Comments on SAB Hypoxia Panel Draft
by the
Illinois Department of Agriculture

Section 4.3, pages 132-144. The question as to whether the areal extent of Gulf hypoxia can be reduced while also protecting water quality and social welfare in the Basin has not been adequately answered. The summary of large-scale policy models reveals that the biophysical models used in these analyses are not appropriate for tile–drained landscapes which the draft report identifies as the dominant source of nitrogen delivered to the Gulf. This failing is primarily because models such as EPIC and earlier versions of SWAT simulate nitrogen losses via erosion and surface runoff while nitrate, which moves through the subsurface, is the dominant form of nitrogen reaching the Gulf. As pointed out on page 104, lines 38-41. *Recent enhancements have been made to allow better simulation of tile-drainage in agricultural fields by SWAT (Du et al., 2006; Green et al., 2006). This indicates that previous modeling results by SWAT in heavily tile-drained watersheds should be reassessed using the revised model*.

The following comments on the Doering analysis for the CENR Topic 6 report are an update of comments submitted to the Task Force by the State of Illinois in 2000. We believe that those comments still apply.

According to Doering et al. (1999), "**Social costs would also be incurred,** such as dislocation in land use, agribusiness infrastructure, and farm communities. We can tell in some cases, and infer in others, where we might begin to incur unacceptable costs of this kind on the basis of historical shifts in crop production, land use, and input use. **We did not estimate these costs."** Also, the analysis does not discuss the impacts on local units of government in areas where large amounts of cropland are taken out of production. In Illinois, property taxes on wetland acres are only 1/6th of the taxes on cropland.

The analysis did not address economic impacts within specific states or watersheds. However, the report concludes that **"Severe restrictions on nitrogen loss from agriculture mean that production ceases on acres in the Mississippi River Basin that are especially vulnerable to nitrogen loss"** (e.g., the Illinois River Basin). Neither the economic analysis nor the Integrated Assessment address the comparative costs and benefits to the industries potentially impacted by the Gulf hypoxia issue. In 2004 Illinois alone exported more than $3.5 billion in commodities; total cash receipts were more than $9 billion. While the CENR reports found no economic impacts on the Gulf fisheries as a result of hypoxia, the proposed solutions will have severe impacts on the economy of states such as Illinois.

Moreover, the validity of the economic analysis is questionable because:

- An aggregate analysis of effects within the entire nation or the entire Mississippi River Basin does not reveal the severe economic disruptions to agriculture in states such as Illinois and Iowa which the draft report has identified as the largest sources of nitrogen and the most effective locations for management practices such as wetlands.

- The model relies on an apparently erroneous understanding of the physical system and the fate and transport of nitrogen as reflected in statements, such as, “In general, crop land likely to be restored to wetlands is less productive than average crop land” (p. 41, Doering et al. 1999). The model’s assumptions about within-basin environmental benefits, is based on this incorrect understanding of nitrogen movement in agricultural landscapes of the Midwest. For example, Table 4.1 of the Doering et al. (1999) report (p. 26) indicates that only 2.5 percent of the nitrogen loss from a continuous corn rotation is lost through leaching and that most of the remainder (75% of the total lost) is nitrogen lost in sediment. As pointed out in the panel’s draft report, nitrogen loss from cropland is primarily associated with subsurface drainage while phosphorus loss is primarily due to surface runoff and erosion The fallacy of the model’s results are obvious by even a cursory comparison of Figure 4.6 of the Doering et al. (1999) report (p. 46), which shows the locations of wetlands if they were restored proportional to regional nitrogen yields by hydrologic unit, and the discussion in section 3.1.2 of the draft report of the spatial distribution of the average total nitrogen yield in the nine large basins during 1980-1996. This incorrect analysis leads to the incorrect claims that measures to restrict nitrogen loss will have significant effects on reducing erosion and phosphorus losses within the basin.

  In most parts of Illinois where restoration of wetlands or riparian areas should be targeted to reduce nitrogen, cropland sells for $4,000-$6,000 per acre and enrollment of these acres in a wetland or riparian area program would be very expensive. In addition, these soils are the most productive in the State and the lost yield would be proportionately higher. The lost production would affect not only agricultural producers and suppliers, but the entire Illinois economy.

