

UNCERTAINTY GUIDANCE

Utah Lake Water Quality Study
Steering Committee Call
March 13, 2020



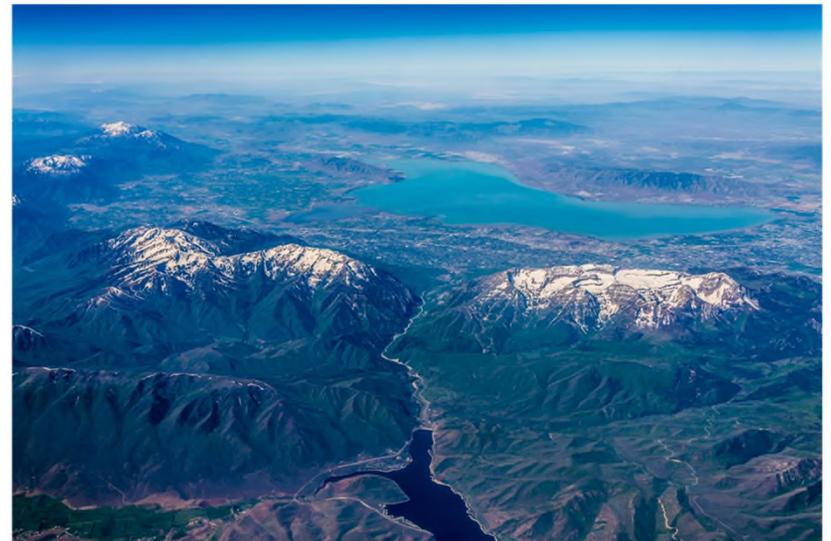
GOALS

- *“Develop a process to characterize uncertainty”*
- Applicable to SP answers to charge and criteria recommendations
- Provides a context for decision-making

Utah Lake Water Quality Study— Uncertainty Guidance

DRAFT

February 11, 2020
Version 6.0



PRESENTED TO

Utah Department of Environmental
Quality
Division of Water Quality
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PREPARED BY

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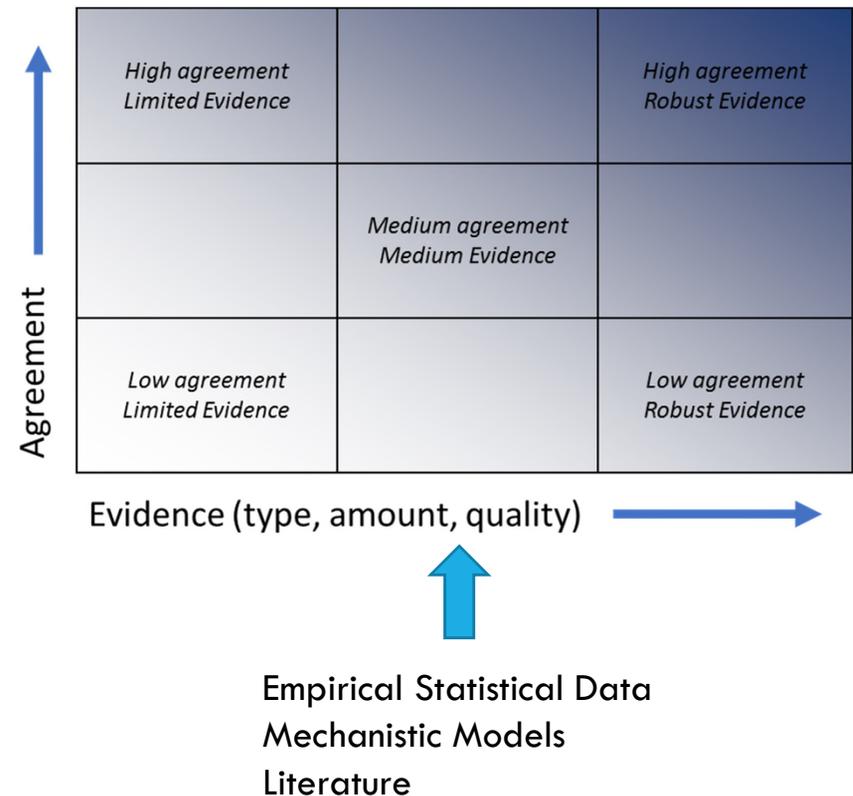
UNCERTAINTY



- Inherent to complex system behavior
- Hard (impossible) to completely eliminate
- It can, however, be described
- Important to communicate consistently, understandably, transparently, and repeatably

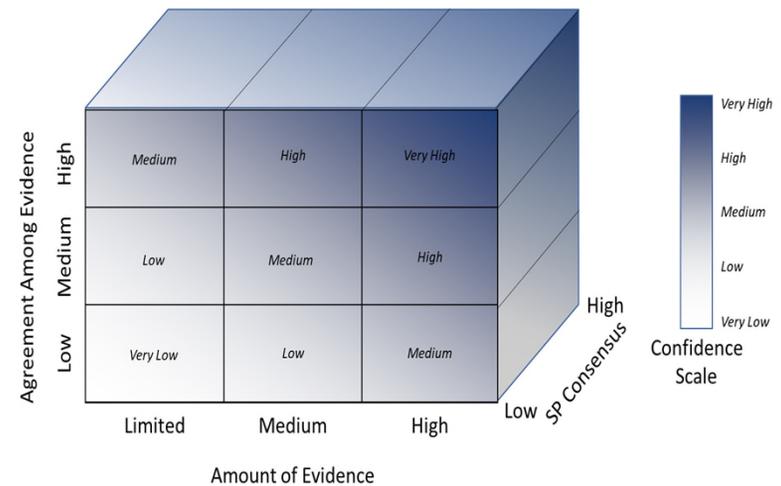
ELEMENTS: EVIDENCE AND AGREEMENT

- Based on established scientific methods for mixed statistical and modeled systems
- Evidence – type, amount, quality
 - Quantifiable when possible; qualifiable when not.
- Agreement – extent
 - Quantifiable



ELEMENTS: CONFIDENCE AND LIKELIHOOD

- Confidence: based on evidence, agreement (among evidence) and consensus (among experts)



- Likelihood: based on interpretation of confidence

Language	Probability
Virtually certain	99-100% Probability
Very likely	90-100% Probability
Likely	66-100% Probability
About as likely as not	33 to 66% Probability
Unlikely	0-33% Probability
Very unlikely	0-10% Probability
Exceptionally Unlikely	0-1% Probability

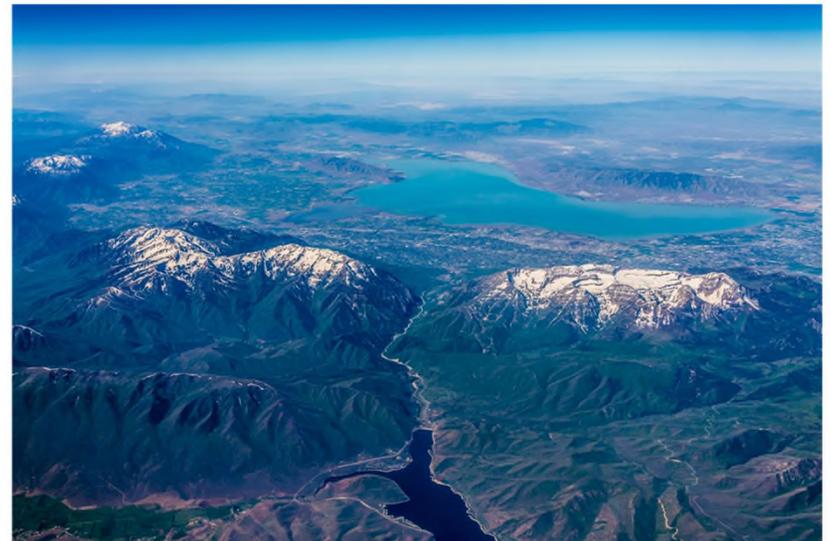
COMMUNICATION

- Consistent application of elements (confidence and likelihood) to SP conclusions
- Traceable accounts – for transparency and reproducibility
- Iterative with SC

Utah Lake Water Quality Study— Uncertainty Guidance

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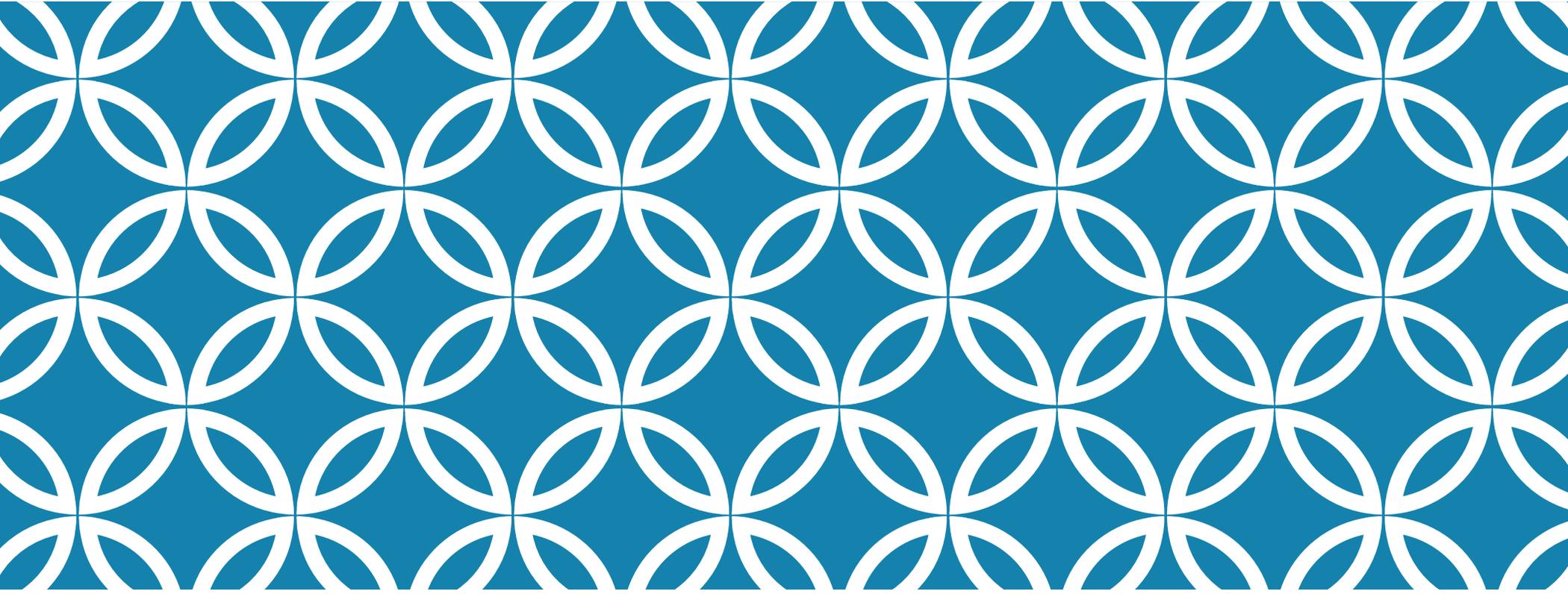


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NUMERIC NUTRIENT CRITERIA TECHNICAL FRAMEWORK

Utah Lake Water Quality Study
Steering Committee Call
March 13, 2020



GOALS

- *“Describes the approach...to derive in-lake numeric nutrient criteria (NNC) recommendations for nitrogen and phosphorus in Utah Lake*
- Based on the literature review of NNC derivation approaches
- Designed to be adaptive, responding to the knowledge landscape as it changes

