Science Panel Member Review of WFWQC's Atmospheric Deposition "DRAFT Sampling and Analysis Plan, V4 (3-12-2020)"

The WFWQC's DRAFT Sampling and Analysis Plan, V4 was shared with the ULWQS Science Panel on March 20, 2020 with a request to review and share comments on the document as part of the ongoing collaboration between the Panel and WFWQC on this topic.

Below are three sections:

I. The comments submitted by individual Science Panel members (Janice Brahney, Mike Brett, Greg Carling, Mitch Hogsett, Hans Paerl). Some of these were submitted already by email to the Science Panel – this version combines all of them and differentiates between general comments and specific comments by page.

II. A retrospective review of the August 2, 2019 comments submitted by the Science Panel [*ULWQS - Atmospheric Deposition Study Comments_8-2-2019.pdf*] as compared to the DRAFT Sampling and Analysis Plan, V4 (3-12-2020), which provides additional context and raises some questions for consideration (i.e., comments that might not have been addressed) given the significant revisions done in the latest version of the Plan.

III. A retrospective review of the WFWQC external review task 1 and 2 [*David Gay Reviews – Complete.pdf]* and [*Task 2 Report and Recommendations (WFWQC AD workplan).pdf]* as compared to the DRAFT Sampling and Analysis Plan, V4 (3-12-2020), which assesses comments provided by Dr. Gay not addressed in the current draft.

I. Individual ULWQS Science Panel Member Comments

General Comments:

A. The Draft Sampling and Analysis Plan, V4 is assumed to be a chapter of a comprehensive Work Plan. The Science Panel provided comments and feedback on a completely different SAP in August 2019. In addition to the comments provided by the Science Panel regarding the Draft Sampling and Analysis Plan submitted in March 2020, does the WFWQC plan to address the comments regarding the August 2019 work plan? Some of the comments regarding the August 2019 Science Panel review were addressed in the March 2020 SAP, but many others are not addressed.
    a. It would be helpful for the WFWQC to submit a 'response to comments document', similar to the process required for a scientific journal submission or typical interaction with Utah DWQ regarding a submittal for a WWTP process retrofit or permit modification. To date, the WFWQC has relied on the Science Panel to review past documents for completeness and this has become a tiresome and unnecessary process.

B. To date, Master's students have worked on the AD research and the data has been disseminated via theses and white papers. There have also been multiple Master's students who

have worked on the research, creating divides in continuity. This research would benefit from employing a PhD student to take the lead for multiple reasons:

a. A PhD should be familiar with standard laboratory procedures, field sampling, data analyses, and literature review. This will reduce the 'learning curve' associated with a new Master's student learning these skills while balancing a full class work load.
b. This project is very involved with field sampling. A PhD student will have more time and expertise to dedicate towards improving and identifying problems with the sampling strategy over a longer time period.

C. Please provide a strategy to share AD data soon after collection/analyses in an organized and QAQC checked fashion. Please add an additional section to the Sampling and Analysis Plan titled "Data Management". Data sharing can be done via an updated excel spreadsheet on a file sharing site, or other similar method.
   a. Past AD research was presented to the Science Panel as annual aerial loading rates to Utah Lake that included contaminated samples (bug carcasses) and unreasonable decay coefficients. During this time, the WFWQC was not able to scientifically defend their assumptions and data, which led to a drawn-out process where the Science Panel had to review the student's theses to determine what data was used and how. This can be avoided in the future by sharing data, calculations, and assumptions with the Science Panel.

D. The editing and formatting of the 'DRAFT Sampling and Analysis Plan, V4' appears as if multiple people worked on it, it was copied and pasted together, and no one proofread it. In addition, PDFs or website text were copied and pasted into the document and no one took the time to correct misspellings due to copying, nor to update formatting.
   a. This is not a problem with the technical aspect, but suggests a lack of oversight in the process.

Specific Comments and Questions (by Page):

1. Page 1. What are the credentials and responsibilities of Seth Barrus? How are responsibilities divided for this project?

2. Page 4. Objective 1 states "Adopt National Atmospheric Deposition Program (NADP) protocols where possible". What protocols are not being used? NADP is referenced throughout the document with no mention of deviations to the wet sampling protocols. Will the WFWQC request and acquire training from NADP personnel?

