Great Salt Lake Wetlands (2013): Preliminary Fringe Wetland Condition Assessment

Sampling and Analysis Plan

Draft 2

Draft May 30, 2013

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ACRONYMS AND ABBREVIATIONS

ASWM	Association of State Wetland Managers
BOD_5	5-day Biochemical Oxygen Demand
BRMBR	Bear River Migratory Bird Refuge
DEQ	Department of Environmental Quality
DO	Dissolved Oxygen
DPM	Designated Project Manager
DQI	Data Quality Indicator
DQO	Data Quality Objectives
DWQ (or Division)	Division of Water Quality
EPA	United States Environmental Protection Agency
GIS	Geographic Information System
GSL	Great Salt Lake
MMI	Multimetric Index
N	Nitrogen
NWI	*National Wetlands Inventory*
P	Phosphorus
QA/QC	Quality Assurance/Quality Control
QAC	Quality Assurance Council
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SAV	Submerged Aquatic Vegetation
SOP	Standard Operating Procedure
UAC	Utah Administrative Code
UPDES	Utah Pollutant Discharge Elimination System
UPHL (or State Lab)	Utah Public Health Laboratories
WMA	Waterfowl Management Agency
WPDG	Wetland Program Development Grant

1.0 Introduction and Background Information

This Sampling and Analysis Plan (SAP) was prepared on behalf of the Utah Division of Water Quality (DWQ) to satisfy requirements outlined in DWQ's Quality Assurance Program Plan (QAPP) for Monitoring Programs and DWQ's Wetland Program Development Grant (WPDG), awarded to DWQ by the United States Environmental Protection Agency (EPA) in 2010. This SAP documents the quality assurance/quality control (QA/QC) requirements and project planning details for a Preliminary Survey of Great Salt Lake (GSL) Fringe Wetlands, scheduled for 2013. 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

The objective of this project is to collect environmental data from a targeted selection of 15 fringe wetland sites during the 2013 field season to improve wetland sampling procedures and aid in the development of an assessment method for this wetland class. Data collection activities will seek to identify potential stressors as well as preliminary metrics that describe the relative condition among fringe wetland sites. Future work by DWQ will incorporate this assessment method into a probabilistic survey of fringe wetlands associated with GSL. This project is funded by an EPA award (WPDG) to DWQ. The overarching goal of the WPDG is to develop methods to quantify the condition of GSL wetlands.

DWQ's efforts investigating GSL wetlands began in response to stakeholder concerns that nutrient loads from water treatment facilities adjacent to GSL could have deleterious impacts on these productive and highly valued ecosystems. Initial work focused on impounded wetlands adjacent to Farmington Bay, where wetland managers and conservation groups observed the occasional dominance of cyanobacterial mats, a common indicator of phosphorus-induced eutrophication. The concern was that these mats could negatively impact the health and vigor of extensive swards of submerged aquatic vegetation (SAV) (e.g., sego pondweed, *Stuckenia* sp.) and alter the species composition of macroinvertebrate communities. Both SAV and benthic macroinvertebrates are key food sources for migratory water birds (Miller and Hoven, 2007) and important ecological components of wetlands and shallow ponds (Keddy, 2010).

A large proportion of impounded wetlands and associated fringe wetlands adjacent to GSL are managed for waterfowl and other wetland-associated avian species by the Division of Wildlife Resources as Waterfowl Management Areas (WMAs), the United States Fish and Wildlife Service's Bear River Migratory Bird Refuge (BRMBR), and other public and private entities. Wetlands within these management areas have specifically designated water quality protections (Utah Administrative Code [UAC] R317-2-13.9) based on their support for "waterfowl, shorebirds and other water-oriented wildlife . . . including necessary aquatic organisms in their food chain" (UAC R317-2-6). However, similar wetland types that occur outside the boundaries of these state or federal wetland management areas are not currently afforded specific water quality protections; rather, they hold narrative standards based on their location within the lake (Beneficial Use Class 5 (A-E)). Presently, it is not clear whether there are practical differences in the level of water quality protection among these wetland areas or whether current levels of water quality protection are sufficient to protect and maintain the wetlands' beneficial uses.