Utah Lake Water Quality Study— Numeric Nutrient Criteria Technical Framework

DRAFT

February 24, 2020
Version 6.0



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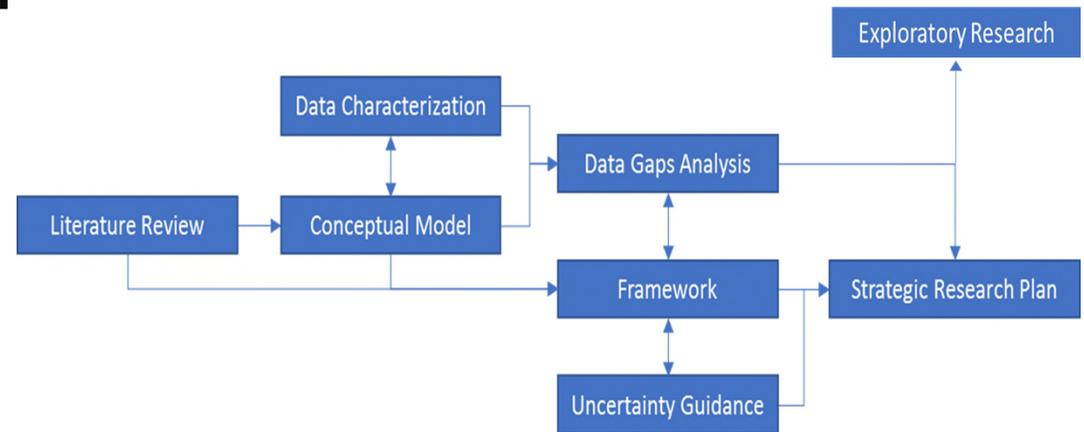
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FRAMEWORK CONTEXT

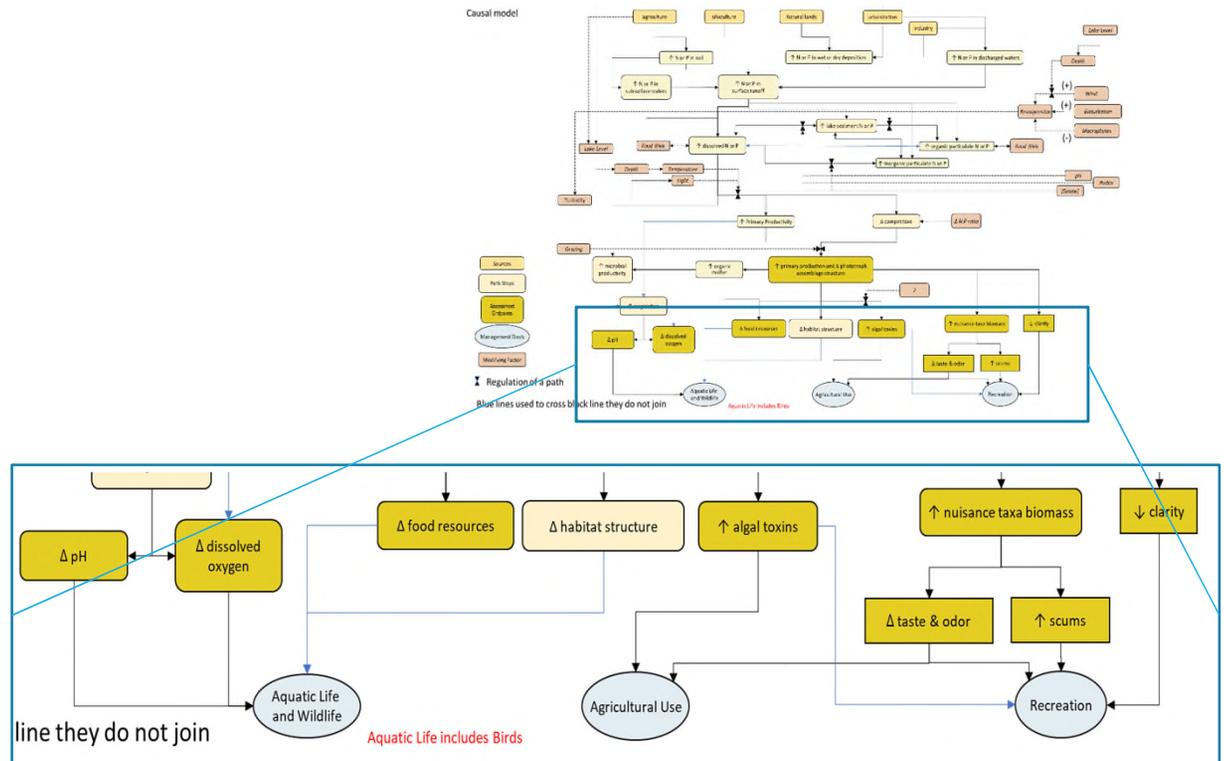
- Built from/informed by several elements



- Designed to help guide research needs

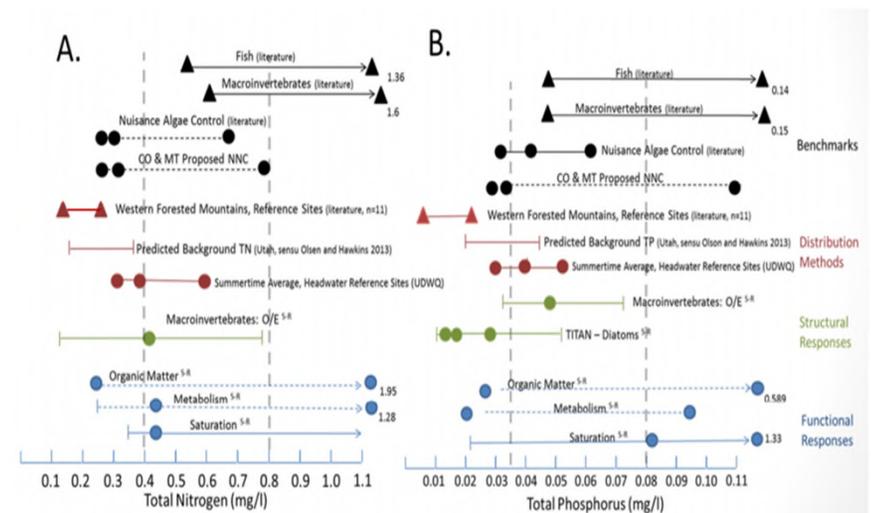
FOCUSED ON ENDPOINTS LINKED TO USES

- Recreation
- Aquatic Life
- Agriculture



A MULTIPLE LINES OF EVIDENCE APPROACH

- “Reference” conditions
- Stressor-response models
- Mechanistic modeling
- Literature



COMBINING LINES

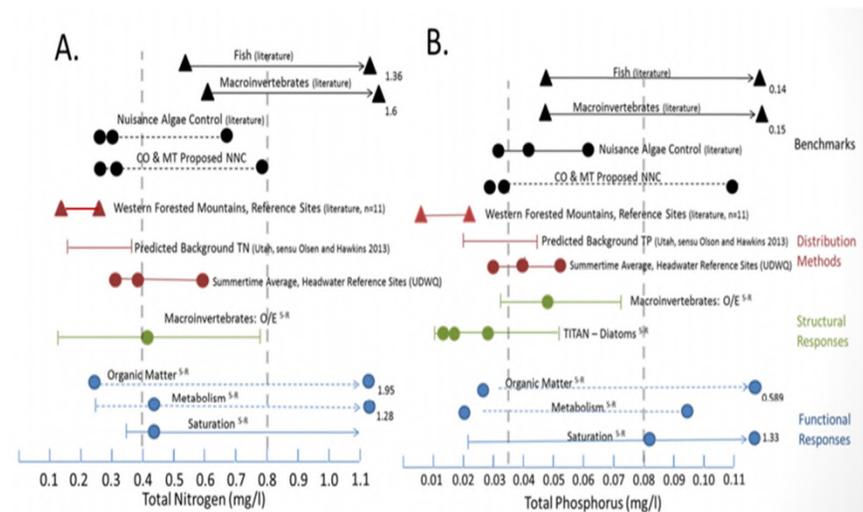
- All evidence considered
- Incorporates uncertainty into recommendations
- Including a clearly traceable narrative as to its derivation

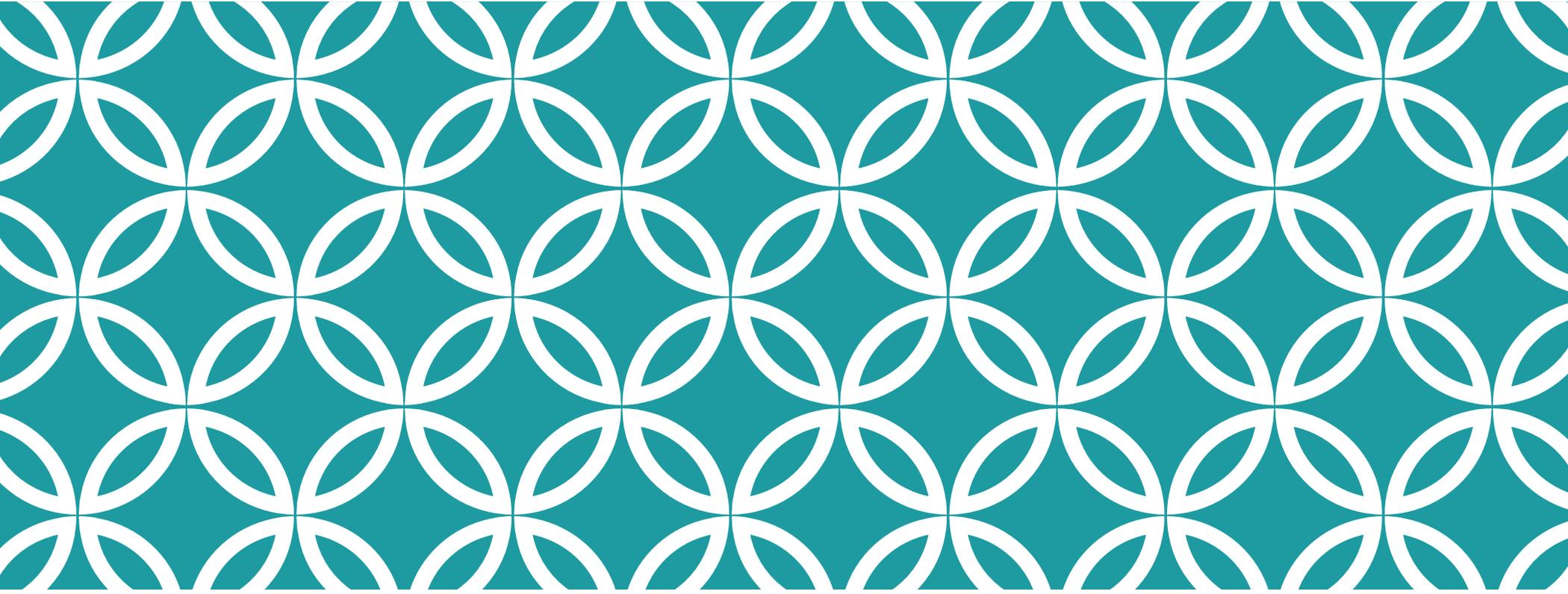
For Example Only

Measures of Effect/Measures of Exposure	TP (mg/L)	Beneficial Uses Protected			Uncertainty	
		Recreation (2A and 2B)	Aquatic Life (3B and 3D)	Agriculture (4)	Likelihood (not likely, as likely as not, very likely)	Confidence (low, medium, high)
Chlorophyll a < some established target from user surveys or other analyses		X	X	X	Very likely	Medium
Cyanobacterial Cell Density > 100,000/ml		X	X		Very Likely	Medium
Microcystin > 4 ug/L		X			As Likely As Not	Medium
Cylindrospermopsin > 8 ug/L		X			As Likely As Not	Low
Anatoxin-a > 20 ug/L		X			As likely as Not	Low
Sufficient Zooplankton Prey Densities			X		As likely as Not	Low
Toxin concentrations to protect irrigation or livestock watering				X	As likely as Not	Low
Dissolved Oxygen > state standard			X		Very Likely	High
pH within state standard			X		Very Likely	Medium

RECOMMENDED NUTRIENT CRITERIA

- The SC will not receive “a number” from the SP
- The SC will receive a range of values with associated uncertainty (confidence and likelihood) for different endpoints
- This can be iterative
- The SC will evaluate these alternatives and recommend values and implementation construct



