Lower Minnesota River
Oxygen Dynamics Assessment
Scope of Work

Background

Metropolitan Council Environmental Services (MCES) and cooperating agencies plan to develop a water-quality model to assess and manage the lower 40 miles of the Minnesota River (Larson, 2004). This reach of the river is highly eutrophic and impaired due to low oxygen and high turbidity. The model will be used to set effluent limitations for wastewater treatment plants (WWTPs) and other discharges and establish water-quality goals for tributaries. The pollutants of concern, in order of priority, are oxygen demand, ammonia, nutrients, and sediment. The proposed model is CE-QUAL-W2 (Cole and Buchak, 1995).

Over a three-year period (2004-2006), monitoring and special field studies are planned to collect information to build and test the model. A wasteload allocation study by the Minnesota Pollution Control Agency (MPCA, 1985) ranked reaeration and sediment oxygen demand rates among the most important model inputs for the lower Minnesota River. Due to the importance of understanding oxygen dynamics in the river, an assessment of these and other oxygen-related rates was added to the three-year monitoring plan.

Scope

The objective of this project is to conduct a comprehensive assessment of oxygen dynamics in the lower 40 miles of the Minnesota River during the summer when river flows are low. The assessment will include measurements or estimates of the following processes:

- **Reaeration** or the transfer of oxygen from the atmosphere to the river
- **Atmospheric diffusion** or the movement of oxygen molecules from high concentrations to low concentrations between the atmosphere and river
- **Community oxygen metabolism** or around-the-clock measurement of oxygen gains and losses in the river from all sources and sinks in the air, water, and sediment
- **Water-column production and respiration** or around-the-clock measurement of oxygen gains and losses in the water column, due mainly to the activities of phytoplankton
- **Community substrate oxygen demand** (CSOD) or the loss of oxygen due to biochemical processes across all substrates, including sediment, rocks, logs, and aquatic plants
- **Sediment oxygen demand** (SOD) or the loss of oxygen due to the decomposition of organic matter in the sediment bed (a component of CSOD).

By measuring these processes at the same time, a complete picture of the various credits and debits to the oxygen budget may be developed.

Tasks and Deliverables

The assessment consists of the following tasks.

Task 1: Preparation. By May 31, 2004, complete all preparations needed to conduct the field studies and produce a final work plan, which details such things as the methodologies, quality assurance, implementation, staffing, equipment, responsibilities, and schedule.

The following methods are to be used in this assessment:

- Reaeration: Non-radioactive krypton gas technique, built upon the Krypton-85 technique developed by Tsivoglou (1967) but modified by HydrO_2
- Atmospheric diffusion: Floating diffusion dome method, originally developed by Copeland and Duffer (1963) and Hall (1970) but modified by HydrO_2, which may also be used to estimate reaeration rates
- Community oxygen metabolism: Diel curve method for determining total community oxygen production and respiration, developed by Odum and Hoskins (1958) but refined by HydrO_2
- Water-column production and respiration (P&R): "light and dark" bottle method (APHA, AWWA, and WEF, 1998)
- CSOD: Computed by subtracting water-column respiration from total production and respiration (corrected for diffusion)
- SOD: In-situ chamber method (Murphy and Hicks, 1986)

Deliverable: Final work plan approved by MCES.

Task 2. Field Work. Conduct field studies to measure or estimate the following: reaeration, atmospheric diffusion, community oxygen metabolism, water-column production and respiration, community substrate oxygen demand, and sediment oxygen demand.

The field studies must be conducted under specific environmental conditions:

- Summer (June 1 through September 15)
- Low river flow (Less than 1,500 cfs at Jordan, Minnesota)
- Warm water temperatures (mean daily temperature greater than 20°C)
- Steady-state conditions (dry, warm weather forecasted for the next 6-10 days)

All fieldwork must be completed within the same period, tentatively scheduled for eight days. By June 1, 2004, the Contractor must be ready to mobilize and conduct the studies at full capacity when these environmental conditions are met. MCES will make the final determination as to when the assessment will be conducted. MCES will provide at least a one-week notice in advance of the fieldwork.

Reaeration should be measured or estimated over as much of the 40-mile reach as possible. Two techniques will be applied. The non-radioactive krypton gas technique will be applied over river miles 36 to 20, with rates determined for individual reaches (approximately every 6 miles).

Several factors make the application of gas tracer methods problematic for the lower 20 miles, including backwashing by the Mississippi River, withdrawal and discharges by the Black Dog facility, and discharges by WWTPs. Therefore, the floating diffusion dome technique will be applied to the lower 20 miles. To compare the two techniques, both will be applied to two shorter reaches, one shallow and one deep. Actual river miles will depend on boat access and river characteristics.

Community oxygen metabolism, water column P&R, CSOD, and SOD will be assessed at six (6) locations strategically spaced through the forty-mile study reach. The first day of the field study will be used to conduct reconnaissance activities necessary for final selection of station locations for these measurements as well as the injection site for reaeration. Specific station locations will be determined after reconnaissance and consultation with MCES. Tentatively, stations are anticipated near river miles 1.2, 7.9, 10.8, 14.6, 25, and 36. The rationale for establishing sampling stations at these locations is based on defining specific river segments for oxygen metabolic assessment in relation to river geomorphic characteristics, tributary and WWTP inflow, and the Black Dog power generating facility.

For SOD, three replicate sediment chambers and one blank chamber will be distributed over representative sediments at each location. To assist with the final work plan, MCES will provide a sediment-bed map showing the distribution of fine and coarse materials in the lower Minnesota River. For the diel curve method, at least two sondes will be deployed at each location: one in the euphotic zone and the other below it.

Deliverable: Digital photographs of fieldwork and copies of field data information (electronic files)

Task 3. Laboratory Analyses. Conduct laboratory analyses on samples taken in the field. The final work plan will specify the analyses, methods, and laboratory.

Deliverable: Laboratory data (electronic files)

Task 4. Data Analyses. Conduct analyses needed to interpret the field and laboratory data.

Deliverables: Results of data analyses (electronic files)

Task 5. Report Writing. Prepare a draft report for MCES and partners to review and complete the final report in response to their suggestions.

Deliverables: Draft and final reports

Schedule

Fieldwork is dependent on summer low flow conditions and must be conducted as soon as conditions are favorable. If these conditions are not met in summer 2004, the project will be delayed to summer 2005 or, if necessary, to summer 2006. Fieldwork must be completed no later than September 15, 2006. Assuming conditions are met in 2004, the schedule is as follows:

Task 1.	Preparation	By May 31, 2004
Task 2.	Field Work	June 1 - September 15, 2004
Task 3.	Laboratory Analyses	4th Quarter 2004
Task 4.	Data Analyses	1st Quarter 2005
Task 5.	Final Report	March 31, 2005

If fieldwork is delayed to 2005, add one year to the schedule for Tasks 2-5. If fieldwork is delayed to 2006, add two years.

References

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