Utah Lake Water Quality Study
Science Panel Comments Regarding
Wasatch Front Water Quality Council's Atmospheric Deposition Study

We've appreciated the opportunity to have informal discussions with the Wasatch Front Water Quality Council over the course of multiple Science Panel meetings and calls. Provided below is the Science Panel's effort to provide formal comments on the draft Atmospheric Deposition Work Plan provided and presented thus far. We look forward to continuing to discuss refinements as appropriate.

Assuming the objective is for the results of the Wasatch Front Water Quality Council's (WFWQC) atmospheric deposition (AD) study is to be utilized in the ULWQS effort, under the direction/review of the Science Panel (SP), then the WFWQC study needs to be approached similar to the other research studies initiated through the RFP process in regards to methodology. In essence, this means, sharing the study protocol and discussing it with the Science Panel and then modifying the protocol based on those discussions. While these efforts have already started, the Science Panel believes there is still more work to be done to get the AD study to accurately estimate lake wide atmospheric deposition nutrient fluxes for use in the existing phosphorus and nitrogen mass balances. The proposal should clearly describe objectives and methods for independent quantification of local (urban) deposition rates, regional deposition rates, and how these values will be used to determine a Utah Lake wide deposition rate. All methods should be based on existing peer-reviewed academic literature. At a minimum, the following tasks need to be addressed in the workplan:

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

The SP has identified the following limitations in the current form of the WFWQC AD proposal. These should be addressed using peer-reviewed literature.

1) **<u>Methods are not clearly linked to objectives and outcomes:</u>**
   As proposed, the WFWQC study would mix material from local, recycled, and far range sources. Thus, the study could not accurately identify deposition rates or loading from each respective source. To illustrate, on page 11, in point "a". the proposal suggests that the sampling method 'allows tracing of regionally and locally emitted atmospheric pollutants". However, there is no attempt to explain how this might be accomplished from a mixed sample. Please avoid ambiguous statements that can lead to confusion on the proposed study outcomes. Please also include how you will measure local vs regional deposition rates and provide adequate justification.

2) **Methods on the quantification of nutrient loading are absent:**
Please include methods that describe how obtained deposition rates would be used to quantify loading to Utah Lake. The proposal should use methods from peer-reviewed literature or be based on methods outlined in the proposal that the SP approves.

3) **Phosphorus Speciation:**
The proposal does not distinguish between mineral P or soluble P. Utah and environs have extensive phosphate deposits which can lead to TP measurements that do not reflect biologically relevant P deposition rates. Additional efforts need to be incorporated to provide estimates of the P species that are, or will be, biologically available. The methods used should be based on peer-reviewed literature. The determination of bioavailable P is necessary to compare P loads associated with natural background, stormwater inputs, WWTP inputs, and agriculture runoff.

4) **Midge biomass should not be considered as a flux of new material into Utah Lake:**
Midge larvae grow in sediments and they do not continue to feed once they emerge, thus all of their biomass is derived from lake sediments. If the goal is to consider midge biomass as 'recycled' material, this should not be done without also considering the concurrent efflux from Utah Lake represented by these insects. Any re-deposition onto the lake will be smaller than the loss from the lake. Or, in any mass balance scenario, midges would amount to a larger arrow out of Utah Lake than in. Furthermore, this is a recycled rate and therefore should not be lumped with any attempt to measure atmospheric loading rates**.** If midge biomass is to be considered, the measurement of midge biomass should be ***explicitly separate*** from any attempts to measure a true atmospheric deposition rate**.** A nitex screen between 100 and 250um maximum should be used to prevent midge or other insect contamination.

5) **Sampler height should be above saltation height, i.e. higher > 2m:**
The sampling stations should be at a minimum of 2m height as suggested in the literature. This height is required to capture the atmospheric deposition fraction of migratory particles, and is comparable with other peer reviewed studies. The rational provided in the WFWQC proposal for a shorter height are provided below, followed by the reasoning associated with the protocols utilized in other peer reviewed studies, which do not match the stated objectives of the WFWQC proposal.