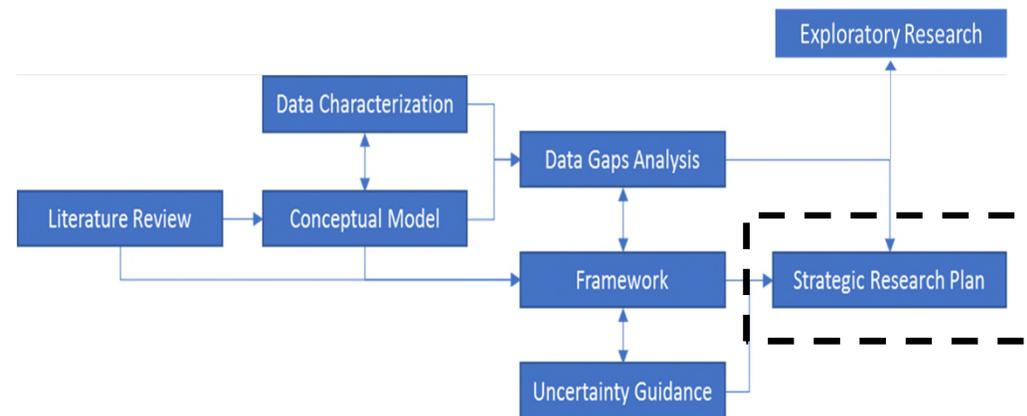


STRATEGIC RESEARCH PRIORITIES

Utah Lake Water Quality Study
Steering Committee Call
March 13, 2020

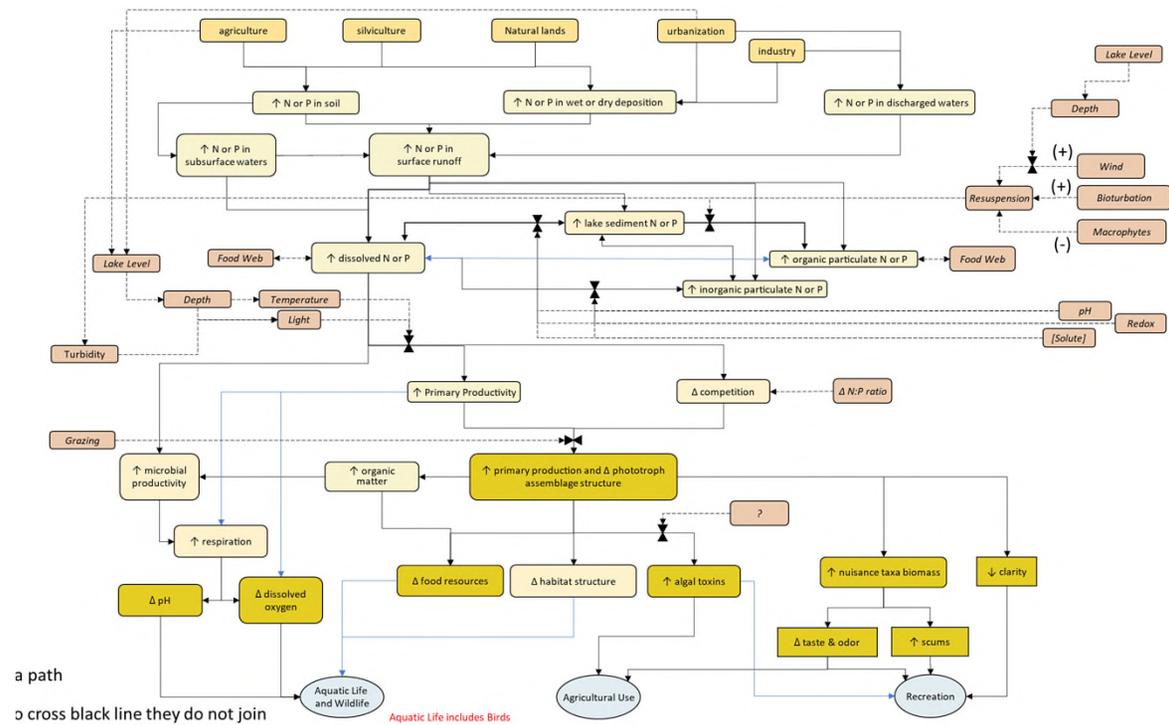
STRATEGIC RESEARCH PLANNING

- “Recommend scientific studies based on the high level questions to support site specific criteria...and guide development of a prioritized set of studies to address gaps”
- Last year, identified immediate research projects
- This year, identifying additional research priorities for RFP development



GOALS

- Identify major gaps in knowledge, reduce uncertainty with which SP:
- Responds to charge questions
- Derives defensible criteria
- Improve understanding of the lake system



STRATEGIC RESEARCH PLAN

- Introduction
- Information needs for:
 - Charge questions
 - NNC setting
- Strategic Plan
 - Priorities
 - Near term RFPs
 - Adaptive research plan

Utah Lake Water Quality Study— Strategic Research Plan

DRAFT

February 18, 2020
Version 3.0



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MAPPING KNOWLEDGE

- We mapped past and ongoing research to every charge question

Questions	Being addressed
1.1. What does the diatom community and macrophyte community in the paleo record tell us about the historical trophic state and nutrient regime of the lake?	Partially
i. Can diatom (benthic and planktonic) and/or macrophyte extent or presence be detected in sediment cores? And if so, what are they?	Paleo RFP
ii. What were the environmental requirements for diatoms and extant macrophyte species?	No
iii. How have environmental conditions changed over time?	Data analysis
1.2. What were the historic phosphorus, nitrogen, and silicon concentrations as depicted by sediment cores? (add calcium, iron, and potentially N and P isotopes)	Paleo RFP
1.3. What information do paleo records (eDNA/scales) provide on the population trajectory/growth of carp over time? What information do the paleo records provide on the historical relationship between carp and the trophic state and nutrient regime of the lake?	No
1.4. What do photopigments and DNA in the paleo record tell us about the historical water quality, trophic state, and nutrient regime of the lake?	Paleo RFP

MAPPING KNOWLEDGE

- We also mapped past and ongoing research to NNC setting needs
- We summarized areas without ongoing research/substantial uncertainty
- Had SP prioritize these research areas

Approach	Line of evidence	How will it help inform NNC	Knowledge gaps	Being addressed
Reference-based	Paleolimnological reconstruction of past conditions	Can inform what reference conditions were, whether conditions previously supported desired assessment endpoint conditions, if and how much such conditions have changed adversely, and whether such conditions are once again achievable	Historic phosphorus, nitrogen, and silicon concentrations	Paleo RFP
			Historic water quality, trophic state, and nutrient regime	Paleo RFP
			Can past diatom communities and macrophyte communities be detected in sediment cores? If so, what were those communities like?	Partially through the paleo RFP (at least with question 1, not sure yet about question 2)
	Model based prediction	The model will be set to minimal or no human contributions and model responses will be evaluated. This will help inform what achievable conditions might be	What are appropriate inputs to use for natural nutrient (N and P) loads?	Partially through paleo RFP, atmospheric deposition studies, and reference-based studies for tributary inputs.
	Direct observation	Provides context for other lines of evidence and can be used as a measure of baseline values for N and P	There are limited observed reference data from Utah Lake and few if any comparable reference lakes due to Utah Lake's unique features	Data analyses, to the degree possible (all data from Utah Lake have been compiled; data from comparable lakes may be evaluated as well)

RESEARCH AREA PRIORITIZATION

- Started with 13 unfunded ideas from 2019
- December Ranking; January – Reranking
- SP approved these rankings
- Seeking SC approval
- Next step: RFP development

Research Areas		Mean Ranking - Feb 2020
1	How large is internal vs external loading (how long would recovery take?)	2.3
2	Sediment budgets (C, N, and P; nutrient flux chambers)	3.6
3	Calcite scavenging (how bioavailable is SRP – does bioassay address?)	4.3
4	Adding modules to the WQ models (sediment diagenesis, calcite scavenging)	4.3
5	Carp effects on nutrient cycling	7.3
6	Lake level (effect on macrophytes)	9.2
7	Bioassays that incorporate sediment (next phase mesocosms)	9.4
8	Macrophyte recovery potential (Provo Bay demo)	10.0
9	Lake-level effects on biogeochemistry and nutrient cycling	10.2
10	Environmental controls on toxin production	11.1
11	Turbidity effect on primary producers	11.2
12	Resuspension rates from bioturbation	11.7
13	Carp effects on zooplankton (and does this influence algal response)	11.8
14	Carp effects on macrophytes	12.1
15	Toxin Production and N Species	13.7
16	Recreational surveys	13.8
17	Macrophyte role (to biogeochemistry)	14.0
18	Additional atmospheric deposition data	14.6
19	Alternative models (PCLake – cyano/macrophyte state change)	14.9

**UTAH DIVISION OF WATER QUALITY
UTAH LAKE WATER QUALITY STUDY SCIENCE PANEL**

OPERATING PRINCIPLES

(September 6, 2018; updated November 12, 2018; updated March 13, 2020)

The Stakeholder Process (or Charter) [<https://documents.deq.utah.gov/water-quality/watershed-protection/utah-lake/DWQ-2017-004494.pdf>] approved on May 12, 2017 provides the foundation for the Utah Lake Water Study Steering Committee and Science Panel and describes the “the purpose, objectives, duties, and composition of each group and the mechanisms by which the groups will interact.”

For any collaborative process to operate smoothly, it is helpful for those involved to agree at the outset on the procedures by which the group will govern its discussions, deliberations, and decision-making. This document captures additional process agreements that will assist the Science Panel in achieving its purpose.

I. Purpose of the Utah Lake Water Quality Study Steering Committee and Science Panel

The Steering Committee is charged with guiding development of site-specific nutrient criteria to protect the designated uses of Utah Lake including numeric criteria for both nitrogen and phosphorus, and specific elements for the magnitude (concentration of pollutants), duration (period of exposure to pollutants), and frequency (recurrence of the exposure to pollutants) necessary to protect defined uses. The Steering Committee will recommend nitrogen and phosphorus criteria to the Commission and the Utah Water Quality Board. Criteria recommended by the Steering Committee will be considered by the Utah Water Quality Board for adoption following review and input from the Commission.

The purpose of the Utah Lake Science Panel (Science Panel) is to assist in development of site-specific nutrient criteria on Utah Lake by overseeing targeted scientific studies.

Recognizing the advisory role of the Science Panel and time limitations of its members, DWQ will provide technical support to help the Panel accomplish the objectives and member duties presented in the Charter. This support will be provided either through available DWQ staff resources or through contractual assistance.

The Charter describes the significant number of tasks the Science Panel will undertake to achieve its purpose:

1. Guide development of a scientifically defensible approach for developing site-specific nutrient criteria with support of a technical contractor.
2. Recommend scientific studies, based on scope outlined by the Steering Committee (i.e., High-level questions), to support site-specific nutrient criteria development:
 - a. Define additional questions to be addressed (i.e., sub-questions) in order to answer each High-level question;
 - b. Determine if sub-questions can be answered with existing data, literature, and information;
 - c. Identify gaps that exist for answering sub-questions; and

- d. Guide development of a prioritized set of studies to address the gaps (i.e., research plan) and specifically:
 - i. Define study objectives and provide direction in development of the RFPs; and
 - ii. Review the proposals and make recommendations (as part of DWQ Decision Team) on preferred option(s):
 1. Assess proposed study methods for appropriateness;
 2. Assess proposed work plans on how/whether they follow standard scientific practices;
 3. Evaluate the studies' expected ability to address high-level questions; and
 4. Review proposed data collection efforts.
 - e. Guide development of a process to characterize scientific uncertainty including confidence of scientific findings and quantified measures of uncertainty.
3. Guide study efforts during implementation by providing advice to principal investigators and study contractors on an as needed (but coordinated/focused) basis including, but not limited to, data collection efforts and issues that arise during implementation.
4. Review, interpret, and provide comments on the study results.
5. Provide independent scientific peer review on relevant Utah Lake studies and other relevant research reports (no more than 3 reports as approved by the Steering Committee).
6. Recommend science-based site-specific nutrient criteria to ensure long-term protection of Utah Lake's designated uses to the Steering Committee.

II. Participation

Membership. The Science Panel consists of five independent ~~(voting)~~ scientists who have responsibility to provide independent and objective recommendations to the Steering Committee; and five Ex Officio ~~(non-voting)~~ members who participate in the Science Panel conversations, provide local context, share professional experience and expertise, and advise on relevant experience with Utah and Utah Lake.

The Panel is a discipline-focused group composed of members with specialized scientific expertise relevant to the unique characteristics and processes present in Utah Lake. All members of the Science Panel are scientists with demonstrated expertise in their respective field of study and are currently active within their areas of expertise. No member on the Science Panel may be a member of the Steering Committee. All members are bound by these Operating Principles.

