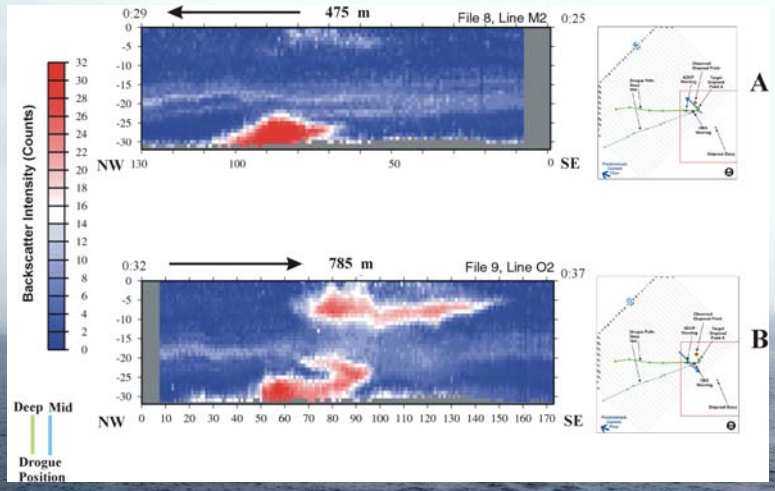
ADCP Data

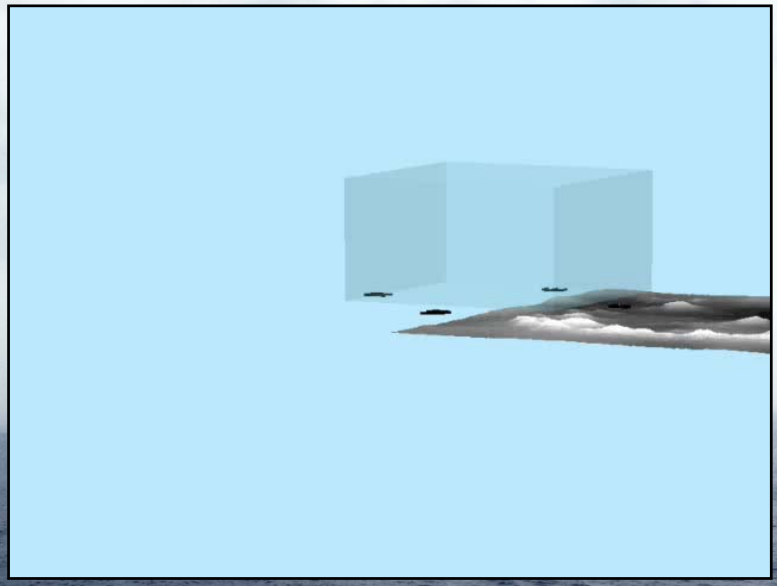


CTD/Transmissometer Profile

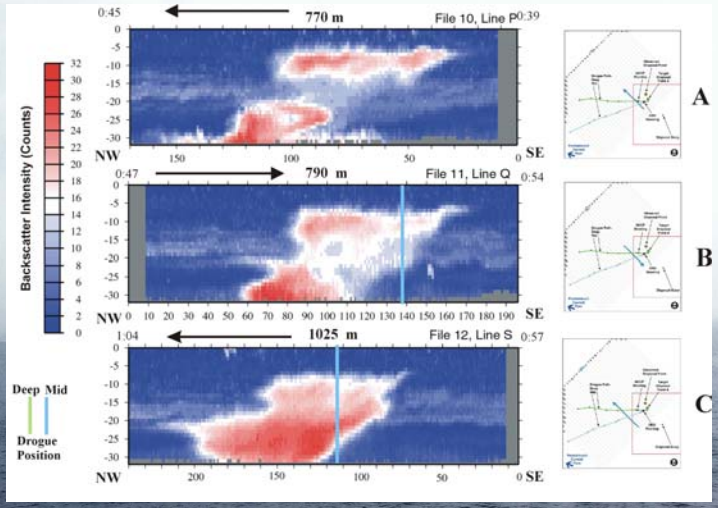


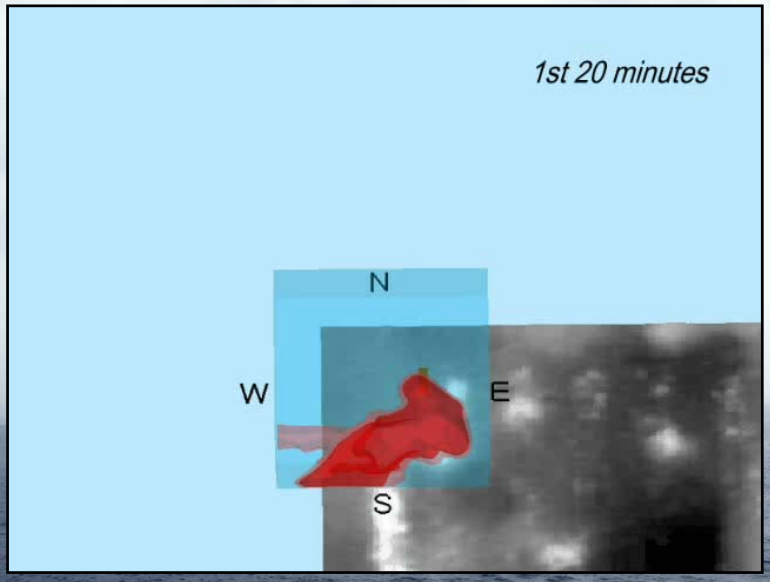
ADCP Data


0:29
475 m
File 8, Line M2
0:25
NW
130
100
50
0
SE
A
0:32
785 m
File 9, Line O2
0:37
NW