There are no established numeric water quality criteria for nutrients, such as nitrogen (N) and phosphorus (P) that apply to the designated aquatic wildlife uses associated with GSL wetlands. This is largely due to the complex response of wetlands to nutrient loading, which is controlled by site-specific abiotic and biotic factors that are not yet well understood for GSL wetlands. While there are established numeric criteria for indicators known to affect aquatic wildlife (Beneficial Uses: 3A-D and 5), such as dissolved oxygen (DO), pH, and soluble metals (see UAC R317-2, Table 2.14.2), the implementation of these criteria to wetlands has proven to be problematic for two reasons (DWQ, 2009). First, the standards as applied to wetlands are based solely on their geographic location, such that they apply only to areas that are currently designated by specific beneficial uses (state and federal wildlife management areas). Wetlands within these management areas account for approximately 80 percent of the impounded wetlands but less than 15 percent of fringe (or sheetflow) wetlands. As such, water quality standards may apply to one wetland area within a WMA but not to a similar area adjacent to it. Moreover, these water quality standards do not account for the wide diversity of wetland types that occur within a management area. GSL wetland classes range from marginal saltgrass and sedge-dominated meadows to permanently flooded ponds (Ducks Unlimited, 2008; Emerson and Hooker, 2011), and each wetland class may represent distinct biological communities and ecosystem processes (Smith et al., 1995; Mitsch and Gosselink, 2007; Keddy, 2010).

The second problem is that current water quality standards are based on criteria that may have little relevance to protecting the designated uses of wetlands. For example, both DO and pH criteria are commonly exceeded in impounded wetlands, and yet available data suggest that these wetlands continue to support their designated uses (DWQ, 2009; Miller et al., 2012). Moreover, exceedances for DO and pH have been observed in nutrient-rich wetlands as well as more oligotrophic, non-impacted "reference" sites. While these parameters may be important in maintaining high-quality aquatic wildlife conditions in lakes and streams where they were developed, there is little evidence to support their use as robust or sensitive indicators of health for wetlands associated with GSL.

Current efforts are being directed toward developing appropriate water quality standards for wetlands by several states (Association of State Wetland Managers [ASWM], 2012). Utah's efforts are included as part of an adaptive wetland monitoring and assessment program for Great Salt Lake wetlands (see: www.deq.utah.gov/Issues/gslwetlands/). Initial fieldwork and analysis of fringe and impounded wetlands was completed through collaboration between DWQ and stakeholder groups, culminating in assessments of wetland condition derived from the physical, chemical, and biological characteristics of these systems (CH2M HILL, 2005 and 2006; DWQ, 2009). Data were collected over a period of several years to develop a preliminary multimetric index (MMI) (Karr and Chu, 1999) assessment framework for impounded wetlands, consisting of four main indicators: water chemistry, submerged aquatic vegetation, surface mats, and macro-invertebrates (DWQ, 2009). DWQ is currently working to validate and refine the preliminary MMI against a probabilistic survey of GSL impounded wetlands and will use this framework to monitor the relative condition of impounded wetlands.

DWQ's short-term goal is to develop an assessment framework for fringe wetlands that is similar to that being refined for impounded wetlands. The 2013 sampling effort will help refine sampling methods and provide environmental data to better understand which characteristics of fringe wetlands best represent ecosystem response to stress. An important element of this project is the development of an appropriate definition of the fringe wetland class that is suitable for probabilistic sampling designs and relevant to the health of GSL. Fringe wetlands sampled in this project are described as predominantly emergent wetlands adjacent to GSL with shallow, freshwater surface inflows. Previous work has commonly referred to these systems as "sheetflow wetlands." This wetland class is described in greater detail in **Section 2.3** (*Study Boundaries*) of this document.

At the end of this project, DWQ will summarize this work and other efforts to characterize GSL fringe wetlands and will draft a preliminary assessment framework for GSL fringe wetlands, including an initial MMI describing a targeted range of wetland condition. This effort is intended to help focus future wetland water quality program efforts by identifying knowledge gaps, improving sampling methods, and augmenting existing environmental datasets. This preliminary assessment framework, as a fringe-class MMI, will require validation, augmentation with further data collection, and refinement using a probabilistic sampling design before it can be incorporated into DWQ's routine monitoring program.