If, in the course of undertaking the tasks described above, the Science Panel identifies the need for additional expertise they can raise that with the Steering Committee and request that an additional member be added for a specific set of discussions or period of time as appropriate.

Procurement. The DWQ Administrative Services Manager will preside over all procurement related initiatives to ensure the requirements of the State of Utah procurement code # 63G-6a are met. The DWQ Administrative Services Manager will ensure that matters related to proposal evaluation, confidentiality, conflicts of interest, favoritism, independence, and bias meet the requirements of 63G-6a, R33-7-703, and R33-24-105 or 106.

Independent members of the Science Panel may not compete for research projects that are managed and funded by the ULWQS. Independent science panel members will recuse themselves from review of

all proposals associated with a solicitation if a conflict of interest is identified as defined in R33-24-105 or 106 or if any of the proposals include individuals from the same university or organization as the independent science panel member.

Ex Officio members of the Science Panel may participate in preliminary scope development for studies, provided they do not intend to bid on the related work. However, they are not able to participate in final decisions on the scope of studies.

Ex Officio members of the Science Panel intending to bid on the work must recuse themselves from any related scoping efforts. If they do not recuse themselves before related scoping efforts occur, they will be disqualified to bid for the work.

Please note one exception to the condition of recusal; if a science panel member works for the same university that is anticipating to bid for work, they may participate in preliminary scope development, provided they themselves are not bidding for or plan on being part of the team who ultimately is engaging in the work.

In addition, Ex Officio members of the Science Panel are not allowed to participate in proposal review and development of recommendations regarding contractors to perform scientific studies.

Finally, all members of the Science Panel are able to participate in evaluation of study products unless they were involved in completing the work. If studies are contracted to an individual with a conflict of interest with a science panel member or from the same university or organization as a science panel member, the science panel member must establish a professional fire-wall regarding Utah Lake studies. No communication between such individuals should occur except through official Science Panel channels.

Please note the ultimate decision on Water Quality Board funded research work will be made by the DWQ, considering recommendations from the Science Panel, per procurement rules through an open bidding process.

Objective. In developing guidelines for selection of members of the Science Panel, the Steering Committee agreed that members of the Science Panel should be independent and objective scientists. In taking an “objective” approach to the ULWQS, members of the Science Panel are to approach all data and findings with an open mind and to eliminate personal biases, *a priori* commitments and emotional involvement. If the objectivity of any of the member of the Science Panel is in question, they will be reminded of these Operating Principles and the criteria of objectivity.

Should a Panel member be found to not meet the objectivity standard the facilitator will be asked to talk with the individual(s) about the situation. A variety of approaches will be explored, accordingly, to redress the concerns. The authority to replace and/or remove a member from the Panel rests with DWQ and the Commission.

Independent. In this context “independent” means that these scientists are not financially connected to any of the individuals or organizations represented on the Steering Committee and they will not bid on the work under the ULWQS.

Should a Panel member be found to not meet the independence standard the facilitator will be asked to talk with the individual(s) about the situation. A variety of approaches will be explored, accordingly, to redress the concerns. The authority to replace and/or remove a member from the Panel rests with DWQ and the Commission.

Ex Officio. Ex Officio members are individuals who either have a relationship with organizations represented on the Steering Committee or intend to bid on research projects that would be managed and funded by the ULWQS. Ex Officio members have expertise and institutional knowledge about Utah Lake and prior research and management activities. It is anticipated that this expertise will be valuable to familiarize the independent Science Panel membership, and to expedite their understanding of Utah Lake and water quality issues.

Attendance at Meetings. Each member is expected to attend all regularly scheduled meetings. If a member cannot attend in person, he or she is expected to participate by phone/webinar.

Withdrawal from the Committee. Any member may withdraw from the Science Panel at any time without prejudice. Communication about the reasons for withdrawing, if related to the Science Panel process, would be appreciated. Good faith provisions apply to those who withdraw.

If a Science Panel member withdraws, the Steering Committee will consider a replacement with input from the remaining Science Panel members. In turn, Steering Committee recommendations will be provided to the Co-Chairs who retain authority for replacing Science Panel members.

Termination from the Committee. As stated above, if a Science Panel member is found to not meet the standard of objectivity or the standard of independence, a variety of approaches will be explored, accordingly, to redress the concerns. The authority to replace and/or remove a member from the Panel rests with DWQ and the Commission.

III. Organizational Structure

Science Panel Members. All Science Panel members agree to attend meetings and follow through on commitments; bring up concerns and opportunities for discussion at the earliest point in the process; and share all relevant information that will assist the group in achieving its goals.

Science Panel Chair. The Science Panel members will nominate and select one of its independent members to serve as the Panel Chair to work with the facilitation team to develop meeting agendas and address issues with the coordination issues.

DWQ Staff. A DWQ staff member will serve as a non-voting participant in the Science Panel deliberations to ensure the study's goals are met in accordance with the Utah Water Quality Act, related state rules, and Clean Water Act requirements. The staff member will work with the Panel Chair and the Facilitator on meeting agenda development and addressing related logistical issues. Other DWQ staff will assist as necessary. Legal questions that need to be addressed will be forwarded through DWQ to the Attorney General's office for their opinion.

Utah Lake Commission. The Commission will also provide administrative support for Science Panel members as necessary.

Steering Committee. The Steering Committee will charge the Science Panel with relevant scientific questions, approve research work plans from the Science Panel; advise the Science Panel on activities, progress, and significant findings of the study; consider feedback, comments, and recommendations from the Science Panel; and review recommendations from the Science Panel as they develop recommendations for Utah Lake water quality criteria. The Steering Committee will provide the Science Panel “key questions” to fill gaps in knowledge for the study. Recommendations for criteria will be provided to the Commission and the Utah Water Quality Board and include policy aspects not addressed by the Science Panel.

Facilitator. Science Panel meetings will be facilitated by RESOLVE with support from SWCA. The facilitation team will not take positions on the issues before the Panel. The facilitator will work to ensure that the process runs smoothly. The facilitator’s role includes developing draft agendas, distributing meeting materials, facilitating meetings, working to resolve any impasse that may arise, and preparing meeting summaries. The facilitator will keep all confidential information in confidence.

IV. Meetings

Open to the Public. All Science Panel meetings will be open to the public. A public comment opportunity, limited to a 5 to 15-minute period at the end of each Science Panel meeting, will be provided.

Agendas. Proposed meeting agendas will be drafted by the facilitator in consultation with the Science Panel Chair and DWQ Ex Officio member and then circulated in advance of meetings to all members for comment. Science Panel agendas will be informed by Steering Committee deliberations as well.

Action Item Memos/Meeting Summaries. In order to assist the Science Panel in documenting its progress and activities, within five days of each meeting the facilitation team will prepare and distribute an action items memo. These memos will convey major decisions, summarize the action items from the meeting, convey timelines for completing agreed upon actions, and briefly summarize the deliberations of each meeting. These will be distributed to all members for review prior to public distribution.

Breaks and Caucuses. Meetings may be suspended at any time at the request of any member to allow consultation among Science Panel members. Requests should be respectful of all members’ time. If the use of caucuses becomes disruptive, the Panel will revisit the process.

V. Decision Making and Commitments

Quorum. The charter defines a quorum as “two thirds of the members of the Science Panel.” A quorum is necessary for meetings to proceed. As such, for meetings where all independent and ex officio members are involved (10 members), a quorum is defined as 7 members. For meetings where only independent members (5 members) are involved (e.g., proposal review), a quorum is defined as 4 members.

Decision Criteria. As described in the Charter:

The goal of the Science Panel is to work toward a consensus recommendation for water quality criteria necessary to ensure long-term protection of Utah Lake’s designated uses. A majority of all Science Panel ~~independent~~ members is required to forward a final recommendation to the Steering Committee. Minority opinion(s) will also be forwarded if there is not consensus. If a

majority is not possible, then alternative position papers from Science Panel ~~[Independent]~~ member(s) will be forwarded for consideration by the Steering Committee.

~~Ex Officio members may also provide their perspective on the information submitted to the Steering Committee by the independent members of the Science Panel.~~

Decision Making. Decisions will be made by those ~~independent~~ Science Panel members present at a meeting (either in person or on the phone) and ~~will be based on a simple majority. ,as noted earlier, at least 4 members need participate for a meeting to proceed.~~ Science Panel members with conflicts of interest on a specific deliverable must recuse themselves from any vote related to that particular work product.

~~For substantive recommendations, at least 3 independent science panel members (a majority) regardless of the number in attendance (4 or 5) would need to agree in order to send recommendations to the Steering Committee.~~ If the members present at a meeting reach agreement on a recommendation to the Steering Committee, the facilitator will convey the results to any absent members to assess their ability to agree. As necessary, if individuals do not support the recommendations and wish to develop minority opinions, they can be forwarded in a package with the recommendation and an explanatory note from the Chair.

NOTE: Recognizing the majority approach is a useful one to help expedite the process, the Science Panel members also understand that developing recommendations with the support of all members (i.e., each member can at least live with the recommendation) would likely provide a stronger message to the Steering Committee. As time permits and the discussions unfold, the Science Panel will strive to achieve the full support of recommendations where possible.

The Charter indicates: "Procedural issues require the support of two thirds of the members present at a meeting." ~~As such, for procedural issues, at least 3 independent science panel members (if there are 4 or 5 members present) will need to agree before an issue is finalized.~~

Absence of Consensus. If a majority cannot be reached, the Science Panel may choose to articulate areas of agreement and disagreement and the reasons why differences continue to exist, or the individuals or sub-groups may decide to develop and share separate sets of opinion papers.

If the group chooses to articulate areas of agreement and disagreement, members representing the different perspectives on specific issues will be asked to prepare language reflecting their views. The language should clearly identify the issues and information needs and uncertainties. In addition, those members that support each perspective will be identified.

If separate sets of opinion papers are conveyed to the Steering Committee, members representing the different perspectives will be asked to prepare a communication reflecting their views.

Recommendation Package. Regardless of how many opinion papers are developed, they will be packaged together and shared with the Steering Committee with an explanatory note from the Chair. The Science Panel Chair, DWQ staff, and facilitation team will compile all recommendations, minority opinions, and position papers into a single recommendation package.

VI. Sharing Information with the Science Panel Members

In the course of undertaking the tasks described above, the Science Panel anticipates sharing a significant amount of information (e.g., data, reports, published papers). Generally, this information will be shared via a Dropbox site which will be managed by the Facilitation Team. Members of the Steering Committee are able to review this material if they are interested.

In some instances, the Science Panel may choose to share information considered confidential (e.g., papers that are not published yet; data that has not been made public yet) and, as such, is not to be shared with anyone in any form outside the Science Panel. This information will be shared via a separate folder on Dropbox for the exclusive use of other Science Panel members – these draft documents, preliminary data, and presentations are not to be shared with anyone, in any form, beyond the Science Panel.

If a Science Panel member(s) has an interest in sharing something they see in this folder beyond the Science Panel, the individuals should reach out to the originator of the information posted (or to one of the facilitation team and we can help figure out where the document came from) to see if they would be willing to have it shared further.

All of the ten Science Panel members, along with the UDWQ staff person assigned to the Science Panel (currently Scott Daly), and the Facilitation Team, will have access to these materials. This group should be considered the “Science Panel team” for the time being.

To ensure there is a common awareness of the materials being included in the folder, it is requested that all information either be: 1) sent through the Facilitation Team (to upload); or 2) if it is easier for a Panelist to upload the material themselves, an email with an explanation of information uploaded be sent to the full Science Panel team directly (or the Facilitation Team if preferable). Either way, the Facilitation Team will maintain an active inventory of information in the folder and inform the rest of the Science Panel of the contents on an as needed basis.

Sharing Information with the Science Panel. If Science Panel members receive information directly from members of the public they will contact the facilitation team to ensure that all Science Panel members receive the information in a timely and coordinated fashion and that the facilitation team can maintain a formal record of the information being shared. If members of the public do communicate directly with the Science Panel, either the facilitation team or a Steering Committee member will reach out to them to explain the process (as described in the Steering Committee Operating Principles) of requesting that communications go through the formal public comment process or through a Steering Committee member and the facilitation team.

