Comment on "Impacts of a Phosphate Detergent Ban on Concentrations of Phosphorus in the James River, Virginia"

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1995

In their article, Hoffman and Bishop reported that the enactment of a detergent phosphate ban in Virginia in 1988 resulted in a decrease in the difference in phosphorus concentration in the James River above and below the city of Richmond's wastewater treatment plant discharge. They concluded, *"This is evidence that implementation of the ban reduced loadings of phosphorus to the James River and improved water quality of the river."* Of concern to us, and the reason for this comment, was those authors' equating of the decrease in phosphorus concentration with an improvement in water quality in the James River. Having been involved in water quality studies on the James River, and having spent considerable time studying eutrophication of waterbodies and evaluating the impact of phosphorus on water quality, we find that the claim of improvement in water quality in the James River as a result of the Virginia detergent P ban has not been properly substantiated. A decrease in phosphorus concentration does not, *per se*, demonstrate an improvement in water quality; it only constitutes an improvement in water quality if it effects a significant decrease in algal-related water quality problems such as would be measured by planktonic algal biomass, algal-related water clarity, or hypolimnetic oxygen depletion.

As described by Lee and Jones (1988), there may have been an unusual situation where a detergent phosphate ban in the USA in the early 1970's could have resulted in improvement in a waterbody's water quality. However, since the mid-1970's the phosphorus content of detergents, and therefore detergent's contribution to the P content of domestic wastewaters, has been reduced in areas not under detergent-P bans, to the point at which a detergent P ban would not impact the phosphorus content of domestic wastewaters sufficiently to cause an improvement in eutrophication-related water quality.

Lee and Jones (1986) reported that at least a 25% reduction in the algal-available P load to a waterbody is needed before a measurable change in the planktonic algal biomass would occur. Their finding was developed from the results of the five-year OECD Eutrophication Studies that involved more than 200 waterbodies in 22 countries (in western Europe, North America, Japan, and Australia) and subsequent studies of the authors (see Jones and Lee 1982, 1986). The updated Vollenweider-OECD normalized P load--eutrophication response models are based on the behavior of more than 750 waterbodies throughout most of the world and have been demonstrated to provide credible prediction of the algal biomass that will develop under altered P-loading conditions. Lee and Jones (1981) found that the Vollenweider-OECD model relating phosphorus load to planktonic algal chlorophyll was applicable to the Potomac Estuary and to Chesapeake Bay. Not only did that model reliably predict the planktonic algal

chlorophyll based on its normalized loading, but it also reliably predicted the planktonic algal chlorophyll after alteration of the P load to the Estuary.

The relationship mentioned above between P load change and change in algal biomass was based largely on lake, reservoir, and estuarine situations. For rivers, especially the James River and similar rivers, a much larger change in algal available P loads is needed to cause a change in planktonic algal biomass. To effect significant reductions in attached algae, the reduction in P load would need to be larger still.

The contribution of detergent-P to domestic wastewaters in non-ban areas has decreased significantly from what it was two or three decades ago. It is sufficiently low that the adoption of a detergent P ban in 1988 as the state of Virginia did, would not have been expected, and would not be expected now, to produce a sufficient change in total P load to a waterbody to cause a measurable change in the algal biomass, even if domestic wastewater were the only source of P for the waterbody.

Hoffman and Bishop stated that the Federal-Interstate Chesapeake Bay Agreement committed the states of the region to implement strategies for reducing the nitrogen and phosphorus loads entering Chesapeake Bay by 40% by the year 2000. A 40% reduction in the algal available phosphorus loads to Chesapeake Bay would be expected to improve the eutrophication-related water quality of the Bay. However, the approach that is being taken by those states for P load reduction includes curtailment of phosphorus loads from non-point-source runoff, such as runoff from agricultural lands. As discussed by Lee *et al.* (1980), a large part of the phosphorus derived from non-point-source runoff is in particulate forms, only a small part of which (typically about 20%) is available for algal growth. This means that the expected improvement of the eutrophication-related water quality of Chesapeake Bay will be some what less than that projected from a reduction in total phosphorus load reduction by 40%.

In a discussion of the Chesapeake Bay Restoration Progress (Anonymous, 1994), it was stated that the phosphorous concentrations in the main part of Chesapeake Bay dropped 16% between 1984 and 1992 largely because of the upgrades in wastewater treatment plants and a regionwide ban on phosphates in detergents. As discussed above, a 16% change in total phosphorous concentration in the Bay would not be expected to have produced a discernable improvement in Bay water quality.

The mistake of trying to equate reduction in phosphorus concentrations to improvement in eutrophication-related water quality, is commonly made. For example, the US EPA (1994) recently released its "National Water Quality Inventory 1992 Report to Congress." Throughout that report, the Agency confused changes in "water quality" with changes in chemical concentrations. The summary of that report stated that the water quality monitoring data confirmed the 16% decrease in total phosphorous concentration in Chesapeake Bay between 1984 and 1992. No mention was made, however, of the changes, if any, in real eutrophication-related *water quality* parameters - the parameters that affect beneficial use - e.g., planktonic algal biomass, algal related water clarity, the extent of hypolimnetic oxygen depletion, etc. in the Bay waters. Those are the parameters

that should be used to judge, after appropriate equilibration time, the efficacy of the phosphorous control program that was initiated in the states near the Bay.

In making its assessment of impairment of the water quality of the Nation's waters, the US EPA (1994) used arbitrarily developed nutrient concentration levels in rivers as a basis for concluding that 37% of the water quality problems of the US rivers are due to nutrient enrichment. A critical review of the real water quality issues in those rivers, however, shows that it is indeed rare that nutrient enrichment leading to increased algal growth is impairing the designated beneficial uses of the rivers.

It is important not to confuse changes in concentrations of chemicals with changes in *water quality*. For many situations, large changes in the concentration of a contaminant can occur without changes in the real water quality of the water. Water quality should be assessed based on the change in the designated beneficial uses of the water that are of concern to the public who must ultimately fund the contaminant control program. In assessing the change in water quality of a particular waterbody that may arise from a given change in phosphorus loads, the type of waterbody (lentic or lotic), the magnitude of change in the algal available P load, the type of algal populations of concern (planktonic or attached), as well as several other morphologic and hydrologic factors must be evaluated. While the adoption of a detergent phosphate ban in the state of Virginia did apparently reduce the phosphorus concentrations in the James River below the city of Richmond as expected, the change in the phosphorus concentration in a river is not a measure of a change in the eutrophication-related water quality. The real measures of change in water quality were not reported. It has not been demonstrated that the detergent P ban adopted by the state of Virginia produced a change in water quality of the James River.

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Reference as:"Lee, G. F. and Jones-Lee, A., 'Comment on "Impact of a Phosphate Detergent Ban on Concentrations of Phosphorus in the James River, Virginia".' Wat. Res. 29:1425-1426 (1995)."