Great Salt Lake Wetland Monitoring
2019-2020
Sampling and Analysis Plan

Version 2

Effective 17 July, 2019

Prepared by the Utah Division of Water Quality

Utah Department of Environmental Quality

195 North 1950 West

Salt Lake City, Utah 84116

This Document builds on three previously developed Sampling and Analysis Plans (SAPs), the 2012 Impounded Wetland Probabilistic Survey, the 2013 Fringe Wetland Targeted Survey, and the 2014 Great Salt Lake Basin Reference Standard Sites Survey.

DISTRIBUTION LIST

The following individuals will receive a copy of this SAP, along with any subsequent revisions.

Becka Downard, Designated Project Manager, Utah Division of Water Quality

Toby Hooker, QA Officer and Monitoring Section Manager, Utah Division of Water Quality

Alex Anderson, Monitoring Team Leader, Utah Division of Water Quality

Ben Holcomb, Standards and Technical Services Section Manager, Utah Division of Water Quality

Ben Brown, Monitoring Section Manager, Utah Division of Water Quality

Any DWQ Monitor or Intern collecting environmental data, Monitoring Section, Utah Division of Water Quality

Table of Contents

1.0 INTRODUCTION AND BACKGROUND INFORMATION 6

1.1 PROJECT BACKGROUND/PROBLEM DEFINITION 6
1.2 PROJECT OBJECTIVE 7
1.3 STUDY AREA 7
1.4 SUMMARY OF PROJECT TASKS AND SCHEDULE 9

2.0 OBJECTIVES AND DESIGN OF THE INVESTIGATION 9

2.1 SPECIFIC OBJECTIVES OF THIS STUDY 9
2.2 SAMPLING DESIGN 13
2.3 STUDY BOUNDARIES 14
2.4 PARAMETERS TO BE MEASURED 15
2.5 DECISION RULES AND TOLERABLE LIMITS 17

3.0 FIELD SAMPLING METHODS 17

3.1 SAFETY PRECAUTIONS AND PLAN 17
3.2 SITE LOCATION 18
3.3 ELECTRONIC DATA GATHERING 18
3.4 FIELD PROTOCOLS BY PARAMETER GROUP 20
3.6 FIELD SAMPLING WORKFLOW 23
3.7 PACKING LIST 24
3.8 SPECIAL TRAINING 24
3.9 FIELD COMPLICATIONS AND CORRECTIVE ACTIONS 25

4.0 LABORATORY SAMPLE HANDLING PROCEDURES 25

4.1 RECEIVING LABORATORY CONTACT INFORMATION 25

5.0 PROJECT QUALITY CONTROL REQUIREMENTS 26

5.1 FIELD QC ACTIVITIES 26
5.2 ANALYTICAL QC LIMITS 27

6.0 DATA ANALYSIS, RECORD KEEPING, AND REPORTING REQUIREMENTS 28

7.0 SCHEDULE 28

8.0 PROJECT TEAM AND RESPONSIBILITIES 28

8.1 FIELD ACTIVITIES 29
8.2 LABORATORY ACTIVITIES 29

REFERENCES 31

APPENDIX A. SITE LIST AND FIELD DATA SHEETS 32

APPENDIX C – DATA QUALITY INDICATORS, SAMPLE CONTAIN REQUIREMENTS, ANALYTICAL QC LIMITS AND REPORTING RANGES 41

LIST OF FIGURES

Figure 1. Great Salt Lake wetlands 8

Figure 2. Selected impounded wetlands for 2019 survey. 14

LIST OF TABLES

Table 1. Data Quality Objectives 10
Table 2. Impounded Wetland sampling stratification 13
Table 3. Parameters to be measured 16
Table 4. SOP's and SAP's for wetland sampling 20
Table 5. Quality Control Sample Collections 27
Table 6. Project Schedule 28
Table 7. Project Team contact information 28

ACRONYMS AND ABBREVIATIONS

CWA	Clean Water Act
DEQ	Department of Environmental Quality
DQI	Data Quality Indicator
DQO	Data Quality Objectives
DWQ (or Division)	Division of Water Quality
FRNG	Fringe wetland
GSL	Great Salt Lake
IW	Impounded wetland
MMI	Multi-metric index
ppm	Parts Per Million
QA/QC	Quality Assurance/Quality Control
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
SAP	Sampling and Analysis Plan
SAV	Submerged aquatic vegetation
SOP	Standard Operating Procedure
UPHL (or State Lab)	Utah Public Health Laboratories
USEPA (or EPA)	United States Environmental Protection Agency

1.0 Introduction and Background Information

This Sampling and Analysis Plan (SAP) was prepared by the Utah Division of Water Quality (DWQ) to satisfy elements of DWQ's Quality Assurance Program Plan (QAPP) for Monitoring Programs, and to support a Wetland Program Development Grant (WPDG) awarded to DWQ by the United States Environmental Protection Agency (EPA) in 2018 (CD-96878701-0). This SAP documents the quality assurance and quality control (QA/QC) requirements and project planning details for a probabilistic survey of two classes of Great Salt Lake wetlands: Impounded Wetland (IWs) and Fringe Wetland (FRNG). This SAP is meant to be a practical, usable document and is therefore subject to change; the Designated Project Manager (DPM) will ensure that all persons listed on the **Distribution List** (page 2) receive the most current version.

1.1 Project Background/Problem Definition

Biological assessments of aquatic resources, including wetlands, rely on three key components. First, integrated measures of biological integrity must be developed for each ecosystem type. These measures are commonly based on the taxonomic composition of aquatic assemblages, such as algae, amphibians, macroinvertebrates or plants. The second component involves the identification and characterization of a collection of *Reference Standard Sites* (i.e. unaltered or least/minimally disturbed areas) that can be used as a baseline for all site comparisons within a given ecosystem type. The third component consists of an appropriate, probabilistic survey design that allows for generalization of wetland health at the watershed scale (Stevens and Jensen, 2007).

Previous work by DWQ's *Wetlands Program* has developed and validated an integrated assessment framework for impounded wetlands (IWs) based on three biological responses (cover of SAV, occurrence of surface algal mats, and composition of benthic aquatic macro-invertebrate communities) (DWQ, 2009). Initial work was based on a 50-site probabilistic survey (DWQ, 2012 [IW-SAP]; and CH2MHill, 2014) and incorporated into Utah's 2014 305(b) *Integrated Report* (DWQ, 2014).

Given that all IWs associated with Great Salt Lake are man-made and that most of these ponds are actively managed for waterfowl production, we lacked a clear, *a priori* set of *Reference Standard Sites* to use as a basis for comparing the relative health among wetlands. For the 2014 *Integrated Report* we benchmarked our sites against the Best Attainable Condition (BAC) ecological reference standard described by Stoddard et al. (2006), where BAC represents the expected ecological condition of sites receiving best management practices and having the least amount of impact from adjacent land use. This reference standard was determined empirically, based on the upper 75th percentile of biological response metrics.

During 2014, UDWG sampled baseline information on IW and FRNG wetland condition (i.e. health) from targeted sites in more remote areas of the GSL basin. An explicit assumption, supported by the data, was that sites farther from urban development have higher levels of ecological integrity. Reference wetlands sampled from Utah's West Desert had aquatic communities in better condition, measured by the health of the submerged aquatic vegetation

(SAV) and macroinvertebrate community, better water quality, and very little nuisance algae cover compared to GSL wetlands sampled near the Wasatch Front (UDWQ, 2015).

Since that survey, changes have been proposed for Utah's wetland water quality standards, national aquatic resource surveys have improved understanding of wetland condition, and the tools available to sample wetlands have improved. The activities covered in this SAP will build on previous surveys and new assessment knowledge to finalize an impounded wetland assessment tool. We will also expand the dataset and build an initial multi-metric index for fringe wetlands through a probabilistic survey.

1.2 Project Objective

The objective of this project is to collect environmental data from a probabilistic selection of IW and/or FRNG wetlands in order to measure wetland health. Our goal is to use the data from these new sites and previous surveys is to identify key indicators of wetland condition and the major stressors that are driving condition. These data will be incorporated into the current assessment frameworks for both IW and FRNG wetlands. The existing IW assessment framework includes a Multi-Metric Index (MMI; Karr and Chu, 1999) consisting of four main indicators: water chemistry, submerged aquatic vegetation, surface mats and macroinvertebrates (DWQ, 2009). A similar MMI is currently being developed for FRNG sites, however additional data collection is required before a preliminary MMI model can be developed.

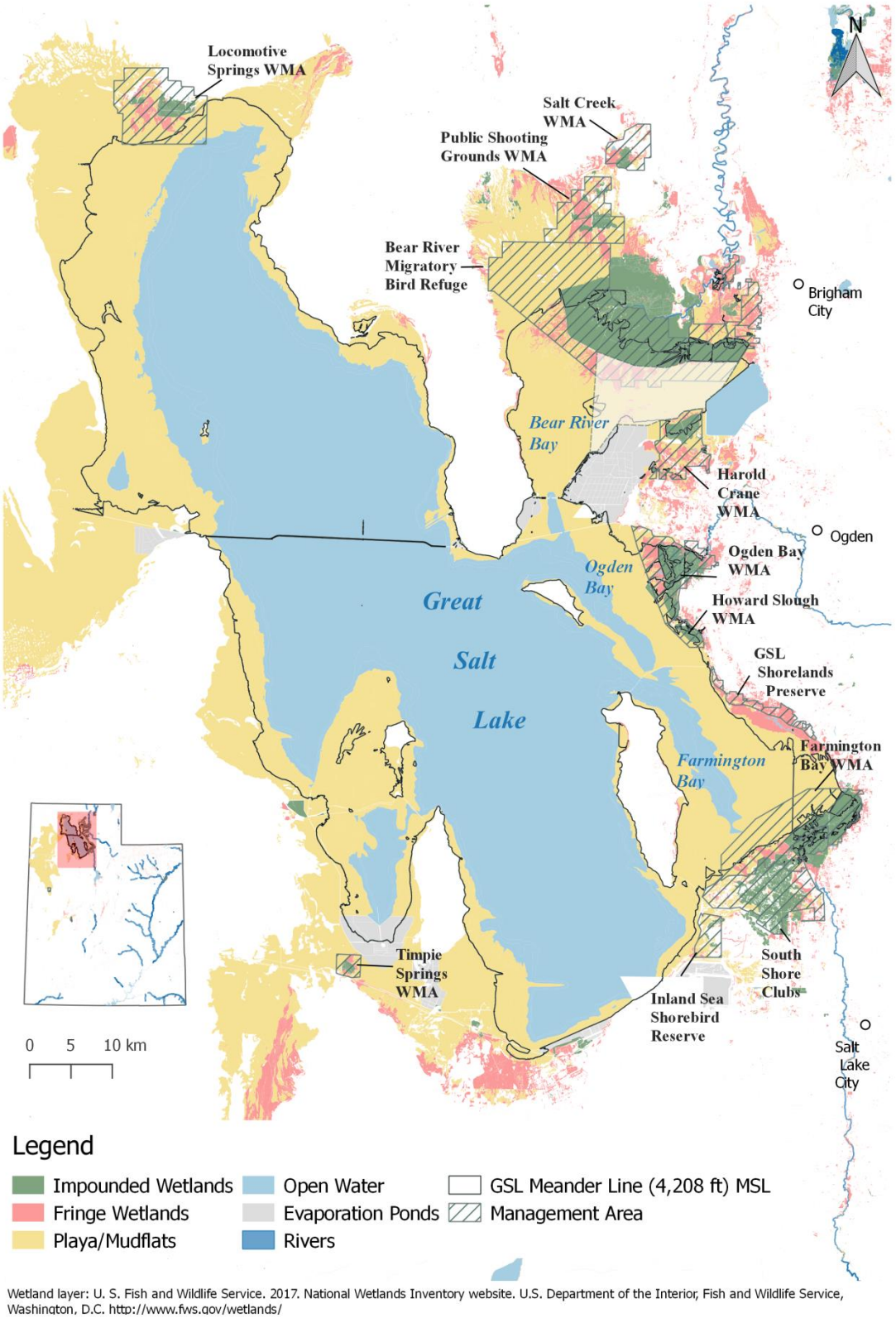
DWQ anticipates the following outputs from this study:

