

# Proposed Research Studies

## 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)

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This memorandum provides a proposed structure for the research studies that were identified and discussed by the Science Panel at their September 22<sup>nd</sup>, 2011 meeting. This structure is provided to the Science Panel for its review and discussion on the October 3, 2011 conference call. We will build upon this to develop the research plan.

### Overall Structure

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.

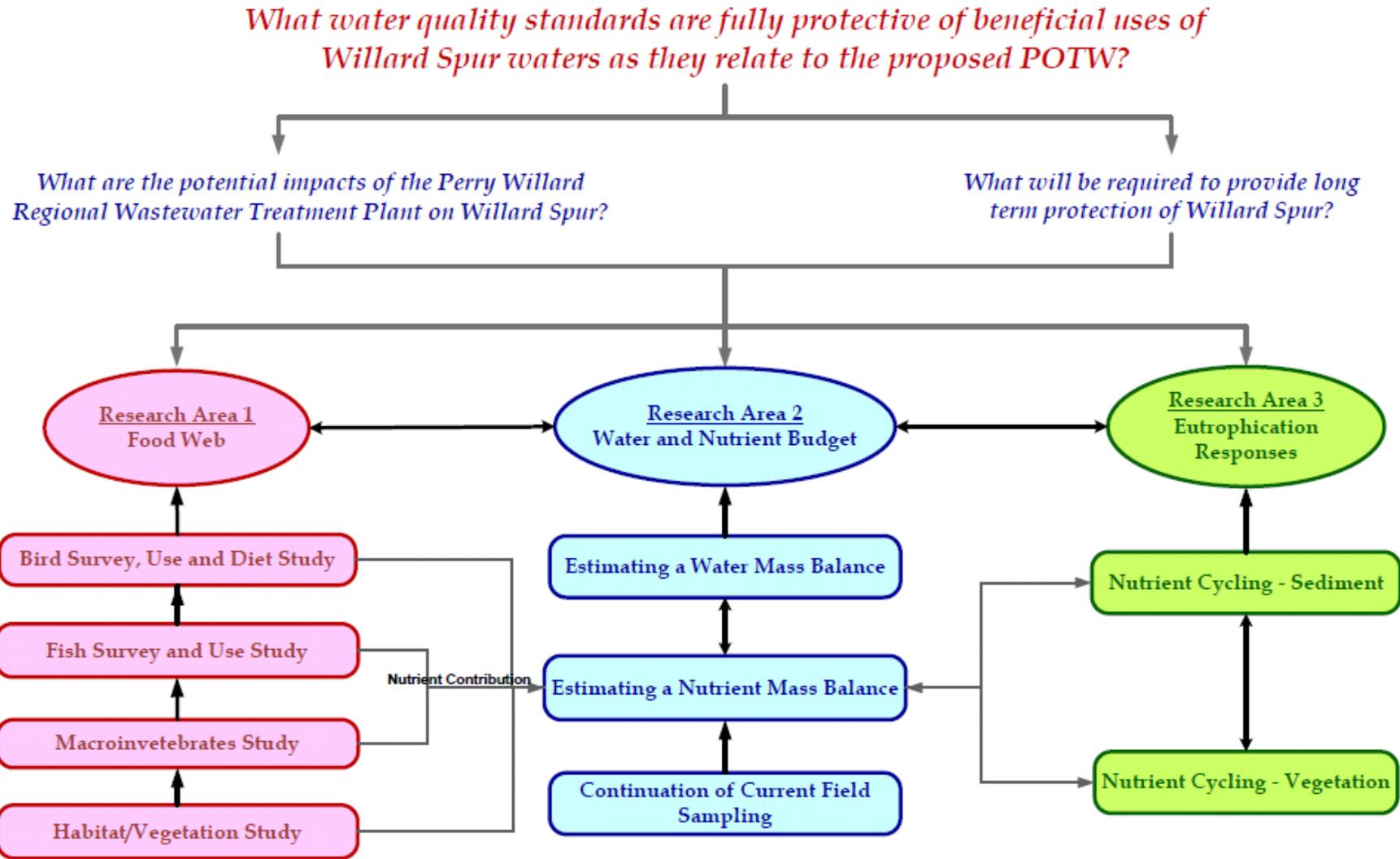
Two questions were identified that follow from the program objective, i.e., these questions must be answered for the program objective to be achieved. The questions are as follows:

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

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.



