

Minnesota River, Metropolitan Reach, Load Allocation Study Summer Field Survey Using Sonde-Equipped Buoys

Minnesota Pollution Control Agency, August 2005

Overview

An intensive survey of water quality in the metropolitan reach of the Minnesota River is planned for summer when river flows are low. Under these conditions, dissolved-oxygen concentrations are expected to be at their lowest. The weeklong survey by the Minnesota Pollution Control Agency (MPCA) will consist of continuous monitoring at four locations using sonde-equipped buoys, daily field measurements at six locations, and grab sampling every other day at two locations. Information collected during the survey will support development of a water-quality model and revision of a load allocation study.

The study reach is from just upstream of the Blue Lake Wastewater Treatment Plant (WWTP) discharge near mile 20.5 to approximately 1.2 miles upstream of the confluence with the Mississippi River. Fieldwork will be triggered by a steady summer flow of less than 1,500 cfs at the U.S. Geological Survey's continuous flow recording station on the Minnesota River near Jordan (River Mile 39.4). The schedule will be coordinated with the Metropolitan Council so the survey does not occur during the same week as an oxygen-dynamics assessment contracted by the Council, as the MPCA is providing diurnal monitoring with sondes during the assessment.

The survey will require a crew of two or three people. By using sonde-equipped buoys, a set of round-the-clock monitoring data will be continuously recorded during the survey. The sondes record dissolved oxygen (DO), pH, temperature and conductivity. During the week the monitors are in place, the field crew will collect probe drift-correction data for the sondes, additional field measurements, and water samples for laboratory analyses (solids, chlorophyll, nutrients, and organic carbon).

Double Sonde Buoy System

Four 61-inch tall by 9-inch diameter, 50-pound regulatory buoys will be used. Each buoy will be equipped with two monitoring sondes. The double-sonde-equipped buoys will be deployed on the first day. Currently the selected sites are upstream of the Blue Lake WWTP discharge (RM-20.5), just upstream of the beginning of the navigational reach (RM-14.7), just upstream of the Seneca WWTP discharge (RM-6.5), and downstream of the Pike Island channel (RM-1.2). Metropolitan Council Environmental Services (MCES) operates the two WWTPs.

The sondes will be YSI 600XLMs. The sondes will be positioned on the buoys' anchor chains so that the faces of the first sonde's probes will be one-third of the depth below the surface and the second sonde's probes will be at two-thirds of the depth. The YSI sondes record DO, pH,

temperature and conductivity. They will be calibrated the day before they are deployed. This will save time, since it takes about 30 to 45 minutes to calibrate one sonde and over one hour to calibrate three to four sondes.

The DO probes will be calibrated with the double-bottle Winkler method. Two Winkler samples will be analyzed, and the mean of the two resulting values used to calibrate the DO probe. "Aged" tap water, at least one day old, will be used as the calibration water. The pH probes will be calibrated using pH 7.0 and 9.18 standard solutions. The conductivity probes will be calibrated using a 1,000 $\mu\text{S}/\text{cm}$ standard solution.

A double anchor method will be used for the buoys. The main anchor will be a Danforth fluked anchor. A second mushroom anchor will be located about ten feet farther along on the anchor chain. This double anchor system will secure the buoy from drifting due to the wake of passing barge tows. To discourage tampering, an anchor chain will be used instead of an anchor rope.

A nickel-plated brass sewage sampler will be used to collect probe drift-correction measurements, since it allows samples to be taken at a more precise depth. The first collection attempt at each buoy will be done only to rinse the sampler in the site's water. The second collection attempt will collect the real sample.

Boats

The Watergate Marina in Saint Paul will be the base of operations. The MPCA's 25-foot Monarch-style survey boat the *Naiad* (MN 2847XX) will be used. The backup boat is the 24-foot flat-decked, Hydrodyne-built *Skipstone* (MN1281XX). Only these two boats have both the deck space and range to cover the 44-mile long round trip on a single load of fuel. The *Skipstone* will be held in reserve on its trailer at the marina. The survey boat will be refueled each working day.

DO Monitoring at RM-3.5

Metropolitan Council Environmental Services (MCES) operates a continuous DO monitor at the airport light bridge (RM-3.5), which is a key monitoring station for the entire Minnesota River basin. Under most flows, the river water intake for the monitor is roughly one meter below the water surface. Because of the importance of checking this monitor's DO calibration, a double-bottle Winkler sample of the river will be taken one meter below the surface next to the sampling pier at the international airport's landing light bridge each day.

Field Measurements

Once every day during the survey, field measurements of DO, temperature, pH and conductivity will be taken at six locations. Measurements will be taken at the four sonde/buoy sites (miles 20.75, 15.1, 6.7, and 1.2) plus upstream of the Black Dog Generating Plant at mile 10.9 and near the MCES monitoring station at mile 3.5. Measurements will be taken in a diamond-shaped pattern, which means sampling at mid-depth one quarter of the way from each bank and at one-third and two-thirds of the depth in the center of the channel. Measurements at each point of the diamond will be recorded. In addition, Secchi disk readings will be taken at quarter points across the channel. At mid-channel, DO, temperature, pH, and conductivity will also be measured at one-half the Secchi disk depth.