- Level III impounded wetland MMI and assessment method to be utilized for multiple monitoring and assessment objectives
- Development of core indicators of fringe wetland condition in draft Level III multi-metric index and assessment method
- Development of assessment criteria that can be used to identify wetland restoration and protection priorities
- Development of wetland management strategies to improve wetland condition and sustain wetland beneficial uses

1.3 Study Area

The majority of Utah's wetlands, approximately 85% of the total wetland acreage, are located adjacent to the Great Salt Lake. Those wetlands fall into three categories: impounded, fringe, and playa/mudflat wetlands (Figure 1). This project will sample a random selection of both IW and FRNG wetlands surrounding Great Salt Lake, Utah.

The project area includes portions of Box Elder, Weber, Davis, Salt Lake, and Tooele counties.



Wetland layer: U. S. Fish and Wildlife Service. 2017. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/wetlands/

Figure 1. Great Salt Lake wetlands

Impounded wetlands represent areas where dikes, berms, ditches and culverts have been constructed to control the inflow and outflow of water through wetlands. These wetlands are often intensively managed and occur as large, shallow ponds that range in size from 20 to over 500 acres (Miller and Hoven, 2007). Fringe wetlands are often (but not always) associated with impounded wetlands, and occur where freshwater flows over very gently sloping portions of the exposed lakebed. Fringe wetlands are often found below the outlets from impounded wetlands, from wastewater treatment facilities, and from other low-gradient surface channels or small streams. Depending on the quantity of water flow, wetland geomorphic features and lake elevation, fringe wetlands can span from the border of impounded wetlands to the margin of Great Salt Lake itself. As such, these wetlands commonly contain wide gradients in water salinity.

1.4 Summary of Project Tasks and Schedule

Sites were identified via GIS-based reconnaissance and discussions with scientists and resource managers knowledgeable about the area. Environmental data collections will take place during the summer and early-autumn of 2019 (IW) and 2020 (FRNG), approximately July to October, and will include 2 visits to each sampling location. Once all of the field and laboratory results are validated through DWQ's QA process, DWQ will generate a QA/QC report to accompany the dataset.

The dataset will be analyzed following the approaches described in the 2015 reference wetland survey and the National Wetland Condition Assessment (2016). DWQ will use the data to compare against results from the IW (2012, 2014) and FRNG (2013) surveys, as appropriate. The findings will be incorporated into DWQs baseline dataset for assessment of GSL wetland health, and as part of the long-term monitoring plan for GSL wetlands.

2.0 Objectives and Design of the Investigation

2.1 Specific Objectives of this Study

The project-level data quality objective for this study is to collect data of the appropriate type, quality, and quantity to allow DWQ to perform wetland condition assessments of GSL wetlands, make decisions about the use and applicability of wetland assessment tools and methods, and set long-term goals for monitoring the health GSL wetlands. Data quality objectives (DQOs) are qualitative and quantitative statements derived from systematic planning that clarify the study objective, determine the most appropriate type of data to collect, determine the most appropriate conditions from which to collect the data, and specify the level of uncertainty allowed in the collected monitoring data while still meeting the project objectives. This information is summarized in Table 1 (below).

The specific objectives of this project is to collect data on sites that will 1) be built into a final MMI and assessment tool for impounded wetlands, and 2) be incorporated into a draft MMI for fringe wetlands.

Table 1. Data Quality Objectives

Step	DQOs for 2012 Great Salt Lake Basin Reference Standard Sites Survey
1. Problem Statement	DWQ's *Wetlands Program* is developing tools to assess, monitor, and report on the water quality of Utah's wetlands. These efforts are based on a multiple lines of evidence approach using MMIs. Current work involves refinement of an MMI for impounded wetlands and development of an MMI for fringe wetlands associated with Great Salt Lake. An important aspect of DWQ's wetlands assessment work is the reporting of wetland condition (i.e. relative health) within and among watersheds, for example Utah's CWA 305(b) *Integrated Report*. Analysis of ecological condition metrics from previous surveys of IWs revealed that the preliminary MMI approach was sound. Targeted surveys developed a well-characterized network of *Reference Standard Sites*. To finalize the IW assessment method, we will conduct a probabilistic sample of 40 IWs, incorporating species-level vegetation data and surrounding landscape analysis into the method. Previous surveys of FRNG wetlands identified potential indicators of condition, but more data are needed to develop a draft index of condition. As such, the goal of this project is to collect samples and analyze data from IW and FRNG wetlands to support a final and draft MMI, respectively. This data will be incorporated into respective IW and FRNG datasets. This project will provide improved descriptions of biologic, chemical, and physical integrity for GSL wetlands.
2. Goal of Study / Decision Statements	**Key Question[s]** Q_0: What are the key indicators of wetland condition in impounded and fringe wetlands? Q_1: What are the primary stressors to or drivers of wetland condition in impounded wetlands? **Potential Outcomes** 1: Information is adequate to calculate MMI scores for: i) water chemistry, ii) benthic macroinvertebrates, iii) SAV, and iv) surface mats; DWQ will compare data with cumulative data from GSL IW and FRNG wetlands 2: Information is inadequate to calculate MMIs. DWQ will identify potential confounding factors, develop appropriate sampling and analytical methods, revise the sampling plan, and complete reporting as above
3. Inputs to Decision	**The following information will be collected:** Field sampling, including collection of water chemistry and biota samples, will be conducted two times during the 2019 growing season (mid-summer and early-autumn) for IW wetlands, and once in mid-summer 2020 for FRNG wetlands, at randomly selected sites around GSL Specific water chemistry parameters and biological metrics for IW and FRNG wetlands are provided in **Table 3** of this document. This information is described in Section 3.4.
4. Study Boundaries	The project area is shown in **FIGURE 1**. This area includes impounded and fringe wetlands within around GSL.

Step	DQOs for 2012 Great Salt Lake Basin Reference Standard Sites Survey
	Sampling sites will be field-checked to ensure that: • Represent the sample target - IW / FRNG wetlands managed for wetland-associated wildlife • Are Accessible - DWQ has received permission to visit wetlands on private property and has permits to in place for public management agencies Specific geographic, hydrologic, and temporal boundaries for IW and FRNG wetlands include: • Availability of boats and other field equipment, as well as equipment functionality, may limit the scheduling of field activities • Staff and equipment availability will be monitored throughout the project period • Weather is a major constraint for all sampling and monitoring activities because storms can limit access to field sites and the ability to safely conduct sampling and measurement activities at the study area • GSL level and private property access may be a constraint and affect sampling locations. Ownership information and permission will be obtained as early in the study as possible
5. Decision Rules	• If information is adequate to address the key questions, then these sites will be sampled. Some of these sites have been sampled over multiple years to develop an understanding of the range of natural, interannual variation of biological response and stressor metrics. • If information is inadequate to address the key questions, DWQ will identify potential confounding factors, develop appropriate sampling and analytical methods, revise the sampling plan, and complete reporting as above

Step	DQOs for 2012 Great Salt Lake Basin Reference Standard Sites Survey
6. Acceptance Criteria	• PARCC elements for data ○ Precision - Field replicates will be collected at 10% of sites for water chemistry, macroinvertebrate, and soil samples as well as field measurements (plant cover, multi-parameter probe measures, etc.) ○ Accuracy - Special efforts will be made to minimize contamination of water chemistry samples through proper collection of field samples, monitoring of sampling-bottle blanks, and the use of appropriate laboratories for analysis. Field surveys will be performed by a wetland monitoring crew trained in each method. Species richness of emergent and submerged-aquatic plant communities is commonly low, and plants are easily identified, however, questionable specimens will be collected and returned to the office for further identification by local experts. Taxonomic identification of macroinvertebrates and zooplankton will be performed by Utah State University (USU) Bug Lab. ○ Representativeness - The sampling locations have been well-defined. Field sampling will occur following standardized sample collection procedures as described in Standard Operating Procedures (SOPs) for each method. Inventory methods were designed to collect data at a scale most descriptive of GSL wetlands (~20 hectares). Site photos and field notes will be collected at each site and can be used to describe any unusual conditions that may occur. ○ Completeness - To ensure the sampling goal of 100% completeness at the end of the season, we will use field reconnaissance and in-depth discussions with wetland managers to verify that sites meet wetland class definitions. ○ Comparability - All field sampling and analytical procedures will be completed following the previously-tested SOPs for each metric, and will be performed by the same field crew throughout the sampling season • Measurement quality objectives for chemical measurements are specified in **Appendix C**. • DWQ QAPP specifies the minimum QA/QC objectives for sample measurement
7. Sampling Plan and Design	The sampling program includes: • Collection and analysis of water, benthic macroinvertebrates, zooplankton, and surface sediment nutrients and metals • Field observations of plant community diversity, cover, and condition, including SAV and algal mat specific data This data will be used to estimate the condition of a population of IW and FRNG wetlands around GSL. Data will be used to construct or finalize MMIs for key indicators based on wetland type. These indicators have been previously linked to the beneficial uses of these wetlands through their relationships to wetland physical, chemical, and biological condition. Successful completion of this project will support development of appropriate assessment frameworks for IW and FRNG wetland classes and provide information on how stressors related to human activity may affect biological responses within the wetlands. In IW's, data will be used to calculate key stressors to wetlands, following methodologies of calculating relative and attributable stress developed by the Environmental Protection Agency's (EPA) National Aquatic Resource Survey.

2.2 Sampling Design

The sampling design is a spatially balanced generalized random tessellation sample (GRTS) of IW and FRNG wetlands. Industrial ponds (i.e. evaporation ponds) and ponds managed for non-waterfowl/waterbird wildlife (e.g. fish, stock ponds) are excluded from the target population. The minimum size of IWs is five acres (approximately 2.0 hectares). The National Wetland Inventory dataset was used when available, and supplemented by other data as necessary. Polygons of potential sample sites were digitized by hand using ArcGIS 10.2 and available imagery for the project area (e.g. statewide NAIP 2006, 2009, 2011), and stored in a geodatabase.