VII. Safeguards for the Members

Good Faith. All members agree to act in good faith in all aspects of the collaborative effort. As such, members will consider the input and viewpoint of other participants and conduct themselves in a manner that promotes joint problem solving and collaboration.

Acting in good faith also requires that specific proposals made in open and frank problem solving conversations not be used against any other member in the future; personal attacks and prejudiced statements are not acceptable; negative generalizations are not productive and have the potential to

impede the ability of the group to develop recommendations; individuals do not represent their personal or organization's views as views of the Panel; and that they express consistent views and opinions in the Panel and in other forums, including in press contacts.

Should a Panel member be found to be acting in bad faith the facilitator will be asked to talk with the individual(s) about the situation. A variety of approaches will be explored, accordingly, to redress the concerns. The authority to replace and/or remove a member from the Panel rests with DWQ and the Commission.

Rights in Other Forums. Participation in the Science Panel process does not limit the rights of any member. Members will make a good faith effort to notify one another in advance, if another action outside the process will be initiated or pursued, which will affect the terms of proposals, recommendations, or agreements being discussed.

Press. All Panel members agree to refrain from making negative comments about or characterizing the views of other Panel members in contacts with the press. They also agree not to knowingly mischaracterize the positions and views of any other party, nor their own, in public forums.

VIII. Process Suggestions/Ground rules

Panel members agree to consider and apply the following process suggestions:

- Seek to learn and understand each other's perspective.
- Encourage respectful, candid, and constructive discussions.
- Seek to resolve differences and reach consensus.
- As appropriate, discuss topics together rather than in isolation.
- Make every effort to avoid surprises.

Panel members agree to apply the following ground rules:

- Focus on the task at hand
- Have one person speaking at a time
- Allow for a balance of speaking time by providing succinct statements and questions.
- Listen with respect
- Be civil
- Keep side conversations to a minimum.
- Turn off cell phones or put them in the non-ring mode during formal meeting sessions.

IX. Travel Arrangements, Reimbursement, and Honorarium

Also as noted in the Charter (Science Panel Composition):

Science Panel [Independent] members will be eligible for reimbursement of out of state travel expenses incurred for participation in Science Panel meetings. Non-public employees are also eligible for a modest honorarium.

Independent Science Panel members are eligible for reimbursement of pre-approved travel costs to include airfare, ground transportation, hotel, per diem, and other approvable expenses. Coordination of travel reimbursement will be managed by DWQ staff and the facilitation team.

Independent Science Panel members are also eligible for a modest honorarium. The honorarium will be determined by the DWQ Director and managed by DWQ staff and the facilitation team.

Ex Officio members are not eligible for an honorarium or reimbursement of travel expenses.

X. Schedule

At present, the Panel is envisioned to meet approximately four to six times per year for the next three years. Initially meetings may be more frequent as the research program is developed. The length and frequency of meetings over time will be driven by the work as defined by the Steering Committee.

**UTAH DIVISION OF WATER QUALITY
UTAH LAKE WATER QUALITY STUDY STEERING COMMITTEE**

OPERATING PRINCIPLES

(Adopted May 10, 2018; Updated September 6, 2018; Updated March 13, 2020)

The Stakeholder Process (or Charter) [<https://documents.deq.utah.gov/water-quality/watershed-protection/utah-lake/DWQ-2017-004494.pdf>] approved on May 12, 2017 provides the foundation for the Utah Lake Water Study Steering Committee and Science Panel and describes the “the purpose, objectives, duties, and composition of each group and the mechanisms by which the groups will interact.”

For any collaborative process to operate smoothly, it is helpful for those involved to agree at the outset on the procedures by which the group will govern its discussions, deliberations, and decision-making. This document captures additional process agreements that will assist the Steering Committee in achieving its purpose.

I. PURPOSE OF THE UTAH LAKE WATER QUALITY STUDY STEERING COMMITTEE

The Steering Committee is charged with guiding development of site-specific nutrient criteria to protect the designated uses of Utah Lake including numeric criteria for both nitrogen and phosphorus, and specific elements for the magnitude (concentration of pollutants), duration (period of exposure to pollutants), and frequency (recurrence of the exposure to pollutants) necessary to protect defined uses. The Steering Committee will recommend nitrogen and phosphorus criteria to the Commission and the Utah Water Quality Board. Criteria recommended by the Steering Committee will be considered by the Utah Water Quality Board for adoption following review and input from the Commission.

II. PARTICIPATION

Interests Represented. The Steering Committee is structured as an interest-based group representing stakeholders with a key interest in the outcomes of the Phase 1 and Phase 2 studies. The Steering Committee members include sixteen (16) representatives from federal, state, and local government, conservation and recreation organizations, and the regulated community. The DWQ Director and the Utah Lake Commission Executive Director will co-chair the Steering Committee.

The members were chosen because of the variety of their interests, experience with water quality or related natural resource issues, and willingness to work together in a collaborative, consensus-based process. In order to foster creative problem solving, members are encouraged to voice their individual viewpoints and ideas. In order to broaden and strengthen the chances of successfully developing consensus recommendations, members are expected to bring the perspectives of their constituent groups, as well as others with similar interests, to the Steering Committee early and often. All individuals participating in the process are bound by these Operating Principles.

Attendance at Meetings. Each member must make a good faith effort to attend each full meeting. If a member cannot attend, his or her alternate is expected to attend in their place to represent their interests. It is the responsibility of the member to inform their alternate about the deliberations.

Withdrawal from the Committee. Any primary or alternate member may withdraw from the Steering Committee at any time without prejudice. Communication about the reasons for withdrawing, if related to the Steering Committee process, would be appreciated. Good faith provisions apply to those who withdraw.

If a primary member withdraws, the expectation is that the alternate member will replace them on the Steering Committee. At that time, nominations could be accepted for the alternate members' seat. If an alternate member withdraws, either an alternate could be chosen by the primary member in consultation with DWQ and the Commission or nominations could be accepted for the seat. Ultimate authority for decisions about replacing members rests with DWQ and the Commission; however, the remaining Steering Committee members will be asked for input on the decision.

III. ORGANIZATIONAL STRUCTURE

Steering Committee Members. Members work together to achieve a mutually acceptable outcome that satisfies, to the greatest degree possible, the interests of all participants. In order for recommendations to be acceptable and implementable, those involved agree to work together to address the concerns and ideas of all those significantly affected. All Steering Committee members agree to:

- Attend meetings and follow through on promises and commitments;
- Bring concerns from their interest group or organization up for discussion at the earliest point in the process;
- Share all relevant information that will assist the group in achieving its goals;
- Keep its organization's decision-makers informed of potential decisions and actions, in order to expedite approval for the final product;
- Support the Steering Committee recommendations if they agree to them; and
- Concur in decisions about the Committee process, including overseeing the implementation of the operating principles.

DWQ Staff. In addition to the DWQ Director who will serve as the Steering Committee Co-Chair, DWQ staff will attend all meetings to serve as water quality experts and provide substantive support as appropriate. At present, Scott Daly, Utah Lake Watershed Coordinator, and Carl Adams, Manager – Watershed Protection Section, will be providing assistance to the Steering Committee as appropriate (though staff changes could result in different staff playing this role over the course of the process). Other DWQ staff will assist as necessary. Legal questions that need to be addressed by the State will go through DWQ to the Attorney General's office.

Utah Lake Commission. The Executive Director of the Commission will serve as the Steering Committee Co-Chair. All recommendations from the Steering Committee will be shared with the Commission for review and/or endorsement prior to being forwarded to the Utah Water Quality Board. The Commission will also provide administrative support for Steering Committee members as necessary.

Science Panel. A Science Panel will be convened to assist the Steering Committee in its efforts. The purpose of the Utah Lake Science Panel (Science Panel) is to assist in development of site-specific nutrient criteria on Utah Lake by overseeing targeted scientific studies. The Charter also indicates the following:

The Steering Committee will nominate a five- to seven-member Science Panel that will provide independent and unbiased scientific advice to the Steering Committee. The Science Panel should

reflect the full range of scientific disciplines required to guide the proposed research program. Candidates may be from the public or private sector. All nominees shall disclose any potential conflicts of interest, any financial relationship or contracts with members of the Steering Committee, DWQ, or other special interests related to Utah Lake. All members of the Science Panel will be objective, preferably independent (i.e., not financially associated with the current Steering Committee members or their organizations) scientists with demonstrated expertise in their respective field of study. Science Panel members must be currently active members of their assigned area of expertise as demonstrated by recent peer-reviewed publications, presentations at scientific meetings, and/or recent experience using applied sciences to manage lake resources. No member on the Science Panel may be a member of the Steering Committee. The Science Panel members will nominate and select one of its members to serve as the panel chair. DWQ will provide final approval of the Science Panel composition, membership, and charter.

In April, 2018, the Steering Committee convened a Science Panel consisting of five independent (voting) scientists who have responsibility to provide independent and objective recommendations to the Steering Committee; and five Ex Officio (non-voting) members who participate in the Science Panel conversations, provide local context, share professional experience and expertise, and advise on relevant experience with Utah and Utah Lake. The Panel is a discipline-focused group composed of members with specialized scientific expertise relevant to the unique characteristics and processes present in Utah Lake. All members of the Science Panel are scientists with demonstrated expertise in their respective field of study and are currently active within their areas of expertise.

If a gap in expertise (either through resignation or because the content of the discussions mandates it) that is critical to the success of the ULWQS the nominations process could be reopened by the Steering Committee. If the Steering Committee is interested in reopening the nominations process, they would reach out to the Science Panel to solicit their thoughts on the apparent need. Alternatively, if the Science Panel identifies the need for additional expertise they can raise that with the Steering Committee and request that an additional member be added for a specific set of discussions or period of time as appropriate.

Utah Water Quality Board. The expected product of the Phase 2 Utah Lake Study is the adoption of any necessary site-specific nutrient criteria by the Utah Water Quality Board. Steering Committee members recognize that final decision-making authority regarding site-specific nutrient criteria for adoption rests with the Utah Water Quality Board. The Utah Water Quality Board will consider all recommendations of site-specific nutrient criteria for adoption from the Steering Committee and the Commission. DWQ will coordinate with the Water Quality Standards Work Group, the Utah Water Quality Board, and the U.S. EPA to obtain formal approval and adoption of any necessary site-specific nutrient criteria.

Facilitator. Committee meetings will be facilitated by RESOLVE with support from SWCA. The facilitation team will not take positions on the issues before the Committee. The facilitator will work to ensure that the process runs smoothly. The facilitator's role usually includes developing draft agendas, distributing meeting materials, facilitating meetings, working to resolve any impasse that may arise, preparing meeting summaries, and other tasks as requested. The facilitator will keep confidential information disclosed in confidence. The facilitator will serve at the will of the group and may be replaced as agreed upon by the members and co-chairs in consultation with DWQ.

Work Groups. As necessary, the Steering Committee may choose to form work groups. The Committee will designate work group members as needed for the anticipated tasks and outcomes. Any Committee member (primary or alternate) can be a member of a work group.

Additional expertise could be added to a work group by a Committee decision if it is thought to be necessary (though there is a preference for only engaging additional expertise to assist the work group in their efforts as opposed to joining the group). At the direction of the Committee, work group members may develop draft products and make recommendations to the Committee. Work groups will not make decisions on behalf of the Committee.

IV. MEETINGS

Open to the Public. All Steering Committee meetings will be open to the public. However, the expectation is that public perspectives will be represented in the Steering Committee process through the involvement of the 16 members. As such, public comment will be limited to a 5 to 15-minute period at the end of each Steering Committee meeting. Members of the public are also encouraged to submit written comments (a form will be provided at each meeting) on the work of the Steering Committee which will then be distributed to all Steering Committee members for their review. In the course of the Steering Committee doing its work additional opportunities for public engagement will be provided. In addition, there will be formal public review and comment process in the course of the Utah Water Quality Board decision-making process.

Agendas. Proposed meeting agendas will be drafted by the facilitator in consultation with the Steering Committee Co-Chairs and then circulated in advance of meetings to all members for comment.

Action Item Memos/Meeting Summaries. In order to assist the Steering Committee in documenting its progress and activities, within five days of each meeting the facilitation team will prepare and distribute an action items memo. These memos will convey major decisions and ensure that timelines for completing agreed upon actions are clear to all participants, and briefly summarize the deliberations of each meeting. These will be distributed to all members for review prior to public distribution.

