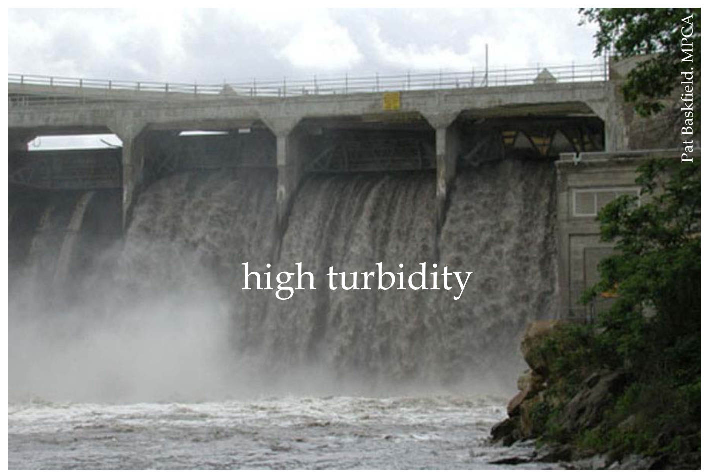
SEDIMENT

ASK an EXPERT
ABOUT THE MINNESOTA RIVER

What is Turbidity?

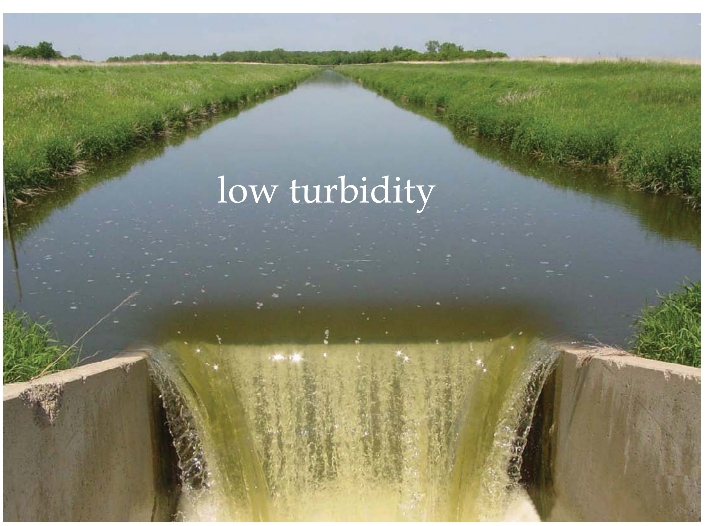
Turbidity refers to how clear the water is. The greater the amount of total suspended solids (TSS) in the water, the murkier it appears and the higher the measured turbidity.

Excessive amounts of sediment degrade the ecological health and aesthetics of the Minnesota River and its tributaries. When suspended sediment, measured by TSS (total suspended solids), is elevated, turbidity increases, water clarity decreases, and light penetration is reduced. Reduced light penetration shifts stream productivity away from beneficial periphyton (mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems) and favors undesirable floating algae. An overabundance of floating algae (phytoplankton) further increases turbidity, compounding the problem. Fine-grained sediments that settle on stream beds cover and degrade the desirable rock and gravel substrates that form essential habitats for invertebrates and fish. During periods of high turbidity, streams take on a murky brownish-green cast, greatly reducing their appeal to people who enjoy water-based recreational activities such as boating, fishing, or swimming.



Pat Baskfield, MPCA

The Blue Earth River at the Rapidan Dam is shown (above) during low and high turbidity.



Chetomba Creek
Hawk Creek Watershed Project

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.