Attributes were added to the dataset identifying each polygon's size class, HUC-8, and whether UDWQ has sampled it before (Table 2). The polygon file was converted to point features and divided into two sample frames – new sites and revisit sites – and a random GRTS sample was taken from each with 100% oversample (n = 60 new IWs, n = 20 revisit IWs). UDWQ will sample 40 IWs this summer, 25% of which are revisit wetlands, following the design of NARS projects (NWCA 2016 design). The sample was drawn using the spsurvey package in R (Kincaid, year).

Following the design of wetland surveys this project is building on, potential sites were stratified by revisit status, watershed, and size class. Figure 2 shows the final sites selected.

FRNG wetland site selection will be added here in 2020, following validation of the 2019 IW approach.

Table 2. Impounded Wetland sampling stratification

Revisit Status	N	Class
	10	Revisit
	30	New
HUC-8		
	1	Curlew Valley
	14	Lower Bear-Malad
	12	Lower Weber
	13	Jordan
Size		
	12	Small (5-20 acres)
	15	Medium (20-100 acres)
	13	Large (>100 acres)

Criteria to evaluate potential sampling sites include:

1) Target / Non-target: Does the site represent an appropriate wetland type (> 5 acres) that is managed for waterfowl or other wetland-associated wildlife?

2) Permission / Access: Has explicit permission to access the site been obtained from the landowner?
3) Sampleable: Can the site be sampled during the appropriate sampling index period(s)?

The project goal is to sample up to 40 IWs in 2019 and 15 FRNG sites in 2020 within the project area.

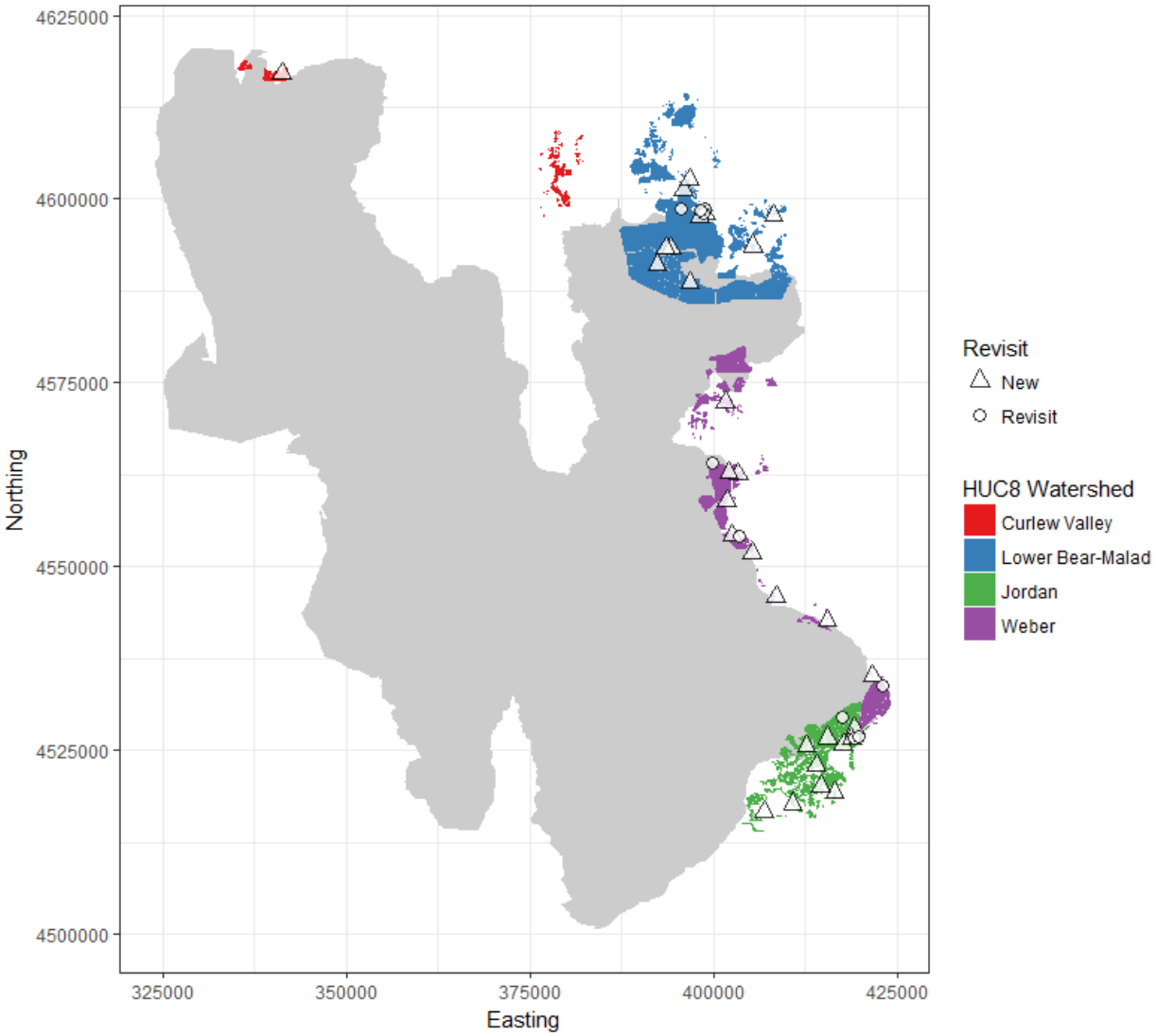


Figure 2. Selected impounded wetlands for 2019 survey.

2.3 Study Boundaries

Impounded and fringe wetlands represent important components of discharge zones within Utah's semiarid valleys. While the physical boundaries of impounded wetlands are often augmented by human efforts, high-quality impounded wetlands are prized for their ability to support large and diverse populations of waterfowl and other waterbirds. Similarly, the

physical boundaries of fringe wetlands are largely constrained by the availability of freshwater inflows, such that these wetlands are prized for their ability to retain sediments and immobilize nutrients and support diverse populations of resident and migratory water birds.

In order to properly assess the baseline condition of these wetlands, the following sections describe where they occur in the landscape, and provide guidance to help identify comparable sampling areas for data collection.

2.3.1 Geographic Boundaries

As shown in **Figure 1**, the project area includes wetlands along the eastern shore of GSL. In general, these wetlands are derived from diversion and management of rivers that flow into GSL.

2.3.2 Hydrologic Boundaries

Impounded wetlands are essentially shallow, steep-sided ponds and their principal source of water is from surface water delivered via extensive networks of canals, ditches and head gates (however, natural impoundments or impoundments without headgates exist in the study area). The relative importance of terrestrial vs. aquatic features within these wetlands can change markedly from year to year and across the growing season. The water source for fringe wetlands is similar to that for IWs, since FRNG wetlands commonly occur below the outfall of IWs.

More specific information on FRNG wetland hydrologic boundaries will be updated.

2.3.3 Temporal Boundaries (Index Period)

Building on the IW and FRNG assessment work (see SAPs), the IW sites will be sampled during two separate index periods, IP-1 (July), and IP-2 (late-August to mid-September). FRNG sites will be sampled in mid-summer, from late-July to early September.

2.4 Parameters to be measured

Data will be collected from samples of surface water, surface soils (0-10 cm), benthic macroinvertebrates, zooplankton, and emergent and submerged vegetation (as appropriate), following the wetland-specific SAPs. Measurements will follow the appropriate methods, as outlined in the wetland SOPs. Supplemental indicators, such as plant and soil $\delta^{15}N$ and $\delta^{13}C$ isotope ratios and C, N, and P concentrations may be determined as resources allow.

Table 3. Parameters to be measured

Description		Field Method *	Details
Vegetation (IW & FRNG)		Visual Observation	Five 1 m^2 quadrats along 100-m transect (IW) perpendicular to water flow; plant cover by species 1 m x 100 m belt transects aligned orthogonal to water flow at 100 m, 300 m, and 500 m from inflow of water to the wetland (FRNG); plant cover by species; collect vouchers of unknown species
Submerged Aquatic Vegetation (IW)		Visual Observation	Condition of SAV from 0 (absent) to 3 (healthy), presence of fruits or flowers
Benthic Macroinvertebrates (IW & FRNG)		Sample Collection using D-net	Five x 1-m sweeps with 500 µm D-net along 100-m transect One wide-mouth polyethylene quart jar *Sent to USU Bug Lab*
Zooplankton (IW)		Sample Collection using Wisconsin Net	Five x 5-m tows (radial) with 243 micron Wisconsin Net One 50-mL centrifuge tube or 100-mL specimen cup *Sent to USU Bug Lab*
Water Chemistry	Field Parameters (IW & FRNG)	Multi-Parameter Probe	Temperature, Specific Conductance, pH, Dissolved Oxygen
	Total (unfiltered) Nutrients (IW & FRNG)	Grab Sample Collection	NH_4^+, NO_3^-/NO_2^-, Total Kjeldahl Nitrogen (TKN), Total P One 500 mL bottle with H_2SO_4 preservative *Sent to State Water Lab*
	Dissolved (filtered) Nutrients (IW)	Grab Sample Collection and Field Filtering	NH_4^+, NO_3^-/NO_2^-, Total N (dissolved), Dissolved P, DOC One 500 mL bottle with H_2SO_4 preservative *Sent to State Water Lab*
	Dissolved (filtered) Metals (IW)	Grab Sample Collection and Field Filtering	Aluminum, Arsenic, Barium, Cadmium, Cobalt, Copper, Iron, Mercury, Manganese, Nickel, Lead, Selenium, Zinc One 250 mL bottle, preserved with HNO_3 *Sent to State Water Lab*
	General Chemistry (IW & FRNG)	Grab Sample Collection	Alkalinity, Total Suspended Solids, Total Volatile Solids, Total Dissolved Solids, Sulfate ($SO_4^=$), major cations and anions One 1000 mL bottle *Sent to State Water Lab*
	Sulfide (IW & FRNG)	Grab Sample Collection	Hydrogen sulfide as Total sulfide One 120 mL bottle with ZnoAc and NaOH preservative *Sent to State Water Lab*
	Chlorophyll-*a* (IW & FRNG)	Grab Sample and Field Filtering	0.7 µm filter residue *Sent to State Water Lab*
	Oxygen Demand (IW)	Grab Sample Collection	5-day Biochemical Oxygen Demand (BOD_5) One 2000 mL bottle *Sent to State Water Lab*
Sediment Available		Sample Collection	Five 0-10 cm cores (composited); Stored in 1-quart zip bag;

Description	Field Method *	Details
Nutrients (IW & FRNG)	using a Corer	PO4,Total N, Total and Organic C *Sent to USU Analytical Lab*
Sediment Total Metals (IW & FRNG)	Sample Collection using a Corer	Five 0-10 cm cores (composite); Stored in 1-gallon zip bag Aluminum, Arsenic, Barium, Cadmium, Cobalt, Copper, Iron, Mercury, Lithium, Manganese, Nickel, Lead, Selenium, and Zinc *Sent to UU ICP-MS Lab*
Sediment Nutrient Extracts (IW & FRNG)	Sample Collection using a Corer	10-15 grams soil to 100 mL KCl solution; shake, filter, and freeze; Nutrient Extracts: NH4, NO3/NO2 *Sent to USU Analytical Lab*
Hydrology (IW)	Visual Observation	Record water depth, water flow, water management actions, and muck depth at the starting point of 100-m transect
Wetland Buffer (IW & FRNG)	Visual Observation	Record the severity of disturbances within 100-m of wetland boundary on scale of 0 (stressor absent) to 3 (stressor is severe)
Landscape Stressors (IW & FRNG)	Desktop GIS Analysis	Measure surrounding land cover classes and road density within 500-m of wetland boundary

* See Section 3.0 and DWQ's Standard Operating Procedures for additional details
Note: All IW parameters will be measured during both Index Periods unless stated otherwise above

2.5 Decision Rules and Tolerable Limits

1.) If information is comparable to previously collected data, then DWQ will summarize and report these results and finalize an IW MMI.

