A Watershed-Based Approach for Developing a Multi-Parameter TMDL in an Urbanizing Embayment

Christopher May Battelle
Jill Brandenberger Battelle
Robert Johnston USN-SPAWAR (PSNS)
PF Wang USN-SPAWAR
Brian Skahill ACOE-WES
Sally Lawrence WA-DOE

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Battelle
The Business of Innovation

Sinclair-Dyes Inlet

Battelle
The Business of Innovation

Project Partners

- US-EPA Region 10
- Suquamish Tribe
- Puget Sound Naval Shipyard & Intermediate Maintenance Activity
- Washington State
  - Department of Ecology
  - Department of Health
  - Department of Transportation
- Kitsap County
  - Kitsap County Health District
  - Surface and Stormwater Management
  - Kitsap County Conservation District
- City of Bremerton
- City of Port Orchard
- City of Bainbridge Island

Battelle
The Business of Innovation

Beneficial Uses

- *Fish & Wildlife Habitat*
- *Shellfish Harvest*
- *Fishing*
- *Contact Recreation*
  - *Swimming*
  - *Boating*
- *Shoreline Development*
- *Commercial & Industrial Activity*
  - *Shipping*
  - *Marinas*
  - *Shipyards*





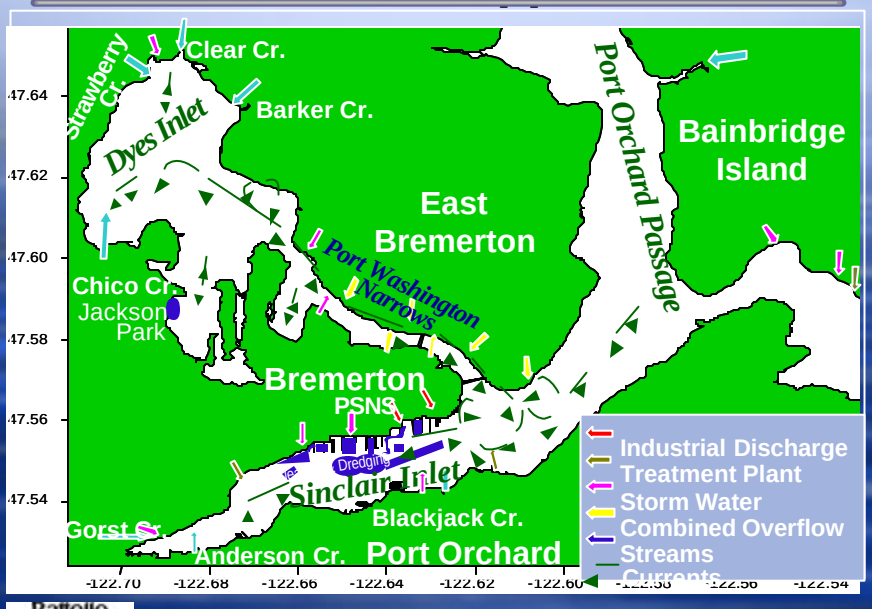

Battelle
The Business of Innovation

Pollution Sources

- Urban Stormwater Runoff
- Agricultural Runoff
- Failing On-Site Sewage Systems
- Wastewater Treatment Plants
- Combined Sewer Overflows
- Industrial Activity Discharges
- Marinas and Boats