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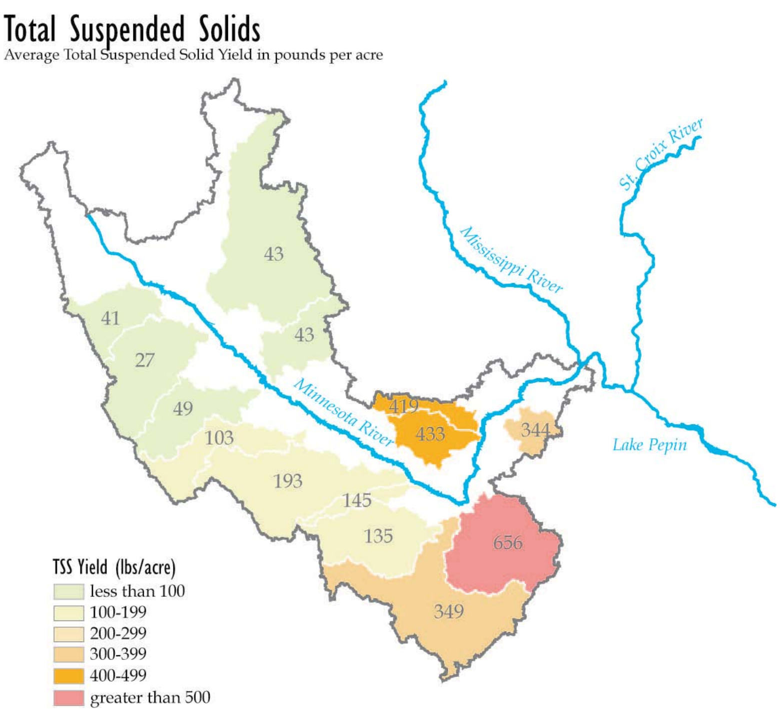
Excessive amounts of sediment degrade the ecological health and aesthetics of the Minnesota River and its tributaries. Turbidity refers to water clarity. The greater the amount of total suspended solids in the water, the murkier it appears and the higher the measured turbidity. This results in reduced 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 swimming.

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.

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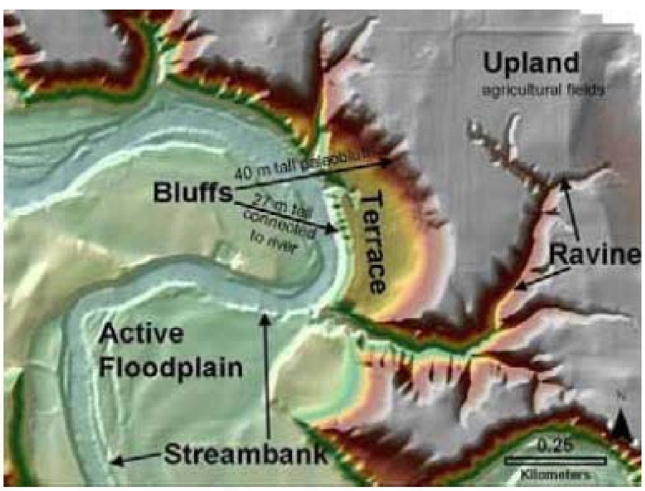
What are Total Suspended Solids?

The transport of sediment is a natural function of rivers. Modification of the landscape has accelerated the rate of erosion of soil into waterways. Increased runoff has resulted in stream bank erosion. Elevated sediment (suspended soil particles) has many impacts. It makes rivers look muddy, affecting aesthetics and swimming. Sediment carries nutrients, pesticides, and other chemicals into the river that may impact fish and wildlife species. Sedimentation can restrict the areas where fish spawn, limit biological diversity, and keep river water cloudy, reducing the potential for growth of beneficial plant species.

Primary Sources of Sediment

Bluffs, ravines, gullies, streambanks, and upland runoff contribute sediment to the streams and rivers in the Minnesota River Basin. Urban stormwater and construction sites also contribute sediment.



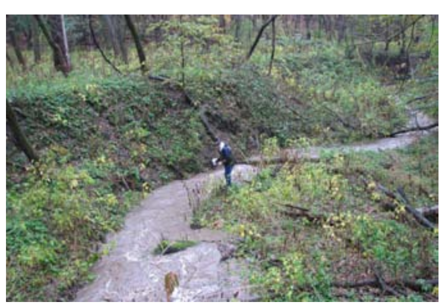
Primary sources of sediment illustrated on a digital elevation model of a portion of the Le Sueur River watershed. Source: Wilcock, 2009

Le Sueur River water quality samples (above) collected throughout the 2002 monitoring season. This illustrates the variability in turbidity throughout the year.

Streambanks

Bluffs like this one in the Le Sueur River Watershed contribute sediment to waterways in the Basin.

Ravines



Ravines are another source of sediment.

Uplands

Soil erosion in farm fields also contributes sediment to streams and rivers. Soils are most vulnerable during the post planting period when residue is minimal and crops have not formed a protective canopy.

