



Health



Environment



Technology



Sustainability

Key Technical Approaches to the Portland Harbor Remedial Investigation

WODCON XXI World Congress & Exhibition
Innovations in Dredging
Miami, Florida

Gene Revelas,
Integral Consulting Inc.,
Olympia, Washington

Laura Jones,
Integral Consulting Inc.,
Portland, Oregon

June 14, 2016



Disclaimer and Acknowledgments

Disclaimer

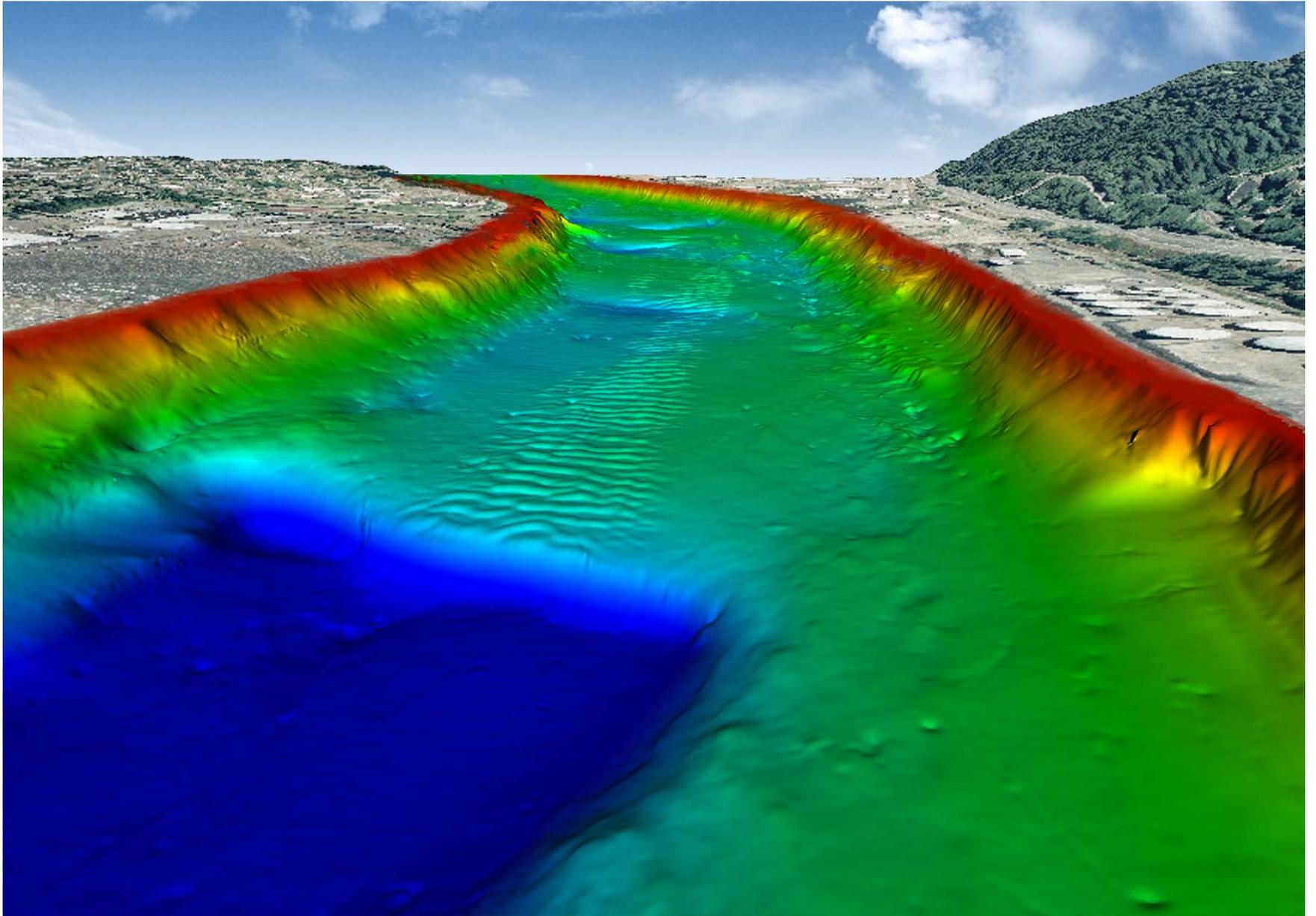
Integral Consulting Inc. (Integral) consulted with the Lower Willamette Group (LWG) on the preparation of draft versions of the remedial investigation that were submitted to the U.S. Environmental Protection Agency (EPA) in 2009 and 2011. EPA issued the final remedial investigation in 2016. Views or positions expressed by Integral in today's presentation do not necessarily reflect those of the LWG or EPA.

Lower Willamette Group

Arkema Inc., Bayer CropScience, Inc., BNSF Railway Company, Chevron USA Inc., City of Portland, EVRAZ, Gunderson LLC, Kinder Morgan Liquids Terminals, NW Natural, Phillips 66 Company, Port of Portland, Siltronic Corporation, TOC Holdings Co., Union Pacific Railroad Company

The Lower Willamette River





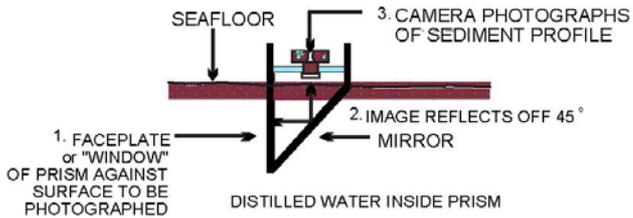
RI/FS Sampling History

- 2001 to 2004 - physical studies ([sediment profile image survey](#), bathymetry, currents)
- 2002 - biota, limited surface sediments, benthos
- 2004 - surface/subsurface sediments, [surface water](#), groundwater
- 2005 - transition zone water, [surface water](#), sediments, benthic tissue
- 2006 - [surface water](#), biota, hydrodynamic model data
- 2007 - sediments (upstream/downstream), [surface water](#), sediment traps, stormwater, biota
- 2008 - sediments (data gaps), sediment traps, stormwater