Battelle
The Business of Innovation

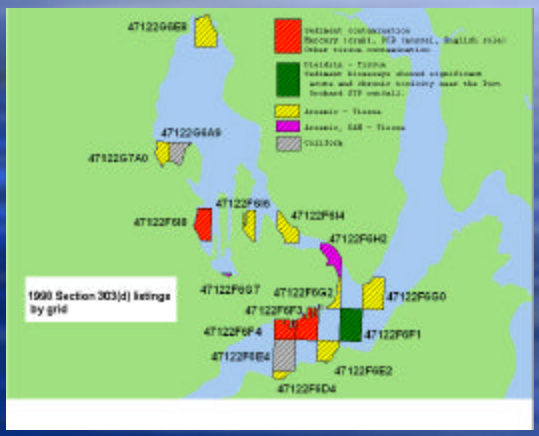
Watershed Approach

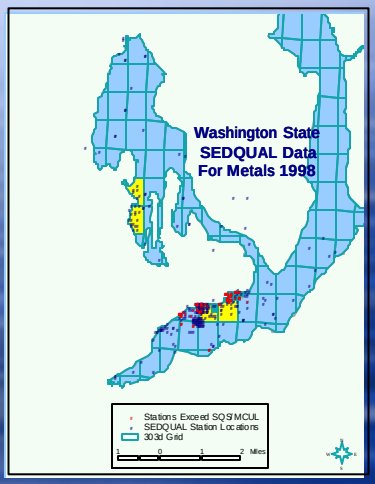


Battelle
The Business of Innovation

Historical Pollution Data

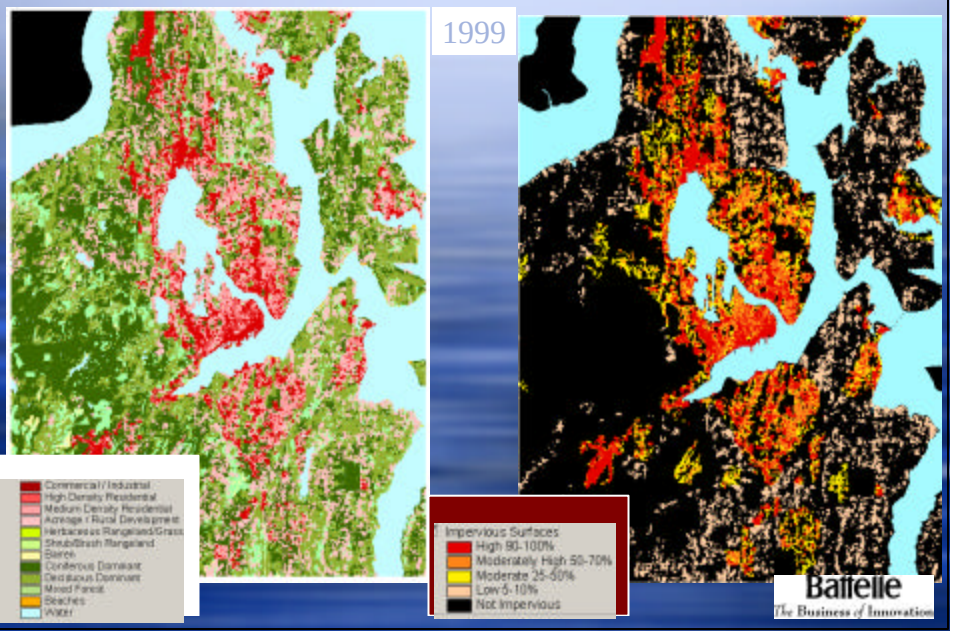
303(d) Listings





Battelle
The Business of Innovation

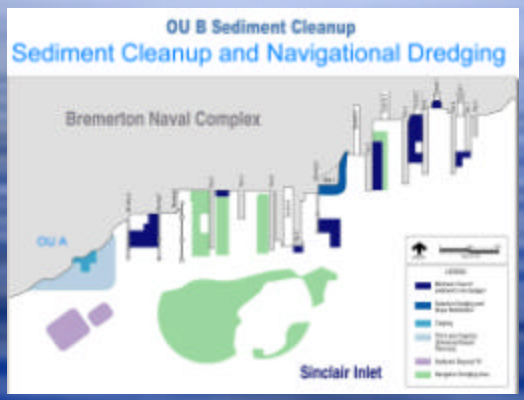
Watershed Development



Battelle
The Business of Innovation

Cleanup Efforts

Data to support 303(d) listings are from before 1999 and likely do not represent current conditions

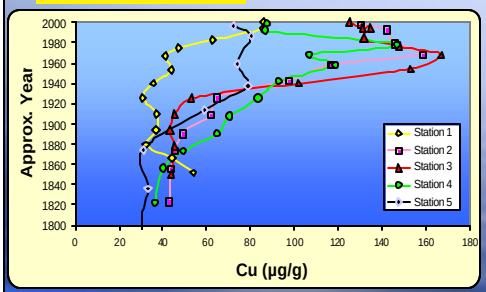


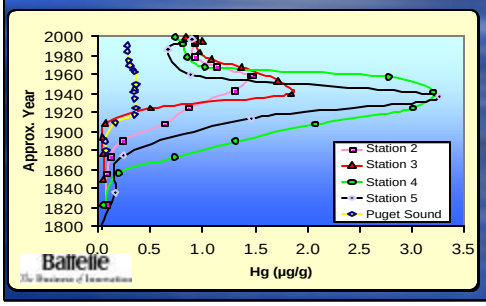
303(d) data were collected before source controls, stormwater treatment, dredging, clean-up, and capping were instituted in Sinclair & Dyes Inlet

