Proposed Research Plan

Development of Water Quality Standards for Willard Spur

TO: Willard Spur Science Panel

COPIES: Willard Spur Steering Committee,
Utah Department of Environmental Quality, Division of Water Quality (DWQ)

FROM: CH2M HILL

DATE: October 27, 2011

This memorandum provides a summary of the proposed research, timeline, budget, and management for the Development of Water Quality Standards for Willard Spur project. The information included herein is based upon Science Panel discussions on September 22 and October 6, 2011. The intent is for this research plan to serve as the basis for the development and implementation of detailed work plans for the research.

Proposed Research

The Science Panel was charged with the responsibility to identify and oversee the studies required to address the question: "*What water quality standards are fully protective of beneficial uses of Willard Spur waters as they relate to the proposed POTW (publicly owned treatment works) discharge?"*This question represents the overall program objective.

Two questions were identified that follow from the program objective, i.e., these questions must be answered for the program objective to be achieved. The questions are as follows:

1. What are the potential impacts of the Perry Willard Regional Wastewater Treatment Plant on Willard Spur?
2. What changes to water quality standards will be required to provide long term protection of Willard Spur as they relate to the proposed POTW discharge?

To provide answers to these questions, the three following key research areas were agreed upon:

1. Define and understand the food web of Willard Spur
2. Define the water and nutrient budget for Willard Spur
3. Define responses to eutrophication within Willard Spur

Research will closely follow the conceptual models defined in a memorandum dated August 2, 2011 ("Draft Conceptual Models"). Figure 1 Illustrates how the various research studies fit into this structure, as well as accomplish the overall program objective. The objectives of each study are detailed in the following sections.

