Thank you for the opportunity to review the Hypoxia Advisory Panel Draft Advisory that evaluates the updated science regarding the causes and extent of hypoxia in the Gulf of Mexico, as well as the scientific basis of possible management options in the Mississippi River Basin. The draft is a comprehensive document that is essentially a literature review of topics pertinent to hypoxia. In some cases the current science and condition of farming and ranching result in the report being outdated and not sensitive to current market conditions.

A general recommendation is to include a glossary so readers can understand technical terms as delivered by individual researchers. This will aide understanding of the context of the research and focus the discussion. Consistency is needed in how units are displayed in the document. It is most helpful to have both English and metric used. Additionally, there are several over-arching topics that should be included in any summary of findings and priority recommendations.

The key strategy for reducing nutrient loads from agricultural non-point sources should be to apply appropriate conservation practices at the point of origin to keep the water clean before it becomes concentrated. This would provide both on-site and off-site benefits and likely be more cost effective than other downstream treatment measures. Assistance should be provided to producers to develop and implement conservation plans that integrate a system of practices to reduce runoff, erosion, and nutrient losses. Key practices could include: cover crops, crop residue management, nutrient management planning to get very specific as to the timing, rates, sources, and methods of application, and drainage water management.

Voluntary Conservation Programs have been delivered through NRCS and partners for more than 70 years with documented successes going back to the inception of the Soil Erosion Service in the 1930s during the "Dust Bowl" days. Technical and/or financial assistance has been made available help address locally identified natural resource concerns including water quality at the field and watershed scales. To further reduce nutrient loadings from agricultural non-point sources, the voluntary incentive-based approach should be embraced and further utilized as resources allow helping achieve established reduction goals for the basin. This fits directly within one of the operating principle of the Task Force as identified in the Action Plan.

Very little attention is given to Within Basin and Social Welfare Goals. Additional consideration should be given to opportunities to focus on conservation practices applied in small watersheds to achieve measurable results that are cost effective from benefits achieved "within basin" and subsequently contribute to reductions in nutrient loadings to the Gulf.

The Conservation Effects Assessment Project (CEAP) should be continued and expanded within the MR Basin to obtain better information regarding effects of conservation practices in reducing nutrient loadings and in utilizing inventories such as the National Resources Inventory to monitor progress. The Hypoxia Source, Fate, and Transport workshop identified a key need to better link land management/conservation activities to downstream reductions in nutrient loadings. *"There have been few long term evaluations of the effectiveness of BMPs at the watershed scale. To address this knowledge gap the USDA-NRCS and USDA-CSREES have recently started the Conservation Effects Assessment Project."* (Page 177 - http://www.umrshnc.org/files/Hypwebversion.pdf).

Section 1 Introduction

Section 1.1 Hypoxia and the Northern Gulf of Mexico—a Brief Overview

A paragraph should be added to identify the desirable estuarine and marine life being impacted by hypoxia; the specific impacts; and the resulting socioeconomic issues for the region.

Section 2 Characterization of Hypoxia

Section 2.1.6 Sources of Organic Matter to the Hypoxic Zone

Additionally, it should be noted that another factor in decreased organic matter (OM) contributions to streams post-agricultural expansion may well have been due to the depletion of OM pools in the soil as a result of tillage disturbance/open field induced erosion plus tillage induced volatilization resulting in less OM delivered to water bodies. The NRCS has efforts underway to increase the practice of OM enhancements to soils to improve soil quality by increasing cover, aggregate stability and infiltration. The effect is to lessen mineral fraction erosion and overland flow with its concomitant reduction in N and P transport and should not increase OM contributions to water bodies.

Section 2.1.7 Denitrification, P Burial, and Nutrient Recycling

The authors' claim that lower denitrification rates are observed when low oxygen levels are present. This seems contradictory and needs to be clarified. Additionally, there needs to be clarification on why the authors state that denitrification is believed to be lower with hypoxia.

Section 3 Nutrient Fate, Transport, and Sources

Section 3.1 Temporal Characteristics of Streamflow and Nutrient Flux

A confidence interval needs to be included in the discussion of recent estimates of the extent of drained agricultural land developed based on land use and soil class/ characteristics.

The authors state that "there is reasonable concordance in the patterns of agricultural drainage predicted…" The term reasonable is a relative term. A correlation coefficient or some other statistic is needed to clarify the data.

The authors cited STATSGO in the document. The SSURGO database is more site specific and provides better information concerning the correlation between drained land and corn/soybean use. STATSGO polygons contain a number of major soils and only some of which might be poorly or very poorly drained. Some of those soil areas may not actually be in corn/soybean production. In addition, some soils that are better drained than above are still tile drained to allow earlier access to the field. SSURGO is data dense and requires time and significant computing power to analyze these large areas.

The authors cite 32 million acres with subsurface drainage in the Midwest states the ADMSTF <http://www.ag.ohio-state.edu /~agwatmgt/LCBpdfs/ Nitrate%20 Solutions_%20Agriculture%20and%20Gulf%20of%20Mexico.pdf> cites 40 million acres of subsurface drainage in the Midwest states. If a USDA inventory is cited the specific year for the inventory should be indicated in the text. National Resources Inventory (NRI) data available includes 1978, 1982, 1987, and 1992. Appendix E indicates 1985 is the year of the estimate, but no mention of that year is indicated in the text. NRI data is accurate to the major land resource area (MLRA) or county level depending on sampling.

There is a lot of variation between the various models. Additional clarification is needed to understand the comparisons in the document.

Section 3.1.1 MARB Annual and Seasonal Fluxes

Additional clarification would be helpful to understand the figures.