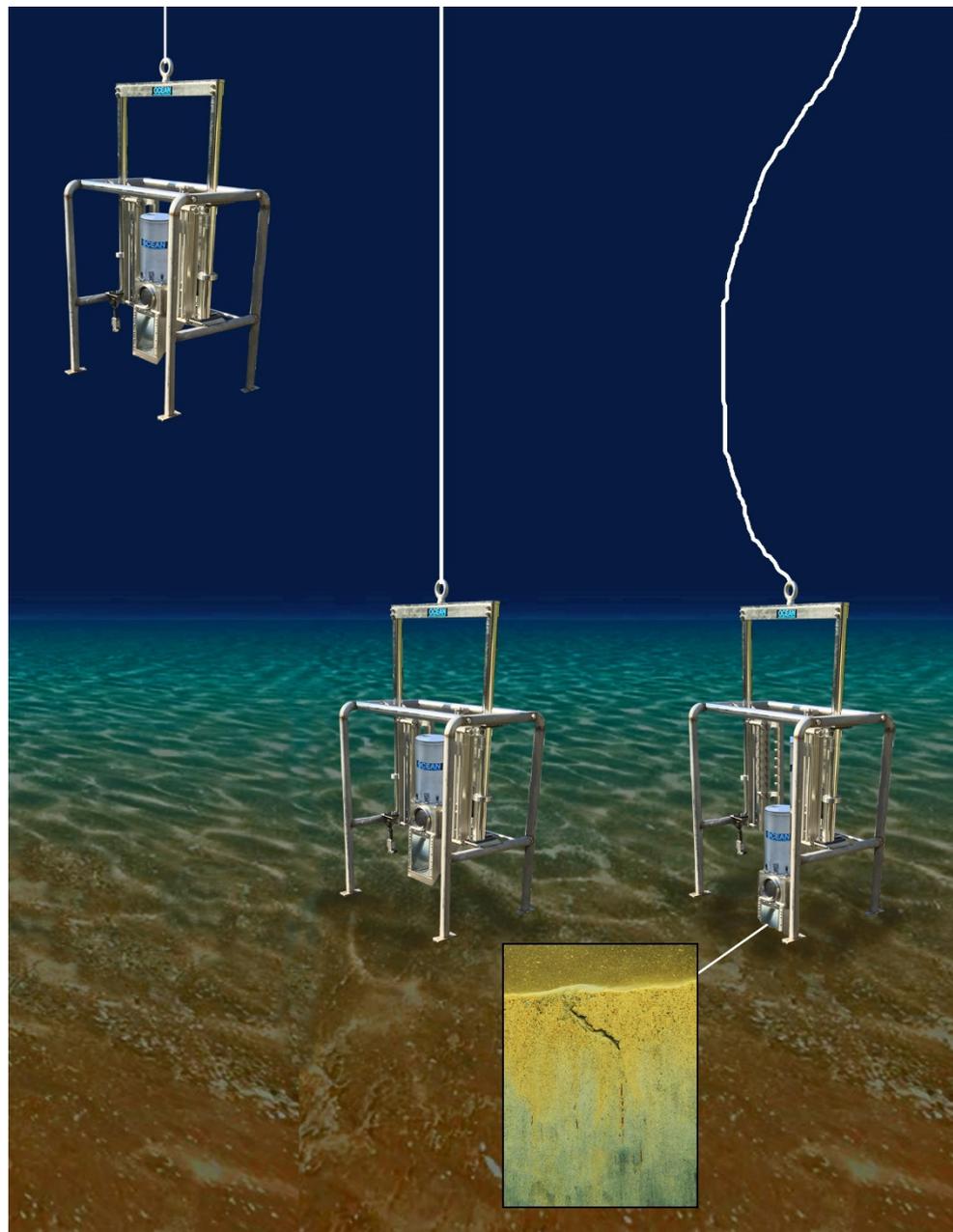
Selected technical approaches

- Sediment profile imaging (SPI) survey
 - Reconnaissance tool to characterize benthic physical, geochemical, and biological conditions
- High-volume surface water collection
 - Characterize surface water contaminant concentrations across all flow regimes