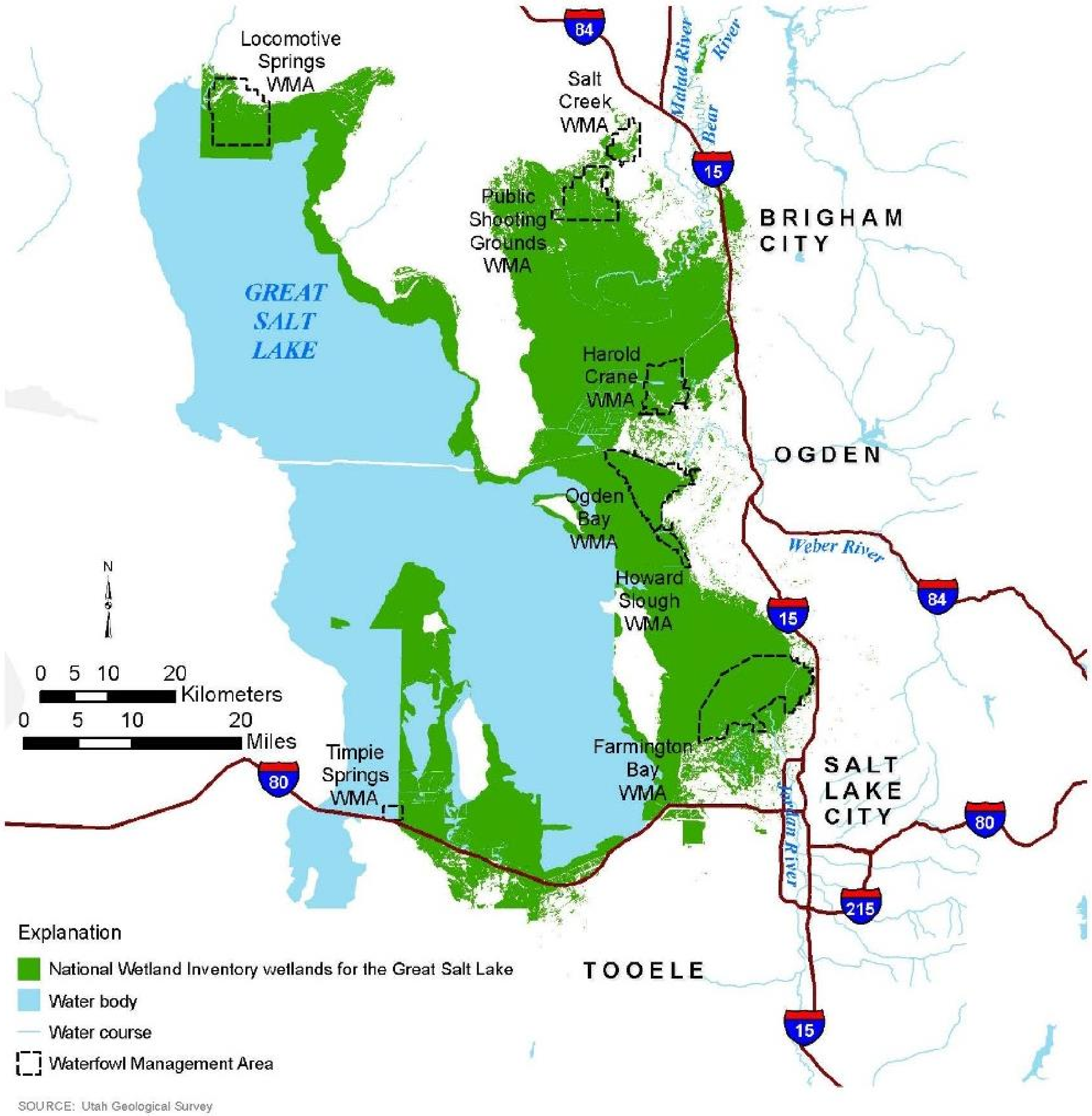
1.2 Study Area

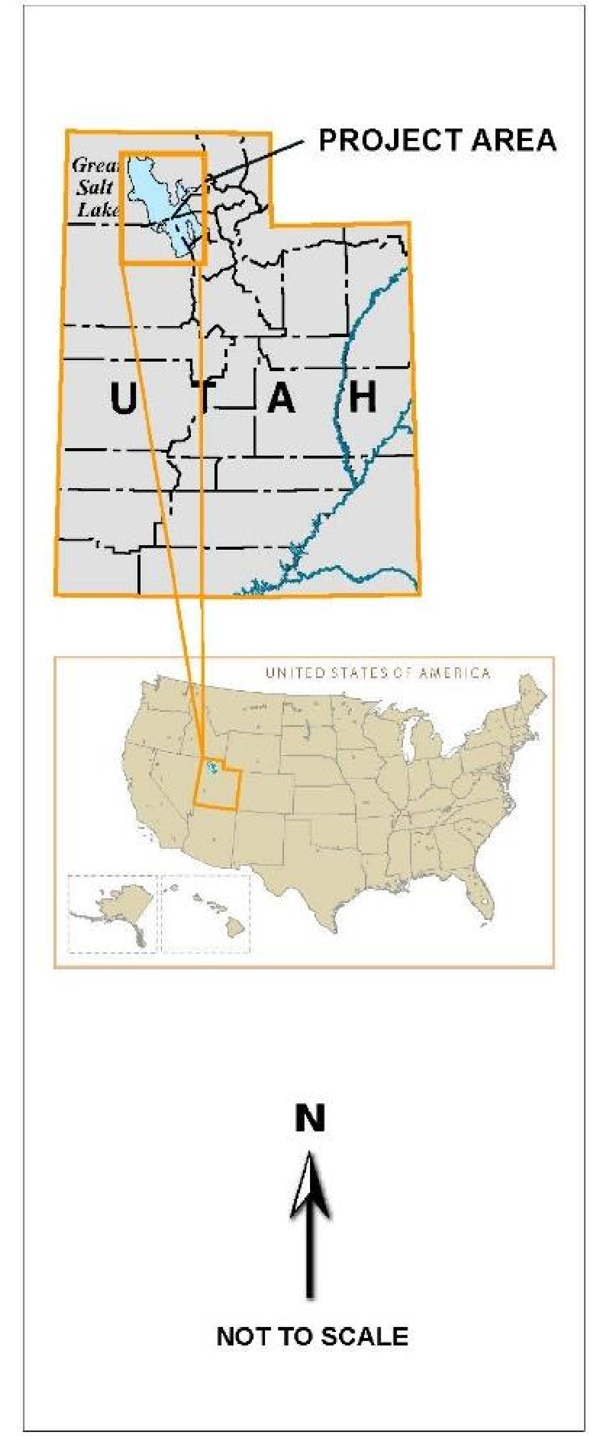
The updated *National Wetlands Inventory* (NWI, 2008) estimated approximately 173,000 hectares (427,000 acres) of wetlands along Great Salt Lake (see **Figure 1-1**).