Section 3.1.2 Subbasin Annual and Seasonal Fluxes

The authors state that "Fall fertilizer application in much of the region has increased greatly since the 1980s" and "For the four states of the upper Mississippi River basin, all show an increasing winter temperature (for the months following fall application of ammonia)." To be correct, they should say "…fall application of anhydrous ammonia." A citation and data should be added to support these general claims.

Clarification is needed concerning the sub-basin discussion. It would be helpful if the discussion and results tied to the different sub-basin groups could be separated. A figure that shows the location and description of the sub-basin groups would be helpful.

Section 3.2 Mass Balance of Nutrients

Clarification concerning the Phosphorus (P) mass balance in the sub basins is needed. Are changes in flux for different sub basins cancelling each other out therefore no net change in stream P concentrations? Or is the intent to say that P entering streams is insensitive to P applications in agriculture? The caption for Figure 33 needs further description for the word "input" to clarify if it refers to stream inputs or inputs to the field.

The last recommendation in this section seems to run counter to the evidence presented in the previous sections. The sub-basins with the greatest decline in NANI or net phosphorus seem to be in the exact areas where N and P fluxes are highest. Considering that P-balance is negative in the upper basin and NANI is at pre-1970 levels its hard to see how the mass-balance approach will contribute to the design of management strategies.

Section 3.3 Nutrient Transport Processes

Although wetlands can be effective at removing nitrogen (N) from surface waters, the result is nitrous oxide (NOx) emissions. NOx is approximately 310 times more effective in global warming potential than carbon dioxide ($CO_{2)}$. The best management option is to improve N management in the field sources.

It is unclear how the removal of P was occurring in the research cited (Royer, et al., 2006).

Section 3.4 Ability to Route and Predict Nutrient Delivery to the Gulf

The U.S. Geological Survey (USGS) found in their water quality study of the South Platte River (NAWQA study) that the river nitrate load was not universally increased as nitrate fertilizer was applied to the landscape due to bacteria using it before the ground water returned to the river. This biochemical relationship should be investigated to determine if the conditions can be replicated at a reasonable cost.

There appears to be some bias in the discussion of various models. A hard number for N and P derived from SPARROW is presented with very little discussion of its use in other studies. The SWAT model had deficiencies pointed out and the results of several studies regarding its use are presented.

A Wisconsin reservoir sediment study found the N concentration to be approximately 53 mg/kg. The P concentration in the sediment was approximately 890 mg/kg. This illustrates the trapping benefits of dams in reducing N and P loads.

The authors state that "the doubling of nitrate export to the Gulf of Mexico over the 1960-1994 periods resulted largely from an increase in fertilizer application rates, particularly to corn, an increase in runoff across the basin, and the expansion of soybean cultivation." Generally soybeans are grown in a corn rotation so if soybean acres increased it is likely that corn acres also increased so N application rates might not be the only factor.

The authors identify Corn Belt hot spots across Iowa, Illinois, and Indiana. The initial maps presented in the study identified N hot spots in Minnesota as well.

The authors discuss the need for best management practice (BMP) evaluation. There are many conservation practices and systems in the USDA/NRCS Field Office Technical Guide and the evaluation of these conservation practices would be beneficial.

Section 4 Scientific Basis for Goals and Management Options

Section 4.1 Adaptive Management

Flood and erosion control structures have sediment and nutrient trapping efficiencies. Land treatment alone might not reach the level of nutrient load reduction desired. Targeting high risk areas within small watersheds would be the most efficient approach to address the issue.

Section 4.2 Setting Targets for Nitrogen and Phosphorus Reduction

"The Panel recommends:

- N reductions by at least 45%
- P reductions by at least 40%"

There has been some reference to seasonal loads in addition to annual loads. It would be helpful if there were additional explanation and clarification of whether targets should be based on seasonal or annual loadings of both N and P.

It would be helpful if the Panel could clarify whether targets represent reductions needed at the mouth of the Mississippi River or at some other geographic location (sub-basin, watershed, or field scale).

Targets are not referenced to specific baseline data/years. Suggest using CENR baseline for frame of reference and identifying progress made to date as part of findings.

The existing coastal goal includes a time frame of 2015 for reducing the extent of the Gulf hypoxic zone to less than 5000 square kilometers. It would be helpful if the authors would comment on time frames needed for achieving recommended N and P reduction targets.

Section 4.3 Protecting Water Quality and Social Welfare in the Basin

It appears that the Science Advisory Board (SAB) considers the Within Basin and Social Welfare goals of the Action Plan as much lesser goals than the goal to reduce the extent of the hypoxic zone. Very little attention is given to within basin issues and approaches. Within basin benefits are described as "co-benefits" which seems to imply secondary. With difficulties in obtaining costs/benefits associated with Gulf fisheries associated with the hypoxic zone, an alternative (or complementary) approach would be to place emphasis on watersheds within the basin and work to plan, implement, and then evaluate cost effective practices to achieve nutrient load reductions within the watershed/basin. Deploying more of a "within basin" approach could serve to achieve measurable and quantifiable results as well as document cost effectiveness "within basin".

Most of the models to date are inadequate for assessing economic impacts on communities within the Mississippi Basin. Improving the resolution of these models without including input-output (general equilibrium) components will do little to increase our understanding of social benefits within the basin.

The finding that it is possible to reduce hypoxia and protect social welfare in the MARB if an approach is chosen that maximizes benefits, including co-benefits and minimizes costs, is not supported by any of the discussion in this section. It may be true, but no studies are cited to demonstrate it.