Page 168, lines 31-45 *Retirement of land through the Conservation Reserve Program has demonstrated the different results for various cropping systems. For lands previously in corn, the reduction in N delivered to the Mississippi may have been as much as 25 to 30 kg N/ha/yr (22 to 27 lb N/ac/yr). For soybeans it would have been somewhat less, and for small grains, particularly wheat in the High Plains, smaller reductions, in the range of 10 kg N/ha/yr (8.9 lb N/ac/yr) may have been realized (see Section 3.1.2. – Subbasin Annual and Seasonal Flux).* What are the references for these statements? Section 3.1.2 does not provide any information regarding N delivered to the Mississippi River from various cropping systems.

Section 4.5.6 In-field Nutrient Management, Application Timing, p.182, lines 13-22,
The load reduction goals cited do not match the values given in Table 9 on page 128. Using those values, the spring nitrate load reduction would be 9-36% and the annual N reduction would be 2-8% of the reduction goal compared to the 1980-1996 baseline. Against the 2001-2005 period, the reductions would be 12-51% of the spring nitrate and 4-16% of the annual load reduction goal.

Page 182, lines 28-43. Nitrification inhibitors
The discussion of the potential for nitrification inhibitors to reduce N losses is very cursory and does not reflect the variable research results. Randall and Sawyer (2005) reported: “Minnesota data obtained on calcareous, poorly drained, glacial till soils suggest an average nitrate leaching

loss reduction of 14% when N-Serve is used with anhydrous ammonia in late October compared to not using N-Serve in the fall. Leaching losses were not influenced by spring application of N-Serve." and "Nitrate leaching losses were not affected by fall-applied N-Serve on well drained soils in Minnesota or in the Illinois and Iowa studies."

Randall and Sawyer (2005) also stated "Many studies have shown that nitrification inhibitors, such as N-Serve, are effective in delaying conversion of ammonium to nitrate when N is fall-applied (Hoeft, 1984), but use of nitrification inhibitors with fall-applied N has not given consistent crop yield responses."

Effects of nutrient management on soil resource sustainability, p. 185-189
Lines 20-22, page 187 states: *There is no direct evidence for an effect of lower non-zero fertilizer rates, near the economic optimum, leading to decreases in SOC from these studies*. While this may be true, the precautionary principle, which is widely followed by the panel elsewhere in the report, would suggest that we be cautious in light of the potential effects on soil sustainability if SOC is decreasing.

Furthermore, the NANI analysis in Section 3.2 suggests that N mineralization may be occurring. Page 79, lines 8-18 through page 81, line 10. *However, the upper Mississippi River subbasin has experienced a decreasing trend in annual flow since the mid 1990s (Figure 26). What appears to be only a slight decrease in nitrate-N yield in the upper Mississippi subbasin in response to what the panel thinks are greatly decreasing net N inputs, demonstrates the difficulty in predicting riverine nutrient yields in tile-drained agricultural lands. Many interacting factors are at work, which are difficult to estimate and/or measure. For example, there are uncertainties in some of the estimates, such as biological N_2 fixation (primarily soybean), as well as our assumption that large soil N pools are in a steady state. The predominant soil types in the upper Mississippi subbasin are Mollisols, which are high in organic matter with large soil organic N pools (much larger than the Ohio River subbasin). As fertilizer rates have stayed constant and yields have increased, several possibilities may account for the lack of riverine response. These include: increasing soybean N_2 fixation percentages, net N mineralization of soil organic N (David et al., 2001), long lag times due to a buildup of relatively easily degradable organic N (amino sugar N, Mulvaney et al., 2001) that is now being released, or perhaps increasing tile drainage and loss of fall applied N. Figure 26 includes a recalculation of net N inputs for 1998 to 2005, increasing soybean fixation rates from 50 to 70%, and assuming a corn acre net soil mineralization rate of 10 kg N/ha/yr (8.9 kg N/ac/yr). These two changes greatly alter the net inputs, pushing the value back up to where it was during the 1980s.*

Soybean production is a net depletion to soil N pools and the fixation rate is a function of available inorganic N (nitrate) in the soil (Gentry et al., 2001). When there was more inorganic N left from corn production prior to the late 1990s, soybean would have fixed less N, compared to recent growing seasons where corn yields have set records and we would expect little residual soil nitrate. This could be leading to increasing soybean N_2 fixation rates, which are not accounted for in typical net N input calculations.