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Tributaries are displayed in downstream order from left to right (west to east) on Figure 1. The tributaries in the middle and downstream parts of the Minnesota River Basin have, in general, greater flow weighted mean concentrations (FWMC) and greater year-to-year variability than tributaries in the western, upstream, part of the basin. The horizontal line indicates threshold level (58 mg/L and 66 mg/L) established by Minnesota Pollution Control Agency for streams in the Western Corn Belt Plains and Glaciated Plains ecoregion (MPCA, 1993). The Total Suspended Solids (TSS) FWMC values are indicators of the condition of the tributary streams and are a measure of their potential to affect water quality in the Minnesota River (Fig 2). FWMC are calculated on a monitoring season basis (approximately April through September).

Total Suspended Solids - Major Tributary Sites
Flow Weighted Mean Concentrations at Major
Minnesota River Tributary Sites (2000-2008)

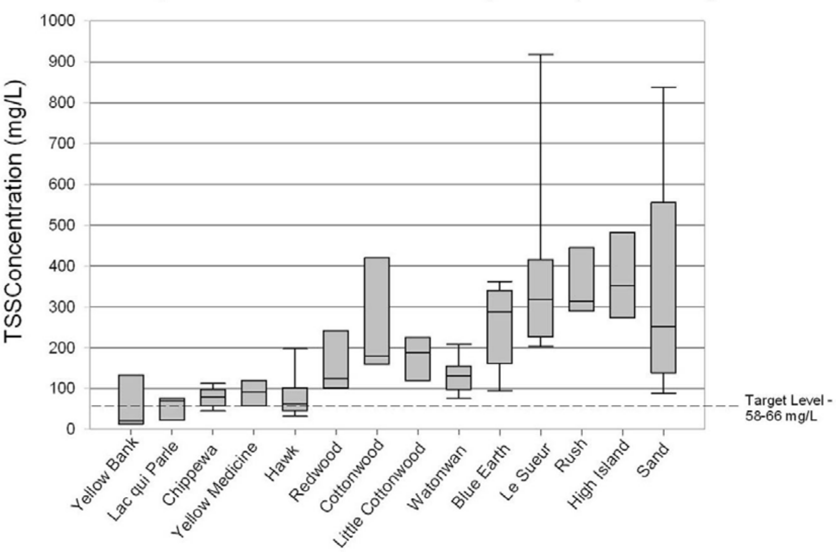

Fig 1
Boxplot showing the monitoring season (approximately April through September) total suspended solids FWMC for major Minnesota River tributary streams in the Minnesota River Basin.

Total Suspended Solids - Mainstem Sites
Flow Weighted Mean Concentrations at Minnesota River Mainstem Sites (2000-2008)

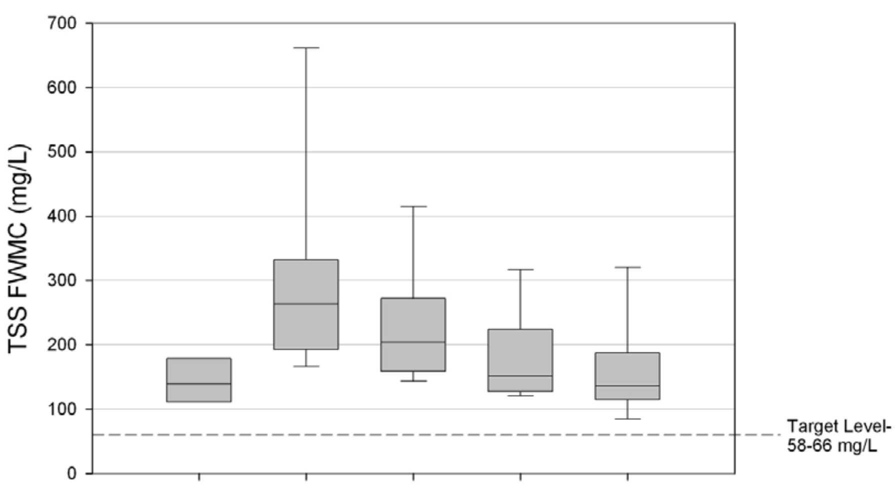

Fig 2
Boxplot showing monitoring season total suspended solids FWMC for Minnesota River and Greater Blue Earth River samplingv sites. The median FWMC's clearly show a decrease in TSS from St. Peter to Jordan to Fort Snelling. After examining a sediment "budget" for the lower Minnesota reach, researchers hypothesize that deposition may account for the apparent sediment "loss",especially in years that the River accesses its floodplain.