Doering et al, 2000 represents a reduction in edge of field N-loss resulting from a reduction in fertilizer application rates and after adjustments in cropping systems used and acreage planted. Fertilization rates were not reduced uniformly across the basin for all crop production systems, but only for those in which it was most cost effective. Therefore it is inappropriate to compare these results to the Batie et al. chart which represents the estimated relationship between nitrogen fertilizer application rates and N-loss for the same cropping system on the same field. Also, the Hu et al., 2007 article referenced in earlier sections of the report indicates the exact opposite of what's reported in the text by McIssac et al. Jaynes et al., 2001 also cited in this report indicates that reductions in edge of field nitrate loss is less than proportionate to reductions in fertilizer application rates.

The diagram in Batie et al. actually shows less than a pound reduction in N-loss per pound of reduction in nitrogen fertilizer. And this holds true for any size reduction in N fertilizer. Because the series have different bases the percentage reduction in N-loss may be larger than the percentage reduction in fertilizer for small reductions in fertilizer. This does not support the results in McIsaac et al. that the text seems to indicate.

David et al. citation seems to be incorrect. It probably should be McIsaac et al., 2001.

The conclusion that relatively small reductions in N fertilizer rates result in proportionately larger reductions in edge of field N losses is not supported by the literature. It is misleading to imply through the citation of the McIsaac et al. results that large reductions in edge of field N-loss can be achieved through relatively minor reductions in fertilizer application.

The discussion of the *Integrated Assessment* would be the place to include the McIssac et al. results and indicate that the major cause of this is not from edge of field reductions, but from in transport transformation of edge of field nitrogen loadings.

Sediment samples from reservoirs have indicated that they trap N and P as well as carbon. In Kansas, N in sediment ranged from 2000-4300 mg/kg and P from 700-1400 mg/kg. The organic carbon ranged from 2.6-6.1%.

Section 4.4 Cost Effective Approaches to Implementation

Section 4.4.1 frames the option of voluntary programs in such a way as to draw the conclusion that voluntary programs ‘cannot be relied upon to induce major environmental improvements’. The authors should define what is meant by voluntary programs in this context and whether the incentive based voluntary conservation programs utilized by USDA fall into this category. The authors should consider changing the text in the last paragraph of the section from…voluntary agreements…to…non-incentive based voluntary agreements…for clarification.

Conservation programs have been utilized in the United States since the 1930s. USDA’s National Resource Inventory (NRI) shows significant reductions in soil erosion. For example, between 1982 and 2003, soil erosion on U.S. cropland decreased 43% (http://www.nrcs.usda.gov/technical/land/nri03/nri03eros-mrb.html). The NRI also shows that the goal of no net loss of wetlands is being achieved. These are two findings from the NRI that demonstrate the success of voluntary conservation programs.

USDA has also worked at the watershed scale for over fifty years. Work at the sub-watershed level is the most effective and reasonably measurable. Eight digit hydrologic units are too large to adequately measure effects. The following are just a few examples:

Reports and modeling done in the Western Lake Erie Basin (Ohio) basin by U.S. Geological Survey, USDA Agricultural Research Service, Heidelberg College, and the Natural Resources Conservation Service (NRCS) have identified the erosion control practices of conservation tillage and conservation buffers as effective in reducing both soil erosion and sediment transport from the watershed. Nutrient management, manure management plans, wetland restorations, and controlled drainage have been shown to effectively reduce nutrient transport from the watershed to the lake. Current USDA Farm Bill programs are a proven means of facilitating installation of these practices by farmers. (http://www.oh.nrcs.usda.gov/programs/erie_basin/erie_basin_project.html)

The North Fork of the Salt River/Mark Twain Lake in Missouri is just one watershed where Missouri NRCS has worked closely with partners to address nonpoint source concerns including sediment and nutrients through Special Area Land Treatment (SALT) projects. These voluntary approaches have been implemented in watersheds and resulted in reductions in nonpoint sources of pollution. (http://www.mowin.org/Success/nfsalt.pdf).

The Coulee Baton “Micro” Watershed is a 5,280-acre watershed project located two miles east of Kaplan, Louisiana. The goal of the project is to improve water quality in the area. A cooperative partnership has been formed to assist landowners and home owners in carrying out watershed work. Voluntary application of various conservation and Best Management Practices on the land by landowners and homeowners is essential to the success of the project. (http://www.la.nrcs.usda.gov/Final%20Coulee%20Baton%20Microwatershed%20Plan%20July%202006.pdf)

Additionally, the work of Moxey, White and Ozanne should be included to discuss the potential for asymmetric information type problems with voluntary programs.

Section 4.4.2 Existing Agricultural Conservation Programs

The economic analysis underpinning the Hey et al. report being cited is not sufficient to support the conclusion that co-benefits from conversion of 7 million acres of cropland to wetlands throughout the basin are great enough by themselves to justify converting cropland to nutrient sinks. The CENR Topic 6 report, which used the same source as the Hey et al. study for its estimates of the recreational benefits and incorporates changes in commodity markets, examined the social benefits of converting 1-18 million acres of cropland to wetlands. It found that there were only net positive benefits to converting cropland to wetlands when the amount was relatively small, approximately 1 million acres.

The authors misrepresent the Conservation Security Program (CSP), saying it is a program designed to cover the full cost of adopting (or applying) conservation practices on a farm. This needs to be changed to "CSP supports ongoing stewardship of private agricultural lands by providing payments for maintaining and enhancing natural resources."

Section 4.4.3 Emissions and Water Quality Trading Programs

The discussion in the text does a good job characterizing the potential for water quality credit trading given the current state of policy.

Section 4.4.4 Agricultural Subsidies and Conservation Compliance Provisions

Lubowski et al. is not in references section.