3. Page 4. Objective 1 states that the NADP sampling station will be used to compare two sampler deviations developed by the WFWQC. What is the comparison strategy?
   a. What happens if there are significant differences in orthophosphate-P, ammonia-N and nitrate-N measurements between the different sampler designs and sampling protocols?

4. Page 5. Objective 4 states the determination of a 'decay rate' by placing a sampler mid-lake. The SAP does not mention how this mid-lake sampler will be used to calculate a decay rate. The map showing samplers (Figure 3, page 8) does not identify a sampling location near the center of the lake, nor is a mid-lake sampler location described in the locations provided on pages 8 and 9. Moreover a decay rate cannot be determined from two points.
    a. Please identify and justify how on shore samples will be used to estimate loading to the lake surface.
    b. Please indicate how a decay rate will be determined. The literature has identified city decay rates so rapid they would barely register over the lake surface, how then will you extrapolate your terrestrial data?
    c. Please describe in detail the mid-lake sampler, how it will be constructed, and how contamination from lake water will be determined and avoided.

5. Page 5. Objective 5 states the determination of phosphorus speciation in urban, west desert, and southwest desert dusts. There is no description of how this will be accomplished or how the data will be used in the SAP.

6. Page 5. It is unclear how Farmington Bay can be used as a control for Utah Lake. Farmington Bay is near a desiccated hyper-eutrophic arm of the Great Salt Lake that frequently undergoes deflation.

7. Page 8. It is unclear how sampling on the shore will apply to deposition rates over the lake. Urban emissions of dusts are very high in magnitude but are not emitted high into the air column, and therefore will not be transported very far. There is no discussion on how onshore deposition rates can or will be applied to the water body. The sites are near light industrial activity, highways, and active mining (Saratoga Springs). The latter is a point source of dust and thus care should be taken as to how these values are extrapolated.

8. Pages 8 and 9. The units provided in the descriptions of sampler locations switch between feet and meters. Please choose a standard unit, preferably International System of Units.

9. Page 10. Step 7 requires washing all sampling equipment with phosphorus-free detergent followed by a DI rinse in the field. Why introduce additional chemicals (i.e. soap) in the field and not just rinse equipment with DI water and rotate out clean screens that were cleaned in the lab? This will reduce the amount of DI water that will need to be transported to each sampling location for cleaning purposes.

10. Page 10. Step 8 utilizes 3-liters of water in the sampling buckets. WFWQC's goal of using DI water is simulate a lake surface. Please note that ammonia can volatilize at the elevated pH concentrations observed in Utah Lake, but will not occur in the neutral pH of DI water. Also, utilizing water in the buckets attracts birds and insects, and requires a significantly more complex sampling plan to subsample the 3-liters of water (minus evaporation losses and plus wash water) compared to a using a true dry bucket to measure atmospheric deposition.

11. Page 13. States 'The tubs, table tops, funnels, bottles, buckets, and all equipment in contact with the samples are cleaned with phosphorus-free detergent, acid-washed with 10% HCl solution, and kept in plastic bags until they are used for sample collection.'
    a. Please add protocol of rinsing equipment with DI water following the acid wash.

12. Page 15. Please briefly describe the methods used for all analyses and reference the Appendix for the specific analysis method. This can be done either as text in paragraph form, or as a table.

13. Page 15. States 'Analysis includes total P, soluble reactive P, total dissolved P, and dissolved organic P.'
    a. Will the various forms of phosphorus be quantified by difference? Will this data be utilized as a QAQC check in addition to aerial loading estimates?
        i. TP > TDP > SRP
        ii. Can dissolved organic P be utilized to identify contamination (bird feces, etc.)?
    b. There is no method for measuring dissolved organic P in the Appendices. Will this be measured?

14. Page 15. The document states that phosphorus species will be analyzed at the BYU Environmental Analytics Lab. Where will nitrogen species be measured?

15. Page 15. States 'For each new lot of gloves, one pair will be soaked in 10% HCL to extract any N or P contamination. This sample will be analyzed with the run to identify any N or P contamination.'
    a. Is this necessary. It is hard to imagine that someone will accidently drop a glove into a sample and leave it there for an extended period. They might accidently dip a finger into a sample, but that is totally different than soaking a glove for a longer period.