   1. *There are samplers on the GSL playa that are 1.5 m high.*
      These samplers were put in place by the USGS to capture dust coming ***off*** the playa, not dust being deposited on the playa. These samplers and Marith Reheis samplers from the playas of southern CA and NV were meant to capture the vertical movement of material *from* the areas they were emplaced. Since the intention of these samplers and that of our current inquiry are not the same, using a similar height to the USGS samplers does not make sense. The literature supports placing samplers below 2m in order to capture local erosion, which we need to *explicitly* exclude in order to answer atmospheric deposition.

2. *The NADP does not have a height guideline for placement of ACM collectors (with the implication that the height can be anywhere).*
   ACM collectors don't have a set height because this is determined at each site individually and because the ACM collectors are not currently being used to capture dry deposition. Their only current dry deposition network is the AM0N network, for the dry deposition of ammonium, which requires a height of 2m.
3. *The proposal suggests the 2m height was a one-off from Dr. Reheis work in southern Great Basin Playas.*
   This is not correct. The literature on saltation heights and eddy fluxes as well as literature on suggested heights of samplers to capture true atmospheric deposition all suggest sampler heights over 2m.

6) The filter mesh size should be a *maximum* of 250 um:

The proposal focuses on aerosol and dust deposition, but does not consider the physics of particle movement through the atmosphere. Particles half a mm in size are only in extremely rare cases transported beyond their immediate vicinity. The standard macroinvertebrate mesh size has no relevance to atmospheric deposition and does not provide support for the use of a 500um mesh size. The justification for mesh size should be based on a clear understanding of the atmospheric transport of particles and be based on peer-reviewed literature.

7) Examples used in the proposal lack clarity in their relevance and should be linked explicitly to Utah Lake and the proposed study:

For example, the proposal uses several examples to illustrate the potential for P to be transported long distances in dust in apparent large numbers, but then falls short of calculating the actual deposition rate as it may apply to Utah Lake. Examples as follows:

1) The proposal suggests dust concentrations from the Sevier basin or other great basin playas would have concentrations up to 800 ppm similar to what has been measured from Utah Lake (but why not draw from actual measurements of playas upwind?). Assuming the deposition rates quoted in this proposal (11 g m^{-2} $yr^{-1,}$ and from Reheis pubs), this is 3-4 tons of TP per year to Utah Lake.

2) In the Spanish example, the mean deposition rate is 13.8 mg TP m^{-2} yr^{-1}, SRP is 4.0 mg m^{-2} yr^{-1} (Morales Baquero et al 2013). Taking these deposition rates and applying them to Utah Lake would arrive at a total loading of 5.8 TP or 1.7 SRP tons to Utah Lake per year.

3) In the Amazon Basin example, the deposition rate is 2.3 mg TP m^{-2} yr^{-1}. Applying this to Utah Lake would result in a deposition rate of 1.0 ton per year to Utah Lake.

4) Figure 5 in the proposal states "note elevated deposition 50 km from lake". The elevated deposition is 2.5 g m^{-2} yr^{-1}, at 800 ppm this is less than 1 metric ton to Utah lake.

Table 1 provides a summary of the examples provided within the workplan with standardized units and P loading rates to Utah Lake. The loading calculations assume a surface area of Utah Lake of 384.3 km^2 and the dust is of regional nature resulting in a uniform deposition rate across the lake (i.e. extinction coefficient = 0). It should also be noted that the TP is composed of mineral bound P and biologically available P. The significance is that not all of the TP associated with dust will contribute to future algal blooms.

