In Situ Water Quality Monitoring During Sediment Remediation at the Denny Way CSO

Scott Mickelson, King County Marine and Sediment Assessment Group

Abstract

King County remediated contaminated sediments in Elliott Bay (Seattle, Washington) during the fall and winter of 2007/2008. Remediation construction activities included dredging contaminated sediment for upland disposal and backfilling the excavated site to original grade with clean sediment. Mechanical dredging and backfilling with a clamshell bucket can potentially cause temporary changes in water quality by releasing fine particulates into the water column. Project permits included a requirement for monitoring turbidity and dissolved oxygen in the water column just outside of a designated construction mixing zone. King County collected continuous, real-time, *in situ* water quality data through the use of sensors deployed on a buoy near the construction site. Identical sensors were deployed at the Seattle Aquarium to collect background water quality data for comparison with the construction site. Telemetered data were uploaded to a project website every 15 minutes. These real-time, *in situ* data provided project staff with the ability to more-effectively monitor water quality during remediation construction activities and make necessary on-the-spot adjustments to dredging and backfilling practices.

Denny Way Sediment Remediation Project

The Denny Way combined sewer overflow (CSO) was the largest in King County's wastewater treatment system, with frequent overflows during rain storms that exceeded system capacity. Overflows during lower tides would discharge directly onto the beach in Myrtle Edwards Park. The system was upgraded in 2005 and discharges were moved offshore. Legacy sediment contamination, however, required remediation in the nearshore area.

King County began sediment remediation in November 2007, through dredging and backfilling with clean material. Approximately 20,000 cubic yards of sediment, contaminated with PCBs, PAHs, phthalates, mercury, and silver, were dredged and transported for upland disposal. Clean backfill material was provided from routine maintenance dredging of the Duwamish River Turning Basin. After backfilling was complete, the area was restored and armored using habitat mix and larger materials.

Washington State Department of Ecology (Ecology) regulations required monitoring of turbidity and dissolved oxygen just outside of the construction mixing zone to determine whether construction activities were causing excursions beyond the applicable water quality criteria found in Chapter 173-201A WAC. King County elected to place an *in situ* monitoring system at the site so that water quality could be measured consistently and at a high frequency. This would allow County construction field staff to be able to better supervise construction activities and institute best management practices if water quality were impacted.

The water quality monitoring sensors were mounted on a buoy at the construction site. High-frequency data were averaged every 15 minutes and uploaded via telemetry to a website. Since the water quality criteria for both turbidity and dissolved oxygen are relative to background, a reference station was established at a permanent sensor installation at the Seattle Aquarium.

Contact Information
Scott Mickelson
King County DNRP
201 S. Jackson St. #600
Seattle, WA 98104
206.296.8247 phone
206.296.0192 fax
scott.mickelson@kingcounty.gov

Acknowledgements
John Blaine, King County Environmental Laboratory
Kyle Comanor, King County Hydrologic Services Group
Jim Devereaux, King County Environmental Laboratory
Tim Finegan, YSI
Angela Grout, King County Marine and Sediment Assessment Group
Bob Kruger, King County Environmental Laboratory
Shawn Larson, Seattle Aquarium
John Phillips, King County Wastewater Treatment Division
Brian Reid, Sound Oceans System, Inc.
Kimberle Stark, King County Marine and Sediment Assessment Group

Equipment

YSI 6600EDS Multi-Parameter Sonde

The YSI 6600EDS (Extended Deployment System) sonde consists of a cylindrical pressure-resistant body with a cable connection on one end and temperature, conductivity, pressure (depth), optical dissolved oxygen, and turbidity probes on the opposite end. An anti-fouling wiping system is used to prolong the calibration life and a "Rapid PulseTM" dissolved oxygen sensor removes the need for a stirring mechanism.

Specifications for the YSI 6163 Turbidity Probe are:
- Range of 0 to 1,000 nephelometric turbidity units (NTU).
- Resolution of 0.1 NTU.
- Accuracy of ±2% or 0.3 NTU.

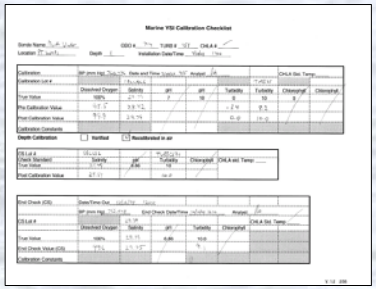
The sonde was deployed at the construction site on an offshore buoy. An existing permanent sonde installation at the Seattle Aquarium provided the reference station.

Sound Ocean Systems, Inc. (SOSI) Offshore Buoy
SOSI ODB-48-1500 buoy body with the following:
- Aluminum mast with sensor mounting plates.
- Autonomous mast light and radar reflector.
- Anti-fouling paint and rubber "rub-rails" at two heights.
- Cable fittings.
- Hull width = 4.'
- Height above water line = 7.9'.
- Depth below water line = 2'.