# 1.0 Understanding the Willard Spur Food Web

Studies focusing on this research area will define the Willard Spur food web and determine whether or not nutrients are critically linked to the food web. Findings from each study will be combined to understand and create a link between each element of the food web. Results from some of the 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 bird species currently use Willard Spur?
2. What are their numbers by species and how do the numbers vary throughout the year?
3. How has bird use (i.e., species and population) changed over time?
4. 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?
5. What is the energy value of their food items?
6. What are the foraging and nesting habits of bird species using Willard Spur? What is their preferred habitat for foraging and nesting?
7. How are food availability and preferred habitats affected by nutrients?
8. How does bird use (species or population) vary with changes in habitat, water level, and water quality (e.g., salinity, DO, etc.)?
9. What is the carrying capacity of Willard Spur for waterfowl and shorebirds? How would the carrying capacity be affected by nutrients?
10. What is the avian contribution to the nutrient budget for 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

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- surveys in the western portion of Willard Spur as part of their GSLM work. 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 is currently preparing a proposal to DWQ to add Willard Spur to his current waterfowl diet/energetic study. Sampling would occur in October.
  4. This study would rely upon data regarding fish, hydrology, habitat, vegetation, water chemistry, and eutrophication responses in water, plants, and macroinvertebrates from other projects in this program.
  5. Results from this objective will be an input to Project 2.2

## 1.2 Fish Use

### Objectives

1. What fish species currently use Willard Spur? Are they native or introduced to Willard Spur?
2. What are their numbers by species and how do the numbers vary throughout the year?
3. How has fish use (i.e., species and population) changed over time?
4. 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?
5. What are the foraging and reproductive habits of fish species using Willard Spur? What is their preferred habitat?
6. How are food availability and preferred habitats affected by nutrients?
7. How does fish use (species or population) vary with changes in habitat, water level, and water quality (e.g., salinity, DO, etc.)?
8. What is the carrying capacity of Willard Spur for fish? How would the carrying capacity be affected by nutrients?
9. What is the fish contribution to the nutrient budget for Willard Spur?

### Notes:

1. No known data exists
2. Possible partnership with DWR to be considered. Dr. Wayne Wurtsbaugh is currently working 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 the Avian Study to leverage sampling efforts for both projects.
4. Results from this objective will be an input Project 2.2
5. Will be linked to Project 1.1 and 1.3 to define food web

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## 1.3 Macroinvertebrates

### Objectives

1. What macroinvertebrate taxa use Willard Spur and what are their numbers?
2. How do macroinvertebrate taxa and populations vary by
  - a. Location in Willard Spur?
  - b. Habitat type and quality?
  - c. Season?
  - d. Water level and water quality?
3. 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 the Avian Study to leverage sampling efforts for both 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 the energetic model for Willard Spur 1.1, item no. 7
6. Results from this objective will be an input to Project 2.2
7. Will be linked to Project 1.1, 1.2, 1.4

## 1.4 Habitat/Vegetation in Willard Spur

### Objectives

1. What is the existing distribution and biomass of vegetation, including emergent vegetation, submerged aquatic vegetation, invasive species, phytoplankton, and algae, within Willard Spur?
2. How does this distribution affect habitat and change spatially and temporally with changing water levels, season, and water quality?
3. What does the literature reveal about a link between invasive species and nutrients and changes in habitat and use by wildlife?
4. What habitat types exist in Willard Spur? How are they linked to water level?
5. 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 invasive species but may be helpful in mapping changes in other vegetation and habitat as well.

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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 LyDAR 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 the Avian Study to leverage sampling efforts for both 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 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.

## 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 meteorological data is 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 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?

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6. Under what conditions does the Perry Willard Regional Wastewater Treatment Plant outflow 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. 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.
2. The effort should develop relationships between inflows and water levels in Willard Spur as well as recurrence intervals.
3. Dr. David Tarboton has recently completed 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.
4. 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.
5. Nutrient contributions from birds, fish, macroinvertebrates, plants, and sediments developed from the other studies should be considered. Close coordination with the Eutrophication Response 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 relationships will be used in the nutrient budget and food web models developed by the Avian Use study.

### 3.1 Nutrient Cycling – Sediment

#### Objectives

1. What are the sediment characteristics and how have deposition rates/patterns changed spatially and temporally? 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? 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?

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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?
3. How do emergent vegetation, SAV, phytoplankton and algae contribute to the nutrient budget?
4. How does the portion of the nutrient cycle including 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.