Section 4.4.7 Key Findings and Recommendations on Cost Effective Approaches

The authors sound like existing agricultural subsidy and conservation programs have been failures. That is not so. They have been of success in bringing conservation to farmers, but making it the farmer's choice. USDA's programs have been very strong on voluntary adoption by farmers and ranchers—showing the way, working closely with early adopters and opinion leaders. In this way USDA has been successful in implementing practices that have helped conservation, but has made it the farmer's choice, rather than as a result of regulation.

Additionally, while the report focuses on issues and recommends remediation related to nutrient loss from agricultural lands, care must be taken to balance water quality recommendations with other resource concerns. Specifically, recommendations provided in Section 4.4.7 regarding restructuring conservation programs to target water quality goals should also include considerations for maximizing wildlife habitat benefits in the process, a specific goal of the programs cited (CRP, WRP, EQIP).

Section 4.5 Options for Managing Nutrients, Co-benefits and Consequences

Section 4.5.1 Agricultural Drainage

The authors cite "Mitsch et al . (1999) that controlled drainage was not widely practiced in the US Corn Belt and that most of the research on controlled drainage had been conducted in more southern climates". NRCS recognized the need for additional research to address the impacts of subsurface tile drainage on water quality and in 2001 established it as one of 14 national priority research needs. Subsequently, the USDA Partnership Management Team consisting of Agricultural Research Service (ARS), CSREES, and NRCS supported establishment of the Agricultural Drainage Management Task Force (ADMS TF) to bring researchers together with field practitioners to improve drainage practices to reduce adverse impacts while enhancing crop production and conserving water. The ADMS TF, focusing initially on the U.S. Corn Belt region, has concluded that sufficient research exists documenting beneficial effects of drainage water management (controlled drainage), to support additional research and demonstrations at the field and watershed scale. Through programs such as Conservation Innovation Grants, projects have been initiated to provide additional documentation of effects of drainage water management in the Corn Belt.

Technologies are currently being explored that will help drainage water management be usable on steeper slopes. Drainage water management appears to have more potential applicability than was referenced in the reports by Cooke et al. and Frankenberger et al.

The authors appear to gloss over the benefits of denitrification which will occur when the water table is raised during the non-growing season. Although reduced volume of drainage flows is the prime benefit, denitrification is an important outcome of controlled drainage. Additional discussion of this is needed.

The authors cite 0.5% slopes or 1% slopes as a recommendation which is very unclear. Either clarify that there is conflicting research recommendations with one researcher recommending <0.5% slope, and another <1.0% slope; or just list that recommendations call for <1.0 % slope. A criterion that includes a range is confusing. Additionally, to be clear, controlled drainage does not require slopes less than 1-percent, it becomes less economic on slopes greater than 1-percent. Drained land with slopes less than 1-percent are the prime candidates from an economic stand point. Just like with all cultural and conservation practices, steeper slopes can be farmed using sustainable agricultural techniques, it just takes more effort and cost.

Recommendation: A drainage assessment would provide better information on land suitable for drainage water management based on technology currently available as well as technologies that will be readily available and deployable in the next two –three years.

Recommendation: Plot and field scale research and demonstrations need to be applied in small watersheds (less than 10,000 acres) to document physical, environmental, and economic effects beyond the field scale.

Brezonik et al. is not included in references section.

Section 4.5.2 Freshwater Wetlands

Although wetlands can be effective at removing N from surface waters, the result is NOx emissions. Again, removal of NOx from watersheds via wetlands to help ameliorate the hypoxia problem should be weighed against the detrimental effects to the atmosphere via greenhouse gas evolution. Discussions about this should be added to the document.

Isomorphic replacement of phosphorus has been reported for magnesium; however, there is little evidence that magnesium bounds phosphorus in alkaline soils—could this be manganese?

It would be useful to define the terms wetland restoration, wetland creation and wetland enhancement. In so doing, it would be beneficial to incorporate or make reference to the definitions used in NRCS Conservation Practice Standards 657 (Wetland Restoration), 658 (Wetland Creation), and 659 (Wetland Enhancement).

Another term and NRCS conservation practice that may be useful to integrate into this section is constructed wetland (NRCS Conservation Practice Standard 656). It is used to treat runoff and wastewater pollutants from agricultural lands, and may have application in combination with wetland restoration, creation or enhancement to reduce N and P within the MARB.

There is opportunity for research collaboration within CEAP-Wetlands to explore at sub-watershed scales the design, placement, and configuration of wetland and associated conservation practices and land treatments (i.e., describes what the practice is comprised of and its implementation based on local conditions and resource concerns) regarding nutrient reduction.

It is also critical that the sub-watershed studies explore the benefits and tradeoffs associated with practices focused on nutrient reduction and on other ecosystem services, such as fish and wildlife habitat, water storage, floodwater attenuation, GHG emissions reduction, and cultural/economic benefits accrued/valued by landowners implementing the practices to re-establish or manage wetlands and associated lands. Including a modeling component in the studies would provide a mechanism to investigate benefits and tradeoffs under different practice and land treatment scenarios, changing climatic conditions, and other drivers that influence provisioning of ecosystem services.

Finally, while the report focuses on issues and recommends remediation related to nutrient loss from agricultural lands, care must be taken to balance water quality recommendations with other resource concerns. Specifically, recommendations provided in Section 4.5.2 should include language that ensures wildlife habitat and other wetland functions are not foregone while targeting wetland restoration to meet water quality objectives.

