## **Nutrient Enrichment**

#### Nitrogen

The predominant form of nitrogen in Minnesota River Basin streams is nitrate. Like phosphorus, nitrate can stimulate excessive levels of algal growth in streams. In recent years, this problem has been particularly severe in the Gulf of Mexico where development of a hypoxic zone (hypoxia means "low oxygen") has been linked to elevated nitrate levels carried to the Gulf by the Mississippi River. Reduced oxygen levels in the hypoxic zone, brought on by decomposition of algae, have damaged the shellfish industry and continue to threaten the aquatic ecosystem of the Gulf Region. The Minnesota River has been identified as a substantial contributor of excess nitrate to the Mississippi River and the Gulf Region.

Nitrate-Nitrogen (nitrate-N) concentrations vary substantially across the Minnesota River Basin. Nitrate-N levels are lowest in the western part of the Basin, elevated in the central portion and greatest in agricultural watersheds in the most easterly part of the Basin. The watersheds shown in orange and red have concentrations that exceed the drinking water standard (10 mg/L). Most of the nitrate-N in the Minnesota River comes from fertilizer, manure, and agricultural drainage.







This image shows the hypoxic zone (sometimes referred to as the dead zone) in the Gulf of Mexico. Reds and orange indicate areas of low oxygen concentration. In July 2008, the hypoxic zone was mapped at 7,988 square miles – the second largest on record since measurements began in 1985. This is larger than the land area of the state of Massachusetts.

## **Environmental Health**

#### Nitrate in Drinking Water

Elevated levels of nitrate in drinking water can cause methemoglobinemia, or blue-baby syndrome. Because of this, both State and Federal regulations



limit nitrate in drinking water to 10 parts per million (ppm) to protect prenatal and infant children. During the 2000 to 2008 monitoring period, several tributary streams in the Minnesota River Basin periodically exceeded the 10 ppm standard. The City of Mankato draws drinking water from a shallow aquifer that is connected to, and partially recharged by, the Blue Earth River. Nitrate-N levels in the Blue Earth River strongly influence nitrate levels in Mankato's water intake supply.



**Pesticides** The Minnesota Department of Agriculture (MDA) is the lead state agency for most aspects of pesticide and fertilizer regulatory functions. The MDA Monitoring Unit collects pesticide samples from multiple stream locations in the Minnesota River Basin. Pesticide monitoring data indicate the seasonal presence of several chemicals

sometimes at levels of concern. Two waterways were included on the 2008 Impaired Waters List for elevated levels of the pesticide Acetochlor. For more information, see the MDA website for the latest information and reports: http://www.mda.state.mn.us/chemicals/pesticides/default.htm

**Mercury** In Minnesota, mercury contamination of fish is a welldocumented problem. Mercury is tightly bound to proteins in all fish tissue, including muscle. There is no way to reduce the amount of mercury in a fish through cooking or cleaning it. The Minnesota Department of Health advises people to restrict their fish consumption due to mercury accumulation in sport fish from lakes and rivers. Large amounts of mercury in your body may harm your nervous system. For more information, see the Minnesota Department of Health's guideline on fish



consumption at http://www.health.state.mn.us/divs/eh/fish/index.html

#### Bacteria

 $\it E.~coli$  bacteria concentration in colony forming units per 100 milliliters. Map includes sites with at least 20 samples. State Water Quality Standards for  $\it E.~coli$  is 126 cfu/100 ml



The presence of indicator bacteria (*E. coli* and fecal coliform) indicate the potential presence of disease-causing organisms. Indicator bacteria levels are elevated across the entire Basin with greater than 90 percent of monitored streams exceeding health standards for bacteria. Data show the highest concentrations in the eastern portion of the Basin (see map). Many streams require an 80 to 90 percent reduction in levels to meet standards.

For more information, visit the Minnesota River Basin Data Center website: http://mrbdc.mnsu.edu Research and photos courtesy of the Minnesota Pollution Control Agency (MPCA), Metropolitan Council Environmental Services (MCES), Minnesota Department of Agriculture (MDA), Minnesota Department of Natural Resources (MNDNR), and NASA Visible Earth Program Produced by Minnesota State University, Mankato Water Resources Center - 9/09

## State of the Minnesota River Water Quality Summary 2000-2008

Conwood River

Watonwan River

# Water Quality Monitoring



The Minnesota River flows more than 335 miles from its source near the Minnesota-South Dakota border to its confluence with the Mississippi River at Minneapolis/St. Paul. The Minnesota River is the state's largest tributary

to the Mississippi River. The Minnesota River Basin, the land that drains into the Minnesota River, encompasses roughly 15,000 square miles and contains all or parts of 37 Minnesota counties. The river drains nearly 20 percent of Minnesota and winds through a predominantly agricultural landscape.