Battelle
The Business of Innovation

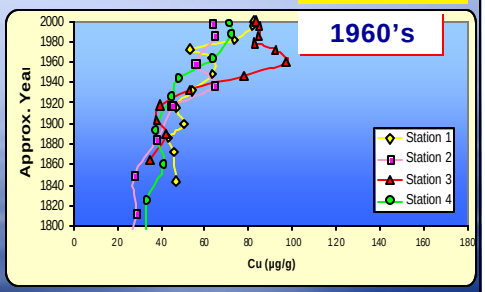
Historical Trends

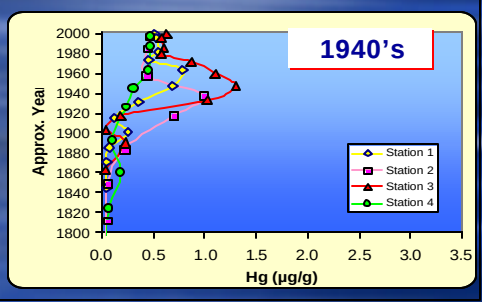
Sinclair Inlet

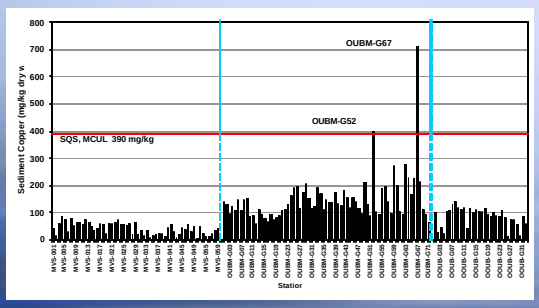


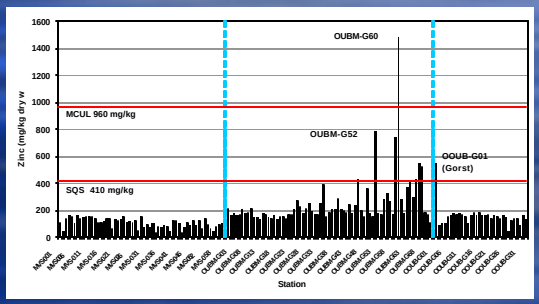


Dyes Inlet





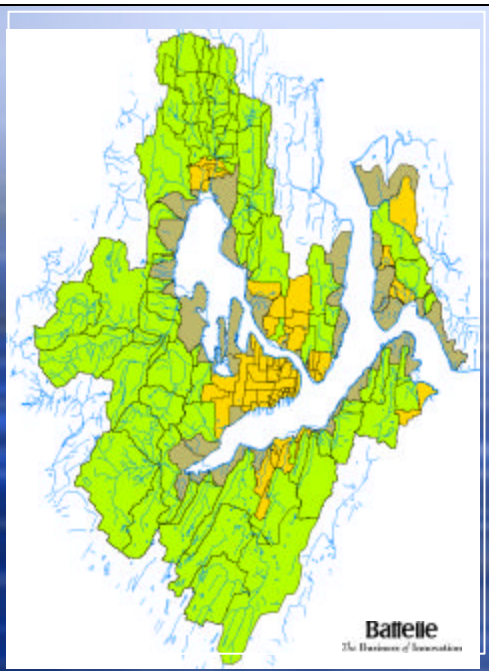




Sediment Metals Verification Study

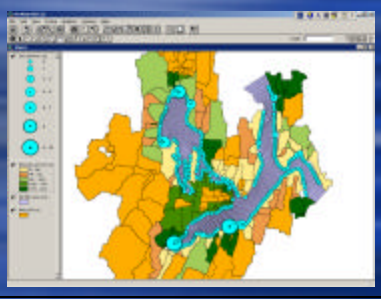
- Sediment concentrations of **lead, cadmium, and silver** meet Washington SQS throughout Sinclair and Dyes Inlets: **present-day data do not support 1998 303(d) listing**
- Very few samples do not meet Washington SQS for copper and zinc (2 and 8, respectively)
- Most samples near PSNS piers in OUBM; one Zn>SQS near Gorst
- Target metals concentrations in Sinclair Inlet sediment are markedly reduced since implementation of cleanup and source control actions.