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
SE
B
Backscatter Intensity (Counts)
Deep
Mid
Drogue Position

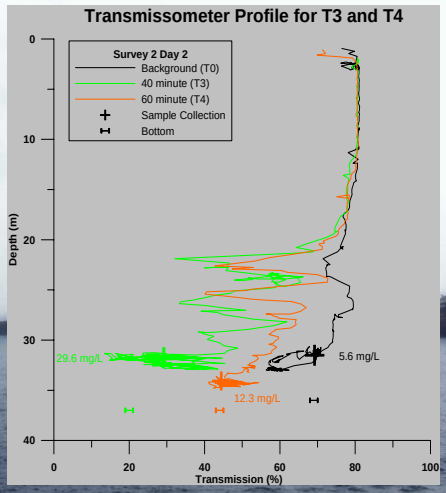


ADCP Data

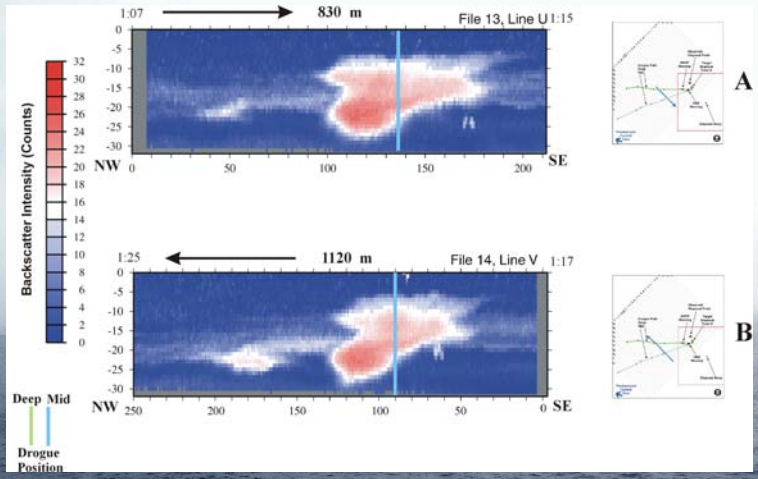

770 m
File 10, Line P
790 m
File 11, Line Q
1025 m
File 12, Line S
Backscatter Intensity (Counts)
Deep Mid
Drogue Position
NW
SE
A
B
C