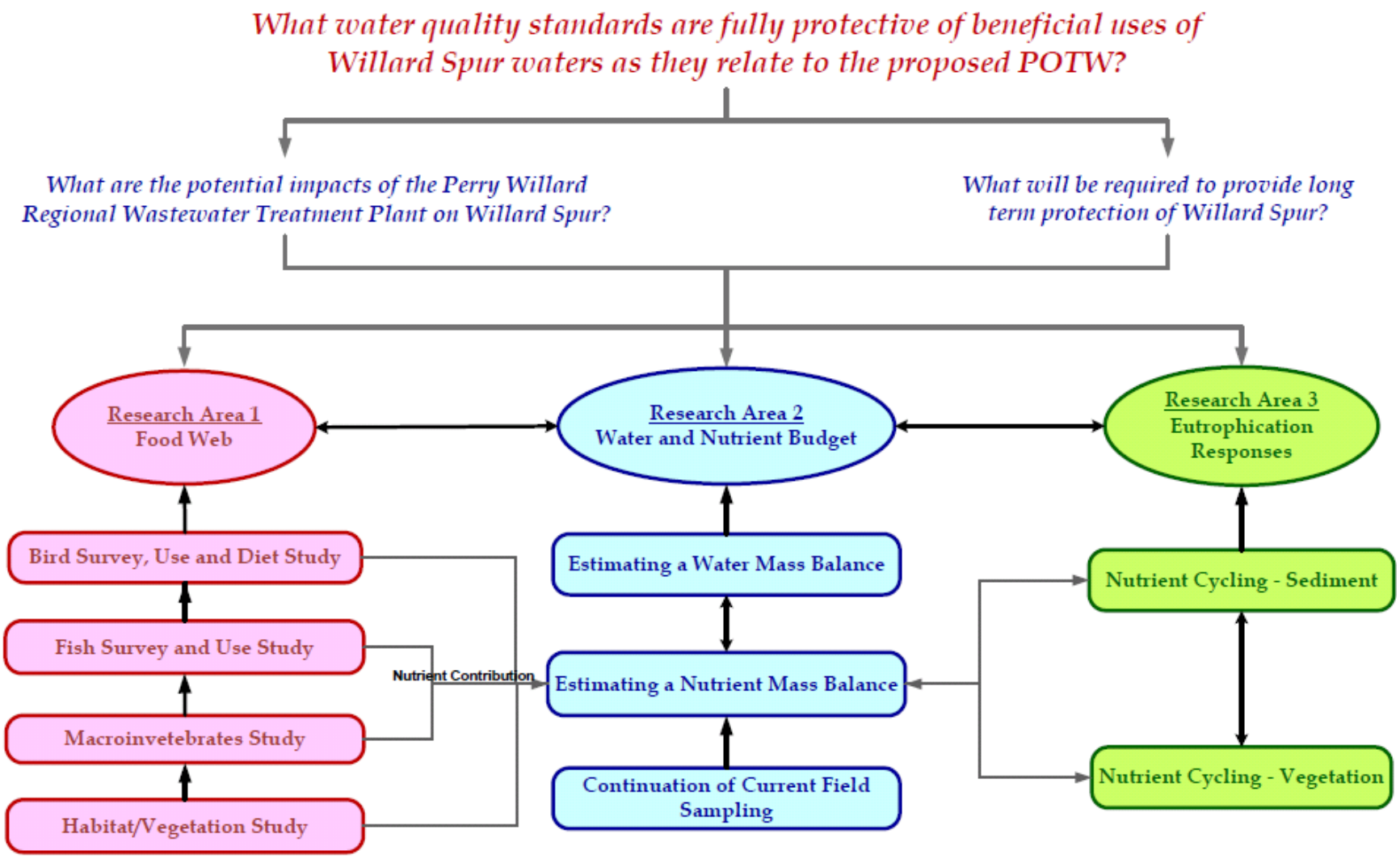

FIGURE 1
Overall Structure of Proposed Research

1.0 Understanding the Willard Spur Food Web

Studies focusing on this research area will define the Willard Spur food web, thereby defining these beneficial uses, and determine if and how the food web changes due to nutrient increases. Investigations will help identify key indicators that can be monitored to evaluate the long-term effect on the Willard Spur ecosystem. Findings from each study will be combined to understand and create a link between each element of the food web. Results from these studies will also be inputs for studies indicated in other research areas.

1.1 Avian Use

Objectives

The avian study(ies) will address the following questions:

1. What does the literature describe in terms of bird species/numbers, existing models, and understanding of bird foraging and reproductive use of Willard Spur? What are the data gaps in the literature?
2. What bird species currently use Willard Spur?
3. What are their numbers by species? What factors might affect bird abundance in Willard Spur, e.g., water level, season, food availability, habitat, etc.? How do bird numbers vary over time in relation to these factors?
4. How has bird use (i.e., species and population) changed over time?
5. What are the preferred food items for waterfowl and shorebirds using Willard Spur at various times during the year? Are the birds opportunistic or specific in what they are looking for?
6. What is the energy value of important food items for key bird guilds?
7. What are the foraging and nesting habits of bird species using Willard Spur? What is their preferred habitat for foraging and nesting?
8. How does bird use (species or population) vary with changes in habitat, water level, and water quality (e.g., salinity, dissolved oxygen, etc.)?
9. What is the avian contribution to the nutrient budget for Willard Spur? How much time do birds spend at Willard Spur? How much mass do they accumulate while at Willard Spur?

Notes:

1. Existing U.S. Fish & Wildlife Service (USFWS) and Utah Division of Wildlife Resources (DWR) bird survey databases for species/population/use/timing will be used and extended for this study and the database will be linked to habitat, water level and field conditions.
2. Possible partnership with USFWS/DWR should be considered. In addition to its monthly bird surveys at Bear River Migratory Bird Refuge (BRMBR), USFWS has an

ongoing study investigating mercury and selenium contaminating in waterbird eggs and their risk to avian reproduction at BRMBR. This study includes an evaluation of nesting and foraging habits/habitats in the area. In addition to its monthly bird surveys at Harold Crane Wildlife Management Area (WMA), DWR continues its aerial bird surveys of Willard Spur. Bio-West, Inc. has also been completing bird surveys in the western portion of Willard Spur as part of the Great Salt Lake Minerals (GSLM) Environmental Impact Statement (EIS). These data will be important for historical comparison and ongoing surveys may be augmented to address specific needs of this project.