Battelle
The Business of Innovation

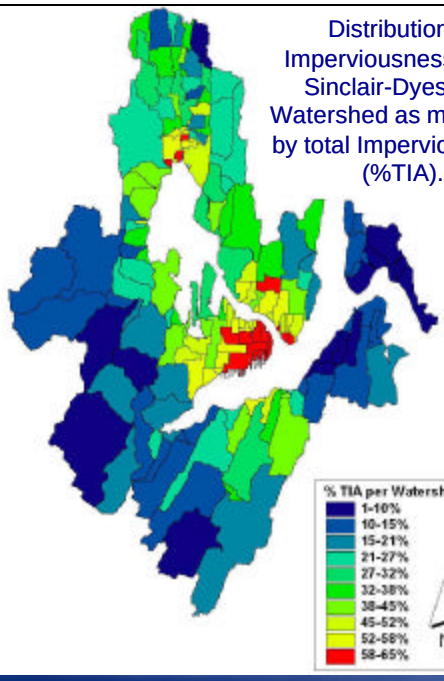


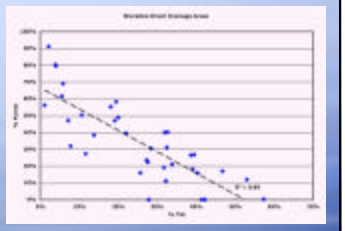
HSPF Watershed Model

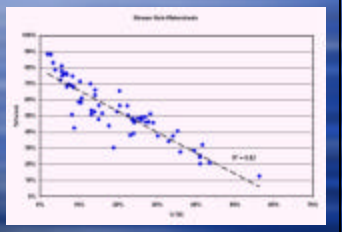
- Open channel (stream)
- Piped channel (storm water)
- Beach (sheet flow)



Distribution of Imperviousness in the Sinclair-Dyes Inlet Watershed as measured by total Impervious Area (%TIA).

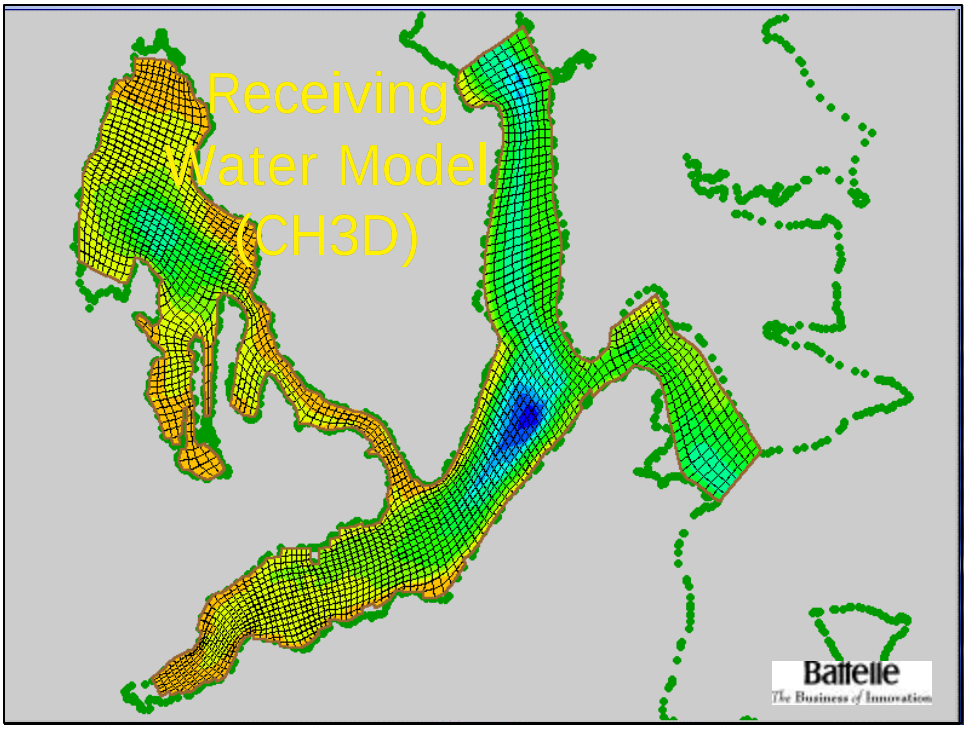






Battelle
The Business of Innovation

Receiving Water Model (CH3D)



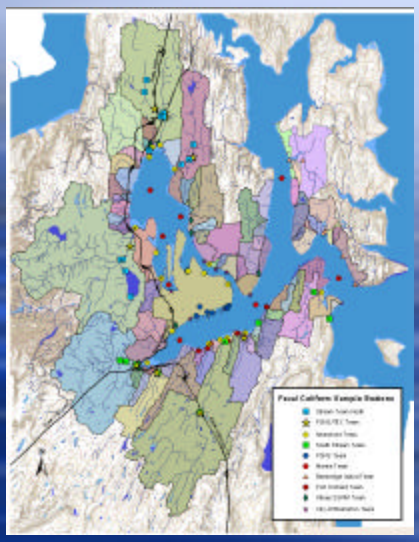
Battelle
The Business of Innovation

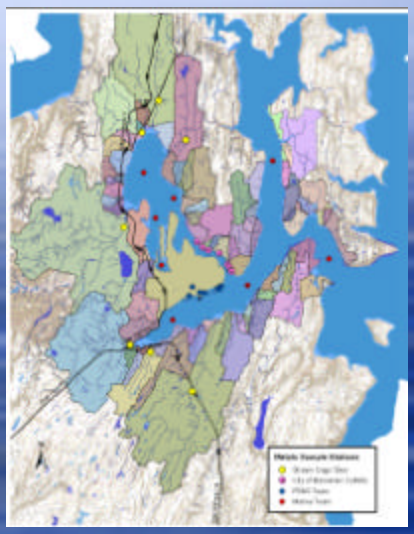
Marine, Stream & Stormwater WQ Monitoring