16. Page 15. How are you ensuring a homogenous subsample? Dust will settle to the bottom of the bag over a 1-week time period. Subsampling settleable solids can result in large inaccuracies. The current protocol requires a 20 mL TP sample to be subsampled from >3-liters, resulting in less than 1% of the volume of water to be subsampled for TP in a non-homogenous bulk sample.
    a. I recommend performing routine QAQC checks on the TP subsampling. This can be accomplished by periodically utilizing an additional bucket and filtering all the water followed by measuring TSS, VSS, and TP on the solids captured on the filter. This data can be compared to aerial estimates calculated via the proposed SAP subsampling method for a QAQC check and to identify subsampling problems.
    b. It would also be very interesting to know the aerial deposition rates of solids (TSS and VSS) for comparisons with existing literature. The current protocols provide very few opportunities for direct comparisons and may result in large amounts of data uncertainty.

17. Page 15. It is unclear how the >3-L DI water samples are subsampled, and original volumes are measured for the proper mass balance to calculate aerial loads. These protocols need to be explained in much better detail. Please provide all calculations.

18. Page 16. What is a phosphate-removing soap? Or is this a phosphate free soap?

19. Page 18-26. There was no attempt to format, edit and proofread after copying and pasting text from PDFs or the internet into the Appendices. Please update formatting.

II. Retrospective Review of Science Panel August 2, 2019 Comments

Addressing Comments from 'ULWQS - Atmospheric Deposition Study Comments_8-2-2019' Document' [*ULWQS - Atmospheric Deposition Study Comments_8-2-2019.pdf*]**:**

It should be noted that Version 2 and Version 4 of WFWQC's Atmospheric Deposition SAP are completely different documents. This creates some confusion since useful information that was included in Version 2 was not included in Version 4. The process of reviewing multiple documents for completeness has become a cumbersome process. All future interactions with the WFWQC and other researchers needs to require the researcher to provide an organized response letter outlining how comments were addressed or why the comment was not addressed. The following comments are in relation to SP comments regarding the WFWQC SAP Version 2 (submitted by the Science Panel on August 2, 2019) that were not addressed in Version 4. The documents are referenced accordingly:

WFWQC = DRAFT Sampling and Analysis Plan, V4 (3-12-2020)
SP = ULWQS - Atmospheric Deposition Study Comments_8-2-2019

1. SP, page 1 paragraph 2: requests 'All methods should be based on existing peer-reviewed academic literature'
   - WFWQC includes the addition of one NADP site
     - Is this a Control for the experimental sampler designs?
   - WFWQC states 'Adopt National Atmospheric Deposition Program (NADP) protocols where possible for wet deposition while adapting various published protocols for determining dry deposition.'
     - WFWQC provides no description of when and why NADP protocols are not utilized
     - WFWQC states that adding water to the buckets mimics the lake surface
       - DI water is pH 7 and lake water is pH>8 and leads to a different NH_x-N volatilization potential, which leads to potential uncertainty (at least for exports from Utah Lake)
       - Water attracts bugs and birds (screens were added in SAP) which adds uncertainty
         - WFWQC needs to describe comparison with NADP dry bucket method in more detail
         - What data QAQC is being done to identify bird feces? NADP considers a sample contaminated if it includes visual bird droppings or bugs and compares N:P molar ratios. Will this be done?

        - What about measuring potassium for feces contamination?
    - Subsampling water with solids is difficult and calculations are not provided in the current SAP
- WFWQC referenced Anderson, K. A., and Downing, J. A. (2006) for adding water to the buckets
    - This study measured agriculture dust, and used sampling heights of 2m and 24m above ground to differentiate between local and regional dust loads
    - WFWQC does not differentiate between local and regional loads and has sampler heights equal to or less than 2 meters.
- WFWQC referenced Jassby A. D., J.E. Reuter, R.P. Axler, C.R. Goldman and S.H. Hackley. 1994 for adding water to the buckets
    - I was not able to download the manuscript to learn the context of adding water
    - This reference is 26 years old. Are there more current applicable references?