Researchers collect water quality samples from across the Minnesota River Basin. A multi-agency team reviews and evaluates water quality data every other year and prepares a State of the Minnesota River monitoring report which can be found online on the Minnesota River Basin Data Center website: http://mrbdc.mnsu.edu

This overview summarizes water quality monitoring at four Minnesota River mainstem locations and fourteen outlets of major tributary streams. The information represents results from more than 4,000 water-quality samples collected from 2000 to 2008. Team partners include state and county agencies and many watershed projects throughout the Basin.







increase in a west-to-east pattern.



worth of water quality data from the Minnesota River at Jordan and Fort Snelling. Trend analyses indicate increasing nitrate-N concentrations in the last ten years. Decreasing trends in total suspended solids and total phosphorus were found over the entire period.

Minnesota River Basin monitoring data from 2000

Water quality data have been collected throughout

the Minnesota River Basin during the past thirty

years and studies have shown excessive nutrient

and sediment concentrations. Large portions of the basin do not meet state water quality standards for bacteria, turbidity, dissolved oxygen, ammonia, and

to 2008 indicate three major categories of water

quality concerns: excessive sediment, nutrient

enrichment and environmental health.

## **Excessive Sediment**

Excessive amounts of sediment degrade the ecological health and aesthetics of the Minnesota River and its tributaries. Turbidity refers to water clarity. The greater the amount of total suspended solids in the water, the murkier it appears and the higher the measured turbidity. This results in reduced light penetration that harms beneficial aquatic species and favors undesirable algae. An overabundance of algae further increases turbidity and compounds the problem.

Fine-grained sediments that settle on stream beds cover desirable rock and gravel that form essential habitats for invertebrates and fish. During periods of high turbidity, streams take on a murky appearance, greatly reducing their appeal to people who enjoy boating, fishing, or swimmir



The photos above show the dramatic increase in turbidity that often occurs when heavy rains fall on unprotected soils. Upon impact, raindrops dislodge soil particles while runoff waters easily transport fine particles of silt and clay across fields or through drainage systems to ditches and tributary streams throughout the Minnesota River Basin. Photo: Chetomba Creek, Hawk Creek Watershed. Note photos were taken only one day apart.

#### Total Suspended Solids

Average Total Suspended Solid Yield in pounds per acre





Streambanks and gullies also contribute sediment to the streams and rivers. Photo: Le Sueur River streambank

The sediment laden Minnesota River flows into the Mississippi River.





Sediment settles in Lake Pepin. Over 90 percent of Lake Pepin's sediment load is coming from the Minnesota River. The lake is filling in at 10 times its natural rate.

greater than the threshold value (see map). These highly-enriched tributary streams deliver phosphorus loads that enrich the mainstem and slow the recovery of the Minnesota River. Phosphorus arises from both point (e.g. municipal and industrial discharges) and non-point sources (e.g. runoff from agricultural lands and urban areas).

### **Nutrient Enrichment**

#### Phosphorus

Phosphorus-enriched streams are commonplace in the Minnesota River Basin. Elevated phosphorus levels stimulate algal growth and often lead to undesirable conditions. An overabundance of algae and sediment contributes to increased turbidity and reduced light penetration. Water clarity is greatly reduced under these conditions. When the algal cells die, their decomposition consumes large amounts of dissolved oxygen. Lower dissolved oxygen can impair the stream's ability to support aquatic life. Some outbreaks of highly elevated algal growth, termed algal blooms, release toxins into the water. Instances of this have occurred within the Minnesota River Basin and resulted in the death of animals (including pets) that ingested these toxins.

Phosphorus concentrations show substantial variation across the Basin. During 2000 to 2008, the average phosphorus concentration in the Minnesota River mainstem reach from Judson to Fort Snelling was 0.31 mg/L. Studies indicate that a reduction in undesirable algal growth cannot be expected unless mainstem phosphorus concentrations are brought below a threshold value of 0.26 mg/L. Several Minnesota River tributaries have phosphorus concentrations substantially

# 1

Watonwan River algal bloom.



Blue Earth River algal bloom.



Lake Pepin algal bloom. The lake is accumulating phosphorus at 15 times the natural rate.

#### Total Phosphorus

Average Flow Weighted Mean Concentrations in milligrams per liter