- Sample representative storm events, as well as wet and dry season baseflow samples
- Collecting data on hydrology and water quality parameters
- Relate land-use to environmental quality
- Quantify loading from the watershed into the receiving waters of the Inlet
- Support TMDLs

Battelle
The Business of Innovation

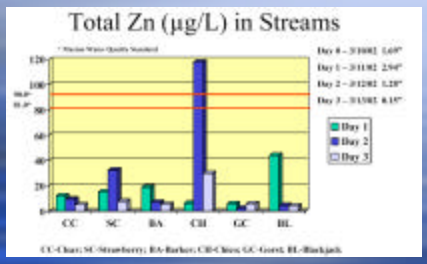
WQ Sample Stations

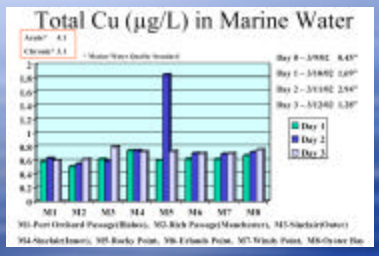


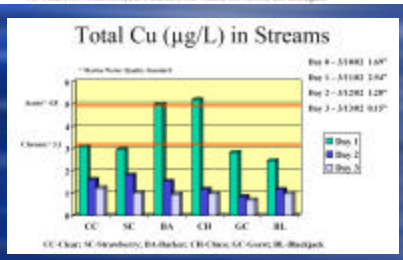


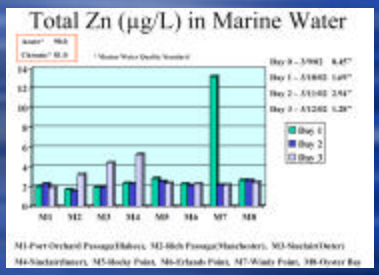
Battelle
The Business of Innovation

Storm Event WQ

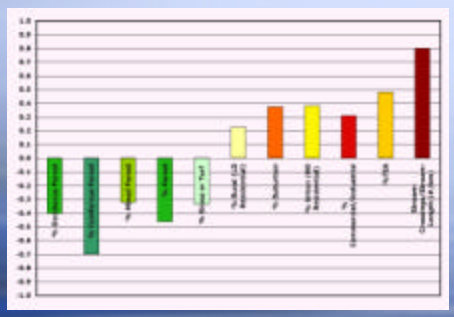


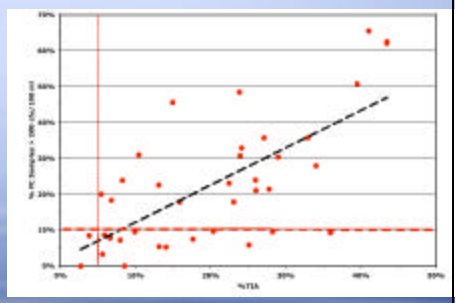




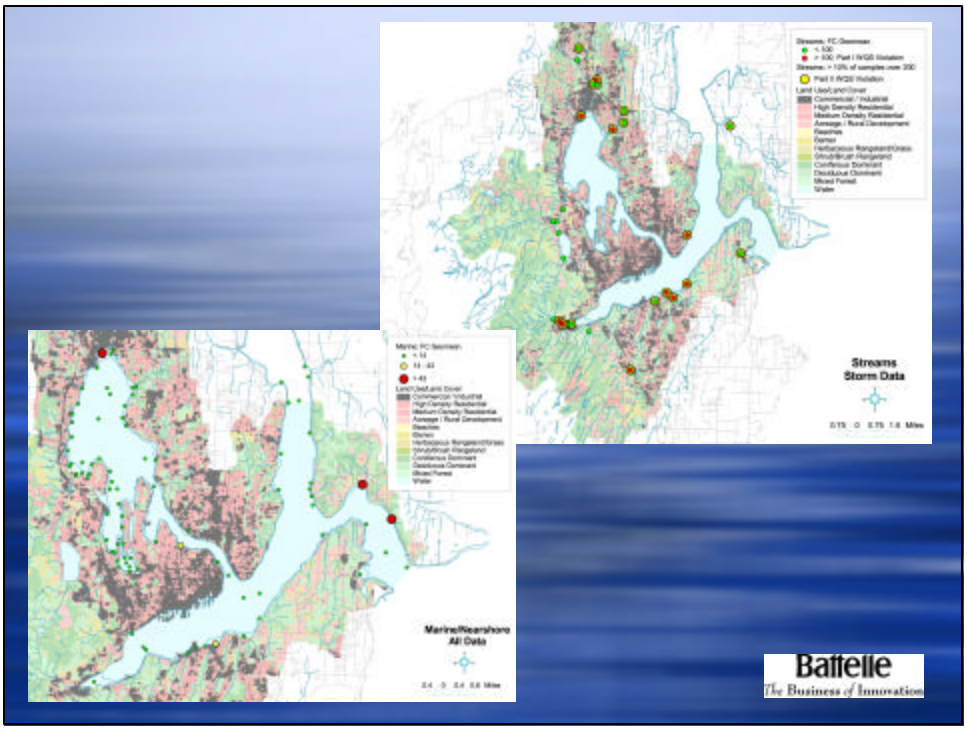


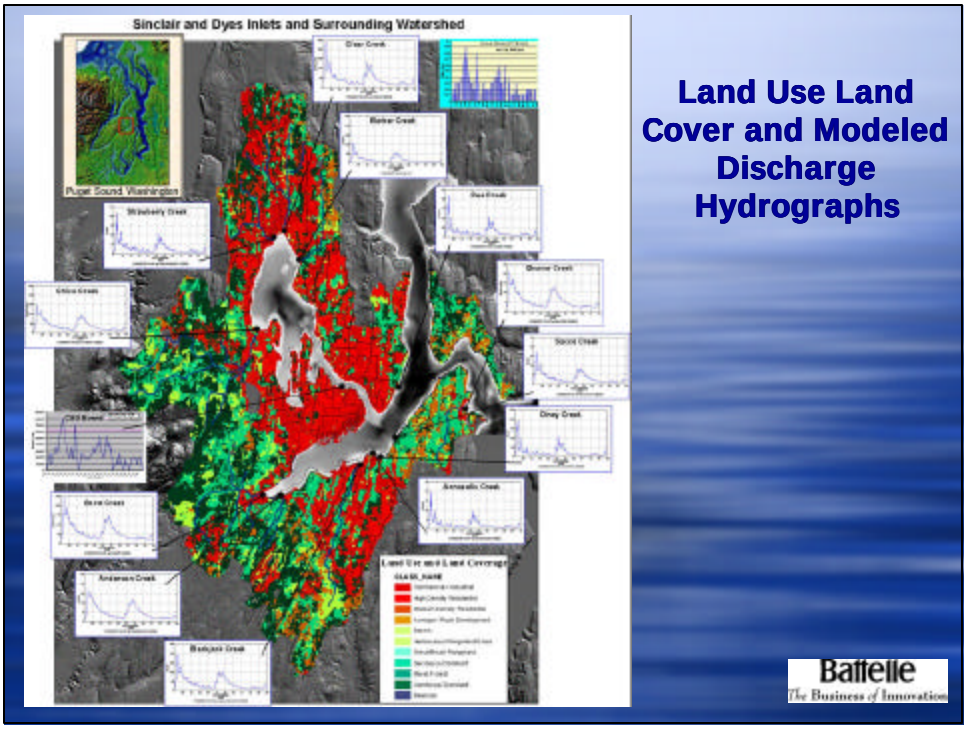
Battelle
The Business of Innovation



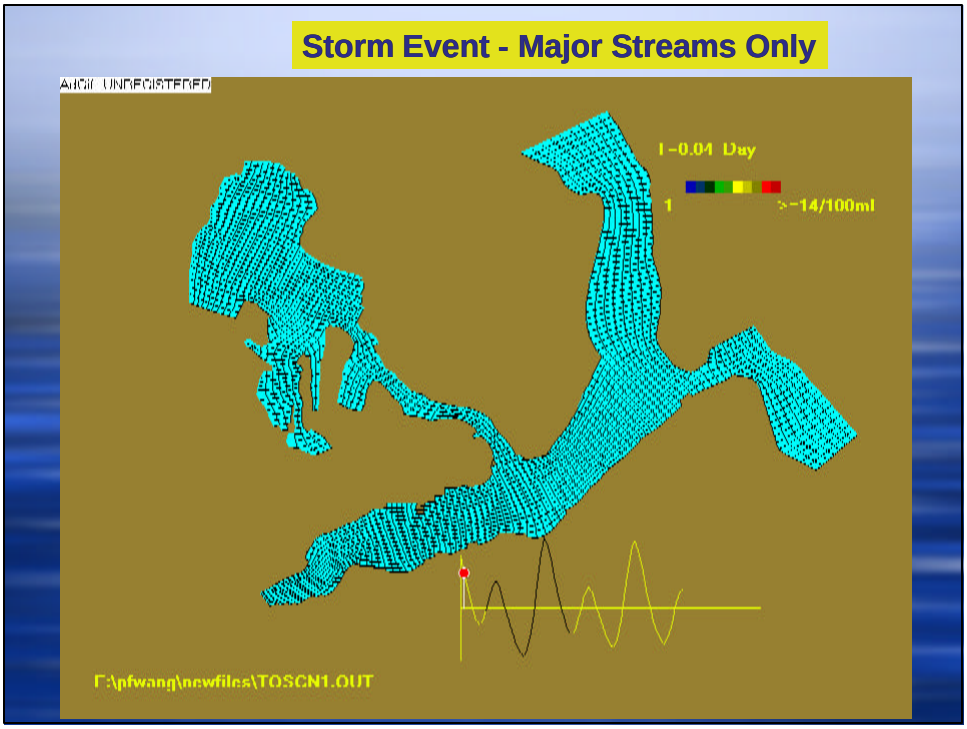