2.) If information is not comparable, DWQ will re-evaluate sample collection and analysis procedures. This information will then be summarized prior to further sampling.

Tolerance limits exist primarily for laboratory analyses, where data quality indicators are defined in DWQ's Quality Assurance Project Plan (QAPP) in terms of acceptability criteria. This information is summarized in Table 4 in the wetland-specific SAPs. The DWQ QAPP defines procedures that specify minimum quality assurance (QA) and quality control (QC) objectives for sample measurements based on the sample matrix.

3.0 Field Sampling Methods

This section summarizes the work-flow and methodology for environmental sample collection from GLS wetlands and incorporates the DQO's in Table 1.

3.1 Safety precautions and plan

Field personnel should take appropriate precautions when operating watercraft and working on, in, or around water, as well as possibly steep or unconsolidated banks, or edges of ponds. All field crews should follow appropriate safety procedures and be equipped with safety

equipment such as proper wading gear, gloves, first aid kits, cellular phone, etc. All boats should be equipped with safety equipment such as personal floatation devices, oars, air horn, etc. Utah's Boating Laws and Rules shall be followed by all field personnel.

Field personnel should be aware that hazardous conditions potentially exist at every water body. If unfavorable conditions are present at the time of sampling, the sample visit is recommended to be rescheduled. If hazardous weather conditions arise during sampling, such as lightning or high winds, personnel should cease sampling and move to a safe location.

Most often, sample bottles are prepared by the State Lab and already contain preservative. During packing and handling of bottles, be sure that caps are tightly sealed. Be careful to avoid contact with preservative (acid). If minor skin contact occurs, rinse with copious amounts of water. If major skin or internal contact occurs, seek medical attention.

Wear gloves or be sure to wash hands after sampling, especially when sampling potentially contaminated areas.

3.2 Site Location

Coordinates from site selection are for the center of each wetland site (see Appendix A), but IW and FRNG wetlands are too large to sample in total, so field sampling will take place along 100-m transects located according to the following rules:

3.2.1 Impounded Wetlands

- Estimate the dominant flow plat within an impoundment. This will generally be downstream of water sources like canals or rivers and can be estimated by finding headgates where water is spilling over the top of boards or seeping around the base.
- The 100-m data gathering transect will run perpendicular to the flow path and should be located where water is open (not crowded by emergent vegetation) and at or near the deepest pooling point in the impoundment (not so deep data gathering can't happen).
- For previously visited sites (Revisit = yes in Appendix A), transects should start as close as possible to 2012 locations.
- Unlike previous surveys, we will sample all sites that meet the definition of an IW (see Section 2.2) regardless of the presence of water. If a site is dry during a visit, start the transect at the point where the wetland is likely to be most deeply flooded when water is present.

3.2.2 Fringe wetlands

- To be updated in 2020, see Fringe 2013 SAP for details.

3.3 Electronic Data Gathering

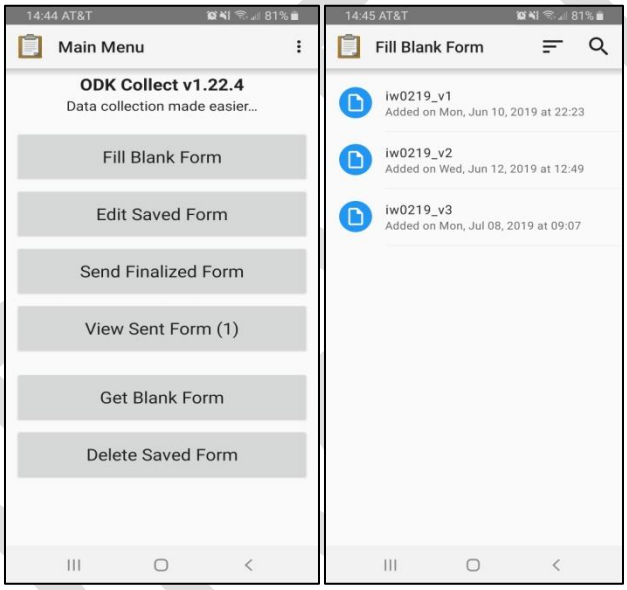
Whenever possible, data will be gathered electronically using Monitoring Section tablets that have the ODK Collect app installed and the project form installed. Google Earth and the kmz file with site locations are useful to have on the tablets. The Wetland Monitoring Board on Trello

has copies of SAPs, datasheets (field sampling, lab and field sheets), packing lists, and other important documents and instructions.

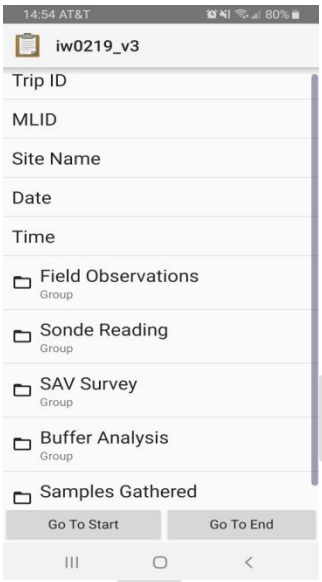
Always bring a hard copy of datasheets and pencils because the tablet can run out of batteries but pencils cannot. Use the strap on the tablet to keep it out of the water because the tablet is not waterproof. The tablet can overheat, but keeping it in a shaded spot for a while can help it return to working temperatures. Storing the tablet in a Ziploc or other sealed bag will make it overheat quickly.

To use the ODK app to collect data:

1. Open ODK Collect 
2. Select 'Fill Blank Form' from the initial screen, then select 'iw0219_v3' to fill



- Once the form is open select the first field (TripID) to begin entering data. You can move from field to field by swiping across the screen from left to right; move backwards in the form by swiping the other direction.
- To return to the whole form from an individual field, select the  button or  button from the top right corner of the screen.
- Aside from the top 5 fields, the form is grouped by parameter type in the approximate order the data should be gathered. It includes fields to take pictures.



- Save form periodically by selecting the save icon: .

4. Save form and finalize by selecting 'Go to End'. The name for each file should be Site Name + Date (SiteName_YYYY-MM-DD).

- A form can be opened and closed multiple times. If you closed the ODK Collect app accidentally, it can be opened again (usually without any information lost) by opening the app and selecting 'Fill Blank Form' from the first menu.

5. At the end of the day, finalize and upload saved forms. Once back in Wi-Fi range, select 'Send Finalized Forms" from the opening screen menu.

3.4 Field protocols by parameter group

The sample-specific collection activities are described in the wetland specific SAPs as well as the accompanying SOPs for each method.

Table 4. SOP's and SAP's for wetland sampling

Parameter	SOP/SAP
Impounded Wetlands (2012)	Great Salt Lake Impounded Wetlands: 2012 Probabilistic Survey of Wetland Condition Sampling and Analysis Plan
Fringe Wetlands (2013)	Great Salt Lake Wetlands (2013): Preliminary Fringe Wetland Condition Assessment Sampling and Analysis Plan
Reference Wetlands (2015)	
Chlorophyll-a	STANDARD OPERATING PROCEDURE FOR THE FILTERING OF

Filtering	CHLOROPHYLL-a SAMPLES
Using Multi-parameter Probe	STANDARD OPERATING PROCEDURE FOR CALIBRATION, MAINTENANCE, AND USE OF HYDROLAB MULTIPROBES
Macroinvertebrate Collection	STANDARD OPERATING PROCEDURE FOR THE COLLECTION OF MACROINVERTEBRATES IN WETLANDS
Water Chemistry Collection	STANDARD OPERATING PROCEDURE FOR COLLECTION OF WATER CHEMISTRY SAMPLES
Zooplankton Collection	STANDARD OPERATING PROCEDURE FOR COLLECTION OF ZOOPLANKTON SAMPLES USING A HORIZONTAL TOW
Aquatic Vegetation Sampling	STANDARD OPERATING PROCEDURE FOR DETERMINING PERCENT COVER OF AQUATIC VEGETATION IN WETLANDS
Sediment Collection	STANDARD OPERATING PROCEDURE FOR COLLECTION OF SEDIMENT SAMPLES IN WETLANDS

For IW sites that aren't flooded: gather as many parameter groups as possible. Water Chemistry samples can be gathered from remaining pools of water or nearby water sources if they are around. Without any water, or sufficiently deep water at a site, macroinvertebrate and zooplankton samples cannot be gathered; this is fine, but note it in the site notes. Soil, vegetation, and buffer data can be gathered regardless of flooding.

3.4.1 Water Chemistry Sampling

Sampling of water chemistry parameters involves two separate activities, as shown in Table 3. *Field parameters* are measured using a multi-parameter probe (Hydrolab or similar). This project will use the temperature, specific conductance, pH, and dissolved oxygen probes. Multi-parameter probe data will be recorded once the results have been verified as acceptable by the field crew, and stored on the instrument; include any notes about site conditions observed during the measurement on tablet.

Field collection of water samples for chemical analysis is the second sampling component. This is also typically one of the first activities performed during a site visit. Specific procedures for collection of water grab samples are described in the SOP. Seven bottles will be gathered from each site: General Chemistry, Total Nutrients, Filtered Nutrients, Filtered Metals, Oxygen Demand, Sulfide, and Chlorophyll-a. Samples can be filtered in the lab; make sure to labeled the volume of water filtered for chlorophyll-a samples on the datasheet and lab sheet.

Replicate water chemistry samples will be gathered at four sites. Blank samples will be gathered weekly for filtered samples.

3.4.2 Zooplankton Sampling

Zooplankton sampling is performed using a 243-micron tow net to collect large plankton within the upper portion of surface waters. Five tows of the net will be conducted from the starting point of the vegetation survey transect. The contents are rinsed with DI water into a sample container (typically a 50 mL centrifuge type or 100 mL specimen cup), preserved in ethanol and labeled with the site MLID and date.