3. Drs. John Cavitt and Josh Vest (and others) have completed extensive work on waterfowl and shorebird energetics for GSL. Dr. Cavitt has prepared a proposal to DWQ to add Willard Spur to his current GSL wetlands waterfowl diet/energetic study. Sampling would occur in October - December.
4. The proposed study will rely upon data regarding fish, hydrology, habitat, vegetation, water chemistry, and eutrophication responses in water, plants, and macroinvertebrates from other projects in this program. Close coordination of efforts will be required especially for questions 8 and 9.
5. Results from this objective will be an input to Project 1.5 and 2.1.
6. This project will be linked to Project 1.1 and 1.3 to define food web.

1.2 Fish Use

Objectives

1. What does the literature describe in terms of fish species/numbers and understanding of fish foraging and reproductive use of Willard Spur? What are the data gaps in the literature?
2. What fish species currently use Willard Spur?
3. For each population, how does the abundance of key life stages vary spatially and temporally? Can the number of piscivorous birds on Willard Spur be used to identify numbers of fish?
4. What factors might affect fish abundance in Willard Spur, e.g., water level, season, food availability, habitat, etc.? How do fish numbers vary over time in relation to these factors?
5. What are the preferred food items for fish using Willard Spur at various times during the year? Are the fish opportunistic or specific in what they are looking for?
6. What are the foraging and reproductive habits of fish species using Willard Spur? What is their preferred habitat?
7. How does fish use (species or population) vary with changes in habitat, water level, and water quality (e.g., salinity, dissolved oxygen, etc.)?

8. What is the fish contribution to the nutrient budget for Willard Spur? How might foraging habits influence abiotic characteristics, which in turn may affect nutrient dynamics?

Notes:

1. Existing data describing the fish population in Willard Spur has yet to be.
2. Possible partnership with DWR to be considered. Dr. Wayne Wurtsbaugh is developing a proposed study with students to understand the fish population of Willard Spur. Bio-West has possibly evaluated fish populations in Bear River Bay as part of their GSLM work.
3. This study should be coordinated with other projects in Research Area #1 to leverage sampling efforts for these projects. Close coordination of efforts will be required especially for questions 7 and 8.
4. Results from this objective will be an input to Project 1.5 and 2.1.
5. This project will be linked to Project 1.1 and 1.3 to define food web.

1.3 Macroinvertebrates

Objectives

1. What does the literature describe in terms of expected macroinvertebrate taxa and how they and their density/biomass might change by key habitats, season, and water quality?
2. What macroinvertebrate taxa use Willard Spur and what are their density/biomass within key habitats?
3. How do macroinvertebrate taxa and density/biomass vary by
    a. Location in Willard Spur?
    b. Habitat type and quality?
    c. Season?
    d. Water level and water quality, i.e., salinity, nutrient concentrations?
4. What is the macroinvertebrate contribution to the nutrient budget for Willard Spur?

Notes:

1. DWQ has been regularly collecting macroinvertebrate samples throughout Willard Spur in 2011. The sampling approach should be re-evaluated to make possible changes for 2012.
2. DWQ and Dr. Larry Grey have done extensive work previously linking macroinvertebrates and nutrients in GSL wetlands. This work should be considered as part of this study.
3. This study should be coordinated with other projects in Research Area #1 to leverage sampling efforts for these projects.

4. DWQ's ongoing study to develop assessment protocol for GSL wetlands should be considered as part of this study.
5. Results from this objective will be an input to Project 1.5 and 2.1.
6. This project will be linked to Projects 1.1, 1.2, 1.4.