2. SP, page 1; 'At a minimum, the following tasks need to be addressed in the work plan:
    1.) Problem statement
    2.) Study objectives
    3.) Methods utilized
    4.) Sampling and analysis plan (SAP)
        a. Quality assurance and quality control plan (QAQC) for field and laboratory methods
        b. Calculations and extinction coefficients
    5.) Data sharing and ongoing discussions with Science Panel'

3. SP Task 1. WFWQC does not include a problem statement

4. SP Task 2. WFWQC lists 5 study objectives
    - Objective 1 is a comparison with NADP methods
        - WFWQC does not describe how this will be accomplished other than comparing data. What are the expectations, comparisons, and consequences?
        - How is dry deposition being compared and to what?
    - Objective 2 is to quantify local and regional sources
        - WFWQC does not describe how this will be accomplished. Literature cited mentions samplers 24 m in height, but all sampler heights in the SAP are 2m or lower.
    - Objective 3 is to characterize the importance of insect and plant contamination
        - This objective is to compare screened versus unscreened samples above a bucket of water. This objective appears to be to learn more about the quality of data collected over the past 3-years by the WFWQC.
        - What are the comparisons and consequences of this objective?
    - Objective 4 is to determine the decay rate across Utah Lake by placing a sampler in middle of the lake
        - WFWQC provides no information regarding how this will be accomplished
        - There is no sampler mentioned in the SAP other than this statement

        - A decay rate cannot be calculated with two points
        - There is no mention of any equations or methods regarding a decay rate
    - Objective 5 is to determine phosphorus speciation of dust
        - WFWQC does not describe how this will be accomplished
        - Will this be accomplished by measuring the P speciation in the dry bucket?

5. SP Task 3. WFWQC Methods
    - WFWQC provides no equations describing how the subsampling will occur and how the data will be utilized
        - Subsampling small amounts of settleable solids from a liquid of varying volumes is difficult
        - There are no equations regarding how the method 'comparisons' will be made

6. SP Task 4. WFWQC Sampling and Analysis plan (SAP)
    - This is the document provided by the WFWQC
        - QAQC for field sampling appears to be replicates and cleaning
            - No description on how method 'comparisons' will be carried out
            - WFWQC presents 'comparisons' as a form of QAQC for non peer-reviewed methods and a strategy to use historical data
        - WFWQC does not contain any calculations
        - WFWQC does not address extinction coefficients (decay rates) even though it is stated as Objective 4

7. SP Task 5. WFWQC does not address data sharing and ongoing discussions with SP
    - Data sharing is not mentioned in the document
    - Ongoing discussions have occurred, but not in a timely manner, nor in a manner that addresses the previous SP comments in an organized fashion (such as the typical method of responding to journal reviewers or how a regulated entity responded to a permitting agency with a copy of the original comments with responses).
        - WFWQC documentation has been very poor and confusing given the large amount of response and effort from the SP

8. SP, page 1; <u>Methods are not clearly linked to objectives and outcomes</u>
    - Comment not addressed by WFWQC

9. SP, page 2; <u>Methods on the quantification of nutrient loading are absent</u>
    - Comment not addressed by WFWQC

10. SP, page 2; <u>Phosphorus Speciation</u>
    - WFWQC will measure Total Phosphorus, Total Dissolved Phosphorus, and Soluble Reactive Phosphorus, per the Appendix
        - The text states that dissolved organic phosphorus will be measured, but methods are not included in the Appendices

- SRP, NH_4-N and NO_3-N can provide a useful method comparison with the NADP samples, but is not described in the document
  - Significant deviations will need to be taken very seriously
- Subsampling TP from the buckets with DI water added will have challenges
  - Calculations and efforts to ensure homogenous subsampling are not described

11. SP, page 2; Midge biomass should not be considered as a flux of new material into Utah Lake
    - 500 um screens were included in the current design. However, aerosol literature is clear that particles greater than 250um are local in origin. How will you distinguish between far travelled dusts and local saltation?
    - The document eludes to a 'comparison' of bug contamination but offers no method of accomplishing this, no calculations, and no data QAQC to identify contamination other than screens
    - WFWQC will perform bug 'sweeps' and bug leaching tests, but no description of how this data will be used
      - This reads as qualitative experiments, not quantitative
      - No calculations provided to support sampling goals

12. SP, page 2; Sampler height should be above saltation height, i.e. higher > 2m
    - WFWQC states that samplers are 1.5-2m above grade
      - There is no description of what samplers meet the 2m criteria
    - Sampling height has been used to separate local versus regional (>>>2m) loads and is not done in this study
      - WFWQC objectives state they will quantify sources with no indication how this will be accomplished
      - Is the goal to quantify the sum of local and regional sources at the Utah Lake perimeter? There is a disconnect between Objectives 2 and 4.

