Preliminary Comments on the Integrated Science Assessment (2nd External Review Draft) from Dr. Doug Burns

In general, I am pleased with the changes that have been made in this version of the ISA by providing an Executive Summary, succinct and shorter chapters that summarize effects and causal relationships, and the relegation of much of the detailed supportive evidence to relevant appendices. The flow and readability of the text are improved for a reader who would not want to wade through the detailed evidence provided in the numerous citations.

Chapter 1.6 – **Freshwater Ecosystem Nitrogen Enrichment and Acidification** This chapter does a good job of summarizing known effects of atmospheric deposition of S and N on acidification and nutrient enrichment in freshwaters. The text effectively refers to the conclusions from the 2008 ISA and adds new information where relevant. Moving some of the detailed text and citations to appendices is effective in improving the flow and succinctness of this chapter. The bolded conclusions are well supported by evidence provided in the text and appendices. I have only a few generally minor suggestions, corrections, or points of clarification as described below.

Section 1.6.1.1, page 59, line 12 – should also mention dry deposited forms such as NO2, NO, etc.

Section 1.6.1.1, page 59, line 14 – not clear what is meant by elevated NO3 concentrations. Do you mean any measurable concentration of NO3?

Section 1.6.1.1, page 59, line 28 – could generalize by removing word “iron” here since there are many varieties of sulfide minerals.

Section 1.6.1.1, page 61, Table 1-3 – for surface water sulfate, should state that preindustrial estimates are being compared to modern “measurements”.

Section 1.6.1.1, page 61, Table 1-3 – could update the surface water pH row to reflect that trends to more recent times such as 2015-16. Why are references cited here but not in other sections of this table?

Subsection 1.6.1.1.1, page 62, line 3 – “conditions” should be “acidification”.

Subsection 1.6.1.1.1, page 62, lines 10-14 – I am not certain about the point being made here. There is a shift away from focusing on chronic vs. episodic conditions to what? I disagree with this statement.

Subsection 1.6.2.1.1, page 67, line 27 – would be good to write out words rather than use HAB on first use.

Section 1.6.2.2, page 69, line 16 – the plus signs here should be plus or minus signs.

Section 1.6.3.2, page 75, line 7 – something missing from this sentence, ANC units do not make sense.

Section 1.6.3.2, page 75, lines 3 to 19 – the CL values do not have much meaning unless compared with deposition values. Would have a lot more value here to discuss CL exceedances rather than just raw CL values.

Chapter 1.8 – **Wetland Ecosystem Nitrogen Enrichment and Acidification.** This brief chapter summarizes current knowledge on the effects of atmospheric N deposition on a variety of wetland end points including biodiversity, endangered species, N leaching, and links to other chemical constituents including greenhouse gases. The chapter effectively builds on the results of 2008 ISA and cites studies that expand the scope of effects, including at least two review/synthesis studies. The two bolded causal statements are well supported by the evidence provided in the chapter and related appendices.

Subsection 1.8.2.2, page 89, line 14 – change "that show that" to "show that"

Chapter 1.9 - Freshwater and Wetland Ecosystem Sulfur Enrichment

This chapter and the accompanying appendix is effective in summarizing the results of the 2008 ISA and updating these results with significant new studies that have been published since release of the previous ISA. A new causal statement on the role of atmospheric S deposition and the ecological effects of sulfide phytotoxicity is warranted by recent published studies. The 2008 causal statement on the role of S deposition and enhanced rates of Hg methylation and bioaccumulation is strengthened by additional evidence published since the previous ISA. I have only one small item for consideration that reflects a growing body of research on S deficiency in crop production.

Appendix 12 – One issue related to sulfur cycling with links to atmospheric deposition is an increasing number of reports that with declines in deposition in recent years, evidence of sulfur crop deficiency is being reported with increasing frequency. While this is not an enrichment issue, it is worthy of at least a brief mention because there are economic implications. As far as I know, there have been no comparable results reported for natural ecosystems. Examples of S deficiency studies include some agricultural reports in the "gray" literature as well as a few papers in the peer-revised literature (I have not performed a comprehensive literature review of this topic):

- Ketterings, Q.M., Godwin, G., Gami, S., Dietzel, K., Lawrence, J., Barney, P., Kilcer, T., Stanyard, M., Albers, C., Cherney, J.H. and Cherney, D., 2012. Soil and tissue testing for sulfur management of alfalfa in New York State. *Soil Science Society of America Journal*, *76*(1), pp.298-306.

- Grant, C.A., Mahli, S.S. and Karamanos, R.E., 2012. Sulfur management for rapeseed. *Field Crops Research*, *128*, pp.119-128.
- Elkin, K.R., Veith, T.L., Lu, H., Goslee, S.C., Buda, A.R., Collick, A.S., Folmar, G.J., Kleinman, P.J. and Bryant, R.B., 2016. Declining Atmospheric Sulfate Deposition in an Agricultural Watershed in Central Pennsylvania, USA. *Agricultural & Environmental Letters*, *1*(1).