Section 4.5.3 Conservation Buffers

The authors make the statement that buffer practices are available to farmers through USDA farm bill programs. This statement can give the false impression that landowners can or will apply these practices ONLY with program assistance. Farmers and ranchers apply conservation buffers and other conservation practices with or without program assistance.

The authors state that "Table 11 summarizes the extent of five major buffer practices installed in 21 states of the MARB in 1999-2006". More recent data is available and was previously provided to the SAB. The data on crop residue management and nutrient s appears low and needs to be rechecked.

The SAB requested all conservation buffer practices rather than the individual performance indicator identified in the Hypoxia Action Plan and reported on in the MART report. NRCS further expanded the list supplied by Dr. Lawrence to include all buffer practices identified by NRCS. Buffer practices are reported by 2 digit HUC by year for fiscal years 2000-2006. Data are available by 8 digit HUC. A total for conservation buffers applied was obtained by applying a correction factor for practices reported in feet as follows: field borders – 25 feet, hedgerows – 15 feet, herbaceous wind barriers – 5 feet, stream bank protection – 15 feet, and windbreaks and shelterbelts – 60 feet.

There were 2.3 million acres of conservation buffer practices during fiscal years 2000-2006. Filter strips were applied to the largest acreage 1.06 million acres (46% of total buffer acreage) with 394,000 acres from the Upper Mississippi sub-basin (HUC code 07). 583,000 (25% of total buffer acreage) of riparian forest buffers were reported in 2000-2006 with 186,000 acres from the Upper Mississippi sub-basin (HUC code 07) and 139,000 acres from the Lower Mississippi sub-basin (HUC code 08).

The authors state that "The extent of other conservation practices established from 2002-2005 …" Updated information has been provided to the SAB for wetlands (1.4 M acres), conservation tillage (20.8 M acres) and nutrient management (18.3 M acres) for 2000-2006.

While it is true that the effectiveness of buffers can be enhanced when they are applied as part of a conservation management system; the study (done in Germany) cited has reductions in runoff and sediment delivery attributed to grass waterways that are not realistic for typical U.S. conditions. The "unmanaged grassed waterway" that achieved a 90% reduction in runoff and 97% reduction in sediment delivery is in reality a broad swale, two to three times as wide as would be constructed in the US (for the size of the watershed), and vegetated with a combination of grasses, forbs, and woody species. A better-managed waterway in the same study (one that was mowed regularly) achieved reductions of 10% and 27% in runoff and sediment delivery, respectively. These numbers are more realistic, because this mowed portion was narrower than the unmowed portion, the width being more typical for U.S. conditions.

Removal of the citation of the German study on the unmanaged waterway, because it gives an unrealistic picture of the effectiveness of grass waterways in reducing runoff volume and sediment delivery would make the study citation more representative of U.S. conditions.

Finally, while the report focuses on issues and recommends remediation related to nutrient loss from agricultural lands, care must be taken to balance water quality recommendations with other resource concerns. Specifically, recommendations provided in Section 4.5.3 regarding restructuring conservation programs to target water quality goals should also include considerations for maximizing wildlife habitat benefits in the process, a specific goal of the programs cited (CRP, WRP, EQIP).

Section 4.5.4 Cropping Systems

The authors discuss a study that shows that perennial vegetation (alfalfa and CRP) have much less nitrate (<2 kg/ha N/year) in drainage water than continuous corn or corn-soybean rotations (≈ 50 kg/ha N/year). It should be made clear that the reason for the difference is that no N is applied to the perennial crop, not because the perennial crops are more efficient users of N.

The authors cite a 2005 paper by Randall without citing the co-author. In the references, there are two citations for Randall with a 2005 date, but with different co-authors. Including the name of the co-author removes the confusion concerning the relevant citation.

Section 4.5.5 Animal Production Systems

This section does not include the current agricultural market conditions. Market conditions have changed significantly during the 2007 crop season. Additionally, generalized statements regarding nutrient management are made where the factors can be different based upon the specific industry, i.e. poultry or swine versus beef or dairy. This can be misleading. The strategy to improve feeding decisions varies depending on the business relationships of the operations.

The authors imply that the USDA 590 standard can produce short term results, but that a more complex suite of options is needed that must be customized to meet site-specific needs. In fact, Comprehensive Nutrient Management Plans do that and meet the 590 standard.

The authors state that farmers in the MARB have adopted the animal feeding operation paradigm because income from traditional grain crops has decreased, among other reasons. This is no longer true. With the increase in biofuel production, corn and soybean prices in the marketplace have increased significantly and farmers have changed their production strategies this crop year.

The authors' state there is 'one way transfer of nutrients' in the MARB. They discuss how N and P is transferred to crop land then the N and P is transferred through the crops to animal production. It is not one way transfer if the N and P for crop land come from animal manure. This completes the cycle. If high fuel prices continue to drive up the cost of commercial fertilizer, the demand for manure to fertilize crops will grow and the one way transfer of nutrients will no longer exist.

The increased cost of commercial fertilizer might also increase the demand for manure as fertilizer, keeping the manure in the localized area. Also, it will not improve the picture for dealing with P. Energy prices mean that more of the residual from ethanol production (distillers grains) will be available and fed by producers. Ethanol production effectively removes the energy component of the grain and thereby concentrates the N and P portions of the feedstuff, resulting in more N and P that can be given off in the manure. Feeding distillers grain can actually increase the problem with dealing with N and P on the farm. Ranchers and livestock producers are addressing this through the ration. Minimizing production costs is a key part of staying in business for farmers and ranchers and is an incentive in nutrient management.

The authors cite new technologies related to control of nutrient export from manure that is misleading. We recommend replacing these with the following:
Alternative manure management technologies that make nutrients more transportable.