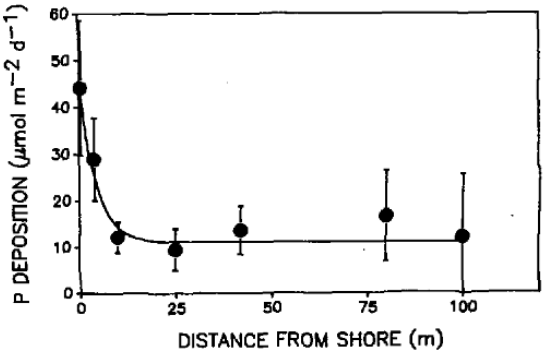
Table 1, Summary of Examples Provided in AD Workplan

Example	TP in dust (ppm)	Flux (g dust/m^2/yr)	Flux (mg P/m^2/yr)	Utah Lake Load (tons TP/yr)
1. Sevier Basin	800	11.0	8.8	3.7
2. Spanish (dry)	1,600	8.6	13.8	5.8
2. Spanish (wet)	1,600	2.5	4.0	1.7
3. Amazon	780	2.9	2.3	1.0
4. Figure 5	800	2.5	2.0	0.8
Owens pre fire	800	9.1	7.3	3.1
Owens post fire	800	14.6	11.7	4.9

Note: TP does not distinguish between bio-available P and mineral bound P

8) <u>Examples used in the proposal should be clearly relevant to Utah Lake:</u>

This is not always the case, for example Utah Lake should not be compared to a small forested New Hampshire Lake. Mirror Lake in New Hampshire is 15 ha compared to Utah Lake's 38,450 ha. The ratio of shoreline to lake area is much greater for Mirror Lake, and therefore so would be the influence of terrestrial deposition of bugs and vegetation to the lake. What is not included in the proposal is that the Cole et al paper shows a rapid drop off in deposition rate at just 10m, which is probably accurate for large fragments of vegetation emerging from a forest canopy, but not likely applicable to the types of local contamination around Utah Lake. The proposal should cite relevant literature examining extinction rates for deposition across lakes.



9) <u>The proposal should only rely on peer-reviewed literature:</u>

The proposal cites unpublished literature indicating P concentrations in deposition that are extremely high (0.8 mg-P/L). No information is given as to the state of the samples