Battelle
The Business of Innovation

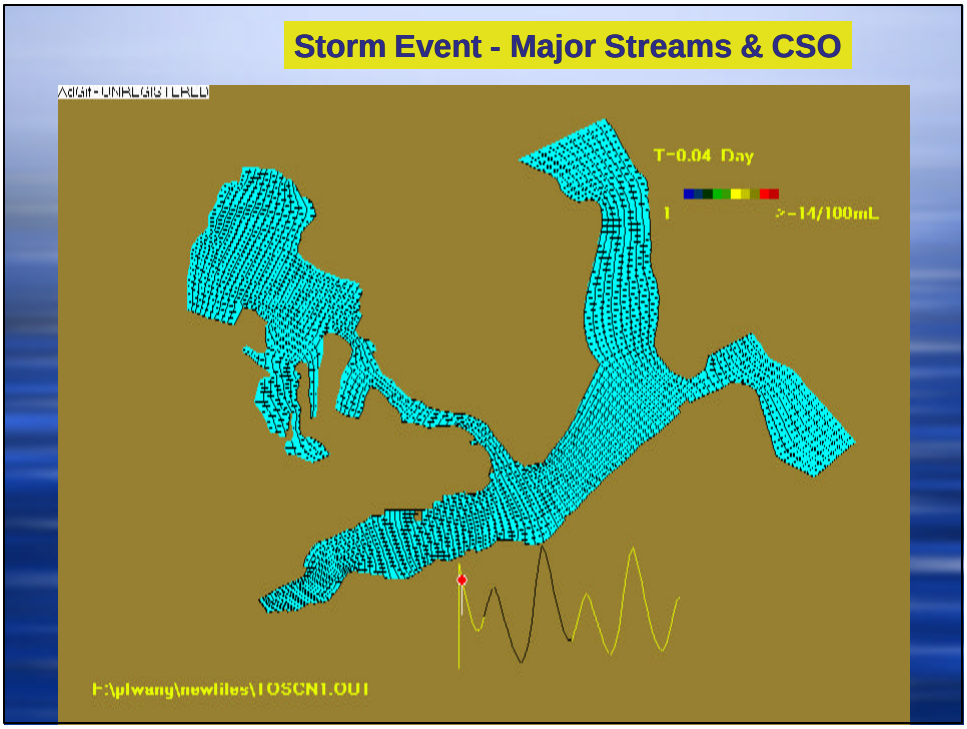

Streams
Storm Data
Marine/Nearshore
All Data
Battelle
The Business of Innovation

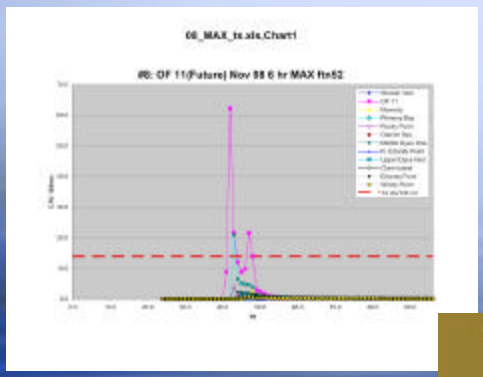

Sinclair and Dyes Inlets and Surrounding Watershed
Puget Sound, Washington
Land Use and Land Coverage
Land Use Land Cover and Modeled Discharge Hydrographs
Battelle
The Business of Innovation