The manure related best management practice (BMP) "coagulate and flocculent techniques (commonly used by municipalities) to separate and concentrate nutrients in liquid manure systems" is misleading. The techniques for using coagulants and flocculants in manure management systems are commonly quite different than the techniques for using them in industries and municipalities, and concentrating the nutrients does not in itself address the problem.

The manure related BMP "biological treatment of manure by aerobic and anaerobic digestion to reduce total solids and produce and capture methane-rich biogas for energy" should be deleted. Aerobic digestion does not produce and capture methane-rich biogas, and aerobic digestion may not reduce total solids, in fact, it could increase total solids. Aerobic digestion is used to capture nutrients in the waste stream by growing aerobic bacteria that feed on the nutrients and then settle out of the liquid as sludge. It does not remove nutrients from the ecosystem; something still has to be done with the sludge. Aerobic treatment can result in nitrification that will move the nitrogen in ammonia into nitrates. Aerobic treatment may be followed by anaerobic treatment to denitrify the nitrates into nitrogen gas. All the phosphorus in the waste stream is conserved. Aerobic treatment has a limited potential application in manure management for liquids following solids separation because the energy required to aerate manure waste streams is cost prohibitive.

Anaerobic digestion will produce methane gas, but it is misleading to call this "methane-rich" gas. The resultant biogas will be about 60% methane with high moisture content. Further treatment to remove the moisture is commonly necessary to use the gas in an engine, and further treatment still to concentrate the methane enough to use it in a natural gas pipeline. The biogas from an anaerobic digester may be flared to prevent the escape of methane as greenhouse gas, and the flame may be used to heat water where this is needed, like in a dairy.

Anaerobic digestion converts the carbon and hydrogen in the waste stream into methane. It commonly results in a limited reduction of total solids in a waste stream by consuming a portion of the volatile solids, but it has a minimal effect on total nitrogen, and a zero effect on total phosphorus. A greater portion of the nitrogen and phosphorus will be in an inorganic form that is more readily available to the plants, but also more mobile in the environment. Whether this is desirable or not depends on the manure management system and the nutrient management plan.

The practice of manure hauling itself is not a barrier to manure transport and spreading over wider areas. There are sometimes social or legal barriers to moving manure down public roads, but these can largely be overcome through alternative technologies that stabilize the manure and concentrate the nutrients prior to hauling. The larger challenges are the economic and marketing challenges to this alternative. Again, these technologies do not themselves reduce nutrient loads and do not necessarily make the manure more transportable. It all depends on the system of which they are a part.

Large-scale consolidation of animal feeding operations (AFOs) may be creating the economies of scale necessary to make alternative manure management technologies feasible.

The Panel's recommendation states that there are nutrient deficient areas of the MARB. There aren't any maps or other documentation to show where these are located. The authors should give examples of where these areas are located.

The authors imply that AFO's are new in the MARB whereas it's the increase in size and concentration of these operations that is relatively new. Dates or time periods for this transformation needs to be used in this section for clarification.

CAFO needs to be defined relative to AFO.

The findings are not supported by the preceding discussion in this section. Citations need to be added to support the findings.

The recommendations are not supported by either discussion of AFOs in the text or by the findings preceding them.

Comprehensive Nutrient Management Plans (CNMP) does address N and P jointly. The authors identify the need for N and P to be managed jointly and this is already happening.

The high pH from slaked lime <u>increases</u> NH_3 volatilization.

Section 4.5.6 In-field Nutrient Management

Other soil properties such as texture, lime presence, permeability, and water holding capacity also need to be considered.

It is known that no-till systems sequester soil organic carbon (SOC) whereas conventional tillage reduces SOC. Detailed discussion needs to take into account the initial SOC status.

The issue of soil quality degradation with reduced nitrogen use needs attention. The system of crop production is not as simple as cutting inputs to save outputs. Iowa field demonstrations (Blackmeir with CIG) have shown tremendous mineralization potential on mollisols.

Section 4.5.7 Most Effective Actions for Other Non-Point Sources

Atmospheric deposition of nitrogen should be re-emphasized. It is an important local as well as regional source of nitrogen input.

The authors state that “While photovoltaic cells have great promise for the future, they are not currently cost competitive producers of electricity.” There are situations where this general statement would not be true. For example, with relatively low energy generation projects that are in remote locations, photovoltaic cells may be a very cost effective solution compared to bringing in electrical lines.

Section 4.5.9 Ethanol and Water Quality in the MARB

The references for the estimates of 2-4 lbs/Acre P loss for corn or soybeans, and 0.5 lbs/A for pasture or hay are incomplete. As a result, it is impossible to determine how the estimates are derived.

The statement that higher corn prices will likely reinforce the perception that “insurance” N is worth the cost is probably true, but N prices are also increasing, so the “insurance” is more expensive than the analysis might indicate.

The authors state that "increasing grain prices have increased the relative economic advantage that rowcrops, particularly corn, have over switchgrass. Substantial subsidies will be needed before farmers would convert row crop land to switchgrass." "Subsidies" should be changed to "incentives", as there may be incentives that are not subsidies.

Clarification is needed with Table 13, Estimated increase in N loss from growing an additional 16 million acres of corn. Suggest putting the row "New corn land to support ethanol" at the bottom at the table as a summary row instead of at the top as it is now. A footnote is needed to explain the source for the numbers in the "Increase in N loss (Millions of Pounds)" column.

Section 4.5.10 Integrating Conservation Options

Air Pollution due to NOx production category should be (-) not (0) in Table 15, Anticipated benefits associated with different agricultural management options. The authors state that the research is limited and that a number of assumptions have been made in making the table. However, without identifying the setting for which each evaluation pertains, it's difficult to evaluate the results.