13. SP, page 3; The filter mesh size should be a maximum of 250 um
    - WFWQC addressed this comment.
      - Mesh screens will be 500 um (<250 um size of openings)

14. SP, page 3; Examples used in the proposal lack clarity in their relevance and should be linked explicitly to Utah Lake and the proposed study
    - WFWQC provided a different SAP and the current SAP does not include any examples
      - This is confusing for the reviewers
      - Is the SAP V4 a chapter of a complete Work Plan that has not been shared with the Science Panel?

15. SP, page 4; Examples used in the proposal should be clearly relevant to Utah Lake
    - WFWQC provided a different SAP and the current SAP does not include any examples
      - This is confusing for the reviewers
      - Is the SAP V4 a chapter of a complete Work Plan that has not been shared with the Science Panel?

16. SP, page 4; The proposal should only rely on peer-reviewed literature
    - There are 4 references to peer-reviewed literature
        - References provided are fairly old and more relevant research has been published
    - This SAP is not a stand-alone document for the objectives stated

17. SP, Page 5; Samplers should be placed according to the guidelines of the NADP to avoid Contamination
    - WFWQC states that some guidelines were adhered to and others were not
        - There is no description of what is not adhered to and why
    - WFWQC states there is no NADP protocol for dry deposition, however there are guidelines for the placement of samplers when the site is measuring dry fluxes of Ammonia.
    - All methodological literature cited is dated, why are newer publications ignored?

III. Retrospective Review of comments provided in the WFWQC External Review Task 1 and Task 2 products

Addressing Comments in the WFWQC Task 1 and Task 2 review by Dr. David Gay: [*David Gay Reviews – Complete.pdf]* and [*Task 2 Report and Recommendations (WFWQC AD workplan).pdf]*

1. Task 2, Page 1; Sampling Times
    - The SAP does not define how long the project will continue

2. Task 2, Page 2; regularly reduce height of grass around the sampler
    - Recommendation not addressed in SAP

3. Task 2, Page 4: Following NCON recommendations
    - Dr. Gay recommended coordinating with Dr. Janice Brahney to collocate her dry deposition sampler at one site to compare results. This recommendation was not addressed in the SAP

4. Task 2, Page 5 and Task 1, Page 81: Organized and repetitive quality assurance project plan
    - Dr. Gay recommended developing a comprehensive quality assurance plan to include specific quality control sampling protocols methods for evaluating QA/QC results. While the SAP details some QAQC sampling, it does not describe how the results will be utilized nor does it present a detailed QAPP describing all QAQC sampling and analysis.

5. Task 2, Page 5: Unknowns
    - Dr. Gay recommends conducting a blind laboratory test to assess laboratory accuracy with assessing four to five times per year. This comment is not addressed in the SAP

6. Task 2, Page 5: Try to reduce occurrence of bird feces

- Dr. Gay recommends employing several methods to deter birds from the sampling locations to reduce bird contamination including owl or raptor decoys, moving objects, and startling sounds. The SAP does not discuss any of these techniques.

7. Task 2, Page 6 and Task 1, Page 81: Meteorological measurements
   - Task 2 recommends installing and maintaining a meteorological station on the south or southwest end of the lake to quantify wind speed and direction to justify and measure the influence of southwest winds. Task 1 recommends establishing a digital an onsite digital rain gage at each location to validate sampler openings and closings. The sampling plan does not discuss these recommendations.

8. Task 2, Page 7 and Task 1, Page 71, 77, and 83: Consider measuring atmospheric concentrations
   - Dr. Gay recommends developing an atmospheric monitoring and modeling program to provide scientific validation of dry depositing measurements. The sampling plan does not discuss this recommendation.

9. Task 2, Page 8: Lake freezing
   - Dr. Gay recommends investigating ice sampling during ice events to quantify lake-wide bulk deposition to validate attenuation. This recommendation is not discussed.

10. Task 1, Page 82: Consider including calcium ion measurements
    - This recommendation is provided to help determine source of dust samples and is not discussed in the sampling plan

11. Task 1, Page 82: Source Identification Survey
    - Dr. Gay recommends completing a source identification survey in the immediate area of the lake to identify all potential TP and TN sources. This information could be paired with sample results and wind direction to determine significance of the source and inform attenuation to the lake. The sampling plan does not discuss this as task.

12. Task 1, Page 83: Back-trajectory analysis using Provo Airport metrological data
    - Dr. Gay recommends an analysis of wind data to identify wind conditions associated with each sample to determine potential source of the sampled dust and deposition characteristics. This recommendation is not addressed.