SPI Image Collection

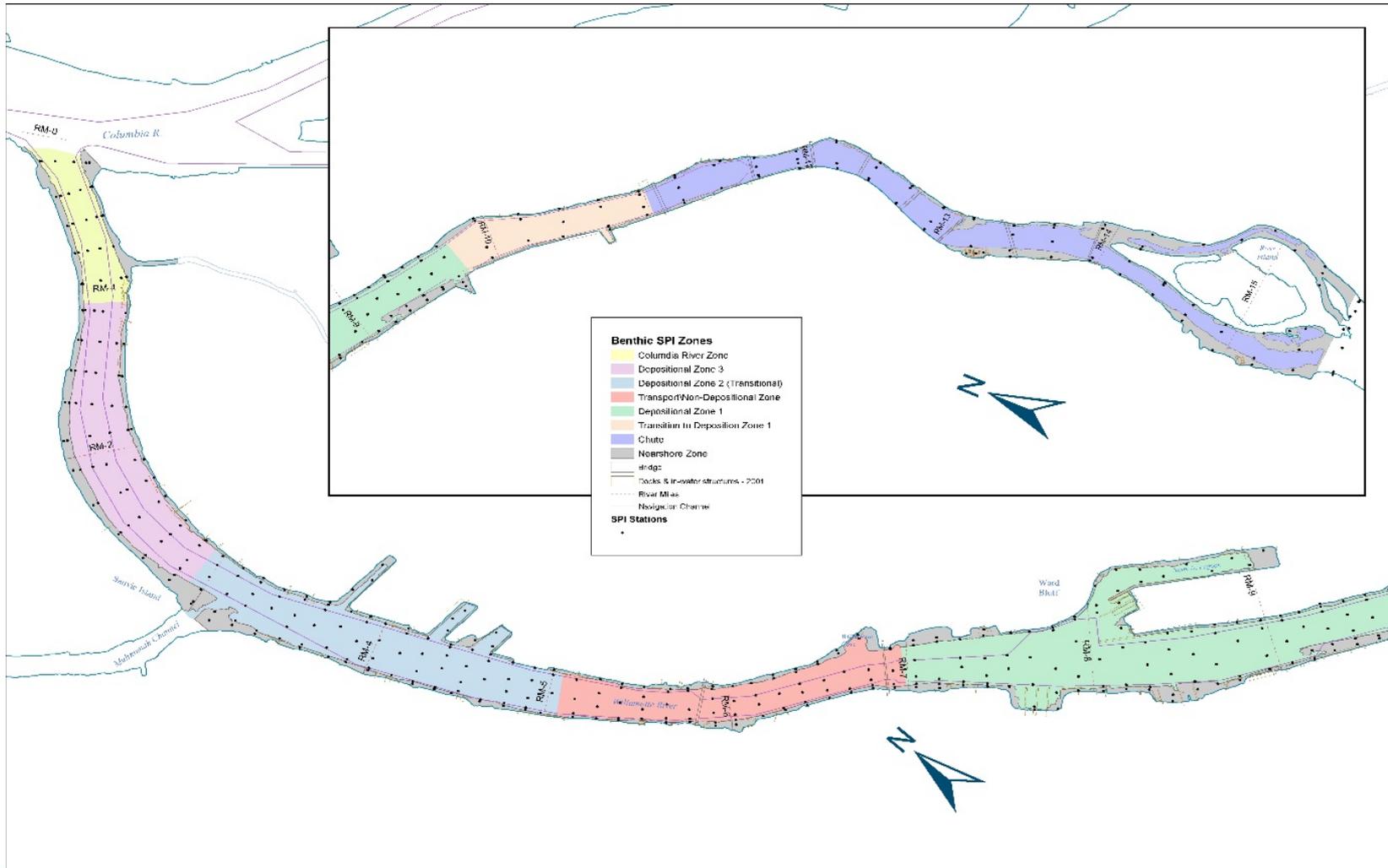


"You can observe a lot just by watching."
- Yogi Berra

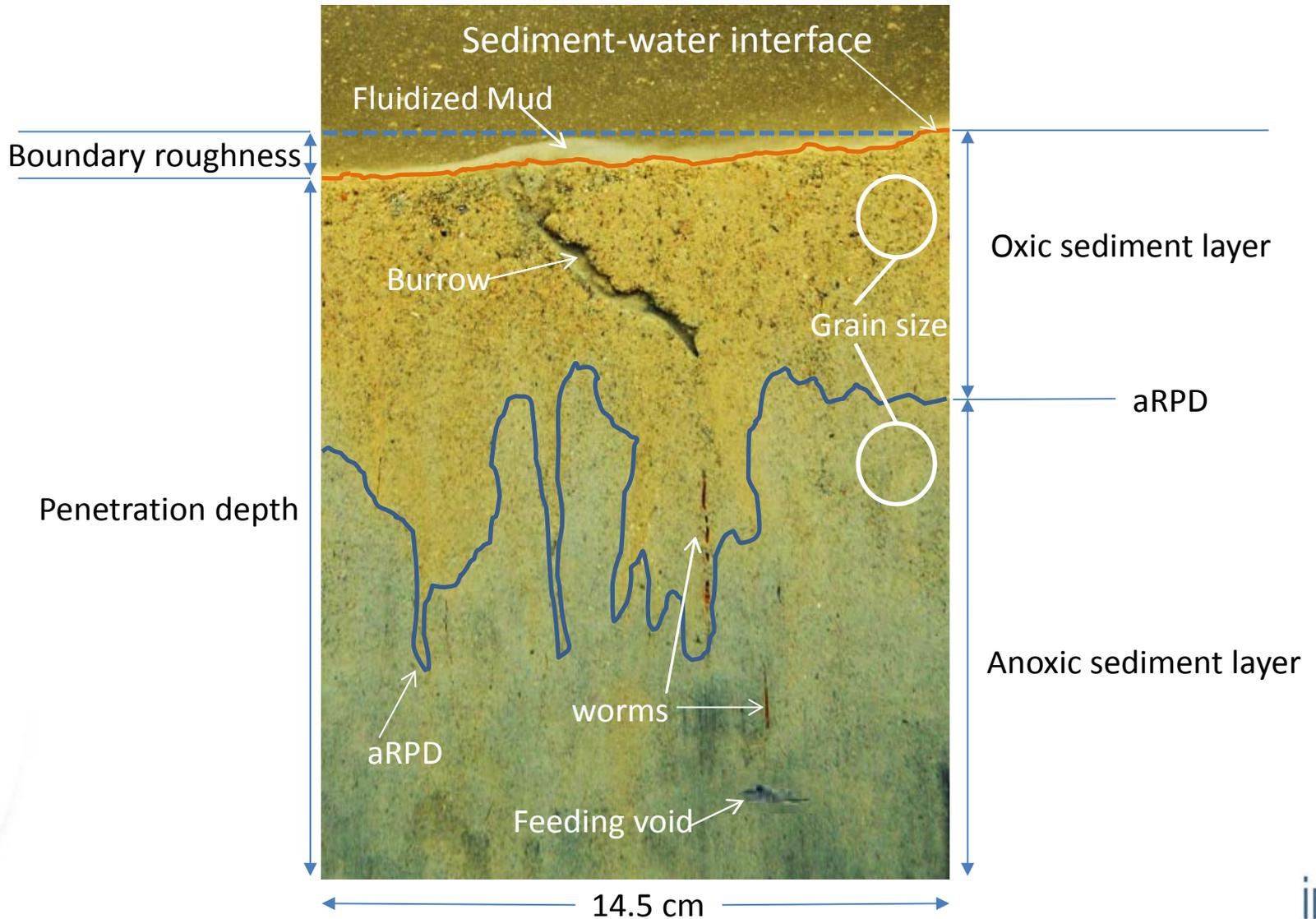


SPI Survey Approach and Objectives

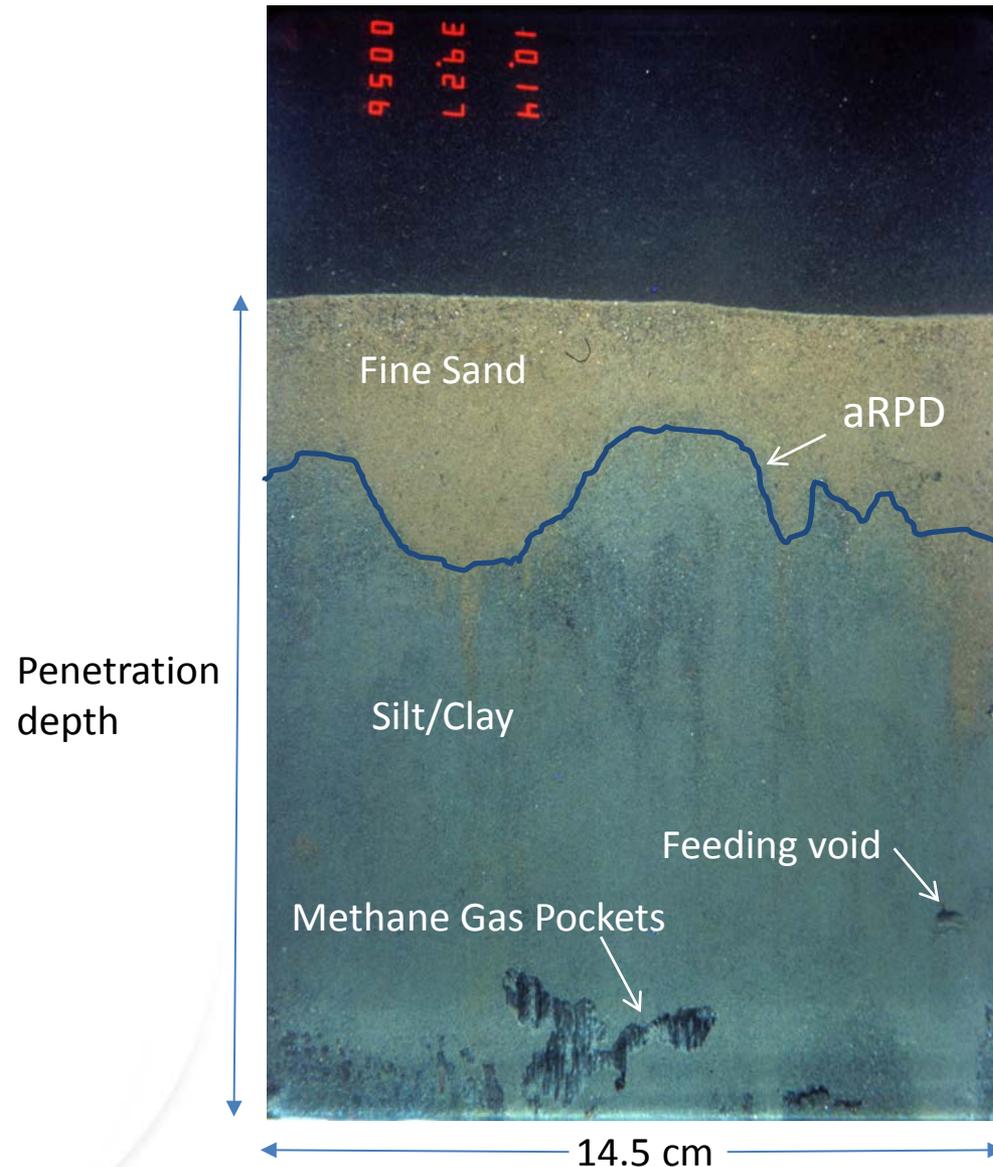
- Conduct a “benthic site walk” of 478 SPI stations in 2 weeks over 16 river miles
- Map benthic gradients in physical and biological features
- Define benthic zones (areas that share attributes) and gradients between zones