Analytical Sampling

Every other day during the survey, grab samples of water will be collected at mid-channel at river miles 15.1 and 3.5 for laboratory analysis of solids, chlorophyll, nutrients, and organic carbon. Ideally the sampling device for collecting the analytical samples will be a 4.2-liter horizontal Van Dorn sampling bottle, but any operator-triggered sampling device will be adequate. See page 5 for more information on water-column sampling.

Cleaning the Sonde's DO Probe Membranes

Based on MCES' experience with biofilm fouling of probes in the Minnesota River, the DO membranes will be cleaned on either the third or fourth day of deployment.

Barge Tow Interference

When collecting instrument readings, wait at least ten minutes after a barge tow passes for river conditions to stabilize. Add an extra five minutes if analytical samples are also being collected. This should not be much of a problem since barge traffic is down. Only one or two barge round trips are expected each day on the Minnesota River.

Data Report

Data collected during the survey will be presented in a report with a preliminary analysis.

Minnesota River Sites

U.S. Army Corps of Engineers (ACE) River Mile Number and Survey Sample Station Name

Station Location

20.75 (Sonde buoy site) “Diamond” pattern site	Headwater sampling site located just far enough upstream to be beyond the influence of the Metropolitan Council’s Environmental Services’ (MCES) Blue Lake wastewater treatment plant’s discharge plume
20.5E	MCES’s Blue Lake wastewater treatment plant’s discharge (Sampling by MCES)
15.1 (Sonde buoy + water column sampling site) “Diamond” pattern site	U.S. ACE’s Upper Savage daymark.
14.7	Beginning of the U.S. ACE maintained minimum nine foot deep navigational channel
10.9 “Diamond” pattern site	Downstream of the Port Marilyn gravel pit dock at RM-11.1 and upstream of the Interstate Highway 35W bridge
10.7E	Xcel Energy’s Black Dog power plant’s Lyndale Lake cooling water discharge
8.8I	Xcel Energy’s Black Dog power plant’s cooling water intake
7.5E	Xcel Energy’s Black Dog power plant’s Cedar Lake cooling water discharge
7.3	Minnesota Highway 77 (Cedar Avenue)
6.7 (Sonde buoy site) “Diamond” pattern site	
6.5E	MCES’s Seneca wastewater treatment plant’s submerged discharge (Sampling by MCES)
4.1	Interstate Highway 494 bridge
4.09E	Metropolitan Airports Commission’s (MAC) high flow stormwater bypass Outfall #040 for the Minneapolis/Saint Paul International Airport Wolt Chamberlain Field.
3.8E	MAC stormwater Outfall #020 (Possible high CBOD ₅)
3.5 (Water column sample) “Diamond” pattern site	MAC airport landing light bridge and the location of an MCES continuous recording DO, temperature, pH and conductivity site
3.0E	MAC stormwater Outfall #030 (Snelling Lake discharge)
1.2 (Sonde buoy site) “Diamond” pattern site	Downstream of the Pike Island channel (A predicted summer low DO point during a low flow summer.)

Field Instrument Data Collected at the Quarter Points of the Channel's Width

Once every day, the following field measurements will be taken in a diamond-shaped sampling pattern at river miles 20.75, 15.1, 10.9, 6.7, 3.5, and 1.2:

Dissolved Oxygen
Temperature
pH
Specific Conductivity at 25 °C

The diamond pattern means sampling at mid-depth one quarter of the way from each bank and at one-third and two-thirds of the depth in the center of the channel. Measurements at each point of the diamond will be recorded. In addition, Secchi disk readings will be taken at quarter points across the channel. At mid-channel, DO, temperature, pH, and conductivity will also be measured at one-half the Secchi disk depth.

Analytical Data

These are individual (not composite) samples collected **every other day** at mid-channel at river miles 15.1 and 3.5. Samples should be collected at the point of the channel's width where most of the river's flow is passing, at both 1/2 of the Secchi disk depth and 2/3 of the way down from the surface. The Minnesota Department of Health will process the samples. James Klang, MPCA, requested these analyses.

Chlorophyll <i>a</i>	1-liter general chemistry bottle
Total solids -----	
Total volatile solids	
Total suspended solids	One 2-liter general chemistry bottle
Total volatile suspended solids	
Total orthophosphorus (2-day holding time) -----	
Kjeldahl nitrogen -----	
Organic nitrogen	
Ammonia nitrogen	
Nitrate + nitrate nitrogen	Two acidified 250-mL nutrient bottles
Total phosphorus	
Total organic carbon (requested by MCES)	
Dissolved organic carbon (requested by MCES) -----	

These sample bottles will be stored in an ice chest containing several bags of ice. These samples will be delivered to the lab the following day or the same day if they can be delivered to the laboratory before 15:30. Mankato State University, under the Middle Minnesota River Monitoring Program, will do corresponding sampling upstream of the Metropolitan reach.