Storm Event - Major Streams Only

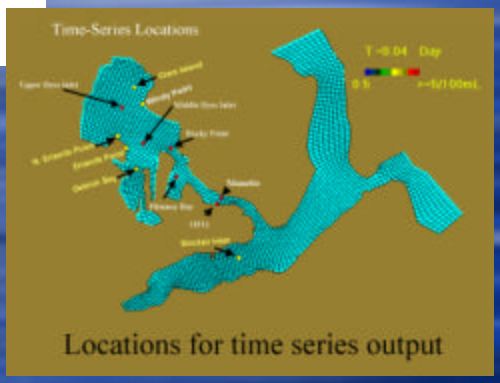


Storm Event - Major Streams & CSO

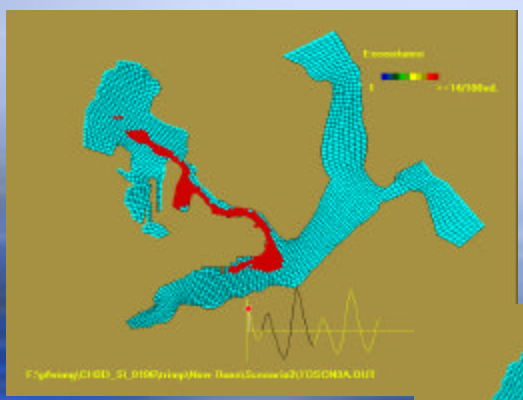




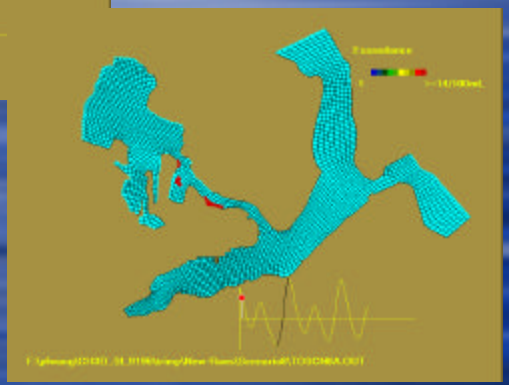
Model Time-Series Data



Battelle
The Business of Innovation



WQS Exceedence Extent



Battelle
The Business of Innovation

Biological Studies

- Contaminants in bottom fish and invertebrates
  - 8 species from Sinclair Inlet and reference areas
  - Tissues analyzed for metals, PCBs, and pesticides
- Concentrations compared to reference and Ecological Benchmarks
  - Copper
  - Mercury
  - PCBs

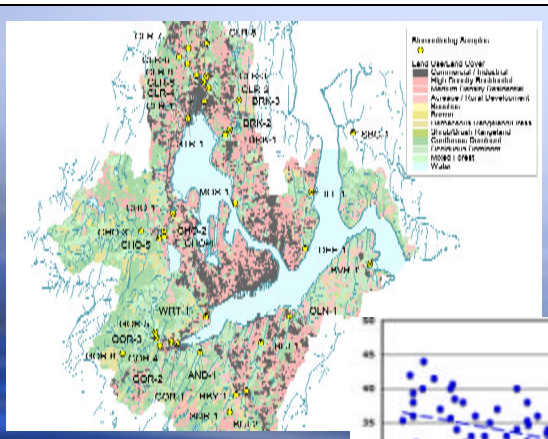
Battelle
The Business of Innovation

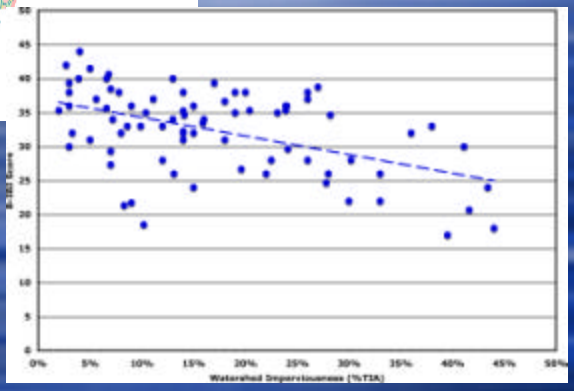
Ecological Assessment

Salmon Habitat Surveys

Stream Culvert Surveys

Battelle
The Business of Innovation





Baffelle
The Business of Innovation

Future Efforts

- Complete Bacterial TMDL
- Copper and other metals analysis
- Nutrient (DO) Assessment
- Caged Mussel Study
- Nearshore Habitat Assessment & Restoration
- Stormwater Treatment Systems (LID)
- Others???

Baffelle
The Business of Innovation

Summary

- Provides a Solid Scientific Foundation
- Pool resources and data to get a better product
- Watershed approach facilitates partnering & is ecologically sound
- Much better chance for successful implementation
- Compliance with Clean Water Act will cost less and do more to restore/enhance beneficial uses

Battelle
The Business of Innovation

Thank You

Chris May, Battelle-PNNL
christopher.may@pnl.gov (360)681-4556

Bob Johnston, USN-SPAWAR, Puget Sound Naval Shipyard (PSNS)
johnston@spawar.navy.mil (360)782-0113

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Questions???

Battelle
The Business of Innovation