

## 5.0 Overall Conclusions

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The results of this assessment indicate that the estimated amounts of total and bioavailable phosphorus entering surface waters within each major basin and the state vary significantly, both by source category and by flow condition. The phosphorus loadings associated with several point and nonpoint source categories can be controlled to various levels, resulting in significant water quality improvements, depending on the water resource and flow condition. The following discussion provides some overall conclusions from this assessment:

- Because of the general nature of this analysis, it can be true that sources of phosphorus which are deemed minor at the basin scale, may actually contribute the majority of phosphorus to specific surface water bodies, at a localized scale. For example, point sources typically contribute little or no phosphorus to Twin Cities Metropolitan and most outstate lakes, but can represent a significant portion of the total phosphorus load to rivers under low flow conditions. Because of this, there is still a need to complete individual assessments of specific watersheds to evaluate specific loading conditions.
- Under average conditions, the point source total phosphorus contribution represents 31 percent of the loadings to surface waters, statewide, whereas nonpoint sources contribute 69 percent. Of these nonpoint sources, cropland and pasture runoff, atmospheric deposition, streambank erosion, human waste products, and commercial/industrial process water each represent between 10 and 30 percent of the total phosphorus loading. All of the remaining source category contributions are below 6 percent. The combination of household and commercial automatic dishwasher detergent represents approximately 3 percent of the total phosphorus contributions to surface waters in the state, during an average year.
- Under low flow conditions, the total point source phosphorus contribution represents 45 percent, compared to 31 and 19 percent for the statewide loadings to surface waters under average and high flow conditions, respectively. The bioavailable low flow point source phosphorus contribution represents 57 percent of the statewide loadings, confirming that point sources of phosphorus are more bioavailable than nonpoint sources. Comparing high flow to average and low flow conditions, the relative statewide nonpoint source contributions of total phosphorus increased significantly for streambank erosion, decreased somewhat for urban runoff, and decreased significantly for atmospheric deposition and ISTS/unsewered communities.

- Nonpoint source phosphorus loadings nearly double from low to average flow conditions, and again from average to high flow conditions.
- Human waste products represent a significant portion of the total and bioavailable phosphorus loadings in the Upper Mississippi and Cedar River basins under each flow condition; and on a statewide basis, for the low and to a lesser extent average flow conditions. During low flow conditions, human waste products contribute between 10 and 20 percent of the bioavailable phosphorus loadings in the Lake Superior and St. Croix, Lower Mississippi, Red, Missouri, and Minnesota River basins.
- Commercial/industrial process water represents a significant portion of the total and bioavailable phosphorus loadings in the Upper Mississippi, Lower Mississippi, Minnesota, and Des Moines River basins under each flow condition, and on a statewide basis, for the low and to a lesser extent average flow conditions.
- Phosphorus contributions from ISTS/unsewered communities are of relative importance in the St. Croix River basin.
- Cropland and pasture runoff represents a significant portion of the total and bioavailable phosphorus loadings in the St. Croix, Lower Mississippi, Red, Missouri, Minnesota, Cedar and Des Moines River basins, and on a statewide basis, under all flow conditions. The phosphorus contribution from cropland and pasture runoff is also significant in the Upper Mississippi River basin for the average and high flow conditions.
- Atmospheric deposition represents a significant portion of the phosphorus loadings in the Lake Superior, St. Croix, Red, and Rainy River basins for each flow condition.
- Non-agricultural rural runoff contributes a significant portion of the phosphorus loadings in the Lake Superior and Rainy River basins for each flow condition, although the typical rate of total phosphorus export from each acre of non-agricultural land is approximately four times lower than the corresponding load from each acre of contributing cropland and pasture runoff.
- Streambank erosion is an important source of phosphorus under high flow conditions for all of the basins, and is fairly significant in the Lake Superior, Lower Mississippi, Rainy and Missouri River basins under average flow conditions. Streambank erosion can also contribute

somewhat significant amounts of total phosphorus statewide and to the Minnesota and Cedar River basins under average flow conditions.

- The concepts for lowering the phosphorus export from point sources address possible reductions of phosphorus discharged to POTWs as well as phosphorus discharged to the surface waters in each basin. Food soils would be very difficult to reduce, and dentifrices, noncontact cooling water and I & I contribute little to the influent phosphorus load discharged to POTWs. If residential and commercial/institutional ADWD and water treatment chemicals were eliminated completely, commercial and industrial process wastewater would still need to be reduced more than 64 percent to attain a 50 percent reduction in the total non-ingested phosphorus contribution to POTWs (the goal established in MN Laws 2003, Chap. 128 Art. 1, Sec. 122). Given the difficulties in completely eliminating phosphorus from commercial/institutional ADWD and water treatment chemicals, and reducing the commercial and industrial process wastewater loading by more than 64 percent, a 50 percent reduction of non-ingested influent phosphorus appears to be an ambitious goal. In addition, a 50 percent reduction in influent may not mean a 50 percent reduction in the effluent depending upon the type of wastewater treatment processes used.
- A large portion of the influent phosphorus load to POTWs is from human waste products and/or is largely uncontrollable. Continued implementation of enhanced biological phosphorus removal (EBPR) will significantly reduce effluent phosphorus concentrations.
- Public education about the use of ADWD based on hardness and the availability of no- and low-phosphorus content products should be encouraged.