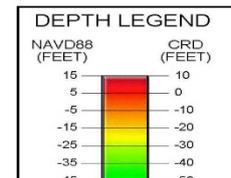
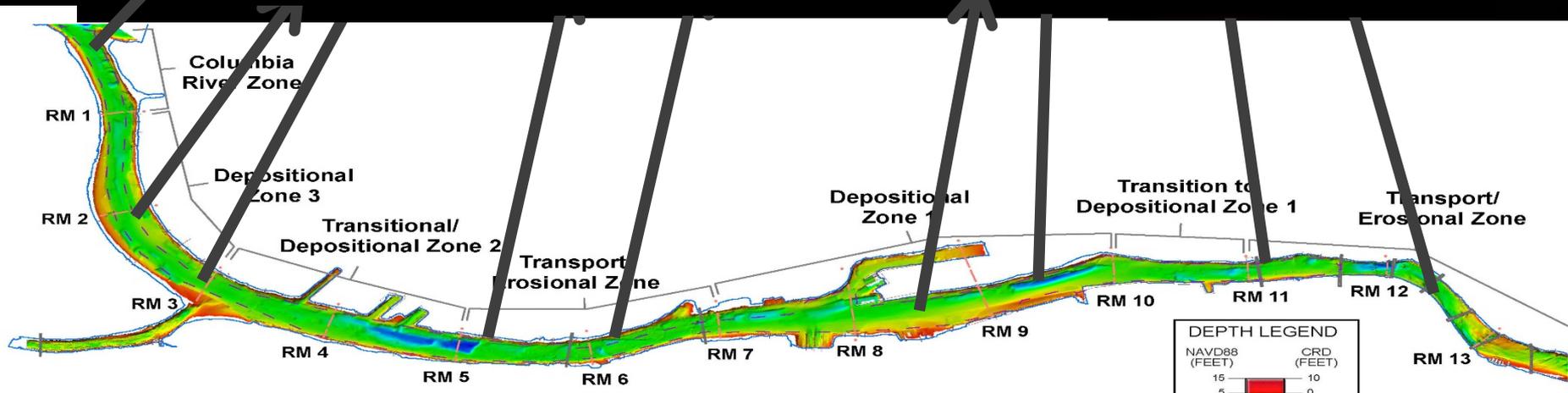
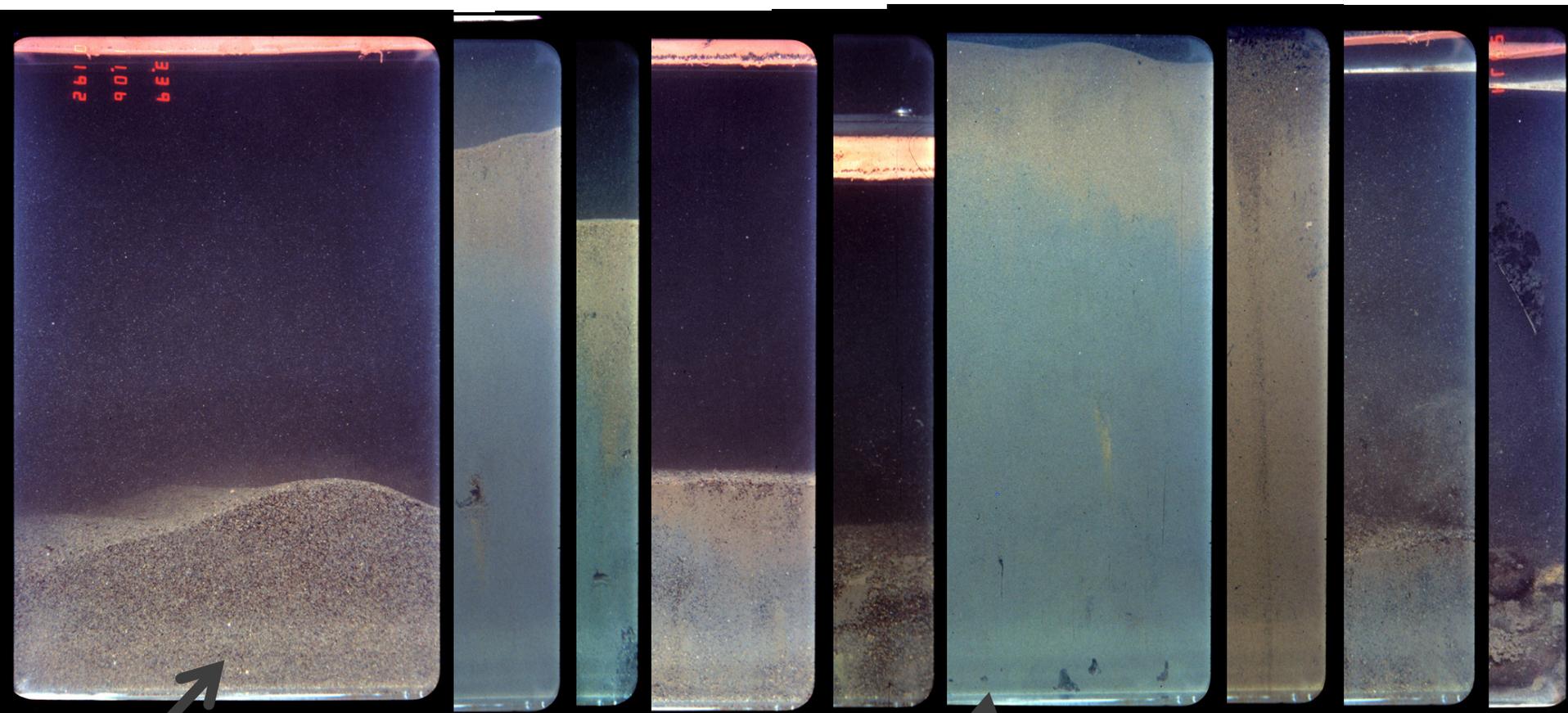
Example of SPI Features



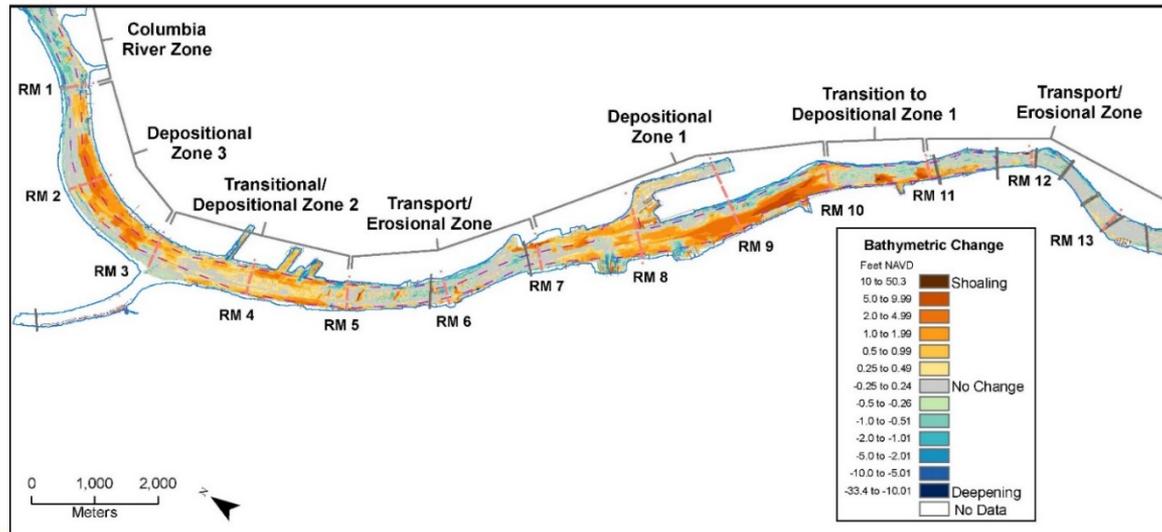
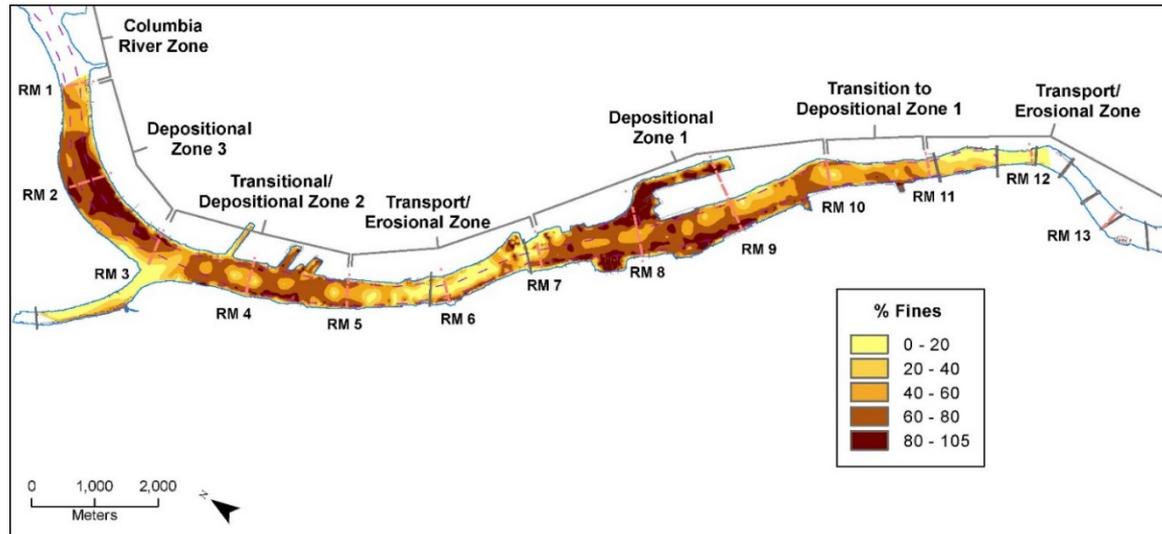
SPI Metrics Used to Define Benthic Zones in Portland Harbor



- Prism penetration depth
- Grain size
- Sediment stratigraphy, erosional and depositional features
- Apparent RPD depth
- Sedimentary methane
- Infaunal community structure (biogenic structures)
- **Infer processes from structures**