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Yields, shown as pounds of sediment delivered per watershed acre, are indicators of the severity of erosion in each tributary watershed. Fig 3-4 show that sediment yields generally increase from west to east across the Minnesota River Basin and that watersheds in the eastern, downstream, part of the Basin have greater year-to year variability in sediment yield. Tributary streams that have greater yields and large watersheds like the Le Sueur have the greatest potential to affect water quality in the Minnesota River mainstem. Figure 3 illustrates four broad data categories across the basin: 1) <100 pounds per acre (western Basin), 2) 100-200 pounds per acre (middle Basin), 3) 400 pounds per acre (Blue Earth & Le Sueur sub-basin), and 4) 300 pounds per acre (lower basin). These results may reflect four combination sets of geomorphology, management practices, and climate variables that define water quality in each of the geographical areas.

Total Suspended Solids - Yields at Major Tributary Sites
Yields at Major Minnesota River Tributary Sites (2000-2008)

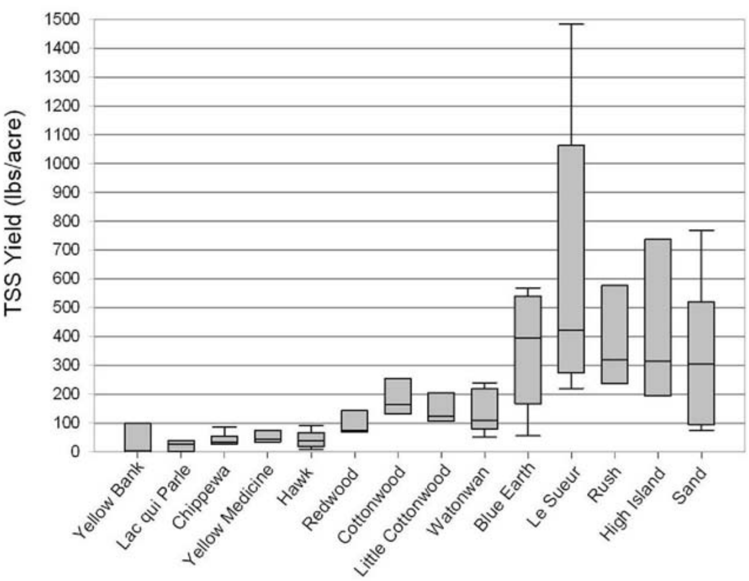

Fig 3
Boxplot showing monitoring season TSS yields for major tributary streams in the Minnesota River Basin.

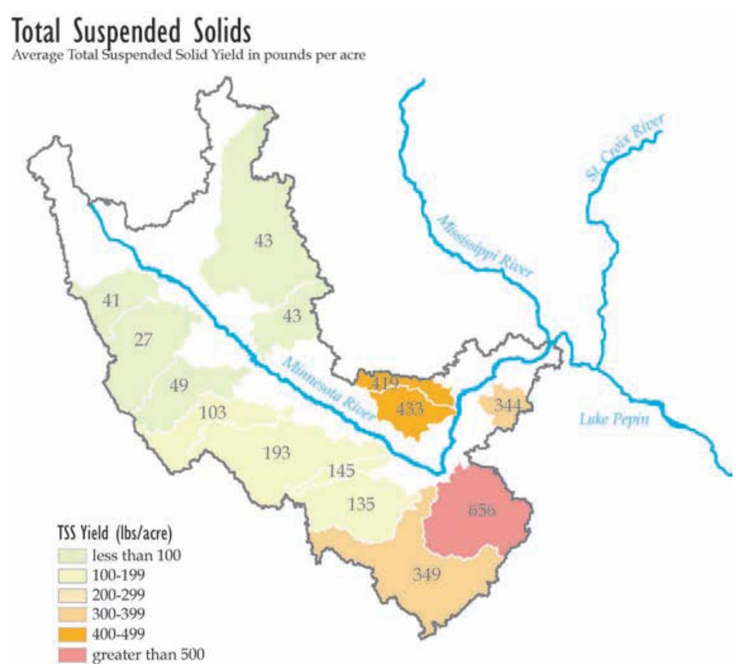

Fig 4
displays the pattern of the nine year yields (2000-08) indicating the disproportionate contribution from the watersheds in the eastern part of the basin. Locations not colored did not have available information.