Zooplankton label can be found at: U:\WQ\PERMITS\MONITORS\Labels\zooplanktonHT_Gray lab_ label.doc)

3.4.3 SAV and Emergent Vegetation Sampling

Impounded Wetlands. Aquatic vegetation is sampled by visual estimation of aerial cover along 100-m transects. A 1-m^2 rectangular quadrat placed at five randomly selected locations along the transect will be used to estimate the cover of each species present. Record the name or voucher number of each species present and the cover of each species within the 1-m2 quadrat.

- *For unknown species*: give each unknown species a voucher name (V##), taken pictures of the leaves, flowers, and whole plant to assist in identification, and grab a sample of the plant to be pressed. In picking a sample for pressing, try to find a plant with flowers and grab the roots when possible).

SAV condition: record the overall condition of SAV within in each quadrat. Also record whether or not SAV flowers or fruits, which are brown and globe-shaped, are present.

- 0 – Absent (no SAV is present in the quadrat)
- 1 – Decomposing/senescing
- 2 – Intact but stressed
- 3 – Healthy

Fringe wetlands - Emergent vegetation and ground cover is sampled by visual estimation of aerial cover of each species within a 1-m band along each 100 m-transect. Follow voucher procedures listed above for new or unknown species.

3.4.4 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates are collected from an undisturbed area using a D-net at 5along a 100-m transect. At five randomly selected locations on the transect the D-net is tapped along the sediment/soil surface while performing a figure-eight type motion along a 1-m length. Samples are composited with wide-mouth polyethylene jars, preserved with ethanol, and labeled internally and externally (MLID + date).

Labels can be found at: U:\WQ\PERMITS\MONITORS\Labels\ BENTHOS JAR TAG (INTERIOR).doc

3.4.5 Sediment Chemistry Sampling

For IWs, sediment available nutrients and total metals are sampled from five sediment cores along a 100-m transect. For FRNG, sediments are sampled from an undisturbed area within the open water flow path and at the end of each vegetation transect for all three sample locations.

Briefly, the goal is to collect the top 10 cm of the loose sediment (or mucky soil). Composite samples in a small bucket, place 10-15 grams of soil in KCl solution and split the remaining soil between two 1-gallon Ziploc bags. Label cup and bags with site MLID and date.

Soil Nutrient Extracts – Once samples are returned to the lab, ensure they are shaken for at least one hour (a 30-minute drive and 30 minutes of shaking in the lab is sufficient). Allow sediment to settle and filter the water through a Whatman #1 filter. At least 50 mL of filtrate is needed. Label cup of filtered solution with site MLID and date; store in the freezer.

3.5 General Decontamination Procedures

All equipment used in the field, or temporary sample containers, must be cleaned and disinfected according to the procedures described in each SOP.

3.6 Field sampling workflow

The electronic data gathering form is set up to guide the work flow.

1. Determine transect starting point (Section 3.2)
2. Record site-wide observations: hydrology, site selection explanation, weather
3. At the transect starting point gather water chemistry samples and zooplankton samples
4. Select 5 random points within 20-meter segments (0-20, 21-40, 41-60, 61-80, 81-100). Gather vegetation data, take a soil core, and make a macroinvertebrate sweep at each point.
5. Take pictures of the site facing each cardinal direction at a representative location on each transect.
6. Assess buffer condition as a final step
7. In the shop: filter chl-a samples (note volume filtered) and soil extract samples. Label all samples taken (MLID + date). Chlorophyll-a and soil nutrient extract samples will be stored in the freezer. Water chemistry samples will be stored in the fridge, the holding time on BOD samples is 48 hours.
8. Finalize and upload electronic forms or scan datasheets.

3.7 Packing List

Sampling Gear

- ☐ Tablet (charged)
- ☐ Hard copy datasheets
- ☐ Multi-parameter probe (charged and calibrated)
- ☐ Ice-filled cooler
- ☐ 1-m^2 vegetation sampling quadrat
- ☐ Paper bags for plant vouchers
- ☐ Gallon Ziploc bags (soils)
- ☐ D-net
- ☐ 234 µm tow net
- ☐ DI water
- ☐ Bug bucket
- ☐ Ethanol
- ☐ Chlorophyll-a filter kit
- ☐ Geo-pump
- ☐ Soil mixing bucket & spoon
- ☐ Soil corer, 10 cm segmenter, plug
- ☐ Ruler
- ☐ Briefcase with macroinvertebrate labels

Containers (pack one for each site)

- ☐ Wide-mouth nalgene bottles (macroinvertebrates)
- ☐ 100 mL specimen cups (zooplankton)
- ☐ BOD bottle
- ☐ General Chemistry bottle
- ☐ Total Nutrients bottle
- ☐ Filtered Nutrients bottle
- ☐ Filtered Metals bottle
- ☐ Sulfide bottle
- ☐ Transfer bottle
- ☐ 100-mL KCl solution

3.8 Special training

Field crews are required to read this SAP and *all applicable* SOP's prior to conducting the field work described in this SAP, and acknowledge they have done so via a signature page that will be kept on file at DWQ along with the official hardcopy of this SAP.

Personnel performing water sampling must be familiar with sampling techniques, safety procedures, proper handling, and record keeping. Field crews should have the supplies and training to provide first aid in the event of an injury or illness.

3.9 Field Complications and Corrective Actions

All sites to be sampled for this project will be evaluated prior to the beginning of the sampling period, to determine whether i) the site meets the project target wetland class, ii) DWQ has received explicit permission to access sites located on private property, and iii) the site contains the physical environment necessary to meet project goals, as described in Section 2.3 of this document. However, it is possible that hydrologic conditions or management actions of a site could change between the time of field reconnaissance and sampling.

Other abnormal field conditions may arise during the course of sampling. Field crews are required to adhere to all proper safety precautions and plans during this project. For example, high winds may represent dangerous and unpredictable conditions within large impounded wetlands, and may also deleteriously degrade water quality by temporarily mixing sediment into the water column. In this case, it is recommended that sampling that site be postponed for that day (or moving to another site that is not affected by high winds). Wind-induced turbidity may subside within a day or two for most impounded wetlands with a large windward fetch.

4.0 Laboratory Sample Handling Procedures

All sample collections will be obtained following the protocols outlined in Section 3.2 above and described in the method-specific SOP (see **Table 4**). Appendix C Table 3 lists the required container type, sample volume, preservatives (if any) and the allowable holding time for all sample collections in this project.

4.1 Receiving Laboratory Contact Information

Contact information for laboratories receiving project samples.

State Lab

State of Utah's Public Health Laboratories, Chemical and Environmental Services Bureau
Contact: Dr. Sanwat Chaudhuri
4431 South 2700 West
Taylorsville, UT 84119
(801) 965-2470

USU Bug Lab

National Aquatic Monitoring Center
Department of Watershed Sciences
Utah State University
5210 Old Main Hill
Logan, UT 84322

Utah State University Analytical Laboratories

Contact: Pam Hole
USU Analytical Laboratories
Skaggs Research Laboratory

1541 N 800 E
Logan, UT 84341
(435)-797-0600
usual@usu.edu

University of Utah ICP-MS Laboratory
Contact: Dr. William P. Johnson
Salt Lake City, UT
(801) 664-8289; email: william.johnson@utah.edu

5.0 Project Quality Control Requirements

Baseline Quality Control requirements for this project will follow those described in DWQ's Division QAPP (available from the project QA Officer), and are outlined in Appendix C Table C3.

5.1 Field QC Activities

Field QC checks and samples will be performed or collected, respectively, as often as appropriate and practical during field sampling. The most detailed QC checks are focused on the collection and analysis of water chemistry samples, however, the entire project design has been constructed with the data quality indicators outlined in Appendix C in mind. Adherence to SOPs for all measurements will minimize bias, improve accuracy and precision, and support data representativeness and comparability associated with this project.

Two types of QC samples will be collected in the field (Table 5).

Field Replicates: Replicate samples will be obtained for 10 percent of all field collections listed in **Table 2-3** (four sites). This includes water chemistry samples, benthic macroinvertebrates, and sediment chemistry.

Performance goal: <20 percent difference between replicates for water (<40 percent for sediment) chemistry. *Performance goals for biological measures are not yet defined; this dataset will be used to inform those goals for future monitoring activities*.

Field Blanks: One set of "Field Blanks" will be collected per week. Reagent-free deionized water will be added to *General Chemistry* (1,000-milliliter), *Total Nutrients* (500-milliliter), and *Biological Oxygen Demand* (2,000-milliliter) bottles in the field, and then capped and handled in the same manner as other samples.

Performance goal: Blank values are below detection limits.

A third QC sample may be collected as appropriate (IW sites only):

Equipment Blanks: Collected at the end of each *full* week of sampling, for samples that require in-field filtration. Reagent-free DI water will be run through each piece of sampling equipment and collected in appropriate sample bottles / containers. This will be performed for the Chlorophyll-a samples using a 0.2 µm filter (filter is retained following SOP), and for *Dissolved Metals* and *Dissolved Nutrients* using the same apparatus as used for field samples.

Performance goal: Blank values are below detection limits.

Table 5. Quality Control Sample Collections

QC Type	*Frequency*	Water Chem: General Chemistry	Water Chem: BOD	Water Chem: Total Nutrients	Water Chem: Dissolved Nutrients	Water Chem: Dissolved Metals	Water Chem: Sulfide	Water Chem: Chlorophyll-a	Benthic Macroinvertebrates	Zooplankton	Sediment Nutrients	Sediment Metals
(1) Field Replicate	One per 10 sites	X	x	X	X	X	X	X	X	X	X	X
(2) Field Blanks	1 set per week	X	x	x	X	X	X					
(3) Equipment Blanks	1 set per week				X	X		X				

5.2 Analytical QC limits

Analytical QC limits are described in each laboratory's quality assurance manual and conform to the requirements laid out in DWQ's QAPP. Contracts initiated with laboratories will contain agreements that outline how QC test results will be reported to DWQ. DWQ and its analyzing laboratories will cooperate to ensure laboratories receive ample sample to perform requested analyses, and to run tests such as lab duplicates and matrix spikes. Appendix C Table 3 describes QC limits, reporting range and accuracy requirements for laboratory analyses.

QC limits for field measurement of water chemistry parameters using a multi-parameter probe (Hydrolab, etc.) can be found in the instrument manuals, and described in the SOPs and the DWQ QAPP.

Field monitoring crews are responsible for performing immediate corrective actions in the field if a QC issue is found during field QC checks. Typically this corrective action will involve instrument maintenance or recalibration; monitors will document this type of corrective action in the field notes.

Special effort will be made by the DPM to validate all incoming project data against data quality indicators and QC limits as they are received by DWQ, and to ensure the timely receipt of results for all submitted samples. This will be performed in conjunction with the QA Officer and Monitoring Section Manager, through the use of a database to track the status of all samples collected and submitted to outside laboratories. Initial validation of the dataset by the DPM will focus on the identification of field and equipment blanks and whether these samples meet DQI requirements (i.e. non-detectable element concentrations). Ancillary field observations, or other available data, will be used to ascertain the causes of blank samples that fail the DQIs; corrective measures will be discussed with the QAO and the field crew and implemented.