These wetlands serve as vital habitat for millions of migratory shorebirds, waterfowl, and other wildlife. In addition, these wetlands provide essential ecosystem services, including moderation of surface water and groundwater flows, and removal of nutrients and other pollutants. There continues to be an essential need to maintain the health and extent of these ecologically critical wetlands, especially in the face of severe and persistent threats from population growth (the majority of Utah's citizens reside within the GSL watershed), industrial and urban development, excessive surface water and groundwater withdrawal, invasive species, and high rates of nutrient loading (Millennium Ecosystem Assessment, 2005; Dahl, 2006). Protecting and maintaining the health of these ecosystems requires scientifically defensible and quantitative measures of wetland condition.

This project will take place in fringe wetlands surrounding the Great Salt Lake, Utah, HUC Sub-region 1602. The project area includes portions of Salt Lake, Box Elder, Weber, Davis, and Tooele counties.

Figure 1-1. Map of National Wetlands Inventory for Great Salt Lake and Vicinity





There are two main classes of wetlands associated with GSL: impounded wetlands and fringe 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 entirely human-made and occur as large, shallow ponds that range in size from 10 to over 200 hectares (20 to 500 acres; Miller and Hoven, 2007).

Fringe wetlands occur where freshwater flows over very gently sloping portions of exposed soil or sediments within the GSL basin. Fringe wetlands are commonly found below the outlets from impounded wetlands, wastewater treatment facilities, and other low-gradient surface channels or small streams. Although less common, this wetland type is also associated with areas of groundwater discharge, such as springs or seeps.

One key characteristic of fringe wetlands is sources of freshwater that flow over very gently sloping portions of the GSL lakebed, such that the water is spread across wide expanses of ground. Most GSL sediments contain substantial quantities of salt, and the salinity of both GSL water and sediments restricts the growth of emergent vegetation. However, the flow of freshwater over the sediments of fringe wetlands can flush enough of the salts out to support various emergent marsh species, including luxurious growth of bulrush (*Scirpus* spp.), cattail (*Typha* spp.), and others. Depending on the quantity of water flow, wetland geomorphic features, and lake elevation, fringe wetlands can extend from the border of impounded wetlands to the margin of GSL itself. Longer-term variation in lake elevation (on the order of decades) can "reset" the dominant vegetation of these wetlands by the intrusion of highly saline lake water into the wetland during high-water years. Plants appear to rapidly recolonize Fringe wetland areas once lake levels decline. As such, these wetlands commonly contain wide gradients in water salinity.

Fringe wetlands surrounding the GSL encompass approximately 121,000 hectares (300,000 acres) and are not typically managed actively by State and Federal agencies for waterfowl habitat.

1.3 Summary of Project Tasks and Schedule

The tasks associated with this preliminary survey of GSL fringe wetlands are as follows:

1. Develop SAP for the preliminary survey (spring 2013)
    a. Identify potential sampling sites
    b. Complete reconnaissance of potential sampling sites
    c. Finalize sampling sites
    d. Review and finalize standard operating procedures (SOPs)
2. Implement SAP (summer 2013)
3. Validate field and laboratory results (fall/winter 2013)
4. Analyze data, characterize sampling sites, and develop preliminary metrics to assess the relative condition among the sampled sites (spring 2014)

2.0 Objectives and Design of the Investigation

2.1 Specific Objectives of this Study

The specific objective of this project is to collect environmental data to aid the development of an assessment method that will characterize the condition of fringe wetlands associated with GSL. Project-level data quality objectives (DQOs) for this study are to collect data of the appropriate type, quality, and quantity to test and improve upon current sampling methods; evaluate the function and characteristics of fringe wetlands that span different types of freshwater sources, geomorphology, and locations within GSL; identify potential stressors to these fringe wetlands; and identify and evaluate potential metrics that can be used to evaluate the relative condition of GSL fringe wetlands.