1st 20 minutes
N
W
E
S

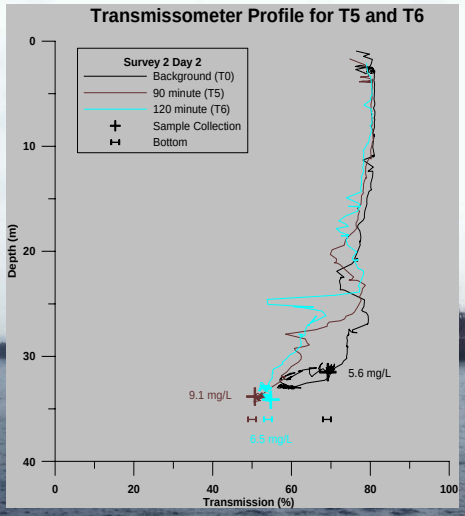
CTD/Transmissometer Profile



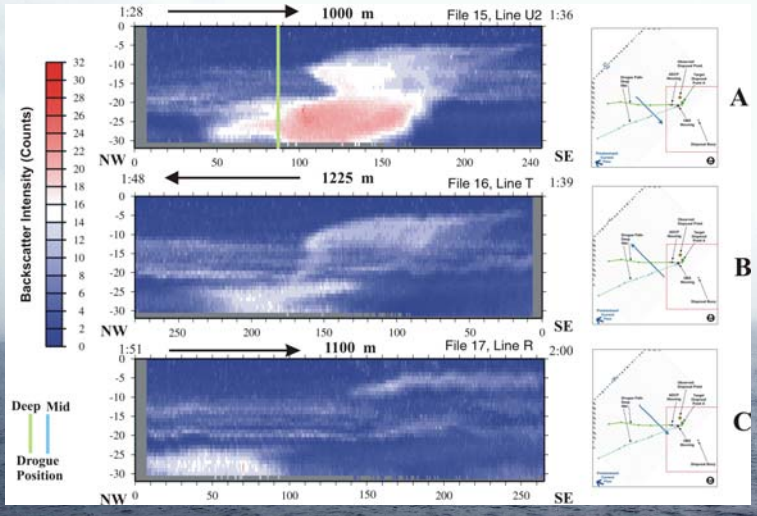
ADCP Data



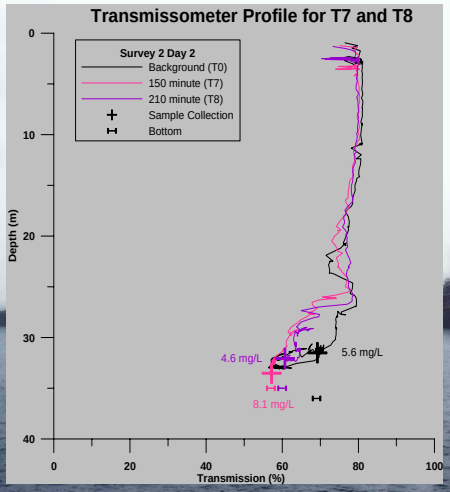
CTD/Transmissometer Profile



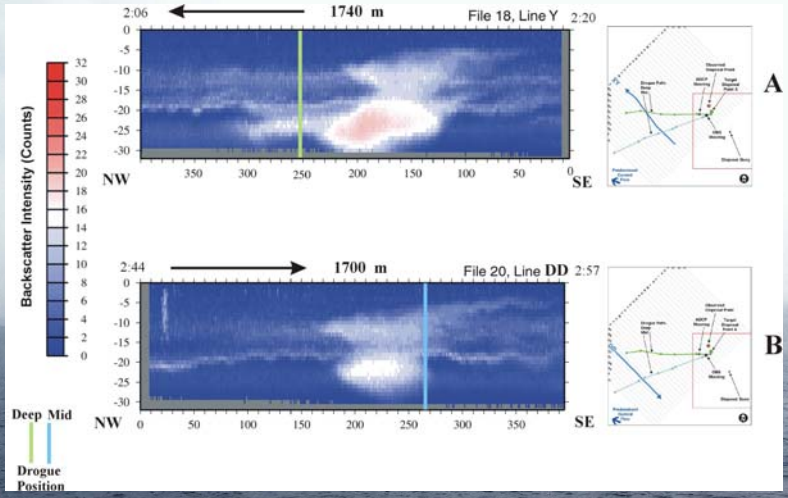
ADCP Data



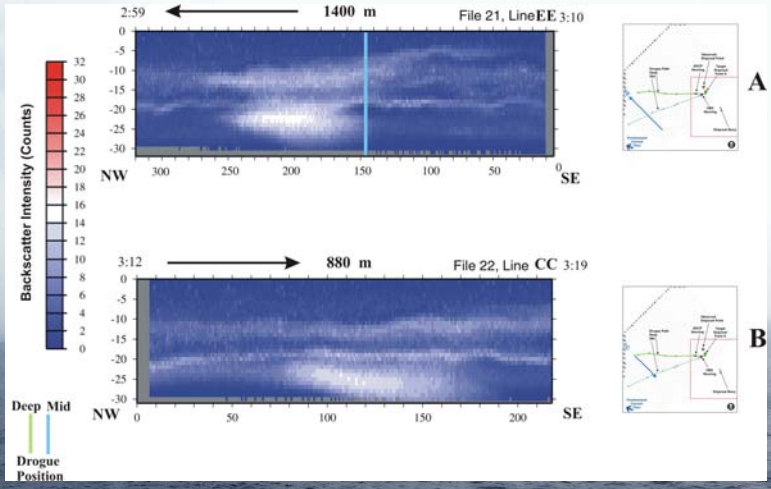
CTD/Transmissometer Profile



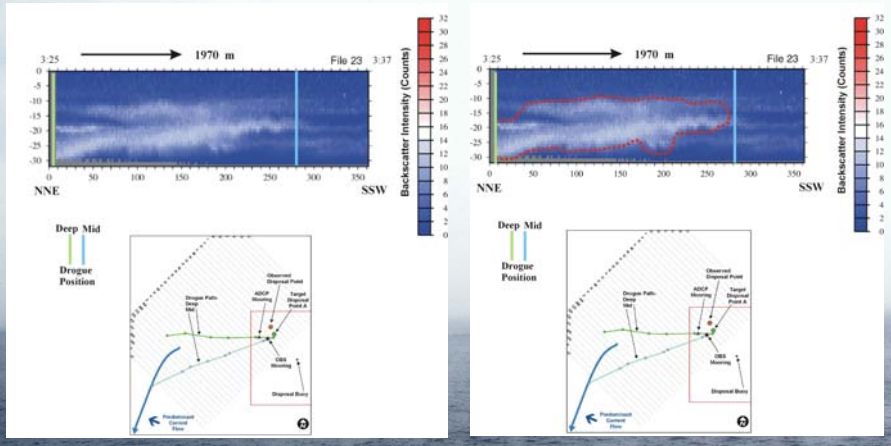
ADCP Data



ADCP Data



ADCP Data



Total Suspended Solids (TSS)

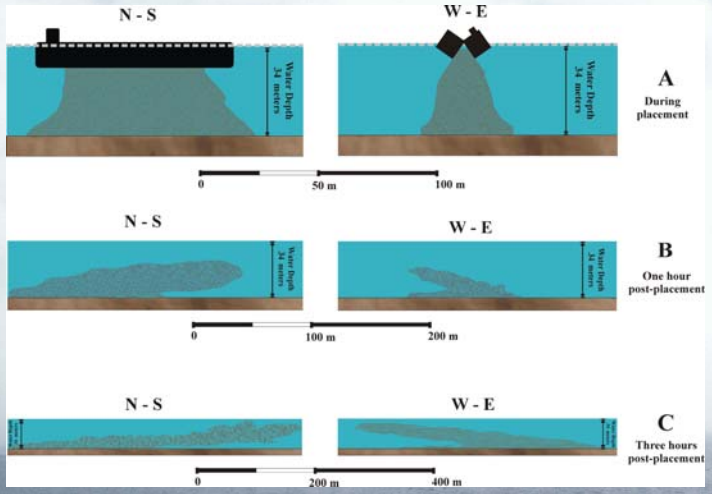
April and September Monitoring Events:

- TSS measurements performed on water samples obtained near the most concentrated portion of the plume (centroid), indicated turbidity values in excess of 20 mg/L were common in the early stages of the monitoring operation, returning to near background levels of 2 to 3 mg/L within 3.5 to 4 hours of an individual disposal event.
- Portions of the plume existed in the upper, mid, and lower water column. However, the most turbid element of each sediment plume was situated in close proximity to the RISDS seafloor.