Section 5 Summary of Findings and Recommendations

Section 5.1 Characterization of Hypoxia

More effort needs to be placed on the interaction between carbon and silicates with nitrogen and phosphorus.

Section 5.2 Nutrient Fate, Transport and Sources

There is a need to predict through modeling the flow of nitrogen and phosphorus, plus pesticides, carbon, and silicates, through the entire River system. Models like SWAT could be expanded into a robust analysis tool. Monitoring of the water within the river system should be given the same consideration as the Gulf hypoxia zone.

Section 5.3 Goals and Management Options

The authors conjecture that "social benefits will exceed social cost over the long run, if not the short term." There is no basis for reaching this conclusion provided in the document. Suggest adding the supporting documentation or deleting.

The statement that there have been no significant reductions in nitrogen loads to the Gulf is not true. NOAA reported this year that based on the most recent five year running average there has been a 22-percent reduction in nitrogen loads to the Gulf. This is just 8-percent from the Actions Plan's goal of 30 percent reduction in loads by 2015.

Based on the rest of the 'logic' presented this would seem to necessitate a revision of the goal.

The rationale for the P reduction goal is not supported by any information provided in the text about the dose-response relationship between phosphorus flux and the size of the hypoxic zone. Feasibility of 40-percent reduction in phosphorus loads within the basin is based on pure conjecture. No information is provided on the amount of phosphorus reduction feasible from agriculture. Furthermore, the importance of P loads on the size of the hypoxic zone has not been established. A realistic P reduction goal based on science more defensible than conjectures is needed.

Some of the recommendations focus on agricultural support payments to reward conservation and to discourage corn and soybean production. Aside from the potential trade impacts, there are additional consequences if these are not well thought out. These recommendations are not supported by the preceding text. They need to be eliminated or the text needs to be beefed up to support them.

Nutrient management (590) is a conservation practice that addresses the timing, rate, and formulation of applied nutrients. Drainage water management is another important conservation practice. Where conservation practices are listed in the report they need to be added to the list.

Appendices

Appendix B Mass Balance of Nutrients

Figures 44 and 45 are misleading and not realistic to what actually happens on the landscape. These figures show excess N and P production on farms by county assuming no export of manure from the farm. So, the figures catalog areas where there are farms that are too big to use all the manure that they produce. This is not surprising, given the consolidation of the animal industries into larger and larger farms over the past thirty years. In many cases, there becomes a time where a farmer makes a decision whether he is an animal farmer or a crop farmer. There probably are not too many 50,000 animal beef feedlots, or million hen layer operations that consider themselves as crop farmers. In many cases, these operations are too involved with producing meat to produce crops, at all.

The figures are misleading in that many (or most) animal operations of this size have plans, and have made arrangements for the manure to go to crop farms in the area. Note that in the Ohio Valley, with its more traditional farming operations, excesses are not as apparent, but larger, more concentrated animal operations in the West show up with large excesses of N and P. In some cases there may be only one or two animal operations in a county, and they may not use any of their own manure, but the manure is being used by crop farmers in the area. This is not accounted for in these maps that show excess production on the farm, but do not account for any utilization plan.

Appendix E Agricultural Drainage

Clarification is needed for the document to be clearer about why the appendix focuses on controlled subsurface drainage. The authors mention ‘novel drainage’ but do not elaborate; additional discussion is needed about what it is and its relevance to hypoxia. The appendix appears to compare controlled drainage to sub-irrigation; additional discussion is needed about the authors’ purpose and intent. Increase in P is likely due to surface water runoff entering the subsurface drainage system, not as an outcome of drainage water management. More technology efforts, including site identification and monitoring, need to be placed on drainage, both surface in ephemeral flow and subsurface drains.

Appendix F Animal Production Systems

The statement that *“….with 97% of poultry production in the U.S. coming from operations with more than 100,000 birds….”* probably is an accurate statement with shell egg production facilities in the country, but not hatching egg production, broiler production, or turkey production. In these sectors, the statement would be true with broiler operations less than 10 years old (50%?) but not even close with hatching eggs or turkeys.

The following statement appears to assume that all pasture area adjacent to a stream. The estimated nutrient loadings are assumptions that are difficult to defend. *“Using spatial databases of streams, pasture boundaries, and animal characteristics 2 (i.e., number of cattle, time in pasture, and type of cattle [heifers vs. milk cows]) for 90% 3 of the dairy farms in the Cannonsville watershed, approximately 3,600 kg of manure P 4 are estimated as deposited directly into streams with 7,650 kg deposited in pasture near 5 streams (<10 m) from the 11,000 dairy cattle in the watershed. At this magnitude, P 6 loadings represent a significant environmental conCENR, with in-stream deposits 7 equivalent to approximately 12% of watershed-level P loadings attributed to agriculture 8 (Scott et al., 1998)”*

Concerning incorporation of manure: intensive tillage decreases aggregate stability. “Soils with low aggregate stability tend to form surface crusts which can reduce both water infiltration and air exchange (1)”. Tillage also destroys worm holes and other channels created by arthropods which increase infiltration. Over the long term, repeated tillage of soil can reduce soil tilth, oxidize organic matter, and break down stable soil aggregates. Applying manure on intensively tilled (conventional tillage) fields can increase the possibilities of surface runoff.

Manure application should be implemented from an understanding that the soil is a biological community which consists of a habitat that needs biological diversity and minimal (physical, chemical and biological) disturbance for optimal soil function.