1.4 Habitat/Vegetation Mapping in Willard Spur

Objectives

1. What does the literature describe in terms of existing vegetation and habitat in Willard Spur?
2. What invasive species of vegetation are of concern in Willard Spur?
3. What species of emergent and submerged aquatic vegetation are of interest in relation to the habitat and impacts from nutrients in Willard Spur?
4. What is the existing distribution of vegetation, including percent cover for emergent vegetation, submerged aquatic vegetation, and invasive species (i.e., *phragmites*), phytoplankton, and biomass of algae, within Willard Spur?
5. How does this distribution affect habitat and change spatially and temporally with changing water levels, season, and water quality, i.e., salinity, nutrient concentrations?
6. What are the effects of nutrients on the distribution and abundance of invasive plant species? (What does the literature reveal?) What are the effects of invasive plant species on habitat values and use by wildlife?What habitat types exist in Willard Spur? How are they linked to water level?
7. What is the evolution of habitat in Willard Spur as water quality and water levels change?

Notes:

1. Dr. Karin Kettenring is beginning an effort this year to map changes in habitat in the eastern third of GSL. This study will continue for the next two years. The study's focus is upon changes in emergent vegetation and invasive species but may be helpful in mapping changes in other vegetation and habitat as well. The extent of this study's coverage of Willard Spur will need to be confirmed.
2. Ducks Unlimited completed an evaluation of GSL wetlands habitat in 2006 that should be considered. Dr. Kettenring also noted that previous vegetation mapping was completed in 1992. Dr. Theron Miller noted that Frontier Geosciences had photographed wetlands in 2004 or 2005 along GSL for the purposes of mapping vegetation but this data has not been processed yet. Should consider using this and other available aerial/satellite imagery.
3. Should look into using drones to aerially photograph Willard Spur at various times of the year to evaluate trends and linkages to algae and phytoplankton.

4. The Utah Geological Survey is currently completing a Phase I wetland mapping effort for GSL. This includes LiDAR mapping of the area in October 2011. This mapping should be helpful in mapping ground elevations, water levels, and habitat.
5. This study should be coordinated with other projects in Research Area #1 to leverage sampling efforts for these projects.
6. DWQ's ongoing study to develop assessment protocol for GSL wetlands should be considered as part of this study.
7. USFWS and Dr. Kettenring have done extensive work evaluating the propagation of invasive species in BRMBR and surrounding areas. This work should be considered as part of this study.
8. DWQ, the Jordan River/Farmington Bay Water Quality Council, and Dr. Heidi Hoven have done extensive work linking SAV, algae, phytoplankton, and nutrients in GSL wetlands. This work should be considered as part of this study.
9. This study will include extensive coordination with other projects.

1.5 Food Web Model

Objectives

1. Develop a food web model that combines input from the Avian Use, Fish Use, Macroinvertebrates, and Habitat/Vegetation studies to enable the evaluation of impacts from water level and water quality.

2.0 Understanding the Water & Nutrient Budget of Willard Spur

Studies focusing on this research area will attempt to understand the sources and loads of nutrients to the Willard Spur and the influence of the discharge from the Perry Willard regional Wastewater Treatment Plant. Findings from each study, notably internal nutrient cycling, will be combined to understand the total budget. Results from some of the studies will also be inputs for studies indicated in other research areas.

2.1 Water and Nutrient Budget

Objectives

1. What hydrologic and meterological data are available for Willard Spur?
2. What are the water sources to Willard Spur? How do flow rates change at these locations throughout the year (i.e., what are the individual and combined hydrographs?)?
3. What are the outflow mechanisms and rates of Willard Spur, i.e., outflow to Bear River bay and evapotranspiration?
4. How does the water level change in relation to inflow, outflow, and wind events? How do water depths and surface area vary spatially and temporally in relation to the water level?

5. What range of flow regimes should be considered for use in evaluating nutrient cycling and the food web of Willard Spur? What are the flow regimes and conditions that are most critical to changing habitat, birds, and nutrients (this will require significant input from and coordination with other projects)?
6. Under what conditions does the Perry Willard Regional Wastewater Treatment Plant effluent reach Willard Spur? How does this outflow mix with Willard Spur? How large of an area does it influence?
7. What is the nutrient budget for Willard Spur? What are the nutrient loads from the various water inflows? How much of a nutrient load is exported from Willard Spur? How does internal nutrient storage and cycling affect the nutrient budget?
8. How do nutrient concentrations vary in Willard Spur both spatially and temporally? Is isotope analysis a valid means of determining the source of nutrients in critical areas of Willard Spur?