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 2-1** below.

Table 2-1. Data Quality Objectives

Step	DQOs for 2013 Great Salt Lake Fringe Wetland Targeted Survey
1. Problem Statement	Wetland resource managers and stakeholders observed the occurrence of algal mats within some impounded and fringe wetlands associated with high N and P loading from wastewater treatment facilities and were concerned about the potential impact these nutrient loads could have on the food sources of water birds and shorebirds using these areas. It was suspected that wetlands with high nutrient loads may not be supporting their beneficial use of waterfowl habitat, including the necessary food chain. In response, DWQ initiated the development of a framework to assess the relative condition of impounded and fringe wetlands of GSL. The assessment framework for impounded wetlands is currently being validated and refined. This project represents the initial data collection effort for fringe wetlands that will result in a preliminary MMI for wetland condition among a targeted selection of sites. Future work will validate this framework with a probabilistic survey of wetlands.
2. Goal of Study / Decision Statements	**Key Question[s]** Q_0: What are the key variables that define the function, characteristics, and condition of GSL fringe wetlands? Q_1: What stressors are impacting the condition of GSL's fringe wetlands? Q_2: What are most useful metrics for evaluating wetland condition and stress with respect to fringe wetlands beneficial use classes? **Potential Outcomes** 1: Information is adequate to answer the key questions, resulting in a preliminary MMI for fringe wetlands to be shared with wetland managers and stakeholders, and subsequently validated using a probabilistic survey. 2: Information is inadequate to develop robust metrics of relative condition of fringe wetlands. 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 one time during the 2013 growing season (midsummer) at 15 selected sites adjacent to GSL. • Water chemistry parameters: Total nutrients, total metals, ~~5-day biochemical oxygen demand (BOD_5)~~, chlorophyll a, general chemistry (major ions, suspended solids), and field measures (DO, temp, pH, salinity) using appropriate and documented methods. • Benthic macroinvertebrates: Species composition and biomass of benthic macroinvertebrate communities using appropriate and documented methods.

Step	DQOs for 2013 Great Salt Lake Fringe Wetland Targeted Survey
	• Field measures of vegetation and surface mat (algae and floating aquatic plants) cover will be collected using appropriate and documented methods. • Sediment metals and nutrient availability: Total (digested) metals and exchangeable concentrations of NH_4, NO_3, and PO_4 using appropriate and documented methods. • Field observations of stressors, including soil and vegetation disturbance, altered hydrology, over grazing, and the establishment and dominance of invasive plant species. • Supplemental Indicators may be collected. These include: Leaf C, N, and P concentration, and $\delta^{15}N$ and $\delta^{13}C$ isotope ratios from dominant emergent plants along transect endpoints and open water sampling locations. This information is described in Section 2.4 and **Tables 2-3** and **4-1**.
4. Study Boundaries	The study area for this project is shown in **Figure 1-1**. This area includes fringe wetlands within Farmington Bay, Ogden Bay, Bear River Bay, and Gilbert Bay portions of Great Salt Lake. Spatial data identifying fringe wetlands is derived from reclassified National Wetland Inventory data and other sources as available. Sampling sites will be field-checked to ensure that they: • Represent the sample target—Fringe wetlands associated with and adjacent to the GSL • Are accessible—DWQ has received permission to visit wetlands on private property Field visits include one sampling window in midsummer, approximately July through early August: • 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 levels 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 answer the key questions, then DWQ will present results and recommendations in a final report. • If information is inadequate to answer 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 2013 Great Salt Lake Fringe Wetland Targeted Survey

6. Acceptance Criteria	• PARCC elements for data
	  ○ **Precision**—Field replicates will be collected at 10 percent of sites (5 sites) for water chemistry variables.
	  ○ **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 of vegetation will be performed by a wetland monitoring crew trained in each method. Few species of vegetation occur within the project area and are easily identified, but questionable specimens will be collected and returned to the office for further identification. Taxonomic identification of macroinvertebrates will be performed by Dr. Larry Gray.
	  ○ **Representativeness**—The sampling locations have been selected based on a review of aerial photos, and sites were chosen due to their landscape scale characteristics. Sites were chosen to encompass potentially unique characteristics of different conditions, such as water source, potential salinity impacts, and morphology. Inventory methods were designed to collect data that is at a scale most descriptive of GSL wetlands (~20 hectares). Field sampling will occur following appropriate sample collection procedures as described in SOPs for each method. 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 percent completeness at the end of the season, we will use field reconnaissance to verify that sites have the proper hydrologic conditions to support fringe wetlands.
	  ○ **Comparability**—All field sampling and analytical procedures will be completed following both previously tested and newly developed 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 **Table 5-2**.
	• DWQ QAPP specifies the minimum QA/QC objectives for sample measurement.