A second factor is soil mineralization. Net N input calculations assume that the soil organic N pool is at a steady state (McIsaac et al., 2002), with mineralization rates in a year balanced by

immobilization (both microbial and crop residue inputs). It is possible that with greater corn production and steady fertilizer rates, we are seeing increased mineralization rates, so that there is a net depletion of soil organic N. This depletion, as discussed earlier, may be small (about 10 kg N/ha/yr or 8.9 lb N/ac/yr), but over many acres would be an important additional input. (emphasis added)

Page 92, lines 10-24, *McIsaac and Hu (2004) showed that for tile and non-tile drained regions of Illinois net N inputs were similar, but that riverine export of N was much greater in the tile drained watersheds. They found that during the 1990s net N inputs were equal to riverine N flux, about 27 kg N ha/yr. This would leave no N available for other fluxes that are thought to be important, such as terrestrial and aquatic denitrification. More recent net N inputs in these same tile drained watersheds are about zero, yet riverine N export has continued.* ***Given that there are denitrification losses (that are unmeasured), this would indicate that N must be coming from a depletion of soil N pools, as suggested by Jaynes et al. (2001). With steady fertilizer N rates, high corn and soybean yields, and high stream N export, the only source available to supply N would the large soil N pool (often 10,000 to 15,000 kg N/ha) in the Mollisols of the upper Midwest. Techniques are not yet available to document the small change that would be occurring in this N pool from a small annual depletion of 25 to 50 kg N/ha/yr, however this has critical implications for the sustainability of production.*** (emphasis added)

4.5.9. Ethanol and Water Quality in the MARB

This section of the draft report presents a very alarming and, we believe, biased view of the potential impacts of increased ethanol production on nutrient losses within the Basin and to the Gulf. The section is severely flawed. It is internally inconsistent and carelessly written, uses values for nitrogen and phosphorus losses from land without reference to the literature, reflects no understanding of the distribution of corn production or CRP acres within the United States or the MARB and ignores key findings elsewhere in the report.

Internal inconsistencies On page 201, lines 17-18 and page 202, lines 37-38, the section suggests an additional 18 million acres of new corn. On page 203, line 20, and in Table 16, the estimate is 16 million acres. On page 202, lines 37-38, the report states: "Thus, increasing corn production by 7.3 million ha (18 million ac) could result in a 33% increase in annual N loss or 7.5 kg N/ha (6.7 lb N ac) from the converted lands." However, in Table 16, the value for land converted from soybeans is 6.7 kg N/ha (6 lb N/ac). We also note that the sentence just quoted in logically nonsensical. There is no relationship between the number of acres in corn production and the annual loss on one acre.

An example of carelessness is on page 204, lines 2-4. "If the loss difference between perennial vegetation and row crops is 1.14 kg P/ha (1.01 lb P/ac), then P losses could increase by 9 million kg P/yr (20 million lb P/yr)." In Table 16, the land area converted from perennial vegetation to corn is 3.2 million ha (8 million ac). The product of multiplying 1.14 kg P/ha by 3.2 million ha is 3.648 million kg P/yr (8.08 million lb P/yr), not 9 million kg P/yr (20 million lb P/yr). We also noted that the panel chose to report total losses in millions of pounds or kilograms, rather than use tons or metric tons as is the convention in the rest of the report.

Another example is in the Key Findings and Recommendations (page 209)"Grain-based ethanol production is rapidly expanding, which will result in increased demand for corn, major increases in corn acreage and increased N and P losses to water (e.g., annual N losses may increase by 118 million kg or 260 million lb)." Table 16 indicates 95.7 million kg or 211 million lb).

Inadequate literature citations On page 203, line 27 – page 204 line 2, values are cited for P losses from corn or soybeans and from CRP, idle land, pasture or hay without providing any references to the literature.

Distribution of corn production and CRP acres
The discussion of the effects of adding corn acres and taking land out of CRP or other perennial vegetation appears to assume that corn is only grown in the MARB. According to the USDA (http://usda.mannlib.cornell.edu/usda/current/Acre/Acre-06-29-2007.pdf), nearly 15 percent of 2006 and 2007 corn was grown in states such as Michigan, New York and California which are not in the MARB. The percentage increase in corn acres in 2007 in the non-MARB states was as large as the increase in the MARB. Even within the MARB, there were 20 million acres of corn (about 22% of the total acres) in 6 drier Missouri River basin states (KS, NE, ND, SD, MT and WY) which are not significant sources of nitrogen to the Gulf. Section 3.1.2 estimates that the Missouri Basin contributes less than 10% of the nitrate load. These states along with Texas and Oklahoma are also where most CRP acres are located.