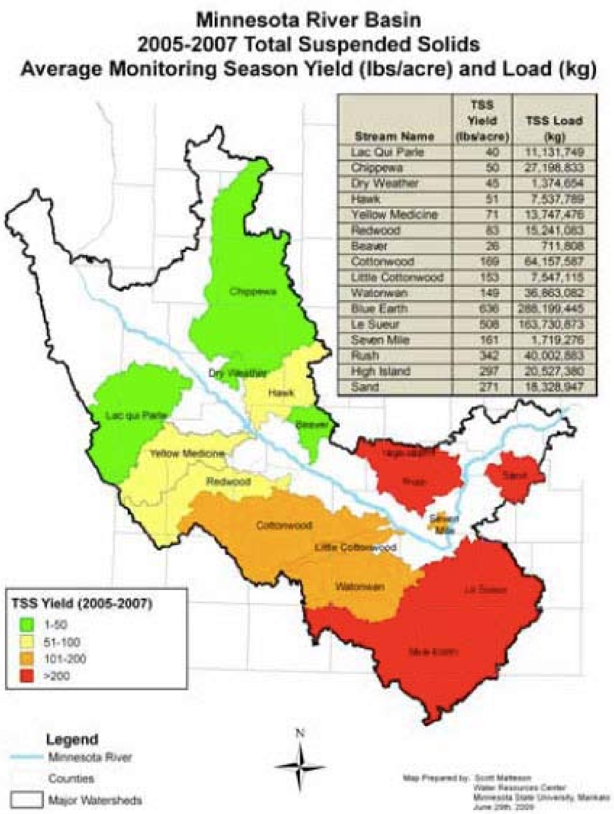

Figure 5. Map of Minnesota River Basin showing annual TSS yield (lbs/acre). Total annual TSS load in kg is given in the inset table.

Sources Contributing to Yields

Erosional processes in fields, streambanks, bluffs, and ravines all contribute to sediment yield. In the western part of the Minnesota River Basin, field erosion and streambanks are the predominant sediment sources. Further east in the Basin, the Minnesota River and its tributaries are more deeply incised resulting in steep bluff areas and ravines. Areas containing bluffs and ravines are located in the downstream reaches of the tributaries where the streams approach their confluence with the Minnesota River. The yields (fig. 3-4), were gathered from downstream monitoring stations near stream mouths, and thus reflect the influence of bluff and ravine erosion in those tributaries where incised terrain features are extensive. Paired monitoring stations, placed upstream and downstream of incised terrain in seven of the tributary watersheds, have clearly shown that sediment yield is greater in the incised areas of those watersheds. Wilcock (2009) summarized findings presented to the Minnesota River Sediment Colloquium concerning these and other sediment sources.

Loads

"For a five year period starting in 2002, the TSS load was 1.8 million tons at Judson and 5.4 million tons at St. Peter, a 300% increase. Nearly all of the increased load can be attributed to the TSS supply from the Blue Earth and Le Sueur Rivers, which discharge into the Minnesota between the two gauges. The 2002-2006 TSS load of these rivers was measured as 3.2 million tons" (Wilcock, 2009).

Downstream Impacts

Lake Pepin is a natural impoundment along the Upper Mississippi River just downstream of St. Paul. The Mississippi River carries sediment downstream and it settles in Lake Pepin. Most of Lake Pepin's sediment is coming from the Minnesota River. Recent studies have indicated an approximate ten fold increase in post-settlement sedimentation rates in Lake Pepin. The Minnesota River, while only accounting for 25% of the flow into the lake is responsible for 88% of the sediment load. The lake is filling in at 10 times its natural rate (Engstrom and Almendinger, (1997).

The sediment laden Minnesota River (left) flows into the Mississippi River (right). When the Minnesota River meets the Mississippi River it carries elevated sediment and nutrient concentrations.