7. Sampling Plan and Design	The baseline sampling program includes the following: • Collection and analysis of water, macroinvertebrates, and surface sediments for chemical, physical, and taxonomic attributes, as appropriate • Field observations of vegetation and algal mat cover These data will be used to estimate the baseline condition of fringe wetlands associated with GSL. Data will be used to construct MMIs for key indicators, such as Water Chemistry, Benthic Macroinvertebrates, Vegetation, and Sediment Chemistry. These indicators have been previously linked to the beneficial uses of these wetlands through their relationships to wetland physical, chemical, and biological condition; however, other indicators may be developed as appropriate. Successful completion of this project will support development of a MMI for fringe wetlands.

2.2 Sampling Design

As previously stated, the objective of the WPDG is to assess the condition of GSL wetlands. This project specifically addresses GSL fringe wetlands with a defined freshwater source flowing across the site. Because this is a preliminary survey, a targeted selection of high- and low-quality wetlands will be used as a first step for testing the ability of wetland condition metrics to discern good vs. poor condition. In an effort to account for a wide range of fringe wetland characteristics, the following categories were developed as part of a desktop evaluation of study sites to clarify potential sources of among-site variation: Historical Sampling Sites, Upstream Water Source, Watershed, and Morphology. A brief description of these categories follows:

1. **Historical Sampling Sites**. Several fringe wetlands sites were included in the initial 2004–2006 studies completed by DWQ (CH2M HILL, 2005 and 2006; Miller and Hoven, 2007). Including these sites in this study will allow for an evaluation of how these sites have changed over time and provide some insight into year-to-year variation in data. These sites are located at Public Shooting Grounds Waterfowl Management Area, Kays Creek, Central Davis Sewer District's outfall, North Davis Sewer District's outfall, and Farmington Bay Waterfowl Management Area (see **Table 2-2**).
2. **Upstream Water Source**. This category attempts to account for potential differences in upstream water quality as influenced by distinct types of water sources, as well as hydrologic characteristics of each site. The different upstream water sources include (1) wastewater treatment plants (a point source), (2) creek/irrigation return flow (a nonpoint source in terms of potential contaminants but contributing to the wetland as a point source), (3) groundwater source, and (4) an impoundment (water from point and nonpoint sources has been detained/integrated prior to entering the fringe wetland).
3. **Watershed**. This category describes the main hydrologic units (HUC-8 subbasins) providing inflow to these wetlands. The subbasins contribute to distinct bays within GSL that vary in lake salinity. Depending on where the fringe site is located, it could be influenced by GSL waters with a wide range of salinity. These locations include (1) Gilbert Bay , (2) Farmington Bay, and (3) Bear River Bay.
4. **Morphology**. This category characterizes the influence of local geography on the geomorphology of fringe wetland, including how water enters and flows across the wetland. This category is subdivided into the following: (1) converging site (a dike or pond distributes water over wide area, water flows across mudflat and converges to single channel), (2) diverging site (water starts at a point source, typically a single channel and braids/spreads across mudflat), and (3) groundwater source.

A goal of this effort is to identify and characterize potential covariates that may influence wetland condition. **Table 2-2** includes a list of the 20 potential sampling sites and their distribution among these categories. **Figure 2-1** illustrates the approximate location for each of these potential sampling sites.