Breaks and Caucuses. Meetings may be suspended at any time at the request of any member to allow consultation among Steering Committee members. Requests should be respectful of all members' time. If the use of caucuses becomes disruptive, the Committee will revisit the process.

V. DECISION MAKING AND COMMITMENTS

Quorum: The charter defines a quorum as "two thirds (10) of the members of the committee." A quorum is necessary for meetings to proceed.

Decision Criteria. As described in the Charter:

The goal of the Steering Committee is to work toward a consensus recommendation for water quality [site-specific nutrient] criteria necessary to ensure long-term protection of Utah Lake's designated uses. A super-majority, defined by support from three-fourths (12) of all Steering Committee members is required to forward a final consensus recommendation to the Commission and Utah Water Quality Board. Minority opinions will also be forwarded. If a supermajority is not

possible, then opinions with position papers will be forwarded for consideration by the Commission and the Utah Water Quality Board.

In addition, the Charter indicates: “Procedural issues require the support of two thirds of the members present at a meeting.”

NOTE: Recognizing the super majority approach is a useful one to help expedite the process, the Steering Committee members also understand that developing recommendations with the support of all members (i.e., each member can at least live with the recommendation) would likely provide a stronger message to decision makers. As time permits and the discussions unfold, the Steering Committee will strive to achieve the full support of recommendations where possible.

Decision Making. Decisions will be made by those Steering Committee members present at a meeting, recognizing at least 12 members would need to be in attendance for any recommendations to the Commission and Utah Water Quality Board, and at least 10 members would need to be in attendance for any procedural issues. If the members present at a meeting reach agreement on a recommendation to the Commission and Utah Water Quality Board (at least 12 members), the facilitator will convey the results to any absent members to assess their ability to agree. As necessary, if individuals do not support the super majority recommendations and wish to submit minority opinions, they can be forwarded in a package with the super majority recommendation and an explanatory note from the Co-Chairs.

Absence of Consensus. If a super majority cannot be reached, the Steering Committee may choose to articulate areas of agreement and disagreement and the reasons why differences continue to exist, or the individuals or sub-groups may decide to develop and share separate sets of opinion papers.

If the group chooses to articulate areas of agreement and disagreement, members representing the different perspectives on specific issues will be asked to prepare language reflecting their views. The language should clearly identify the issues and information needs and uncertainties. In addition, those members that support each perspective will be identified.

If separate sets of opinion papers are conveyed to the Commission and Board, members representing the different perspectives will be asked to prepare a communication reflecting their views. Regardless of how many opinion papers are developed, they will be packaged together and shared with the Commission and Board along with an explanatory note from the Co-Chairs.

Independent Review. The Steering Committee will utilize the process outlined in 19-5-105.3 and implementing rules R317-1-10 to provide for independent review of any deliverable from the Science Panel that is challenged by one or more Steering Committee members or by any person who has or is seeking a permit in accordance with Title 19-5 and ~~that is within the geographic boundaries~~ that could be reasonably impacted by the Utah Lake Water Quality Study outcomes.

VI. HANDLING PUBLIC COMMENTS IN THE ULWQS PROCESS

Introduction. Members of the public and individuals from the broader Utah Lake Water Quality Study (ULWQS) stakeholder group are provided an opportunity to comment on the efforts of the study at every Steering Committee (SC) and Science Panel (SP) meeting. Typically, the amount of time given to each individual for verbal comment depends on the number of people intending to comment. Additional

comments may be submitted in writing to the SC co-chairs or on comment cards available at each meeting.

Generally, the SC receives two types of comments from the public and stakeholders: 1) official written comments addressed to the SC co-chairs; and 2) verbal and written comments received at SC meetings. While there are some similarities in the approach for addressing these two comment types, they are discussed separately to sufficiently address the unique character of each. The approach for each type is presented below.

Official Written Comments Addressed to the Co-Chairs. Written comments received by the SC co-chairs will be evaluated for relevance to the ULWQS. The co-chairs, at their discretion, will provide a written response to the commenter and share the comment and co-chair response with the SC. Note, the co-chairs will make every effort to respond to comments; however, the co-chairs may choose to not respond to some comments. Comments and responses will be provided to the SC with the meeting package prior to the next scheduled meeting. If the co-chairs have chosen not to respond to a comment, their rationale as to why will be included and provided to the SC in the meeting package.

Comments Received at SC Meetings. Comments made during the open public comment period or written on the provided comment cards during a SC meeting will be summarized in the meeting summary. Additionally, all comment cards submitted during the meeting will be photo copied into a PFD document and distributed to the SC with the meeting summary document.

Steering Committee Comment Response. For comments received by the co-chairs and at SC meetings, the facilitation team will ask SC members if additional clarification or information is needed for any comment or co-chair response. The facilitation team will also ask SC members to identify comments they would specifically include on the next meeting agenda for SC discussion or response. Additionally, for any verbal comment received during a SC meeting, SC members may choose to acknowledge the comment or provide a brief response at the end of the open public comment period or recommend any comment for additional discussion at the next meeting. SC agendas will allocate time for discussion of comments at the completion of the open public comment period.

Sharing Information with the Science Panel. If Steering Committee members know of members of the public who wish to provide information to the Science Panel they will recommend the information be shared through: 1) the Steering Committee members themselves (who would then forward the information to the facilitation team for distribution); 2) the formal public comment process (either at a meeting/call or via the DWQ website); or 3) by sending the information to the facilitation team directly for distribution. This approach will ensure that all Science Panel members receive the information in a timely and coordinated fashion and that the facilitation team can maintain a formal record of the information being shared. If members of the public do communicate directly with the Science Panel, either the facilitation team or a Steering Committee member will reach out to them to explain the process.

VII. SAFEGUARDS FOR THE MEMBERS

Good Faith. All members agree to act in good faith in all aspects of the collaborative effort. As such, members will consider the input and viewpoint of other participants and conduct themselves in a manner that promotes joint problem solving and collaboration.

Acting in good faith also requires that specific proposals made in open and frank problem solving conversations not be used against any other member in the future; personal attacks and prejudiced statements are not acceptable; negative generalizations are not productive and have the potential to impede the ability of the group to develop recommendations; individuals do not represent their personal or organization's views as views of the Committee; and that they express consistent views and opinions in the Committee and in other forums, including in press contacts.

Should a Committee member be found to be acting in bad faith the facilitator will be asked to talk with the individual(s) about the situation. A variety of approaches will be explored, accordingly, to redress the concerns. The authority to replace and/or remove a member from the Committee rests with DWQ and the Commission.

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Press. All Committee members agree to refrain from making negative comments about or characterizing the views of other Committee members in contacts with the press. They also agree not to knowingly mischaracterize the positions and views of any other party, nor their own, in public forums.

VIII. PROCESS SUGGESTIONS/GROUND RULES

Committee members agree to consider and apply the following process suggestions:

- Seek to learn and understand each other's perspective.
- Encourage respectful, candid, and constructive discussions.
- Seek to resolve differences and reach consensus.
- As appropriate, discuss topics together rather than in isolation.
- Make every effort to avoid surprises.

Committee members agree to apply the following ground rules:

- Focus on the task at hand
- Have one person speaking at a time
- Allow for a balance of speaking time by providing succinct statements and questions.
- Listen with respect
- Be civil
- Keep side conversations to a minimum.
- Turn off cell phones or put them in the non-ring mode during formal meeting sessions.

IX. SCHEDULE

At present, the Steering Committee is envisioned to meet approximately six times per year for the next three years. In addition, the Science Panel is expected to meet approximately six times per year. Initially meetings may be more frequent as the research program is developed. The length and frequency of meetings over time will be driven by the work for the Steering Committee, the Science Panel, and structured through conversations about how best to meet the process goals.

Overview and Design

A lake curtain will be installed spring 2020 off the north break wall to deflect waves and currents which should reduce the intensity of water exchange at the site. It is recommended that Utah Lake Commission or State of Utah place navigational buoys. (Figure 3). Management utilizing Cyanobacteria Action Threshold Levels will be implemented for technologies of Pak 27, Phoslock, and SeClear. The management area will extend out of the marina within the lake curtain (3.35-5 acres of treatment). Water samples will be collected at discrete timepoints to allow for analysis of effectiveness and longevity of technologies and management plan.



Addendum: Demonstration for Controlling Cyanobacterial Blooms in Utah Lake

Date: December 10th, 2019



Figure 3: Project Plan for Lincoln Marina including lake curtain installation and proposed treatment area.

Cyanobacteria Action Threshold Levels

Table 1: Designation of cyanobacteria action thresholds that when exceeded would trigger a corresponding algaecide application

Parameter	Action Threshold	Units	Description
Cyanobacteria cell density	10,000	Cells/mL	An elbow-depth collected sample, excluding any surface scums
Cyanobacteria scum coverage	0.5%	Surface area of Marina	~500-1000 sq.ft of coverage with cyanobacteria as dominant component of accumulated surface scum

Table 2: Application Rate Guidance**

Cyanobacteria* (cells/mL)	PAK 27 dose (lbs/ac-ft)	Phoslock Dose (lbs/ac-ft)	SeClear Dose (gals/ac-ft)	Notes
<10,000-50,000	20-30	25	1.25	Preferred target application range. Thorough control predicted and keep below recreation guidance of 20k cells/mL
50,000-250,000	30-60	50	2	Multiple PAK 27 applications may be needed
250,000-500,000	60-80	75	3	Multiple PAK 27 applications may be needed
> 500,000	80-100	100	3.8	Multiple PAK 27 applications may be needed

* based on *Microcystis spp.*

**Other factors may affect rate selection in the field



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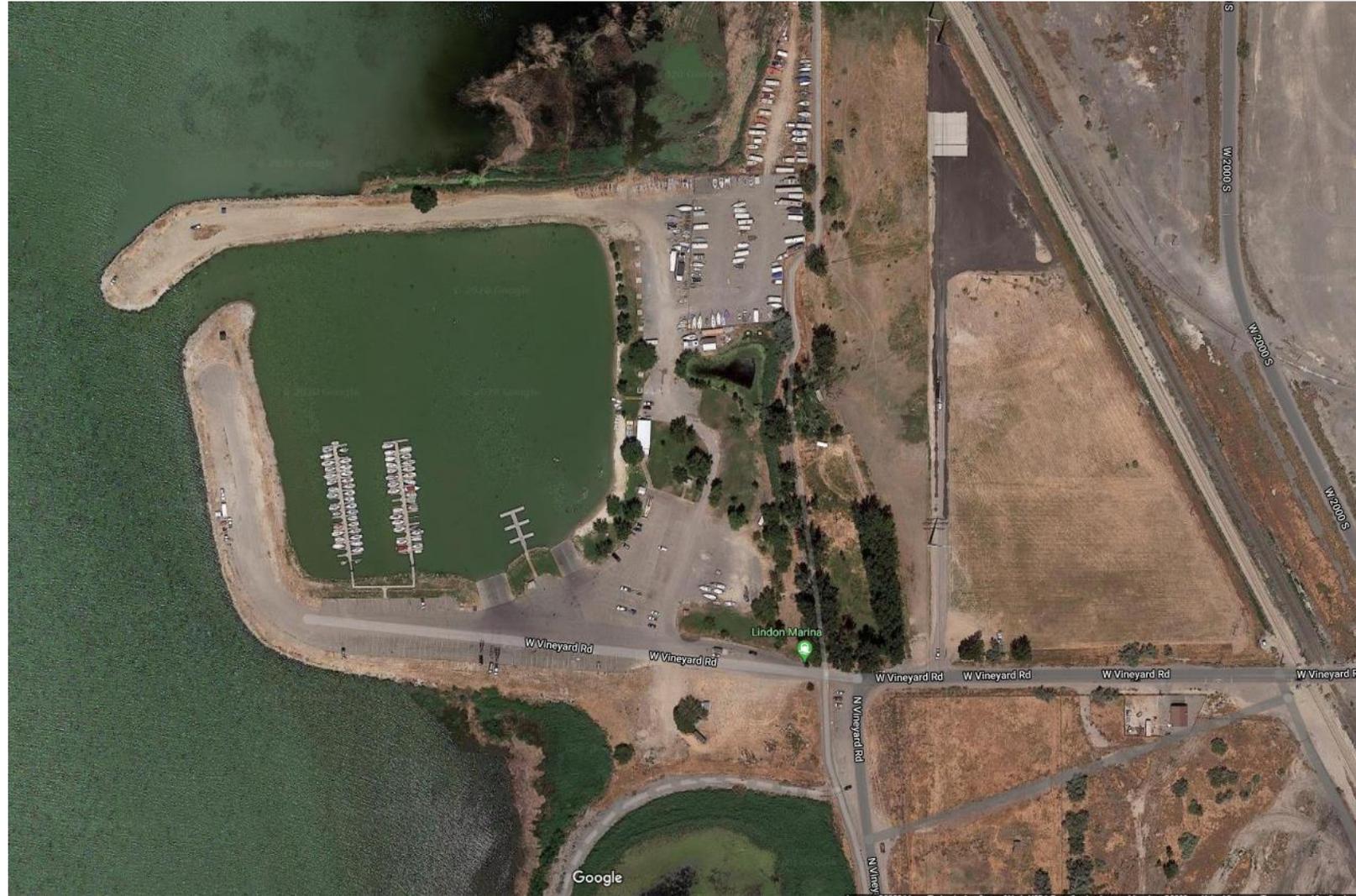
F. 479.271.7693

earthsciencelabs.com



Innova™

CLEAN WATER SOLUTIONS



Recommended Treatment Solution

Prior to treatment:



36-hours post-treatment:



ATS Innova recommends EarthTec, manufactured by Earth Science Laboratories, as the primary chemical treatment solution for the Utah Lake pilot project. EarthTec is a copper-based algaecide/bactericide with a record of safe and effective use for 25+ years throughout the U.S. for a wide variety of purposes, including treatment of potable water reservoirs, lakes, ponds, pipelines, canals, aqueducts, irrigation systems, farms, and within water and wastewater treatment plants. It is also approved for agriculture, including rice fields (e.g., control of tadpole shrimp) and for irrigation lines (e.g., keeping drip irrigation lines and their emitters free from algae and bacteria). It has been used for many years in aquaculture where farmers describe curative effects on fish suffering from bacterial or fungal diseases of the fins or gills, called “fin rot”. EarthTec is also used for the control of invasive quagga and zebra mussels.

Due to its unique formulation, the copper in EarthTec is kept entirely in the cupric ion form (Cu^{2+}) – the most biologically active form of copper – and therefore works at a significantly lower copper dose than any other copper products. There is virtually no waste or loss to precipitation or settling, and for that reason EarthTec is the most environmentally safe and responsible way to apply copper for algae control.

Copper sulfate 2012	Ionic Copper 2013	
10	8	treatments per year
500	60	lbs or gallons per treatment
5,000	10	lbs, weight per gal of EarthTec
25%	4,800	lbs per year
1,250	5%	fraction that is elemental copper
	240	elemental copper applied, lbs
100%	19.20%	total copper applied, %

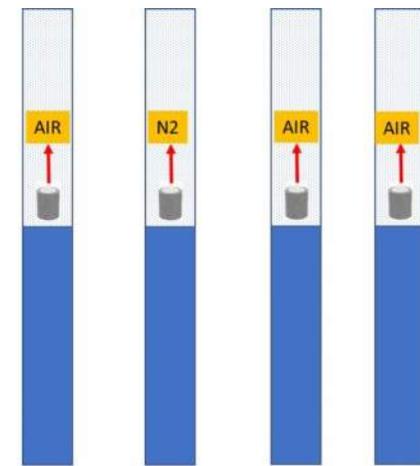
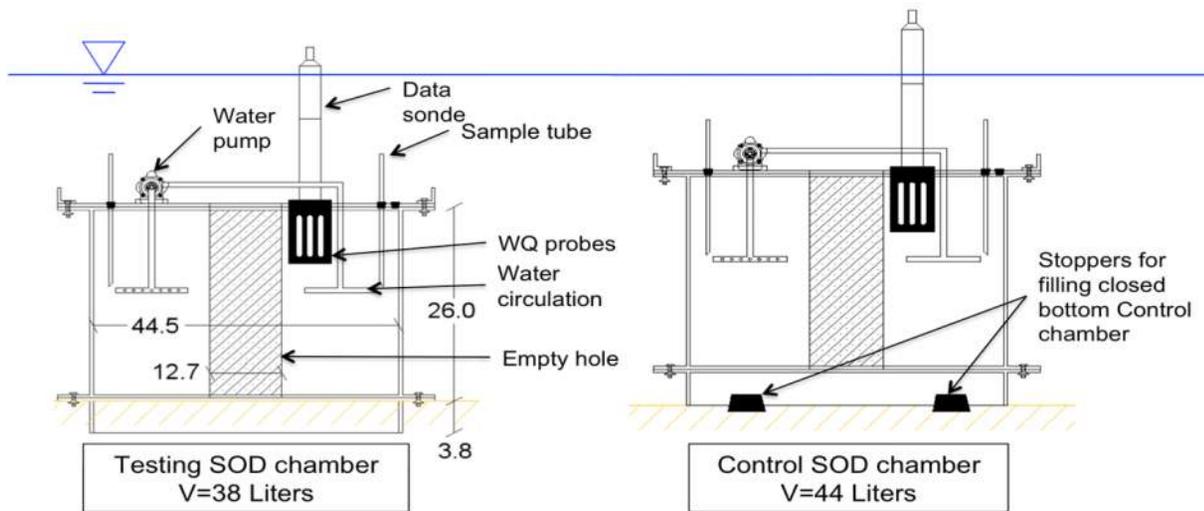
Science Panel Update

Steering Committee Meeting #9

March 13, 2020



Utah Lake Sediment-Water Nutrient Interactions



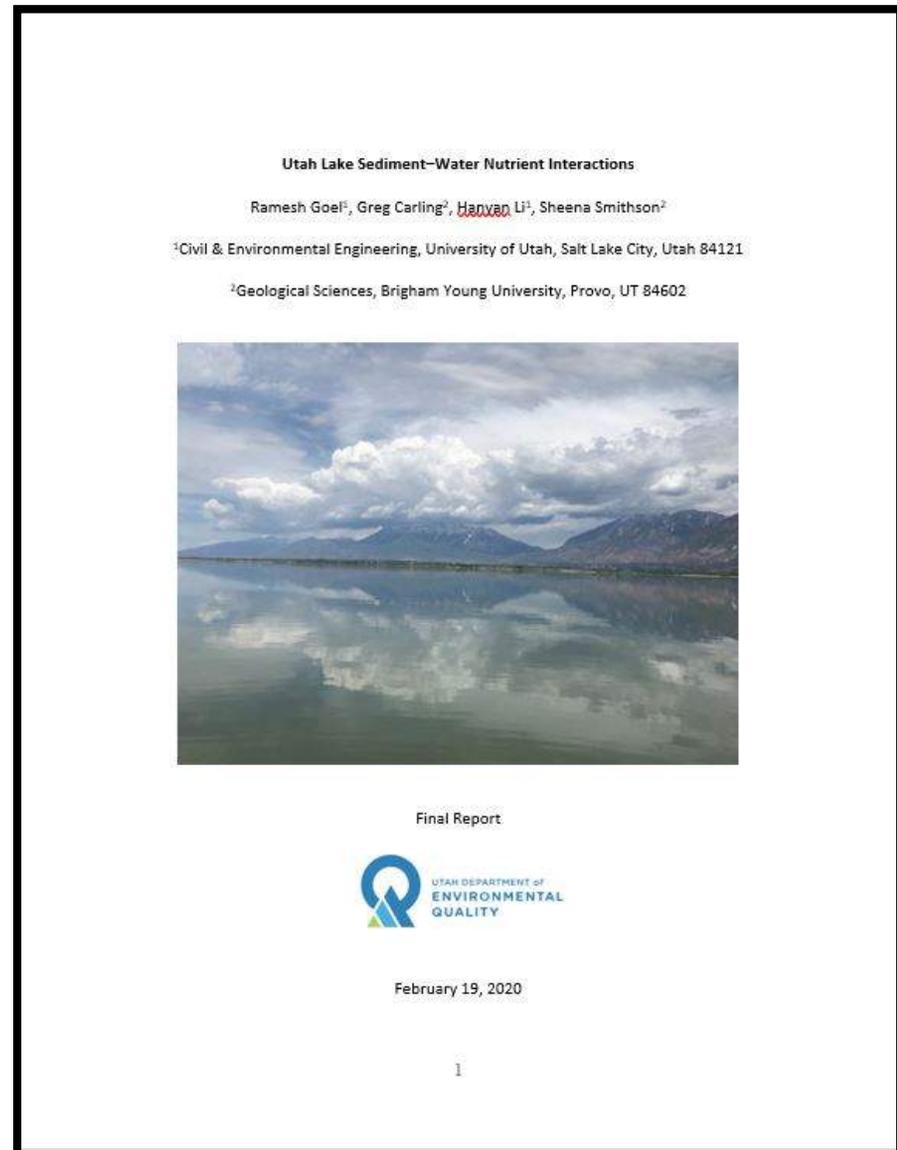
Aerobic Anaerobic pH=7 pH=9.5



Utah Lake Sediment-Water Nutrient Interactions

Update

- DRAFT Final Report has been submitted.
- SP is reviewing.
- Final Report following review.



Utah Lake Sediment-Water Nutrient Interactions

Challenges

- Anaerobic tests resulted in pH ~9.5
 - Where fluxes a result of anaerobic conditions or high pH?
- pH of 7.0 test is unrealistic
 - It is impossible to have a pH of 7.0 in Utah Lake
 - Sediments buffered water back pH=8.6
- The water column nutrient interactions were not adequately separated from the sediments
- **Science Panel needs time to identify data and relationships relevant to the ULWQS goals and to answer Steering Committee questions.**



Utah Lake Sediment-Water Nutrient Interactions

Preliminary Highlights

- SRP:TDP ratio ~50%
 - Indicates 50% of the dissolved P is bioavailable ($\text{PO}_4\text{-P}$)
 - What is the 'other' DP?
 - Dissolved Organic-P?
 - Ca-P?
 - ???

Site	Test	Sample ID	SRP	TDP	%SRP-P
Buoy	Ambient, Aerobic	1	0.02	0.06	45%
		2	0.03	0.06	56%
		3	0.03	0.05	57%
Provo Bay	Ambient, Aerobic	97	0.22	0.40	53%
		98	0.26	0.51	51%
		99	0.23	0.43	53%

Notes: SRP = Soluble Reactive Phosphorus ($\text{PO}_4\text{-P}$)

TDP = Total Dissolved Phosphorus



Utah Lake Sediment-Water Nutrient Interactions

Preliminary Highlights

- 'Ambient' **TDP** Sediment Phosphorus Fluxes
 - Provo Bay = 5 mg/m²/day
 - Buoy = 4 mg/m²/day
 - This would increase ambient concentrations by ~0.005 mg-P/L per day in 1 meter deep of water
 - ~1660 kg of P released from sediments per day (Utah Lake Proper)
 - Assuming:
 - 3 meters deep
 - 15 mg/L VSS
 - 50% of VSS is Organic-C
 - 106 C:P (Redfield molar ratio)
 - Then it takes ~115 days to provide enough sediment-P to account for observed water column VSS associated P
 - In reality, seston will have a higher C:P ratio
- What about the water column P rates?
 - Not adequately identified in this study.....
 - Can Bioassay information be used to supplement?
 - That is the goal.....



Utah Lake Sediment-Water Nutrient Interactions

Preliminary Highlights

- ‘Ambient’ **SRP** Sediment Phosphorus Fluxes
 - Provo Bay = -12 mg/m²/day
 - Buoy = -2 mg/m²/day
 - The sediments acted as a sink for SRP
 - What about the water column P rates?
 - Note that the water column resulted in an overall sink for PO₄-P in prior research (table below, Hogsett et al., 2019)
 - This agrees with the Utah Lake P mass balances
 - All data is pointing in the same direction....