Notes:

1. The flow regimes identified in No. 5 will inform the scenarios addressed in Research Area #1.
2. DWQ and USGS have been collecting flow and meteorological data throughout 2011. The current monitoring plan should be re-evaluated and possible changes considered for 2012.
3. The effort should develop relationships between inflows and water levels in Willard Spur as well as recurrence intervals.
4. Dr. David Tarboton is completing significant work evaluating changes in GSL water level due to changes in inputs and outputs to GSL. This work should be considered as part of this study.
5. DWQ is working to understand the residence time of water and understand the influence of seiche events on water level in Willard Spur. This work should be considered as part of this study.
6. Nutrient contributions from birds, fish, macroinvertebrates, plants, and sediments developed from the other studies should be considered. Close coordination with the Eutrophication Response (Research Area #3) studies is critical.

3.0 Eutrophication Responses

This research area will define the link between nutrient loading and the Willard Spur food web to understand the response of the system to nutrients. These experiments will be designed to identify critical thresholds in response. These relationships will be used in the nutrient budget and food web models developed Research Areas #1 and 2.

3.1 Nutrient Cycling – Sediment

Objectives

1. What are the sediment characteristics? Dodeposition rates/patterns changed spatially and temporally? Does the organic matter content of sediment change temporally and spatially? How have nutrient deposition rates changed over time? How have diatoms in the sediment changed over time?
2. What controls sediment and pore water chemistry in Willard Spur, e.g., hydrology, redox potential, inundation, TOC, etc.? How does it change spatially and temporally? How does it affect macroinvertebrate and SAV populations? How do sulfide and metal concentrations compare with other GSL wetland locations?
3. How much of the nutrient load is stored in sediments in Willard Spur? How much of Willard Spur sediment nutrient stores are available for reintroduction into the system via both geochemical and biological processes?
4. What is the sediment oxygen demand (SOD) in Willard Spur? How does it change spatially and temporally? What processes control or drive SOD in Willard Spur?
5. What is the current sediment/water exchange rate for nutrients in Willard Spur? How does it change spatially and temporally? What processes control or drive this flux in Willard Spur?

Notes:

1. DWQ has been collecting sediment samples throughout Willard Spur in 2011. The data and current sampling plan should be re-evaluated and possible changes considered for 2012.
2. Drs. Bill Johnson and Ramesh Goelle and their students have done significant work investigating relationships between nutrients and sediments in GSL wetlands. This work should be considered as part of this study.
3. DWQ's ongoing study to develop assessment protocol for GSL wetlands should be considered as part of this study.
4. This work should be closely coordinated with macroinvertebrate, vegetation, other nutrient cycling, and nutrient budget studies.

3.2 Nutrient Cycling – Vegetation

Objectives

1. What role do emergent vegetation, SAV, phytoplankton and algae play in the nutrient cycle of Willard Spur?
2. What controls the response of emergent vegetation, SAV, phytoplankton and algae and how do they interact? How do nutrients affect these elements and their response? What is the threshold of nutrients that creates this response? How do other factors affect these responses, i.e., salinity?

3. How do emergent vegetation, SAV, phytoplankton and algae contribute to the nutrient budget? How do they contribute to the export of nutrients from Willard Spur to Bear River Bay?
4. How does the portion of the nutrient cycle attributed to emergent vegetation, SAV, phytoplankton and algae affect the sediment, water chemistry, and macroinvertebrate populations?

Notes:

1. DWQ has been monitoring SAV throughout Willard Spur in 2011. The data and current monitoring plan should be re-evaluated and possible changes considered for 2012.
2. Dr. Heidi Hoven has done significant work investigating the relationships between nutrients, SAV, phytoplankton, algae, water chemistry, and sediment in GSL wetlands. This work should be considered as part of this study.
3. DWQ's ongoing study to develop assessment protocol for GSL wetlands should be considered as part of this study.
4. This work should be closely coordinated with macroinvertebrate, vegetation, other nutrient cycling, and nutrient budget studies.