Ignores key findings in report
Section 3.1.2 of the report (pp. 74-86) is very clear that the primary sources of nitrogen and phosphorus flux to the Gulf are the Ohio and upper Mississippi River sub-basins which contribute 84% of the nitrate-N, 73% of the TKN and 64% of total P. These areas which represent the tile-drained, corn-soybean landscape of Iowa, Illinois, Indiana and Ohio contribute nearly all of the spring N flux to the Gulf.

We performed our own analysis in an attempt to estimate the effects of increased ethanol production on N losses to the Gulf.We focused on those states that the draft reports identifies as the primary sources of N – Iowa, Illinois, Indiana, Ohio, and Minnesota (Section 3.1.2). Although unsure of the appropriateness of the 6.7 kg N/ha difference in N loss between corn-soybeans and continuous corn, we used that value in estimating the increase in N loss across all new corn acres in those five states that are within the MARB. For those states, (according to the USDA http://usda.mannlib.cornell.edu/usda/current/Acre/Acre-06-29-2007.pdf) corn acres increased by 6.45 million and soybean acres decreased by 5.9 million. The difference in these estimates is less than 1 % of the total area planted to corn and soybeans in the five states.

If all new corn acres resulted in a 6.7 kg/ha increase in N loss, the total change in the five states identified as the primary source of N to the Gulf would be 15,601 metric tons per year, 16.3 % of the 95,700 metric tons shown in Table 16. (The average total N flux to the Gulf during water years 2001 to 2005 was 1,242,000 metric tons.) We also did calculations in which we assumed the 6.7 kg/ha difference for tile-drained cropland (about one-third of the cropland in the five states, according to 1987 USDA estimates) and a 3.35 kg/ha difference for non tile-drained land. Under these assumptions, total N loss from new corn acres is 10,520 tons, 11 percent of the estimate in Table 16 and less than 1 % of the average total N flux to the Gulf. Using a value for non tile-drained land that is half of the value for tile-drained cropland appears reasonable if not conservative. McIsaac and Hu (2004) reported that riverine N flux was much lower in non tile-drained regions. "During 1977-97, NNI to the tile-drained region had increased to 27 kg N /ha-yr and riverine N flux was approximately 100% of this value. In the non-tile-drained region, NNI was approximately 23 kg N/ha- yr and riverine N flux was between 25% and 37% of this value (5 to 9 kg N /ha-yr). "

We did not assume any conversion of CRP land to corn in these states. There is very little CRP in the tile–drained areas (page 168, lines 40-41). We looked closely at land use in 12 intensively tile-drained counties in central Illinois. These counties include 20.9 percent of the cropland acres in the state and 23.7 percent of the 2006 corn acres. However, in 2006 there were only 99,310 acres of CRP and 42,500 acres of hay, less than 2.8 percent of total cropland acres. This example suggests that the primary source of new corn acres in the intensively tile-drained areas of the Corn Belt identified as the primary source of nitrogen to the Gulf will be conversion from soybean acres. As pointed out on page 168, lines 40-41, *"… most land enrolled in CRP is primarily sloping, erosive land that is not tile drained"*. If additional corn acres comes from CRP, pasture and hay in these areas nitrogen losses will increase, but not to the extent indicated in Table 16.Even if we assume that 3.2 million ha of permanent vegetation on sloping erosive lands are converted to corn, but the average loss is 7 kg N/ha/yr (5-9 kg N/ha/yr, McIsaac and Hu, 2004), the difference is only 3 kg N/ha/yr or 9.6 million kg, far less than the 73.6 million kg in Table 16.

Finally we note a March 9, 2007 USDA press release which reported that an estimated 23.2 million acres out of 27.8 million acres of eligible CRP contracts are expected to be re-enrolled. An estimated 4.6 million acres in CRP contracts will exit CRP between 2007 and 2010. **Of the 4.6 million acres, approximately 1.4 million acres are located in major corn producing states**.(emphasis added) "The percentage of landowners choosing to remain in CRP is consistent with what we have seen in the past, despite speculation that re-enrollment would drop significantly due to high corn prices," said Johanns."
http://www.fsa.usda.gov/FSA/printapp?fileName=nr_20070308_rel_0058.html&newsType=newsrel