Table 2-2. Proposed 2013 Sampling Site Locations

Site ID *	Site Name	Historic Sampling Site	Water Source	Location	Morphology	Location ID
PSGWMA-WLO	Public Shooting Grounds – Widgeon Lake Outfall	Yes	Impoundment	Bear River Bay	Diffuse	5972210
PSGWMA-HLO	Public Shooting Grounds – Hull Lake Outfall	No	Impoundment	Bear River Bay	Point Source	5972220
PROM-01	Promontory Point Springs – 01	No	Groundwater	Bear River Bay	Groundwater	5972230
PROM-02	Promontory Point Springs – 02	No	Groundwater	Bear River Bay	Groundwater	5972240
BRMBR-U2D	Bear River Migratory Bird Refuge – Unit 2D Outfall	No	Impoundment	Bear River Bay	Diffuse	5972250
BRMBR-U3E	Bear River Migratory Bird Refuge – Unit 3E Outfall	No	Impoundment	Bear River Bay	Diffuse	5972260
HCWMA-BPDR	Harold Crane WMA Bypass Drain	No	Channel	Bear River Bay	Point source	5972270
HCWMA-NODI	Harold Crane WMA North Dike	No	Impoundment	Bear River Bay	Diffuse	5972280
OBWMA-U1	Ogden Bay WMA Unit 1 Outlet	No	Impoundment	Gilbert Bay	Diffuse	5972290
OBWMA-WR	Ogden Bay WMA Weber River Outfall	No	Channel	Gilbert Bay	Point Source	5972300
HSWMA-NUO	Howard Slough WMA North Unit Outlet	No	Impoundment	Gilbert Bay	Point Source	5972310
HSWMA-SO	Howard Slough WMA South Outlet	No	Impoundment	Gilbert Bay	Point Source	5972320
NDSD	North Davis Sewer District	Yes	UPDES	Farmington Bay	Point source	5972200
TNCKC	The Nature Conservancy Kays Creek	Yes	Channel	Farmington Bay	Point source	5972330
CDSD	Central Davis Sewer District	Yes	UPDES	Farmington Bay	Point source	5972340
FBWMA-U1	Farmington Bay Waterfowl Management Area Unit 1 Outlet	Yes	Impoundment	Farmington Bay	Point source	5972350
FBWMA-TRPN	Farmington Bay Waterfowl Management Area Turpin Unit Outlet	Yes	Impoundment	Farmington Bay	Point source	5972360
NWOD	NW Oil Drain Outfall	No	Channel	Farmington Bay	Point source	5972370
ADCO	Ambassador Duck Club Outfall	No	Impoundment	Farmington Bay	Point source	5972380
GOGGDR	Goggin Drain Outfall	No	Channel	Gilbert Bay	Point source	5972390

NOTES:
UPDES = Utah Pollutant Discharge Elimination System

Figure 2-1. Potential Fringe Sampling Sites

DWQ will evaluate each potential sampling site to confirm which sites meet selection criteria and will be included in the final list of sites sampled. DWQ's objective is to sample 15 sites in 2013.

Criteria to evaluate potential sampling sites include the following:

Target/Nontarget: Does the site represent a fringe wetland (> 2 hectares or 5 acres) that is adjacent to GSL and receives freshwater inflow?

Permission/Access: Has explicit permission to access the site been obtained from the landowner?

Sampleable: Can the site be sampled during the sampling index period?

Representation: If there is an adequate number of available sites, do the available sites provide an adequate representation for each of the categories listed in **Table 2-2**?

2.3 Study Boundaries

Fringe wetlands represent an important and unique component of the GSL ecosystem. While the physical boundaries of fringe wetlands are constrained by the availability of freshwater inflows as well as seasonal variations in lake high stand, these wetlands are prized for their ability to retain sediments and immobilize nutrients, in addition to supporting large and diverse populations of waterfowl and other water birds. These systems are highly sensitive to the *quantity* of water they receive during the growing season. In order to properly assess the baseline condition of fringe wetlands associated with GSL with respect to water *quality*, it is necessary to clearly describe where fringe wetlands occur in the landscape and to identify comparable portions of fringe wetlands to be sampled during data collection.

2.3.1 Geographic Boundaries

As shown in **Figure 2-1**, the project area includes wetlands along the eastern and southeastern shores of GSL and an isolated area of wetlands on the east side of the Promontory mountain range. Additional, fine-scale maps for the major subbasins are included in the **Appendix A**. All fringe wetlands are located above the elevation of GSL and below 4,218 feet above sea level.

2.3.2 Hydrologic Boundaries

The principal source of water to fringe wetlands is from surface water delivered via extensive networks of impounded wetland outfalls, canals, ditches, and streams. The relative importance of terrestrial vs. aquatic features within these wetlands can change markedly from year to year and across the growing season.

Three important measurement parameters of fringe wetland assessment are *water chemistry*; *soil chemistry*, including analyses of salinity, nutrients, and metals; and the cover of native and exotic *vegetation*. Water depth exerts a strong influence of these parameters, above and beyond any potential effects of water quality, per se. As such, specific efforts will be made during site reconnaissance to identify the dominant flow pathways within each wetland where water depths are adequate for sampling. Sampling locations within a given site will be at least 50 m from an adjacent dike or shoreline and roughly 100 m from any water source. These sampling restrictions will allow the field crew to collect data from central portions of the wetland along the major flow pathway, where water chemistry is expected to be most representative of ambient hydrologic conditions and where samples represent conditions that may drive processes throughout the wetland.

2.3.3 Temporal Boundaries (Index Period)

The sampling period for this project is early July through August 20 (summer), 2013.