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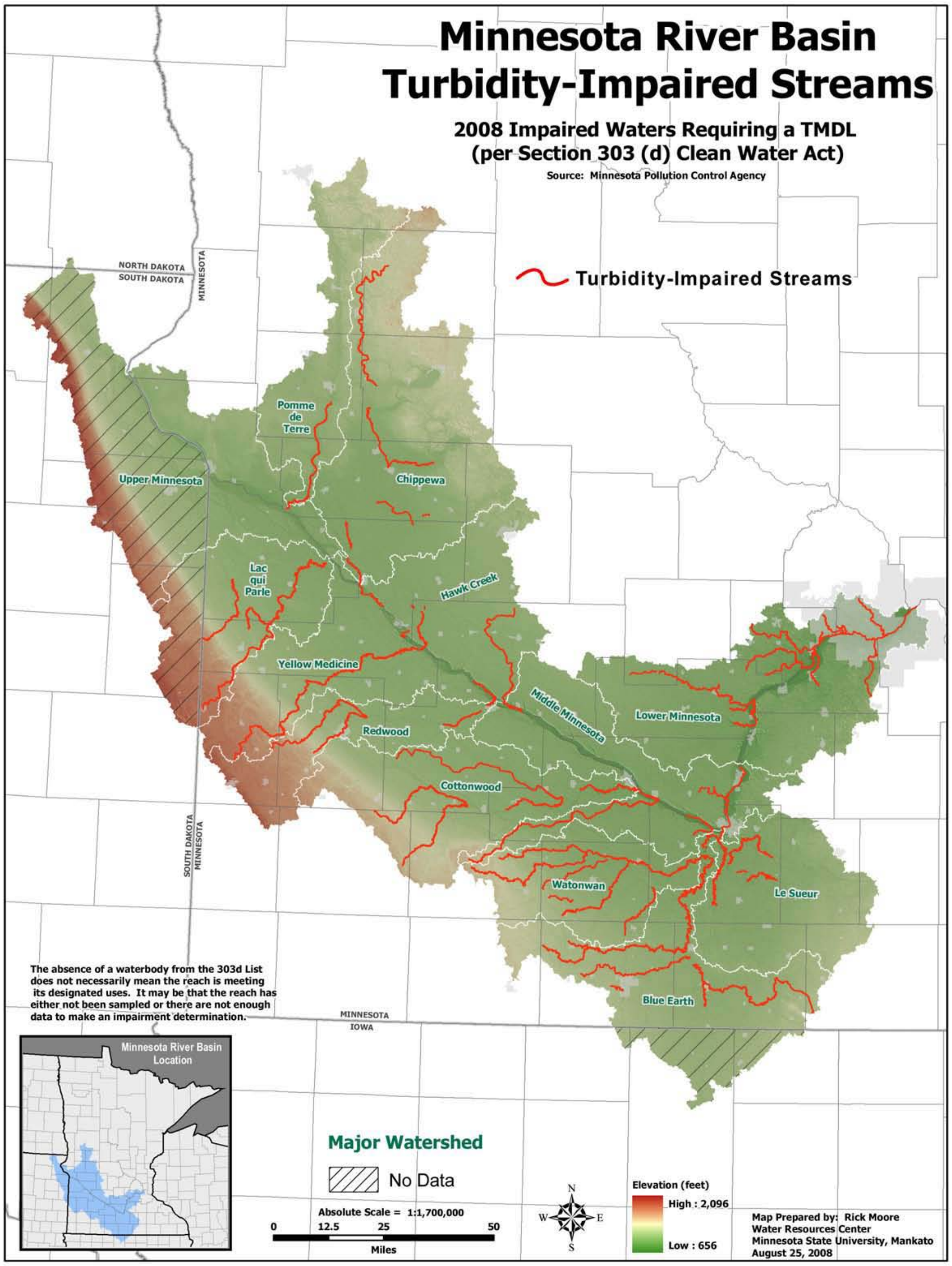

The "Minnesota River Basin Turbidity-Impaired Streams" map above shows assessed water bodies that do not meet Minnesota water quality standards for turbidity and are therefore listed on the Minnesota's Impaired Waters 303(d) List. Learn more about impaired waters on the MPCA website: http://www.pca.state.mn.us/water/tmdl/tmdl-303dlist.html

"Ask an Expert about the Minnesota River" project profiles scientists and citizens answering questions about the health of the Minnesota River. More answers to questions about the Minnesota River can be found at: mrbdc.mnsu.edu/learn

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