6.0 Data Analysis, Record Keeping, and Reporting Requirements

Electronic data sheets will be uploaded to the DPM server at the end of each sampling data. Data will be downloaded weekly and stored on DWQ network drives.

All field data sheets will be scanned by the field crew (as pdf files) as part of routine operations in between field sampling trips. These files will be stored on the DWQ network drive on a bi-weekly basis. Site photos will also be uploaded to the DWQ network drive for this project.

Once all data have been received and results from all field-collected blanks have been validated, the dataset will be formatted following Tidy Data Guidelines. The report on GSL Wetland Monitoring is anticipated in September, 2021. Once the project report has been reviewed and finalized, this work will be integrated into a report to EPA as a contract deliverable and made available online on the DWQ Wetland Program web page.

7.0 Schedule

Table 6. Project Schedule

Task	2019 – IW								2020 – FR										
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Update Sampling & Analysis Plan		X										X								
Site Reconnaissance			X											x						
Sampling - Index Period #1			X												x	x				
Sampling - Index Period #2					X															
Sample Analysis						X	X										x	x		
Data Validation							X												x	
Data Analysis							X												x	
Report Writing							X	X												x

This project is funded by a WPDG grant to DWQ (*contract #* CD-96878701-0).

Anticipated Equipment -- Equipment needs for each sampling type is listed in Section 3.7 and in method-specific SOPs. Equipment needs for this project have already been addressed and necessary equipment has been purchased. The Monitoring Team Leader will monitor the inventory of consumable supplies and place orders when needed.

8.0 Project Team and Responsibilities

Table 7. Project Team contact information

Title	Name	Organizational Affiliation	Key Tasks or Responsibilities	Telephone number/ email
Project Manager	Becka Downard	UDWQ	Oversees direction of project, data analysis, reporting	(801) 536-4340 rdownard@utah.gov

UDWQ QA Officer	Toby Hooker	UDWQ	Oversees QA for Division, responds to QA issues	(801) 536-4289 tobyhooker@utah.gov
Monitoring Section Manager	Ben Brown	UDWQ	Oversees the monitoring section	(801) 536-4363 brbrown@utah.gov
Monitoring Team Leader	Alex Anderson	UDWQ	Directs day-to-day work of project, performs field data collection	(801) 536-4361 aranderson@utah.gov
Monitoring Team	Brent Shaw, Summer Interns	UDWQ	Performs field data collection	Contact Alex Anderson
Laboratory Contact	Sanwat Chaudhuri	State Laboratory	Water analyses	(801) 965-2470

UDWQ Project Management Staff

The lead project sponsor will be the Utah Department of Environmental Quality (DEQ), UDWQ whose mission is to "Protect, maintain and enhance the quality of Utah's surface and underground waters for appropriate beneficial uses." The UDWQ Director is Erica Gaddis.

The UDWQ Project Manager for this study will be Becka Downard, the DWQ staff Wetlands Scientist. She will be responsible for project management, tracking, review of technical reports, and dissemination of project results.

Toby Hooker serves as the Division Quality Assurance Officer (QAO). He is the point of contact for all data quality assurance matters with the Division, is a DWQ representative to the DEQ's Quality Assurance Council (QAC), and assures that only the current versions of the Division QAPP and associated SOPs are in use. Toby provides approval for all project SAPs. Ben Brown is the Monitoring Section Manager and oversees the monitoring staff and field activities for the Division.

Alex Anderson is the Monitoring Team Leader for this project. Alex coordinates the summer field crew and equipment needs for this project, ensures that all sampling procedures are understood and adhered to during the sampling campaign, and arranges for collected samples to be delivered to the appropriate labs for analysis. Alex also coordinates the scanning and uploaded of field data and photos to the project folder on the DWQ network drive. Alex provides the DPM frequent updates regarding the status of field sampling progress and initiates discussion of any problem situations encountered.

8.1 Field Activities

Day-to-day field operations will be overseen by Alex Anderson, an experienced member of the UDWQ Monitoring Section. He has many years of previous experience monitoring wetlands in Utah. The monitoring team will consist of one other UDWQ Monitor and two project interns.

8.2 Laboratory Activities

A variety of sample types will be collected during this study, requiring multiple analyzing laboratories.

Water chemistry samples will be analyzed by the Chemical and Environmental Services Bureau of the State of Utah's Public Health Laboratories (hereafter referred to as the State Lab). The laboratory is overseen by Dr. Sanwat Chaudhuri. The State Lab maintains an in-house QAPP, available from the QAP (James Harris). Macroinvertebrate and Zooplankton samples will be analyzed by the USU Bug Lab (USU-BLM Aquatic Resource Monitoring Center). Sediment-Nutrient samples will be analyzed by the Utah State University Analytical Laboratories. Sediment-Metal samples will be analyzed by University of Utah ICP-MS laboratory.

References

Association of State Wetland Managers [ASWM]. 2012. State Water Quality Standards for Wetlands [Draft], Online information, aswm.org/wetland-programs/water-quality-standards-for-wetlands, accessed 24 April, 2012.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. US Fish and Wildlife Service, Biological Services Program, FWS/OBS-79/31, Washington, DC, 142 pp.

Dahl, T.E. 2005. Status and trends of wetlands in the coterminous United States 1998-2004. US Fish and Wildlife Service, Washington, D.C., 112 pp.

Ducks Unlimited. 2008. Great Salt Lake wetlands assessment project. [GIS database] Online: www.ducks.org/utah/utah-projects/ut-great-salt-lake-wetlands-assessment-project, accessed 5 June, 2012.

Emerson, R. and T.D. Hooker. 2011. Utah wetland functional classification and landscape profile generation within Bear River Bay, Great Salt Lake, Utah. Utah Geological Survey, Salt Lake City, UT. Contract deliverable for US EPA, Region 8 Wetlands Program, 39 pp.

Hoven, H.M., and T.G. Miller. 2009. Developing vegetation metrics for the assessment of beneficial uses of impounded wetlands surrounding Great Salt Lake, Utah, USA. Natural Resources and Environmental Issues, Vol. 15, no. 11. Online, digitalcommons.usu.edu /nrei/vol15/iss1/11, accessed May 15, 2012.

Keddy, P.A. 2010. Wetland Ecology: principles and conservation, 2nd edition. Cambridge University Press, NY, 497 pp.

Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: wetlands and water synthesis. World Resource Institute, Washington, D.C., 80 pp.

Miller, T.G., and H. M. Hoven. 2007. Ecological and beneficial use assessment of Farmington Bay wetlands: Assessment and site-specific nutrient criteria methods development, Phase I. Progress Report to EPA, Region 8, for Wetland Program Development Grant No: CD988706-03. Online, www.deq.utah.gov/Issues/gslwetlands/assessment.htm, accessed May, 2012.

Mitsch, W.J. and J.G. Gosselink. 2007. Wetlands, 4th edition. Wiley & Sons, Hoboken, NJ, 582 pp.

National Wetlands Inventory [NWI]. 2008. Wetlands data for Utah [GIS data]. US Fish and Wildlife Service. Online, fws.gov/wetlands/Data/Mapper.html, accessed March, 2010.

Smith, R.D., A. Ammann, C. Bartoldus, and M.M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Technical Report WRP-DE-9, US Army Engineer Waterways Experiment Station, Vicksburg, MS, 90 pp.

Utah Division of Water Quality [DWQ]. 2009. Development of an assessment framework for impounded wetlands of Great Salt Lake. Great Salt Lake Water Quality Studies, Nov. 2009. Online, www.deq.utah.gov/Issues/gslwetlands/assessment.htm, accessed May 1, 2012.

Appendix A. Site List

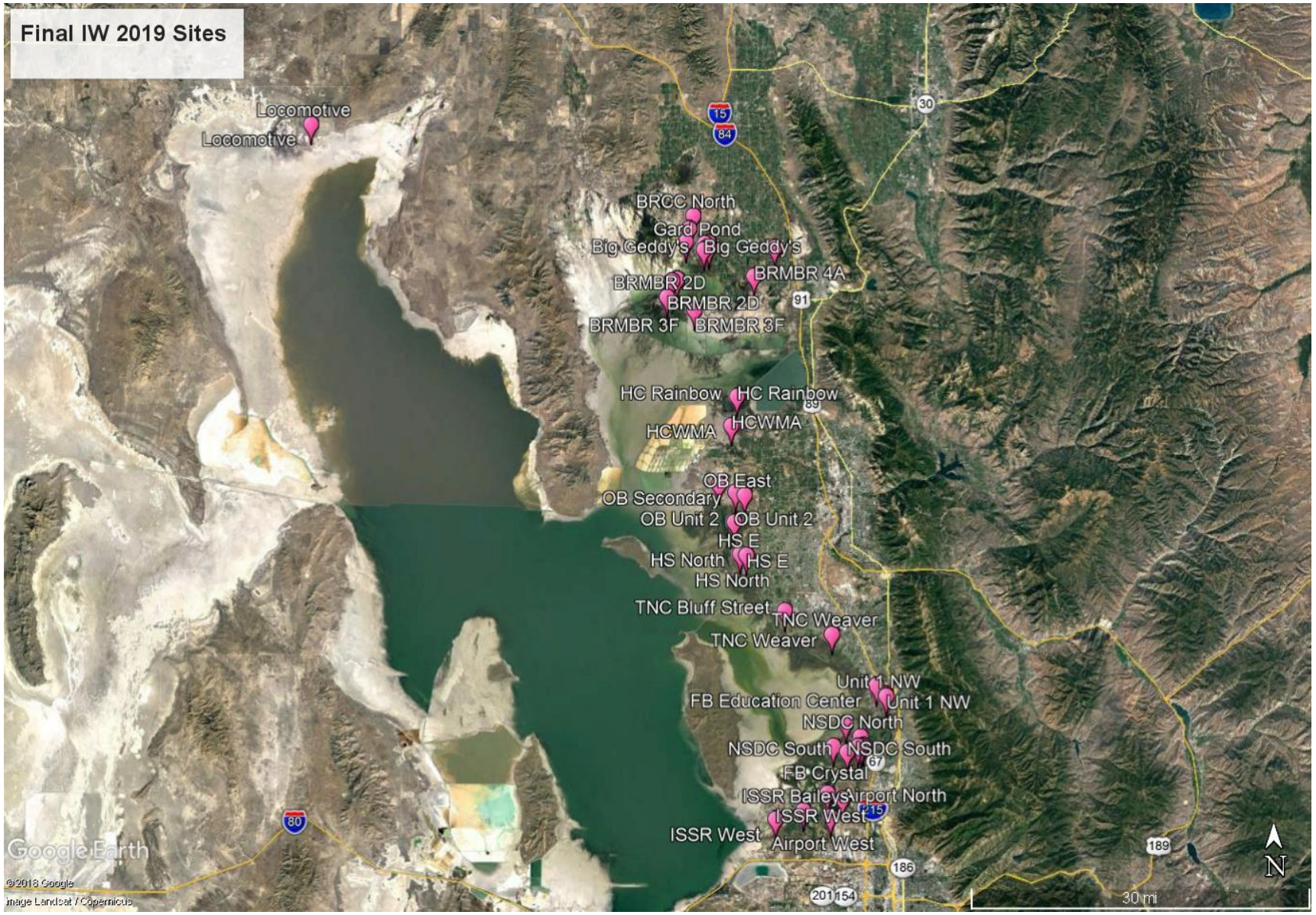
siteID	Name	Size	Watershed	Property Name	STORET	Latitude	Longitude	Revisit	IP1	IP2
iw19-01	Locomotive	Equal	Curlew Valley	Locomotive Springs	5971840	41.69	-112.907	no	8/13	
iw19-03	BRMBR 1A	medium	Lower Bear	Bear River Migratory Bird Refuge	5971841	41.48508	-112.266	no	8/08	
iw19-04	BRMBR 4A	medium	Lower Bear	Bear River Migratory Bird Refuge	5971842	41.48867	-112.133	no	8/07	
iw19-05	BRMBR 2D	medium	Lower Bear	Bear River Migratory Bird Refuge	*5971839*	41.46385	-112.289	no	8/08	
iw19-06	BRMBR 3F	large	Lower Bear	Bear River Migratory Bird Refuge	5971843	41.44321	-112.235	no	8/07	
iw19-09	BRMBR Unit 1	medium	Lower Bear	Bear River Migratory Bird Refuge	5971930	41.48377	-112.276	no	8/08	
iw19-10	BR Oxbow	small	Lower Bear	Bear River Migratory Bird Refuge	5971844	41.5267	-112.1	no	8/07	
iw19-07	BRCC Cattail	small	Lower Bear	Bear River Duck Club	5971845	41.52747	-112.211	no	7/31	
iw19-08	BRCC Deep	large	Lower Bear	Bear River Duck Club	5971846	41.55587	-112.247	no	7/30	
iw19-11	Big Geddy's	large	Lower Bear	Bear River Duck Club	5971847	41.52317	-112.221	no	7/31	
iw19-12	BRCC North	small	Lower Bear	Bear River Duck Club	5971848	41.56835	-112.239	no	7/30	
iw19-01 -R	BRCC NE	large	Lower Bear	Bear River Duck Club	5971410	41.53291	-112.213	yes	7/31	
iw19-02 -R	BRCC SE	medium	Lower Bear	Bear River Duck Club	5971510	41.52789	-112.215	yes	7/31	
iw19-03 -R	N. Geddys	medium	Lower Bear	Bear River Duck Club	5971340	41.5338	-112.25	yes	7/30	