Landowners understanding soil function will approach manure application from this managerial point of view:

1) Protect the soil: covering the soil with a growing crop, a cover crop, or with crop residue will intercept and decrease the kinetic energy of the raindrop. This will increase the opportune time for water to infiltrate into the soil profile which will decrease manure runoff.
2) Minimize soil disturbance: reduce tillage limits the habitat disturbance for micro and macro fauna which are responsible for improving aggregate stability (increasing infiltration) and regulating nutrient cycling (mineralizing manure). The quicker the water infiltrates and the sooner the manure is mineralized; potential for manure runoff is reduced. For example: Knifing manure below the soil surface and limiting soil surface disturbance (disking, plowing) will decrease negative impacts to the soil habitat.
3) Increase Bio-Diversity: a diverse crop rotation will maximize on capturing light energy which is converted to chemical energy thus feeding the microbial biomass (micro and macro fauna). The microbial biomass regulates soil mineralization which converts manure from an organic substance into an inorganic substance-utilized by plants. A larger microbial biomass population will expedite mineralization of manure.
4) Time manure applications: The microbial biomass is regulated by temperature and moisture. Manure application should be avoided if the soil conditions consist of low soil temperatures and are at field capacity. Low soil temperatures decrease microbial biomass activity which decreases the mineralization of manure. Soils that are at field capacity are subject to compaction; compaction destroys soil structure and limits air exchange in the soil. Mineralization of manure is a biological process, so timing is very critical. If soils are too saturated or too dry; mineralization of manure is decreased.

(1) B.K. Guino, O.J. Idowu, R.R Schindlebeck, H.M. van Es D.W. Wolfe, J.E. Thies and G.S. Abawi, Cornell Soil Health Assessment Training Manual

<u>Appendix H Ethanol and Water Quality</u>

This section needs to bring in other studies besides those from the Center for Agricultural and Rural Development (CARD) and the Agricultural and Trade Policy (IATP). USDA's 2007 Economic baseline contains estimates of ethanol production out to 2016 and recent analysis from WRI contains changes in N-loss from producing 16 billion gallons of Ethanol. CARD has also put out an updated analysis in May 2007 that is more relevant to the 2015 deadline in the Action Plan's goal for reducing the size of the hypoxic zone. The information in these reports needs to be incorporated in the section on ethanol in the main body of the report as well. The Energy Bill being proposed will, if the mandate requiring 36 billion gallons of alternative fuels to be used by 2022 remains in the final bill, change the outlook for 2022 considerably; but it is not clear that ethanol use will increase to this level until the mandate kicks in.

The estimates in the document are not consistent with USDA Economic Baseline projections. The authors use estimates from the Institute for Agricultural and Trade Policy (IATP) and the Center for Agricultural and Rural Development (CARD). USDA projections indicate 12.2 billion gallons of ethanol with corn price at 3.30 per bushel by 2016. Corn acres will expand by 11 million acres over the same period, with 7 million acres coming from other crops, primarily soybeans and the remainder from idled lands (pasture, fallow and CRP). It should be noted that the report shows that CRP land will be at 39 million in 2016, which is 3 million acres more than in 2006.

The authors attempt to project the impact of ethanol production on local and regional nutrient balances and state that there will be 'substantial increases of N and P loads to the Mississippi River'. The scenario they create projects that the distillers grains from half the projected ethanol production capacity would support *"…19 million dairy cows and…"* This is over twice the total number of dairy cows in the U.S. Growing the U.S. dairy herd to take the DDGs would produce so much milk that there would be no use for it. It would also compound the problems with too much manure in the region. It might be better to use gasification or some other technology to use the DDG as a fuel source. Even after this, the ash component (including P) will have to be dealt with.

According to Dan Loy at Iowa State University, http://www.iowabeefcenter.org/content/Distillers_Newsletter_February_2007.pdf beef cattle can use DDGs for up to 50% of their ration. Since dairy cattle can't use more than about 25% DDGs, feedlots would be just as likely to locate next to ethanol plants. The report should cite the percentage of DDGs in beef rations.

Currently cattle producers feeding DDGs are adjusting their rations and soil testing to determine fertilizer applications. Farmers and ranchers have to make a living and monitor their inputs closely. The market is adjusting to accommodate these new variables.

The discussion about ethanol production, DDGs and nutrient impacts is pure conjecture at this point and shouldn't be in the report. The Concentrated Animal Feeding Operations (CAFO) rule will likely prevent over application of manure in these areas, and if the cost of handling and shipping manure is greater than handling DDG then it is just as likely that the plants will continue to dry and export DDG as they are to feed it within the basin. Increased value of livestock feed will likely cause dried DDG to be more valuable than wet DDG with manure handling and nutrient management costs.

Discussion of cellulosic vs. starch based ethanol is not relevant to the 2015 goal of the Action Plan. Most analysis does not project more than 250 million gallons of ethanol coming from cellulose prior to 2020 or later. Recent report from CARD entitled "Emerging Biofuels: Outlook of Effects on U.S. Grain, Oilseed, and Livestock Markets" suggests that cellulosic-based ethanol will never supplant corn-based ethanol.

Figure 51, Corn response to nitrogen application in different rotations versus fertilizer nitrogen not recovered, is not discussed in the appendix and need to be deleted or moved to the appropriate place in the text. The citation of Tierney is not in the reference list and needs to be added. The citation for the long-run projection needs to be filled in. There are two Elobeid et al, 2006 articles, one contains the forecast the other does not contain this forecast.

Again, thank you for the opportunity to review this report and provide comments. Richard Swenson, Director, Animal Husbandry and Clean Water Division is available to provide further information. He can be contacted at 301/504-2198 or Richard.Swenson@wdc.usda.gov.