TABLE 3. AVERAGED NUTRIENT FLUXES FROM WATER AND SEDIMENT COLUMN

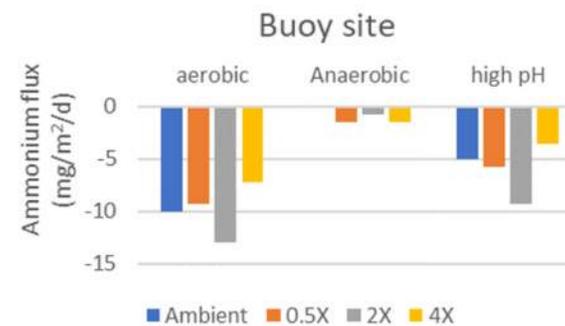
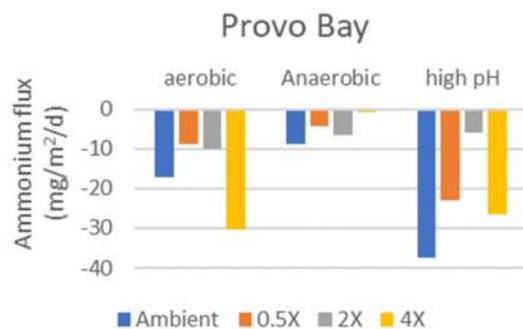
Site	Sediment nutrient fluxes, g/(m ² ·day)				WC nutrient rates, g/(m ³ ·day)			
	NH ₄ -N	NO ₃ -N	TIN	PO ₄ -P	NH ₄ -N	NO ₃ -N	TIN	PO ₄ -P
1	1.442	0	1.442	0.010	1.279	0	1.27	-0.08
2	0.023	0.005	0.03	0.071	-0.132	-0.012	-0.144	-0.288
3	-0.033	0.021	-0.01	0	-0.048	-0.048	-0.10	0
4	0.141	0	0.141	0.031	-0.283	0	-0.283	-0.070
5	0.027	0.012	0.04	0	0.06	-0.024	0.036	0
6	-0.001	0.004	0.00	0.010	-0.091	0.007	-0.084	-0.014
7	0.093	-0.008	0.09	-0.004	-0.444	-0.012	-0.456	0
8	0.027	0.08	0.11	0.001	0.06	-0.348	-0.288	0



Utah Lake Sediment-Water Nutrient Interactions

Preliminary Highlights

- Ammonium was removed from the system during all testing scenarios
 - Ammonia volatilization? Bioassimilation? Nitrification?
 - A net loss of N and P was also observed in the chamber studies (Hogsett et al., 2019)
 - Agrees with Utah Lake nutrient mass balance



Utah Lake Sediment-Water Nutrient Interactions

Preliminary Highlights

- Sediment Oxygen Demand (SOD)
 - Provo Bay
 - SOD = $-0.03 \text{ g/m}^2/\text{day}$
 - Much lower (smaller) than previously measured
 - Table below (Hogsett et al., 2019)
 - Only one chamber (protocol requires 2)
 - WC = $-1.6 \text{ g/m}^2/\text{day}$
 - Buoy
 - SOD = $-2.0 \text{ g/m}^2/\text{day}$
 - Only one chamber (protocol requires 2)
 - WC = $-0.4 \text{ g/m}^2/\text{day}$

TABLE 2. SEDIMENT AND WATER COLUMN AMBIENT DISSOLVED OXYGEN DEPLETION RATES

Site	<i>SOD</i> , $\text{g}/(\text{m}^2 \cdot \text{day})$	<i>WC_{dark}</i> , $\text{g}/(\text{m}^3 \cdot \text{day})$	<i>Ambient</i> , $\text{g}/(\text{m}^3 \cdot \text{day})$	<i>%_{SOD}</i>
→ 1	-4.61	-6.66	-11.3	41
2	-1.42	-3.45	-4.9	29
→ 3	-1.49	-2.28	-2.8	18
4	-2.04	-1.9	-2.9	35
5	-1.67	-3.4	-5.1	33
6	-1.03	-1.28	-1.7	27
7	-1.06	-4.17	-4.5	8
8	-0.9	-1.11	-1.4	21

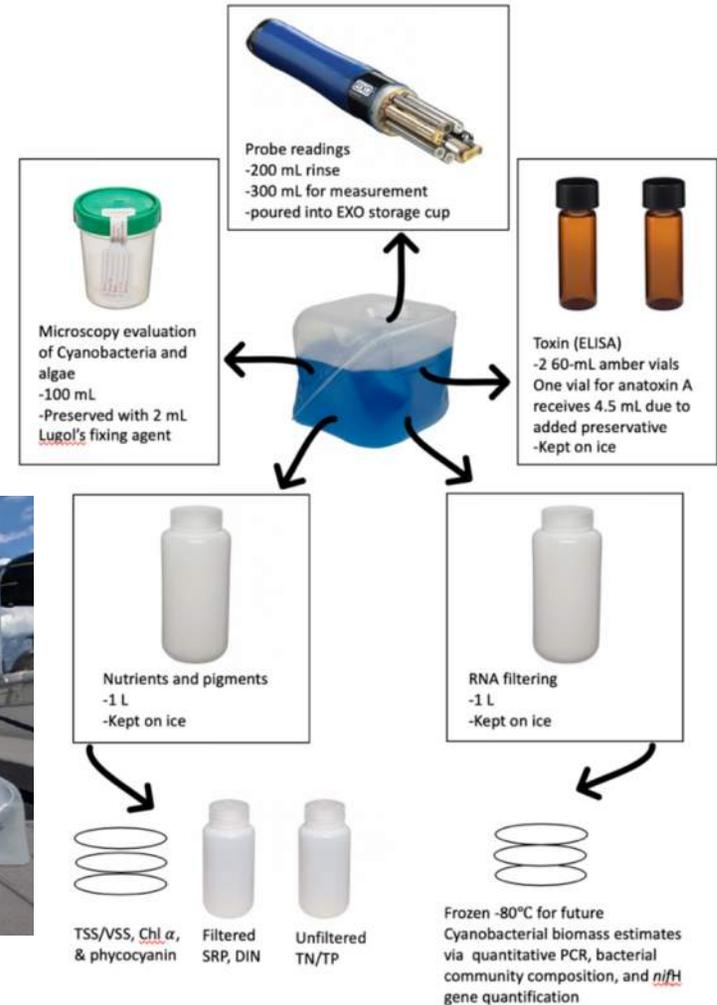
SOD, sediment oxygen demand; WC, water column.



Bioassays to Investigate Nutrient Limitation in Utah Lake

Update

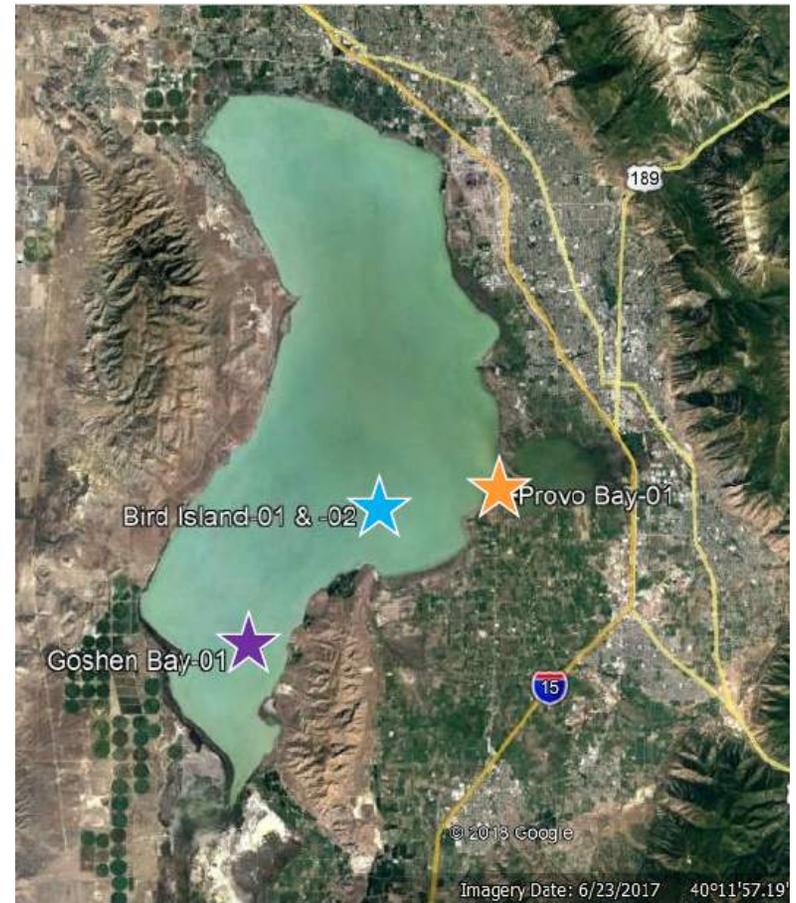
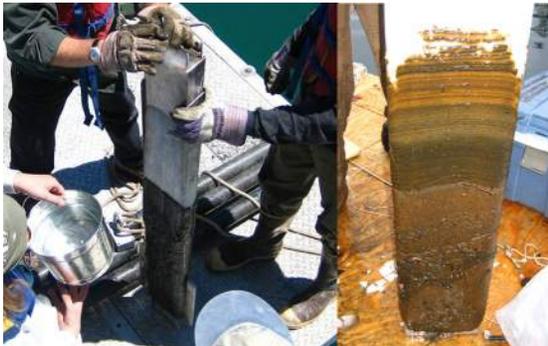
- 2 more sampling events
 - Final report due afterwards



Paleo Study

Update

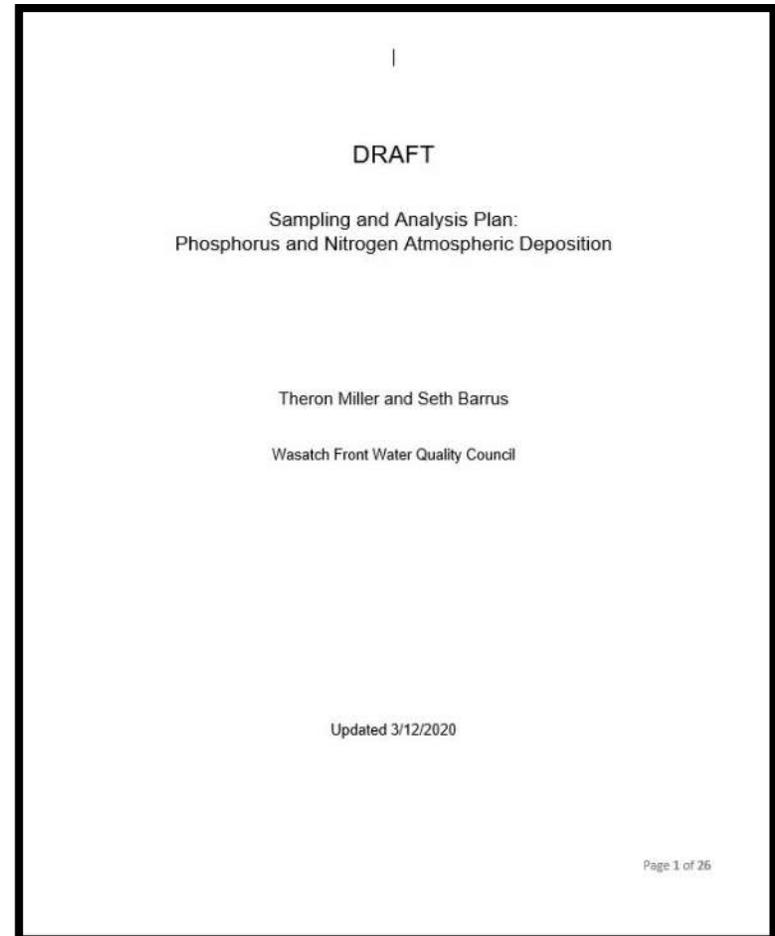
- Sediment core analyses are ongoing
- Final Report due in early 2021



Atmospheric Deposition

Update

- WFWQC provided DRAFT Sampling Analysis Plan this week
 - Needs to be reviewed and commented on by SP
- There will be a NADP site installed at Utah Lake
 - Samples from this site will be collected via NADP protocols and sent to NADP for analyses
 - Allows comparison of methods



TSSD Study

Update

- Concept testing in 2020