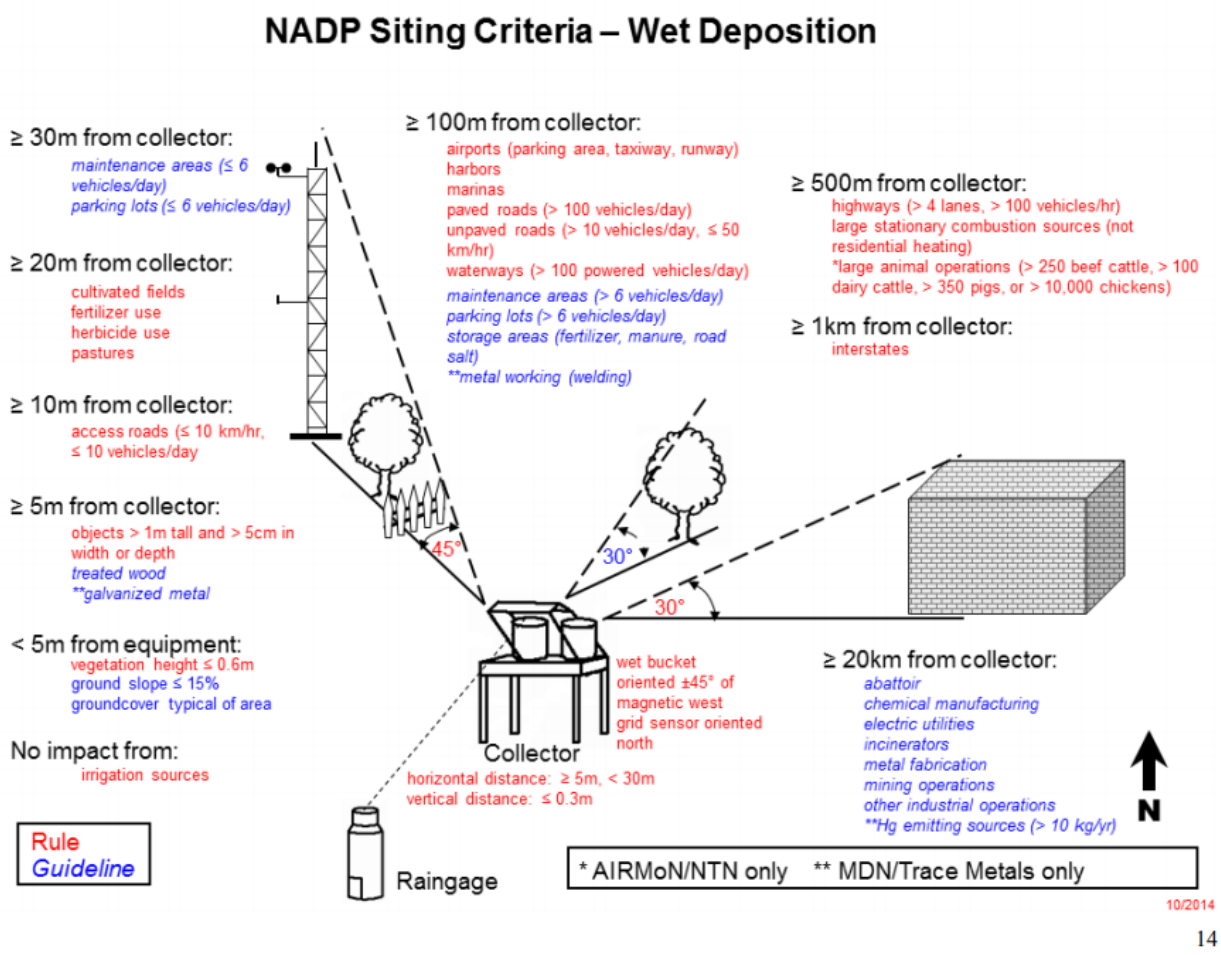
and whether they were contaminated by bugs or bird feces, or what actions were taken to avoid or remove contaminated samples. These types of samplers often have bug and bird contamination and including these results is misleading. Given that P does not have a stable gaseous form, and is thus primarily transported in particulate form, concentrations in precipitation are not expected to be large. Further, there have been no dust leaching studies anywhere in the world that would suggest a rain storm could produce values as high as 0.798 mg/L. The proposal states that the values may be compromised by agriculture or construction, but still goes on to inappropriately extrapolate these values across the entire lake arriving at a deposition rate higher than has been observed anywhere else in the world (110 tons to Utah Lake per year) and is in direct conflict with the examples provided in the proposal introduction (see point 7).

10) <u>Samplers should be placed according to the guidelines of the NADP to avoid contamination:</u>

Sampler locations should be explicit in the proposal and approved by the SP. If samplers are placed in a region close to a source of contamination (road dust, irrigation spray, mining), the proposal needs to clearly identify how it will determine the zone of influence. On page 10, the proposal states "*4. Select sites that adhere to NADP protocol (as is currently being followed on three of the sample sites, Figure 6)*,". This is a misleading comparison since the NADP protocols being referenced are not for the measurement of dry deposition. The proposal cites criteria from the NADP as the following "*designated as Guidelines. These criteria are recommendations based on scientific judgment. Due to practical siting considerations and research goals, it may not be possible for sites to meet one or more of these criteria. Failure to meet these criteria does not prohibit a site from either joining, or remaining in an NADP network. Again, the extent of the departure from these criteria may designate the site as Research/Provisional".* This is somewhat misleading as some sites, while still in the network, are treated differently in how their data are used and how the data are used in the models. Sites listed as research and provisional may not be used in assessments.