Proposed Timeline

The proposed Willard Spur research program is expected to extend at least through December 2014. The Willard Spur program will be delivered in three phases:

1. Development and planning (2011)
2. Implementation (2012-2013)
3. Evaluation & Recommendations (2014)

The Science Panel has recommended that implementation phase be phased over a two year period (2012-2013). The primary reasons are to allow for a better review and understanding of available literature, mapping, and data, allow for another year of baseline monitoring to perhaps capture a different hydrologic scenario (i.e., not a high runoff year), and allow for detailed monitoring of specific sites in Willard Spur throughout 2012. The information captured in this first phase of work is considered essential in better focusing and prioritizing investigations and research for the second phase of the implementation period.

Proposed Budget

The Utah Water Quality Board approved the expenditure of up to $1 million for the proposed Willard Spur research in December 2010. DWQ will work with the Science Panel to prioritize the proposed research and the Principal Investigators to refine their workplans and budgets to meet the State's budget.

Proposed Delivery Model

Organization

Critical to the success of the research program is the involvement of a Steering Committee and Science Panel to provide input, guide research, and provide recommendations to DWQ. DWQ will facilitate the process, work with the Water Quality Standards Workgroup (another venue soliciting stakeholder and public input), and provide final recommendations to the Utah Water Quality Board. The Utah Water Quality Board holds the authority to make any changes to Utah water quality rules and regulations. See Figure 1 for an illustration of how the various decision making bodies are organized. See memorandum dated August 1, 2011 ("Background Information") for further description of the organization and approach for this project.

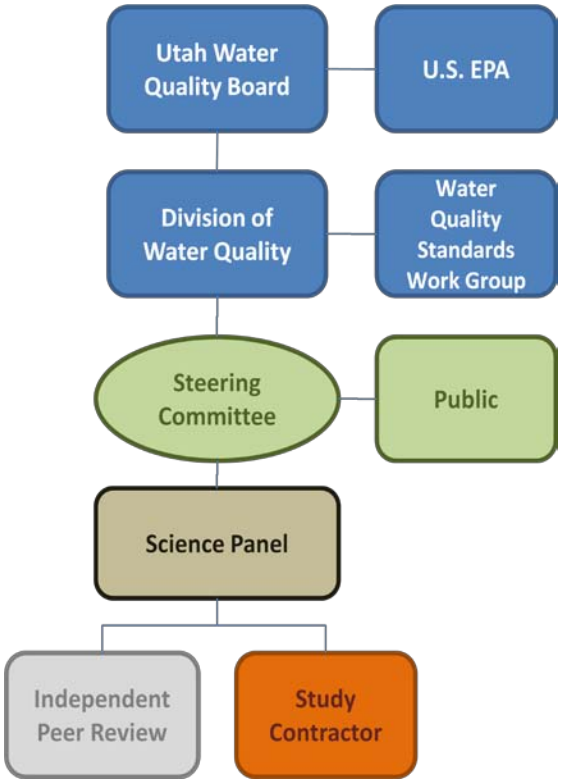

FIGURE 1
Organizational Chart

Program Management

A programmatic approach to managing this project will be required by virtue of the number of individual projects (i.e., studies) and Principal Investigators (PIs) that will be engaged in achieving the objectives. Each project will have its own objectives and deliverables but must integrate cohesively with other projects to achieve the overall program objectives. A programmatic approach provides for a small, core team that directs and oversees these activities to achieve that purpose.

DWQ will implement and oversee all activities for the Willard Spur Program. CH2M HILL's role is to support DWQ in completing these tasks and achieving program objectives. Figure 2 illustrates the collaboration between DWQ, CH2M HILL, the Steering Committee, Science Panel, and the Independent Review Panel.