- The highest turbidity values were consistently detected within lower 3 m of the water column

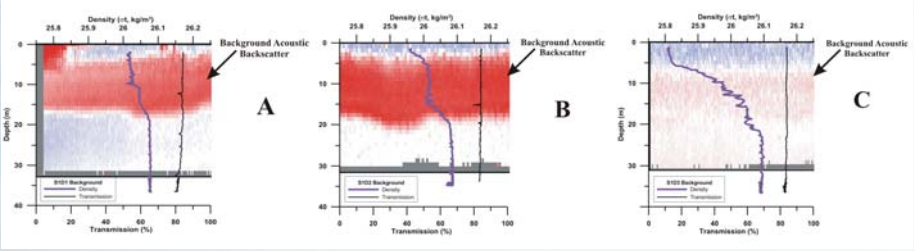
Toxicity

April and September Monitoring Events:

- Mysids and silversides exhibited no lethal responses to any of the water samples collected.
- Mean responses for all samples, from background to 120 minutes were greater than 90% survival.
- Lack of toxicity near the centroid of the sediment plumes sampled as part of monitoring effort falls within the expectations of the study.
- Metals concentrations in the barge were consistent with pre-dredge sediment characterization data, while PAH concentrations… (1992/94 versus 2004 detection limits)



Schematic representation of the morphology of a typical sediment plume formed over RIDS



Relationship between small-scale variability in water column density and background acoustic backscatter intensity