NADP Criteria (for reference):

Note that the NADP conducts site visits to assess the suitability of all sites. That means they could reject a location based on local circumstances whether or not the site met the initial criteria. Dust from roads in Utah can be particularly problematic. It is explicitly stated that "*deposition equipment (i.e., collectors and raingages), AMoN samplers, and AMNet equipment should* ***be located such that they cannot be impacted by irrigation sources. Wind speed and wind direction should be considered when assessing potential impact from nearby irrigation sources.*** *"* If samplers are to be placed near central-pivot irrigation systems, particularly those that use the Jordan River as a water source or ditch water, an assessment of wind speeds and water spray should be used to justify the placement.



NADP Siting Criteria – Ammonia Monitoring Network

≥ 30m from sampler:
- unpaved roads (> 10 vehicles/day, ≤ 50 km/hr)
- waterways (> 100 power vehicles/day)
- *maintenance areas (> 6 vehicles/day)*
- *parking lots (> 6 vehicles/day)*

≥ 20m from sampler:
- cultivated fields
- fertilizer use
- herbicide use
- pastures

≥ 10m from sampler:
- access roads (≤ 10 km/hr, ≤ 10 vehicles/day
- *maintenance areas (≤ 6 vehicles/day)*
- *parking lots (≤ 6 vehicles/day)*

≥ 5m from sampler:
- objects > 1m tall and >5cm in width or depth

< 5m from sampler:
- avoid local low elevations
- *groundcover typical of area*
- *ground slope ≤ 15%*
- *vegetation height ≤ 0.6m*

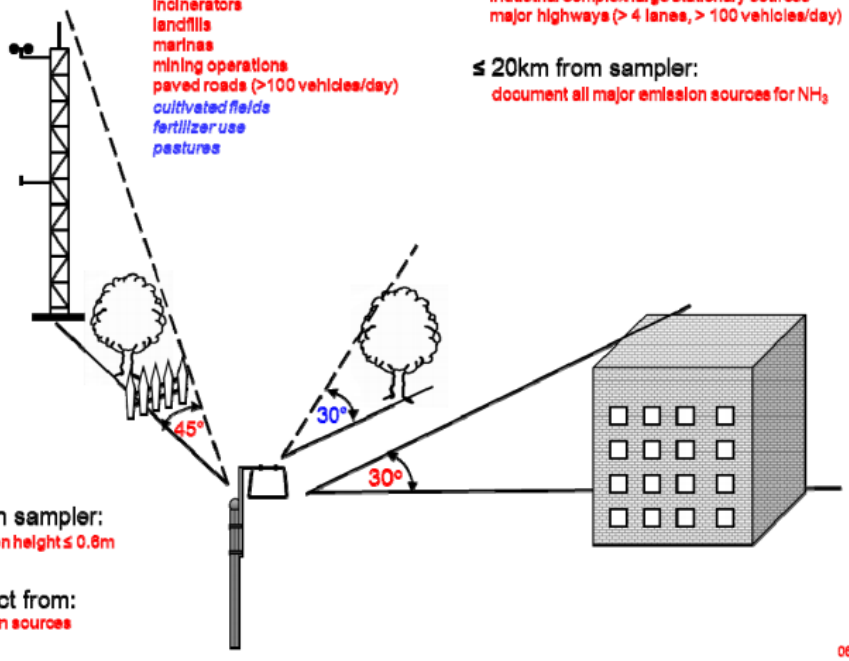
< 2m from sampler:
- vegetation height ≤ 0.6m

No impact from:
- irrigation sources

≥ 100m from sampler:
- airports
- chemical manufacturing
- electric utilities
- small feedlot operations
- harbors
- incinerators
- landfills
- marinas
- mining operations
- paved roads (>100 vehicles/day)
- *cultivated fields*
- *fertilizer use*
- *pastures*

≥ 500m from sampler:
- animal operations (>250 beef cattle, >100 dairy cattle, >350 pigs, or >10,000 chickens)
- industrial complex/large stationary sources
- major highways (> 4 lanes, > 100 vehicles/day)

≤ 20km from sampler:
- document all major emission sources for NH_3



Rule
Guideline

08/2013

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