siteID	Name	Size	Watershed	Property Name	STORET	Latitude	Longitude	Revisit	IP1	IP2
iw19-05 -R	Gard Pond	medium	Lower Bear	Bear River Duck Club	5971380	41.53155	-112.22	yes	7/31	
iw19-28	HC Rainbow	medium	Lower Weber	Harold Crane Waterfowl Management Area	5971760	41.33497	-112.164995	no	8/01	
iw19-27	HCWMA South	large	Lower Weber	Harold Crane Waterfowl Management Area	*5971859*	41.29755	-112.175	no	8/01	
iw19-26	OB East	large	Lower Weber	Ogden Bay Waterfowl Management Area	5971849	41.20858	-112.153	no	7/29	
iw19-33	OB Secondary	medium	Lower Weber	Ogden Bay Waterfowl Management Area	5971851	41.21121	-112.168	no	8/01	
iw19-37	OB Unit 2	large	Lower Weber	Ogden Bay Waterfowl Management Area	5971854	41.17694	-112.17	no	7/24	
iw19-10 -R	Unit 1 N	medium	Lower Weber	Ogden Bay Waterfowl Management Area	5971540	41.22205	-112.194	yes	7/29	
iw19-32	HS North	medium	Lower Weber	Howard Slough Waterfowl Management Area	5971838	41.13485	-112.16	no	7/24	
iw19-09 -R	HS E	medium	Lower Weber	Howard Slough Waterfowl Management Area	5971690	41.13235	-112.15	yes	7/24	
iw19-34	TNC Weaver	small	Lower Weber	Great Salt Lake Shorelands Preserve	5971852	41.03124	-112.005	no	7/22	
iw19-39	TNC Bluff St	small	Lower Weber	Great Salt Lake Shorelands Preserve	5971855	41.06014	-112.088	no	7/22	
iw19-38	FB Education C	medium	Lower Weber	Farmington Bay Waterfowl Management Area	5971872	40.96454	-111.931	no	7/23	
iw19-42	FB Crystal	large	Lower Jordan	Farmington Bay Waterfowl Management Area	5971856	40.88743	-112.002	no	7/23	
iw19-16-R	FB NE	large	Lower Jordan	Farmington Bay Waterfowl Management Area	5971560	40.87704	-112.036	no	7/23	
iw19-11 -R	Unit 1 NW	small	Lower Weber	Farmington Bay Waterfowl Management Area	5971700	40.95223	-111.915	yes	7/10	

siteID	Name	Size	Watershed	Property Name	STORET	Latitude	Longitude	Revisit	IP1	IP2
iw19-15 -R	Turpin Unit	large	Lower Jordan	Farmington Bay Waterfowl Management Area	5971090	40.91353	-111.98	yes	6/11	
iw19-44	NSDC South	medium	Lower Jordan	New State Duck Club	5971858	40.88012	-111.977	no	8/06	
iw19-48	NSDC North	small	Lower Jordan	New State Duck Club	5971861	40.90048	-111.959	no	8/15	
iw19-51	NSDC Central	medium	Lower Jordan	New State Duck Club	5971862	40.88737	-111.963	no	8/05	
iw19-16 -R	NSDC 1	small	Lower Jordan	New State Duck Club	5971120	40.88743	-111.958	yes	8/05	
iw19-17 -R	NSDC 2	medium	Lower Jordan	New State Duck Club	5971160	40.8897	-111.952	yes	8/08	
iw19-50	Rudy	medium	Lower Jordan	Rudy Duck Club	5971863	40.82844	-112.012	no	7/25	
iw19-41	ISSR Baileys	small	Lower Jordan	Inland Sea Shorebird Reserve	5971900	40.80636	-112.057	no	7/09	
iw19-45	ISSR West	medium	Lower Jordan	Inland Sea Shorebird Reserve	5971250	40.79617	-112.103	no	7/09	
iw19-47	Airport North	medium	Lower Jordan	SLC Airport	5971860	40.82063	-111.989	no	7/25	
iw19-43	Airport West	medium	Lower Jordan	SLC Airport	5971857	40.8533	-112.02	no	7/25	
Field Rep	Field Rep #1	NA	*MLID Changed*	TNC?	5971853				7/22	
Field Rep	Field Rep #2	NA	NA	Big Geddy's	5971864				7/31	
Field Rep	Field Rep #3	NA	NA	BRMBR 2D	5971865				8/08	
Field Rep	Field Rep #4	NA	NA	_____	5971866	_____	_____			

siteID	Name	Size	Watershed	Property Name	STORET	Latitude	Longitude	Revisit	IP1	IP2
Field Rep	Field Rep #5			_____	5971873	_____	_____			
Field Rep	Field Rep #6			_____	5971874	_____	_____			
Field Rep	Field Rep #7			_____	5971875	_____	_____			
Field Rep	Field Rep #8			_____	5971876	_____	_____			
Field Blank	Blank #1	NA	NA	NA	5971867				7/22	
Field Blank	Blank #2	NA	NA	NA	5971868				7/31	
Field Blank	Blank #3	NA	NA	NA	5971869				8/08	
Field Blank	Blank #4	NA	NA	NA	5971871					
Field Blank	Blank #5				5971877					
Field Blank	Blank #6				5971878					
Field Blank	Blank #7				5971879					
Field Blank	Blank #8				5971880					

**Extra MLID's if needed: 5971831 - 5971837*



Appendix B - Field Data Sheets & Lab Sheets

2019 IW Field Sheet

Trip Name:	☐ Primary	☐ Replicate
Sample Date:	**Sample Collectors:** EF #2	
	ST #3	
Sample Time:	#1 AA	
	Other:_____	
Location ID#:	**Site Name:**	

Field Observations

Weather in past 48 hours:
Current weather:

Hydrology: Outflow	Y	N	Water Depth:		
Backed up by boards	Y	N	Water clarity:		
Flowing out of weir	Y	N	Describe:		
Phragmites:	Y	N	Algal mats:	Y	N

Water Source:

Other Notes:

Temp (C):		EC[25C]:	
pH:		Chl-A Vol (filtered):	
LDO (mg/L)			
LDO (%sat)			

Missing Samples (include sample type and brief explanation):

☐ **Water Chem**	☐ **Zooplankton**	☐ **Chl-a filtered**
☐ **Sonde Reading**	☐ **Pictures**	☐ **H20 Filtered**
☐ **SAV Survey**	**Reviewed:**	
☐ **Macroinvert.**	Monitor: _____	Date: _____
☐ **Sed Nutr & Metal**	Data Manager: _____	Date: _____

2019 IW SAV Sheet

GPS coords of transect start

Lat:

Long: Sampler(s): _____

Wetland-Scale Cover Estimates ~200 m of sampling location

%Algal mat		%SAV	
%Floating Aquatic Veg		%Bare mud/substrate	
%Emergent Veg		*%Benthic mat*	

Quadrat:	1	2	3	4	5	Average
Plot location along transect (m)						
Water depth (cm)						
Height of SAV (cm)						
SAV cover (%)						
[1]SAV condition						
Cover - Spp1:						
Cover - Spp2:						
Cover - Spp3:						
[2]Filamentous algae cover (%) [Surface]						
Epiphytic Alg. cover (%)						
Duckweed cover (%)						

[1]SAV condition: 0 = absent 1 = Decomposing/senescing, 2 = Intact, but stressed, 3 = Healthy, F = Flowers/Fruits

[2]Filamentous algae: Extent of algae on SAV and/or surface of pond in %; (¤) = Veg Sample Collected

Plant Vouchers or Comments:

Fish Observed:		
Depth loose muck:		

2019 IW Desktop Analysis	
Date:	**Sampler:**
Location ID#:	**Site Name:**

Landuse Analysis (% of 1 km buffer)

Wetland
Open Water
Crops + Pasture
Development
Industrial
Forest
Barren

100 m Buffer (length in meters)

North	Northeast
East	Southeast
South	Southwest
West	Northwest

Roads (length within 100 m)

Notes

2019 IW Buffer Sheet					
Grazing[3]		0	1	2	3
Hydrologic mods		0	1	2	3
Trails & Tracks		0	1	2	3
Herbicide		0	1	2	3
Noxious Weeds	Phragmites	0	1	2	3
	Pepperweeds	0	1	2	3
	Thistles	0	1	2	3
	Purple Loosestrife	0	1	2	3
	Tamarisk	0	1	2	3
	Other Species	0	1	2	3
	Other Name				
Other Disturbances		0	1	2	3
Other Name					

[3]Buffer Disturbance: 0 = absent 1 = low cover/severity, 2 = moderate cover or severity, 3 = high cover/severity