Other Lines of Evidence—Grain Size and Riverbed Elevation Change

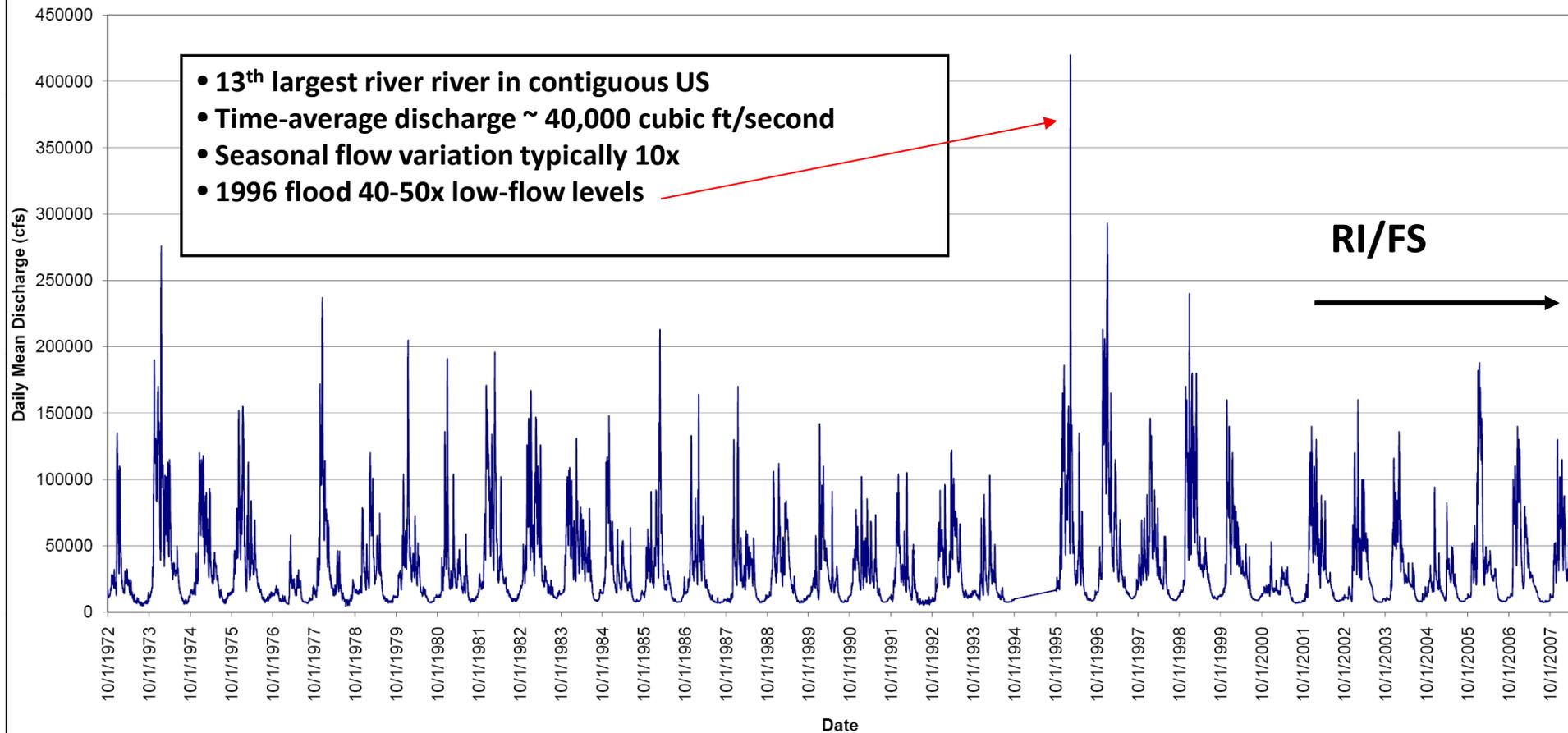


SPI Survey Contributions to RI/FS

- Key to development of conceptual site model (CSM)
- Supported surface mixed layer definition (physical and biological processes)
- Defined broad benthic zones and the gradients between them
- Informed RI sampling designs and data interpretation

High-Volume Surface Water Sampling

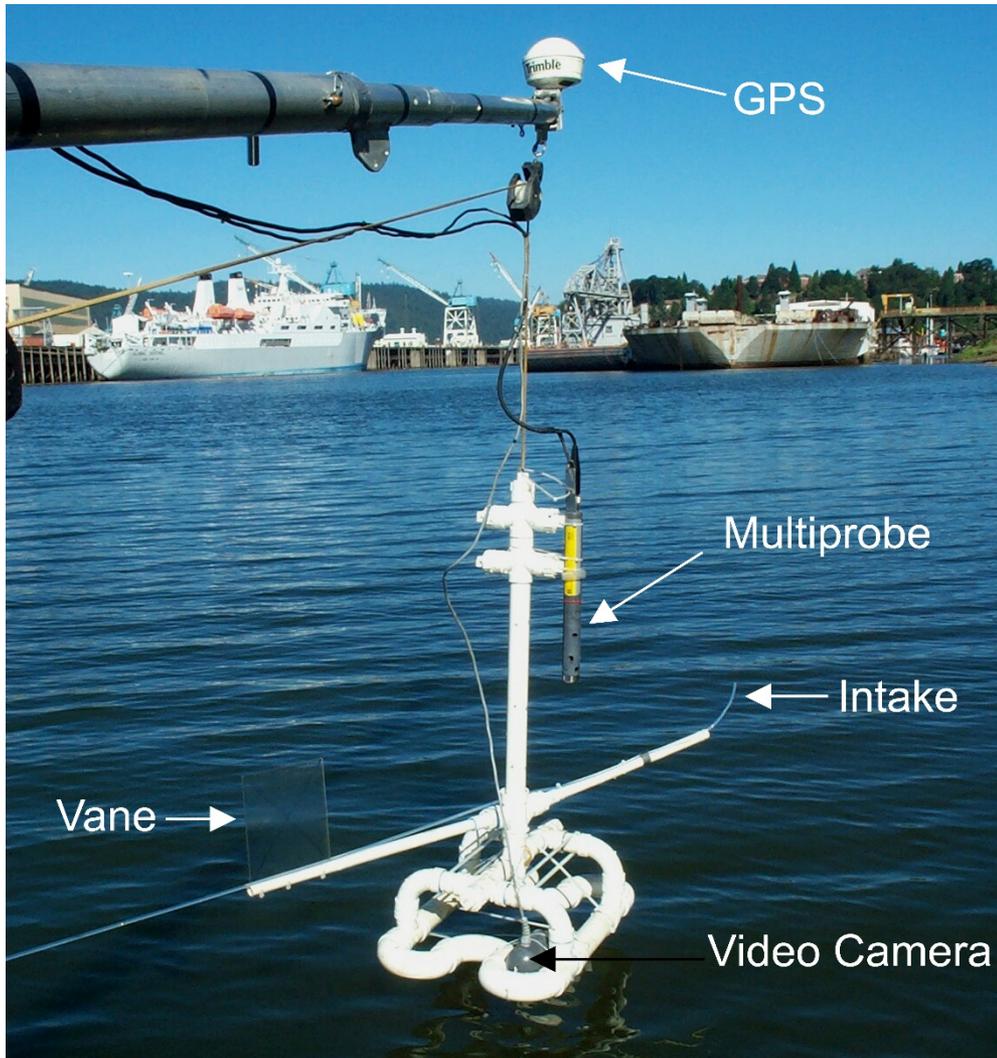
Daily Mean Discharge (cfs), October 1, 1972 - March 31, 2008



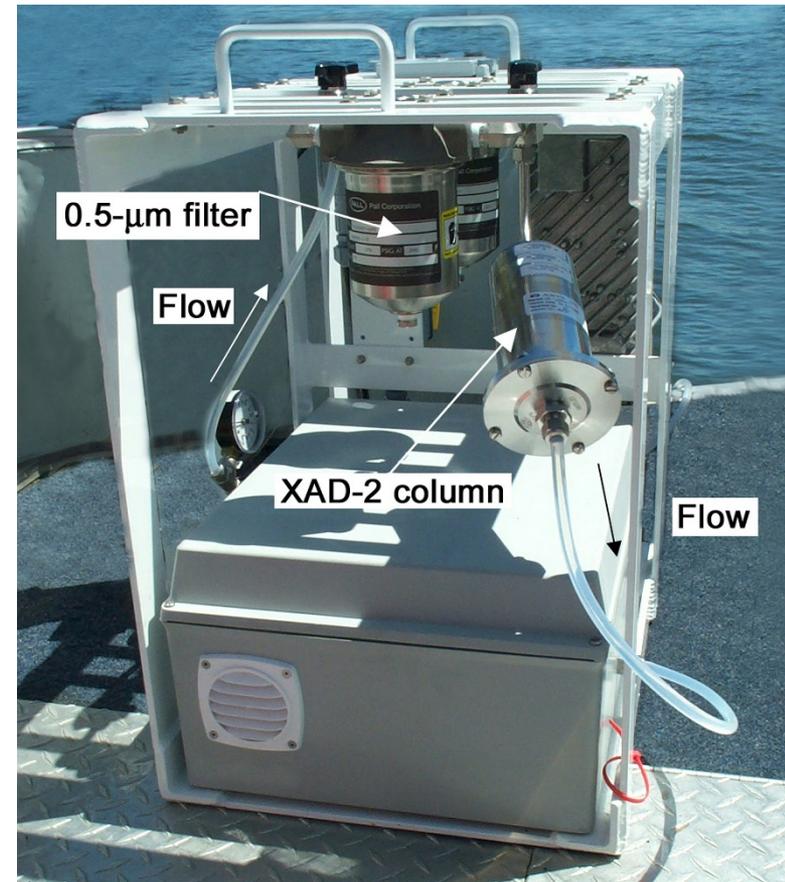
Objectives of Surface Water Investigation

