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Treatment wetlands: Cost-effective practice for intercepting nitrate before it reaches and adversely impacts surface waters

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Constructed treatment wetlands—an innovative conservation practice advocated by the USDA Farm Service Agency (FSA)—can be an exceedingly cost-effective approach to reducing nitrogen loadings in watersheds dominated by tile-drained cropland. The practice has potential to enhance water quality in regions such as the Corn Belt that are extensively tile drained.

The treatment wetland practice is part of the Iowa Conservation Reserve Enhancement Program (CREP), a partnership between FSA and the Iowa Department of Agriculture and Land Stewardship. Initiated in 2001, the Iowa CREP encourages farmers to adopt practices that ameliorate the effects of tile-drained lands on water quality. Tile drainage systems in North Central Iowa are targeted for enrollment. In addition to Conservation Reserve Program annual rental payments and 50% cost-share payments, producers are offered incentive payments and easements to encourage participation.

The Iowa CREP project demonstrates the effectiveness of situating treatment wetlands at suitable locations along tile drainage systems, such as the headwaters of small streams, to intercept and denitrify water from tile drainage.

The Iowa CREP is currently authorized to enroll 9,000 ac (3,642 ha) of treatment wetlands on tile-drained cropland. These wetlands consist of the treatment pool itself and a grassed buffer around it to prevent sediment from overwhelming the wetland. The wetland buffer to pool ratio currently averages 3.6 to 1. The size of the 27 wetland pools and buffers constructed to date are modest, ranging in combined size from 18 to 70 ac (8 to 29 ha). However, the 0.5% to 2% range in wetland pool-to-watershed ratio stipulated by the program permits these wetlands to reduce nitrogen runoff from a much greater area. Monitoring data from these wetlands show they remove 40% to 90% of the nitrate flowing into the wetlands. Given the focus on surface water quality improvements, these treatment wetlands are not necessarily located where wetlands existed historically.

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A review of the practice's costs found them to be relatively modest. We reviewed the federal and state funds spent to establish 27 of the existing treatment wetlands. Federal funds defrayed most of the construction costs and continue to provide a stream of rental payments that compensate for the agricultural returns forgone by program participants. The remainder of construction costs was covered by the state, as was a conservation easement payment. To facilitate comparison to other practices, we calculated the net present value (using an interest rate of 4.7%) of the cost and payment streams over an assumed lifespan of 50 years.

The total package of incentives provided by the FSA and the State of Iowa averaged \$1.38 lb^{-1} (\$3.04 kg^{-1}) of nitrate-nitrogen removed. This average of actual unit cost is considerably lower than an estimate for wetlands restoration equivalent to \$5.89 lb^{-1} (\$12.96 kg^{-1}) of nitrate-nitrogen removed that was developed for the integrated assessment on hypoxia in the Gulf of Mexico, particularly because the latter does not encompass costs associated with the required buffer (NOAA 1999). The average unit cost for the 27 assessed enrollments also compares favorably to another estimate from the hypoxia study that pertained to achieving nitrogen reductions via reducing the amount of fertilizer applied to fields (NOAA 1999).

This practice may be even more cost effective than the foregoing suggests. The models estimated by Crumpton et al. (2007) are based upon watersheds greater than 200 mi2 (519 km2) in size. Treatment wetland impacts are likely to be greater in practice because tile drainage networks typically drain areas of less than a few square miles, and the practice would target those where nitrate loads are greatest. Thus, the cost to achieve reduced nitrate-nitrogen loads by a pound at such sites is likely to be less than \$1.38 a year for 50 years.

Water control structure constructed for treatment wetland project in Boone County, Iowa.

To provide context at a federal policy relevant scale, Crumpton et al. (2007) estimated how extensively treatment wetlands would have to be established in the Upper Mississippi and Ohio River basins to meet a goal set by the interagency Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (2001). They recommended a 30% reduction in nitrate-nitrogen discharged into the Gulf of Mexico to reduce the gulf's "dead zone."

The modeling effort indicated that 518,700 to 1,111,500 ac (210,000 to 450,000 ha) of strategically situated wetland pools—reducing by 40% to 60% the nitrate loads entering them—could reduce the nitrate load leaving the two basins by 30%. Given that the annualized cost over 50 years of the 27 assessed wetlands is \$357 thousand, achieving this 30% reduction by relying exclusively on treatment wetlands is estimated to cost just under a billion dollars on an annualized basis.

While the analysis of current contracts focuses on nitrate loads, wetland pools and the buffers surrounding them are likely to generate environmental benefits beyond water quality impacts, such as increases in wildlife habitat, carbon sequestration, and flood water retention. In particular, preliminary analysis has shown treatment wetlands create habitat for upland duck, shorebird, and grassland bird species. Amphibians, reptiles, and native pollinators should respond similarly to the enhanced habitat.

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