Other Observations or Comments:

Trip ID **IWwet2019** Agency **1**
Collector Project Code **304**

Sampler Contact Information (name and phone number): **Becka Downard (801) 536-4340**

Monitoring Location ID: Time:

Description: Date:
MM - DD - YY

Field Specific Conductance (µS/cm): . Sample Type **4**

TEST REQUESTS:

Biological Oxygen Demand	Temp:		pH:	Comments:
Chemistry **Partial List: ALK, CL, COND, SO4, TDS, TSS, TVS**	Temp:		pH:	Comments:
Non-Filtered Nutrients **Partial List: NH3, NO32, TPO4, TN, TOC**	Temp:		pH:	Comments:
Filtered Nutrients **Partial List: NH3, NO32, TPO4, TN, TOC**	Temp:		pH:	Comments:
Filtered Metals **Partial List: Hg, Al, As, Ba, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn, Ca, Fe, K, Mg, Na,**	Temp:		pH:	Comments:
Chlorophyll-a **Partial List: PHEO**	Temp:		pH:	Comments:
Sulfide **Parial List: H2S**	Temp:		pH:	Comments:

Site Notes

FIELD COMMENTS: Weather Conditions:
Field Conditions:

Sheen present?: ☐ Y ☐ N Trash near sampling site? ☐ Y ☐ Algal mat at site? ☐ Y ☐ N
Wildlife/Livestock near sampling site? ☐ Y ☐ N Recent rain or other precip. in the past 48 hours? ☐ Y ☐ N

Anthropogenic disturbances present at site that may affect sample results? ☐ Y ☐ N
(i.e. construction; car-bodies on stream bank; swimming, etc.)
If yes to any above, explain here:

Were all lab samples collected at this site as indicated on lab sheet? ☐ Y ☐ N
If no, explain which samples were not collected and why:

Were all sonde parameters collected at site? ☐ Y ☐ N
If no, which ones were NOT collected and why:

Were any photos taken at site this visit? ☐ Y ☐ N

Appendix C – Data Quality Indicators, Sample Contain Requirements, Analytical QC Limits and Reporting Ranges

Table C1. Data quality indicators

Data Quality Indicator	QC Check / QC Sample	Evaluation Criteria	Goal
Precision - *measure of agreement among repeated measurements of the same property under identical or substantially similar conditions*	Field replicate pairs	Relative percent difference (RPD)	Water samples: ± 20%; Sediments : ± 40%; *For results above lab reporting limits*
	Laboratory duplicates	RPD	RPD from laboratory duplicates [1]
	Matrix spike duplicates	RPD	RPD from laboratory data [1]
Bias - *the systematic or persistent distortion of a measurement process that causes errors in one direction* and Accuracy - *measure of the overall agreement of a measurement to a known value, such as a reference or standard; includes both random error (precision) and systematic error (bias) components of sampling and analytical operations*	Randomized site selection (GRTS), with stratification by hydrologic units (HUC8) and accounting for three IW size classes (<20 acres, 20-100 acres, and >100 acres)	Procedures for GRTS are properly implemented	100% compliance
	Calibration of field water quality instruments	Documentation of successful instrument calibration	100% compliance
	SOPs for environmental data collection	Qualitative determination of adherence to SOPs, and field audits	All data collected following SOPs or specific procedures described in this SAP
	Field / Equipment blanks	Detection Limit	< Detection Limit
	Method blanks	Detection Limit	< Detection Limit
	Lab control / Matrix spikes	% Recovery of spikes (and RPD)	% Recovery and RPD from laboratory [2]
Representativeness - *degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a*	SOPs	Qualitative determination of adherence to SOPs, and field audits	All data collected following SOPs
	SAP requirements	Adherence to sampling location,	100% compliance unless approved

Data Quality Indicator	QC Check / QC Sample	Evaluation Criteria	Goal
sampling point, or environmental condition	Field photos / notes	time, and conditions Document any variation from SAP/ SOP	by Project Manager & noted in field notes 100% compliance
	Holding times	Holding times	100% compliance
	Field replicates	RPD	Water samples: ± 20%; Sediments : ± 40%; *For results above lab reporting limits*
	Field/trip/equipment blanks	Detection Limit	< Detection Limit
Comparability - *qualitative term expressing the measure of confidence that one dataset can be compared to another and can be combined in order to answer a question or make a decision*	SOPs (sample collection and handling)	Qualitative determination of SOP adherence and field audits	All data collected following SOPs or specific procedures described in this SAP
	Holding times	Holding times	100% compliance
	Analytical methods	DWQ or EPA-approved methods	100% use of approved methods
	Similar frequency and types of QC samples (field dups, blanks, lab QA)	Verify	Evaluate for comparability
Completeness - *measure of the amount of valid data obtained from a measurement system compared to the amount of valid data expected to be obtained*	Complete sampling	% Valid data	100% completeness
Sensitivity - *capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest; primarily a lab parameter*	Laboratory detection limit	Must be below action level required by SAP	100% compliance

[1] ± 10 to 20%, based on a compilation of laboratory reporting for commonly analyzed constituents
[2] ± 10 to 20%, based on a compilation of laboratory reporting for commonly analyzed constituents
RPD - Relative Percent Difference (RPD (%) = $\{(X_1 - X_2)/(X_1+X_2)\}/2 \times 100$, where X_1 = result from first sample and X_2 = result from second sample

Table C2. Sample container requirements

Sample Type / Analyte	Container Type	Volume	Preservative	Holding Time	Receiving Lab
Vegetation					
Voucher Specimens	Paper bag, plant press	n/a	n/a	n/a	
Benthic Macroinvertebrates					
5-Sample Composite	Plastic jar	1 Qt, wide-mouth	95% Ethanol	n/a	USU Bug Lab
Zooplankton					
5-Sample Composite	Plastic tube	50 mL centrifuge tube	95% Ethanol	n/a	USU Bug Lab
Water Chemistry					
Total (unfiltered) Nutrients	Plastic bottle	500 mL	H_2SO_4 *	28 d	State Lab
Dissolved (filtered) Nutrients	Plastic bottle	250 mL	H_2SO_4 *	28 d	State Lab
Dissolved (filtered) Metals	Plastic bottle	250 mL	HNO_3 *	28 d - 6 mo	State Lab
General Chemistry (unfiltered)	Plastic bottle	1.8 L	ice chest & fridge at the shop	7 d	State Lab
Sulfide	Plastic bottle	120 mL	ice chest & fridge at the shop	7 d	State Lab
Chlorophyll-α	Filter membrane wrapped in Aluminum foil	100 to 500 mL	Dry ice & freezer at the shop	3 weeks	State Lab
Oxygen Demand	Plastic bottle	2 L	ice chest & fridge at the shop	48 hr	State Lab
Sediment Nutrients					
5-Separate Samples	Plastic bag	1 gallon	ice chest / lab freezer	n/a	USU Analytics Lab
10-15 gram sample	Plastic cup	100 mL	2M KCl, lab freezer	n/a	USU Analytics Lab
Sediment Metals					
5-sample Composite	Plastic bag	1 gallon	ice chest / lab freezer	n/a	UU ICP-MS Lab

* State Lab will supply preservative in the sample container

** Lab for Sediment analyses is currently being negotiated (8 June, 2012)

Table C3. Analytical QC limits and reporting ranges

Sample Type	Parameter	Method #	MRL *	Units	Calibration Range	Precision	Accuracy	Recovery	Current Numeric Criteria **		
									2A/2B	3B/3C/3D	4
Water Chemistry (nutrients)	NH_4-N	350.1	0.05	mg/L	0.05 - 10.0	± 15%	± 15% †	± 15%		pH dependent	
	NO_2/NO_3-N	351.4	0.10	mg/L	0.10 - 10.0	± 15%	± 15%	± 15%	4	4 / 4 / na,	na
	TKN ††	353.2	0.10	mg/L	0.10 - 5.0	± 15%	± 15%	± 15%			
	TP	365.1	0.02	mg/L	0.01 - 1.0	± 15%	± 15%	± 15%	0.05	0.05 / na / na	na
	DOC	5310B	0.5 *est*	mg/L	0.5 - 20.0	± 15%	± 15%	± 15%			
Water Chemistry (metals)	Al	200.8	10	µg/L	10 - 100	± 15%	± 15%	± 15%		87 / 750	
	As	200.8	1	µg/L	10 - 100	± 15%	± 15%	± 15%			
	Ba	200.8	100	µg/L	10 - 100	± 15%	± 15%	± 15%			
	Co	200.8	?	µg/L	n.d	± 15%	± 15%	± 15%			
	Cu	200.8	1	µg/L	1 - 100	± 15%	± 15%	± 15%		9 / 13	200
	Fe	200.7	20	µg/L	4 - 4000	± 15%	± 15%	± 15%		1000 max	
	Hg	245.1	0.2	µg/L	0.2 - 10	± 15%	± 15%	± 15%		0.012 /	
	Mn	200.8	5	µg/L	5 - 100	± 15%	± 15%	± 15%			
	Ni	200.8	5	µg/L	5 - 100	± 15%	± 15%	± 15%		52 / 468	
	Pb	200.8	0.1	µg/L	0.1 - 100	± 15%	± 15%	± 15%		2.5 / 65	100
	Se	3114 C	1	µg/L	1 - 10	± 15%	± 15%	± 15%		4.6 / 18.4	50
	Zn	200.8	10	µg/L	10 - 100	± 15%	± 15%	± 15%		120 / 120	
	Hardness	200.7		--- calculated from D-Ca and D-Mg ---							
Sulfide	H_2S	376.2	0.1	mg/L	0.1 - 20	± 10% *est*	± 10%	± 15%			
Water Chemistry (general)	Alkalinity	2320 B	4	mg/L	4 - 1230	± 15%	± 10%	± 10%			
	TDS	2540 C	10	mg/L	10 +	± 15%	± 10%	± 10%			
	TSS	160.2	4	mg/L	4 +	± 15%	± 10%	± 10%			
	TVS	160.4	5	mg/L	5 +	± 15%	± 10%	± 10%			
	$SO_4^=$	375.2	20	mg/L	20 - 300	± 15%	± 10%	± 10%			
Water Chemistry (other)	Chl-a	10200 H	0.1	µg/L	0.1 - 20	± 15%	± 10%	± 10%			
	BOD_5	405.1	3	mg/L	24 - 240	± 10%	± 10%		5	5 / 5 / 5	5
Benthic Macro-invertebrates				Taxa	> 50 indiv	Genus or better	Reference collections				
Zooplankton				Taxa	> 200 indiv						

* Method Reporting Limit; ** Numeric Criteria for Beneficial Uses of State-managed wetlands (R317-2 Standards of Quality for Water). *Note that nutrients presented as Pollution Indicators; values for dissolved metals refer to chronic / acute values*. [na = not applicable]. † Matrix control samples are within ±20% (nutrients) & ±30% (metals), per State Lab QA Manual. †† Total N used to calculate organic N (filtered), for Total N: MRL = 0.2 mg/L, Range = 0.2-10; other QC values same as TKN