- Assess water quality under various flow conditions
- Support the ecological risk assessment (ERA) and human health risk assessment (HHRA)
 - Including food-web model
- Support fate and transport evaluation
- Assist in characterization of background conditions and identification of chemical sources
- Refine the CSM

High Volume Water Sampler and Filter System



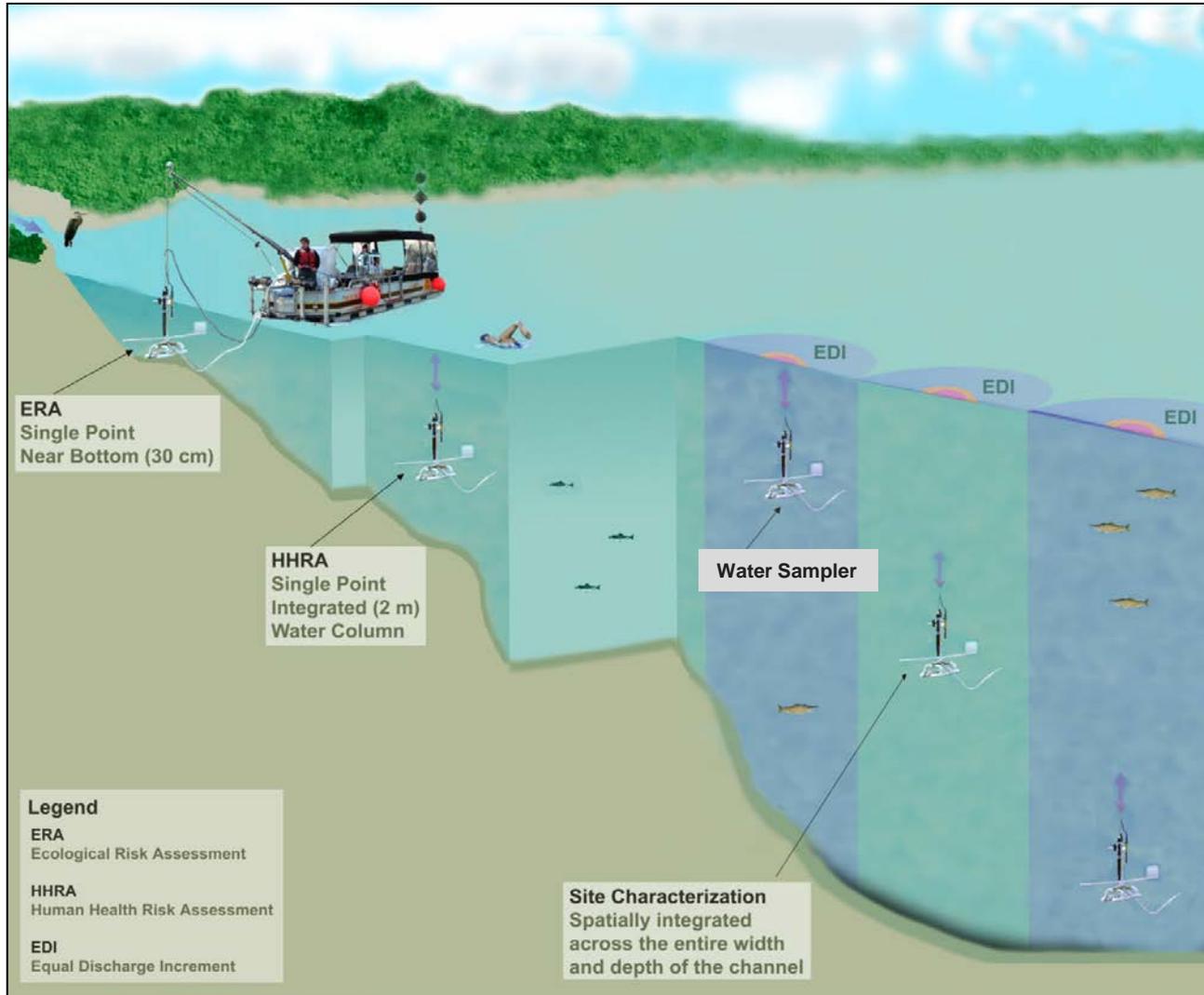
Oregon WQC for PCBs (Human Health) = $6.4 \times 10^{-6} \mu\text{g/L}$