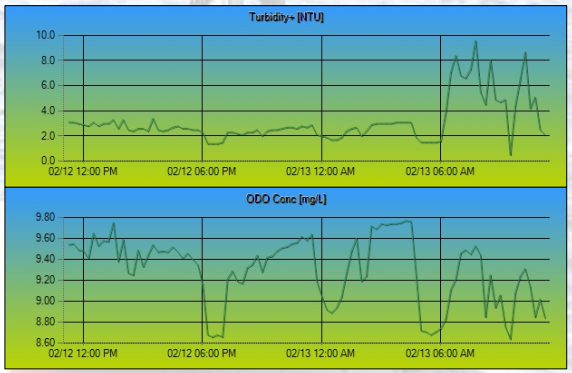
Deployment
The sonde was deployed at a depth of one meter below the surface from the SOSI buoy. The size and weight of the buoy (~300 lbs.) allowed deployment and retrieval using King County's research vessel *Liberty*. Two solar panels and a deep-cycle marine battery were employed to power the system. The system was controlled by a voltage regulator that shut charging down when voltage was greater than 14 and turned the unit off when the voltage was less than 11.5.

Field Activities and Quality Control

- Monthly maintenance included cleaning and changing O-rings.
- Monthly calibration included: dissolved oxygen calibrated in water-saturated air; and turbidity calibrated to 0 and 10 NTU standards of RO water and formazin.
- Quality Control included collection of water samples for field and/or laboratory analysis of dissolved oxygen (Winkler) and turbidity. Routine QC was performed weekly. More frequent QC was dictated by field supervisors and project managers as warranted by *in situ* instrument readings.
- An e-mail alert system was programmed to notify field construction managers when turbidity at the site reached a nominal level of 5 NTU. This alert would then trigger a real-time spreadsheet analysis comparing site turbidity to background turbidity at the Seattle Aquarium.
- If conditions warranted, adjustments to dredging practices could be made in real-time.



24-Hour Snapshot of Water Quality Data at Construction Site Buoy



Real-time water quality data from current King County sites may be viewed at http://www.ysieconet.com/public/WebUI/Default.aspx?hidCustomerID=165

Water Quality Standards

Turbidity - "*Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.*"

Dissolved Oxygen – "*Excellent quality . . . 6.0 mg/L . . . When a water body's D.O. is lower than the criteria in Table 210 (1)(d) (or within 0.2 mg/L of the criteria and that condition is due to natural conditions), then human actions considered cumulatively may not cause the D.O. of that water body to decrease more than 0.2 mg/L.*"

Chapter 173-201A WAC

Conclusions

Use of *in situ* water quality monitoring instrumentation during the Denny Way sediment remediation project provided King County with real-time turbidity data that allowed instantaneous implementation of best management practices during dredging activities. Only one excursion above the turbidity water quality criterion was recorded during dredging activities. There were no excursions below the dissolved oxygen criterion.

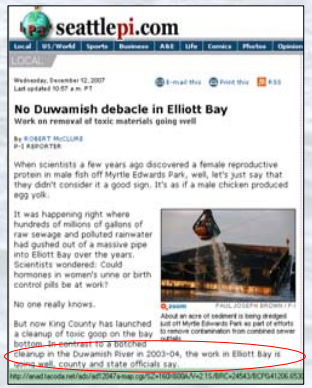
Several excursions above the turbidity criterion were recorded during backfilling activities due to the amount of fine material in the "habitat mix" used as clean backfill. The real-time data was useful in modifying backfilling procedures.

Other benefits of the *in situ* water quality monitoring are:

- Acceptance of monitoring methodology by Ecology.
- Positive coverage in the local press.
- Inquiries for use of the instrumentation and buoy on other construction monitoring projects
- **The ability to manage rather than just monitor water quality during construction**.

Lessons Learned

- Continuous, real-time, water quality data collection provides a much-more robust data set than manual water quality data collection.
- A single buoy/sonde deployment may not effectively capture multi-directional dredging plumes – multiple buoys with sondes deployed at multiple depths, based on pre-construction hydro-acoustic surveys, would be advantageous.
- Environmental effects including wind, tides, and large vessel traffic may also affect construction plume movement, which would be alleviated with multiple buoy/sonde deployments.
- Given the winter time-frame for construction activities, discharges from the Duwamish River and storm drains may have affected "background" water quality measurements at the Seattle Aquarium.


seattlepi.com

LOCAL

No Duwamish debacle in Elliott Bay
Work on removal of toxic materials going well

By ROBERT McCLURE
P-I REPORTER

When scientists a few years ago discovered a female reproductive protein in male fish off Myrtle Edwards Park, well, let's just say that they didn't consider it a good sign. It's as if a male chicken produced egg yolk.

It was happening right where hundreds of millions of gallons of raw sewage and polluted rainwater had gushed out of a massive pipe into Elliott Bay over the years. Scientists wondered: Could hormones in women's urine or birth control pills be at work?

No one really knows.

But now King County has launched a cleanup of toxic goop on the bay bottom. [illegible]

Cleanup in the Duwamish River in 2003-04, the work in Elliott Bay is going well, county and state officials say.