As DWQ's project manager, Jeff DenBleyker will coordinate and facilitate the activities of the Steering Committee and Science Panel on behalf of DWQ and administrate the overall program. Jeff will administrate the individual research projects identified as part of the program and facilitate the Science Panel's role by providing day-to-day management and oversight of the projects and bringing them to a successful conclusion. Jeff will defer to DWQ staff first to provide assistance to the Steering Committee, Science Panel, or PIs. If DWQ staff are not available, Jeff will supplement with CH2M HILL staff as needed.

Jeff will be assisted by a small team of scientists from CH2M HILL (see Figure 2) whose role will be to assist with: 1)project planning and development, 2) oversight of the development of project workplans (including scopes of work, schedules, budgets, Data Quality Objectives (DQOs), quality assurance protocol, standard operating procedures for field sampling), 3) advising/managing PIs on a day-to-day basis, 4) analysis/evaluation of final reports, 5) integration of results into an integrated decision science model, and 5) development of a final program report. This team will include 3 Task Leads. They are as follows:

- Gary Santolo – food web and avian studies
- Earl Byron, PhD – water and nutrient budget
- Sharook Madon, PhD – nutrient cycling

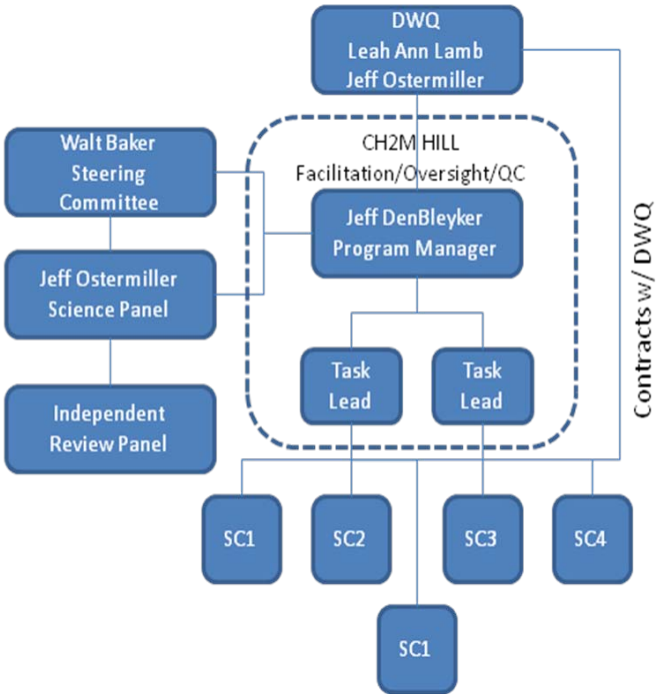

Figure 2
Organizational Chart for Proposed Programmatic Approach

Selection of Principal Investigators

The selection of principal investigators for completion of the identified research will be based upon qualifications to do the work, experience and familiarity with the Willard Spur and Great Salt Lake ecosystem, their proposed approach, and proposed budget and schedule. As identified above, the required timeline makes it impossible to implement a formal selection process with a public request for proposals. Thus, it is proposed that selections be made with the following criteria:

1. All work will be completed through contracts with State of Utah academic or research institutions, State of Utah or federal agencies, or amending existing contracts if applicable. These entities may subcontract work with others if required, however the primary contract must be between these entities and the Division of Water Quality.

2. Projects in Research Areas 1 and 2 are extremely time critical and are already well defined. This work will be completed by PIs at State of Utah or federal agencies who are qualified and already engaged with work with DWQ on Willard Spur and/or GSL work. These PIs will be engaged immediately to define workplans for work beginning in January 2012. Workplans will be reviewed by DWQ, the Science Panel, CH2M HILL to provide input and ensure clear linkages among subprojects exist and that specific outputs are directly tied to overall program objectives. Where appropriate, collaboration between these PIs and other scientists is encouraged, but the overall responsibility for managing these work elements lies with each PI.

3. Projects in Research Area 3 are less time critical but if current timelines are to be met they must urgently begin by April 2012. This area also requires interdisciplinary cooperation. We propose that DWQ submit a request for proposals to State of Utah universities for this work. The selected university(ies) will hold the prime contract but may subcontract to others.