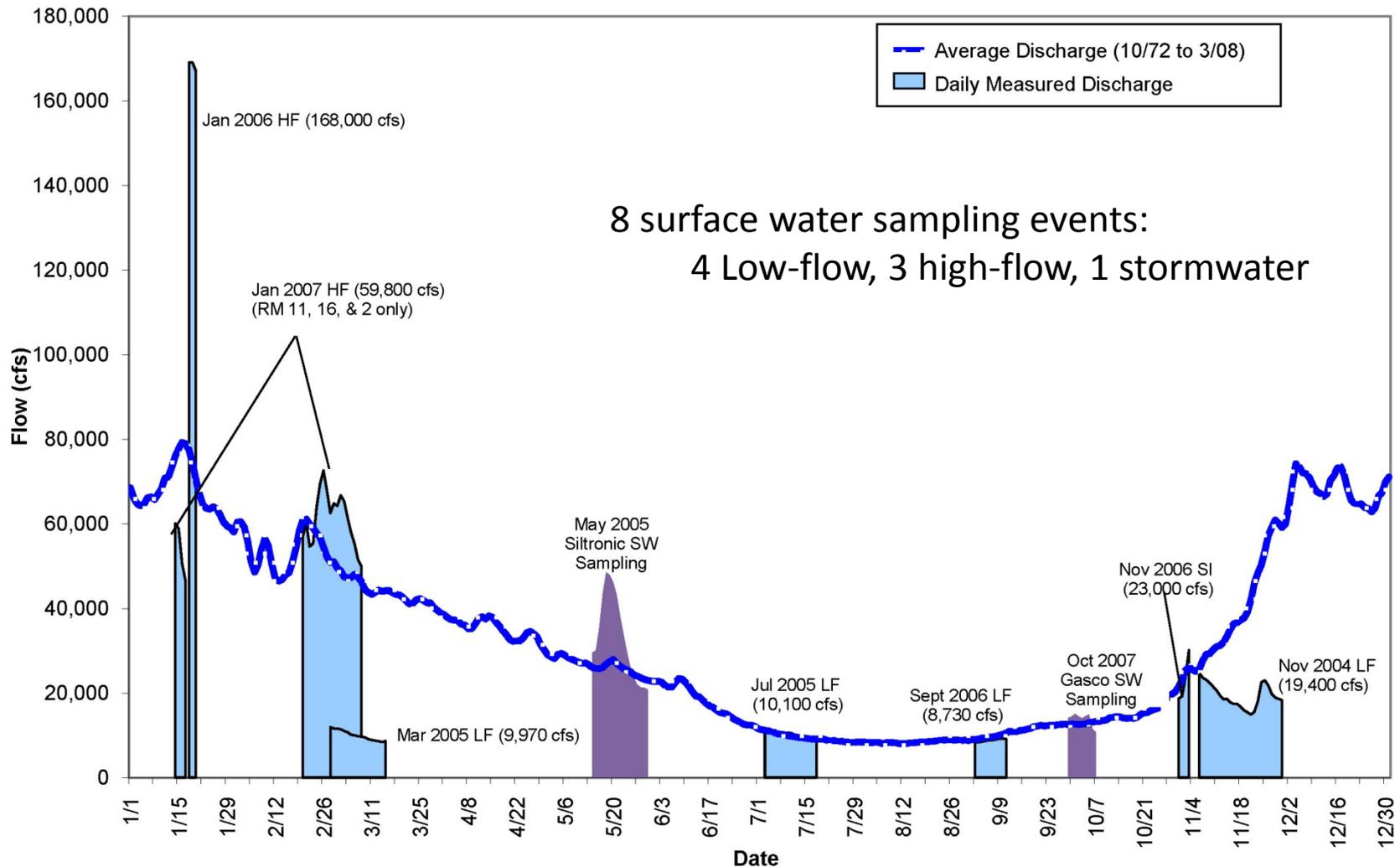
High-Volume Surface Water Sampling



Sample Types

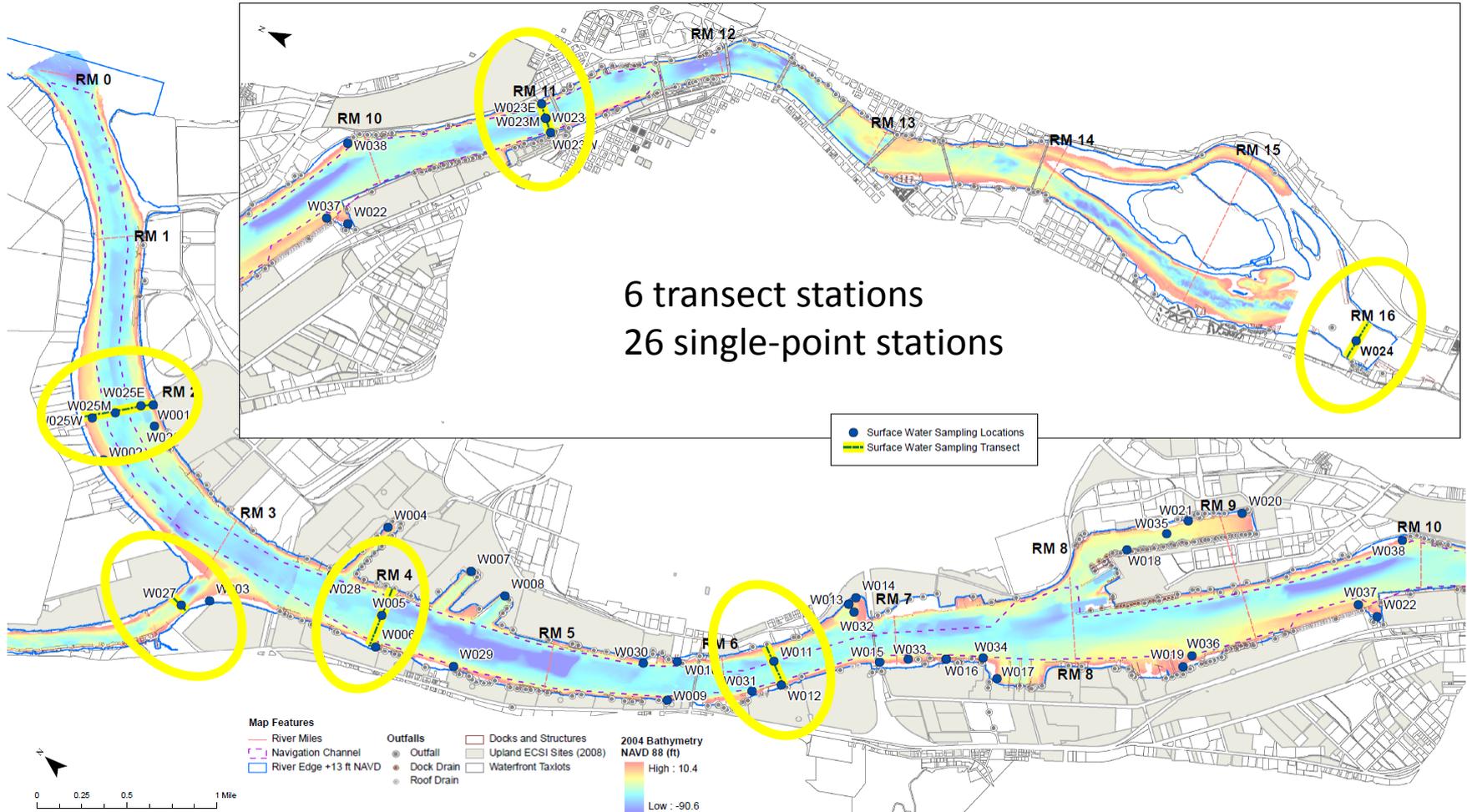


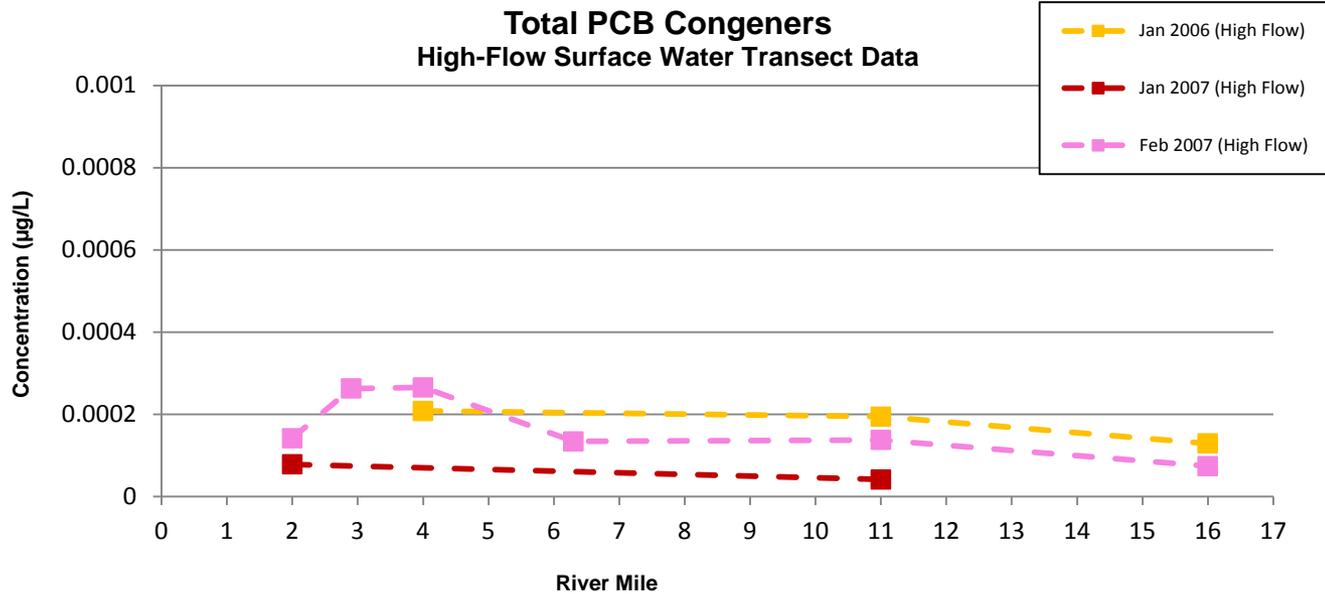
Hydrograph and Sampling Events



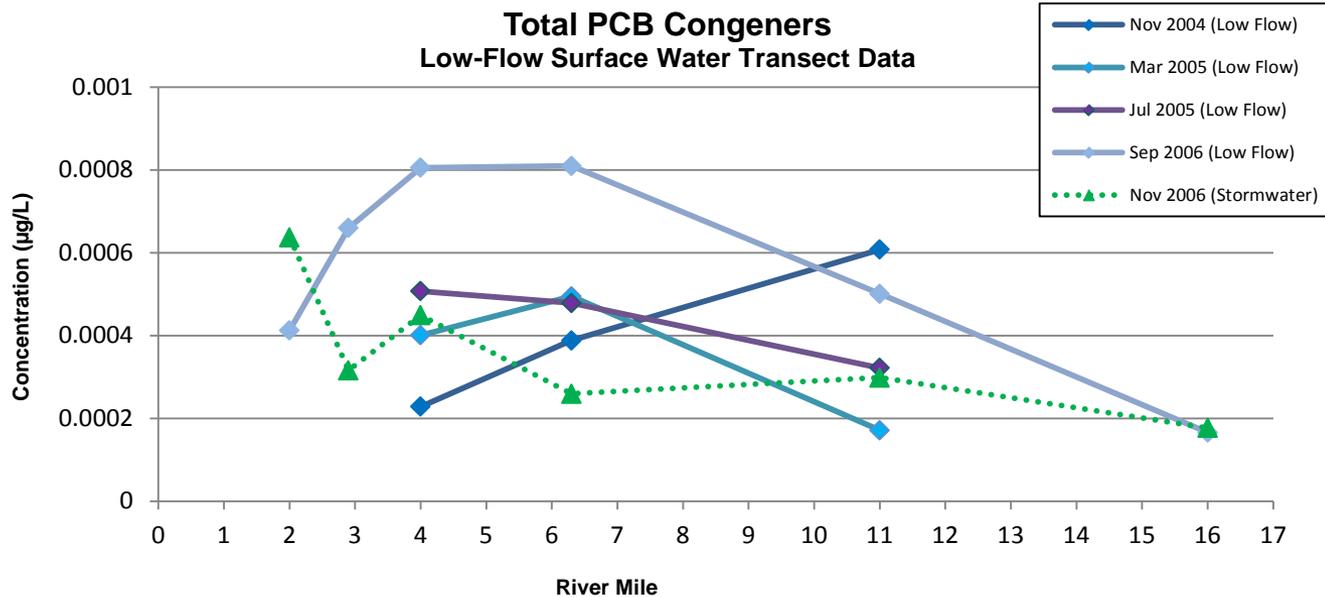
8 surface water sampling events:
4 Low-flow, 3 high-flow, 1 stormwater

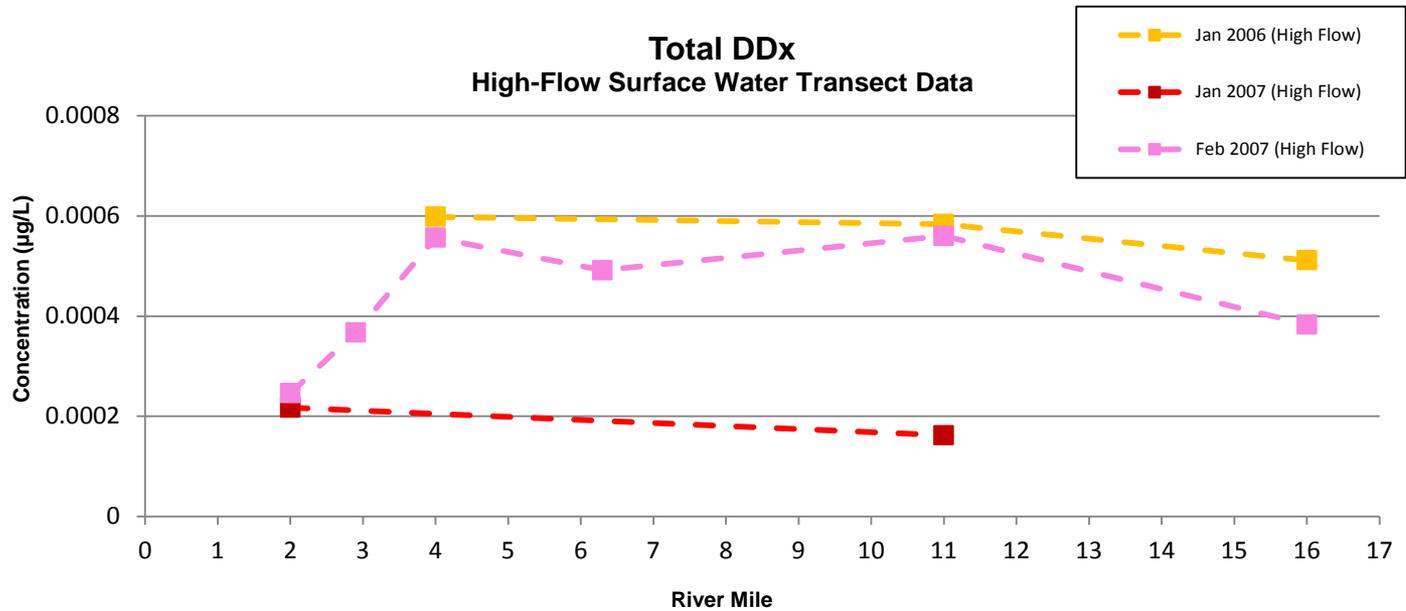
Surface Water Sampling Locations



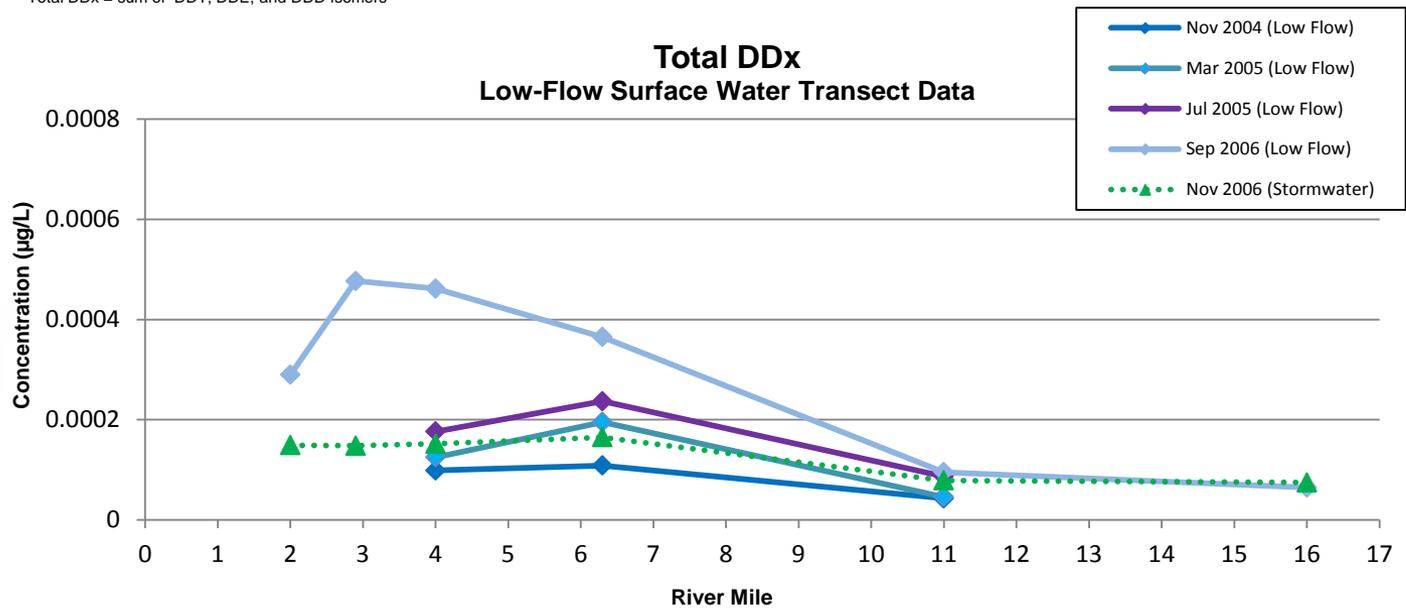


PCB = polychlorinated biphenyl





Total DDx = sum of DDT, DDE, and DDD isomers



Surface Water Study Contributions to RI/FS

- Achieved low-level detection limits required for the HHRA
- Supported development of surface water background concentrations
- Key to refinement of the CSM
- Informed the loading analysis in the RI
- Provided boundary conditions for fate and transport modeling

Conclusions

The SPI survey and high-volume surface water sampling programs yielded benefits throughout the RI/FS process and informed the:

- CSM definition and refinement
- Collection and interpretation of other data types
- ERA and HHRA
- Fate and transport sampling design and modeling
- Remedial alternatives development and evaluation

Questions?



Gene Revelas (grevelas@integral-corp.com)
Laura Jones (ljones@integral-corp.com)