2.4 Parameters to Be Measured

This project will collect data to support four distinct sets of indicators:

1) Vegetation composition and cover observations will be collected to characterize the aboveground attributes of the wetlands, which will enable DWQ to define the physical structure of the habitats and will help determine if exotic or invasive species are a significant aspect of each individual wetland.
2) Benthic macroinvertebrate community composition observations will be collected to help characterize the importance of different feeding groups and functional classes in the processing of organic materials in the wetlands.
3) Water chemistry (nutrients, major ions, and metals) data will be collected to characterize the basic constituents available as building blocks for vegetation, macroinvertebrates, and other biological processes. Metal data will be used to determine if any toxic conditions may be present in the wetlands.
4) Sediment extractable nutrients and metals data will be collected to help determine if any historical inputs to the wetlands may have deposited nutrients, such as P, or toxic contaminants, such as Hg, that may continue to affect the condition of the wetlands.

Supplemental indicators may include the following:

1) Leaf CNP concentrations and $\delta^{15}N$ and $\delta^{13}C$ isotope ratios of dominant emergent plant species will be collected to assess the potential sources of nutrients for plant growth in the wetlands.
2) Bird use observations in wetlands will be collected to allow managers to gain some insights into whether wetland condition can be related to the four indicators explained above.

These parameters will be measured at all sites. A brief description of each measured parameter is included in **Table 2-3**.

Table 2-3. Parameters to Be Measured

Description		Field Method*	Details
Vegetation		Visual Observation	1 m wide by 100 m belt-transects perpendicular to main flow path at 10%, 50%, and 90% of path length (up to 500 m); total of three transects per site Vegetation species composition and % cover Cover of Filamentous Algae and Floating Aquatic Vegetation ** No samples will be collected, visual observation only
		Leaf Harvest	Five leaves from dominant plant species at each sampling location; sample mature leaf (fully expanded leaf 1-3 nodes below the top of plant, or the top 30 centimeters of culm (for *Schoenoplectus* spp.). ** One gallon-size zip bag per sampling location **(9)** ** *Sent to USU Isotope Lab*
Benthic Macroinvertebrates		Sample Collection using Stovepipe	Five stovepipe collections within dominant flow path ** One wide-mouth quart jar at each sample location **(3)** ** *Sent to Gray Lab*
Water Chemistry	Field Parameters	Multi-Parameter Probe	Temperature, Specific Conductance, pH, Dissolved Oxygen
	General Chemistry	Grab Sample Collection	Alkalinity, Total Suspended Solids, Total Volatile Solids, Total Dissolved Solids, Sulfate ($SO_4^{=}$), (Na, K, Ca, Mg, Cl, F), and *Hardness* ** One 1000 mL bottle ** *Sent to State Water Lab*
	Total (unfiltered) Nutrients	Grab Sample Collection	NH_4^+, NO_3^-/NO_2^-, Total Kjeldahl Nitrogen (TKN), Total P, DOC ** One 500 mL bottle with H_2SO_4 preservative ** *Sent to State Water Lab*
	Total (unfiltered) Metals	Grab Sample Collection	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*
	Sulfide	Grab Sample Collection	Hydrogen sulfide as total sulfide ** One 120 mL bottle with ZnoAc and NaOH preservative ** *Sent to State Water Lab*
	Chlorophyll-*a*	Grab Sample and Field Filtering	0.7-µm filter residue *Sent to State Water Lab*
Sediments	Extractable nutrients	Sample Collection using a Corer	Separate 0-10 cm cores at endpoints and center of vegetation transects (Nutrient Extracts: NH4, NO3/NO2, PO4); Total N, Total P and Organic C ** Stored in separate 1-gallon zip bags **(9 samples)**** *Sent to USU Stable Isotope Lab*
	Acid-soluble metals	Sample Collection using a Corer	Separate 0-10 cm cores (collect half of each sediment-nutrient core and composite) from main flowpath and each perpendicular transect Aluminum, Arsenic, Barium, Cadmium, Cobalt, Copper, Iron, Mercury, Manganese, Nickel, Lead, Selenium, and Zinc ** Stored in separate 1-gallon zip bags **(9)**** *Sent to UU ICP-MS Lab*

* See Section 3.0 and DWQ's SOPs for additional details

2.5 Decision Rules and Tolerable Limits

1.) If information is adequate to develop a preliminary MMI for GSL fringe wetlands, then DWQ will summarize these results for stakeholders and pursue a probabilistic survey of fringe wetlands as a validation dataset.

2.) If information is inadequate to develop a preliminary MMI, DWQ will identify potential confounding factors; revise appropriate sampling and analytical methods, including the sampling plan; and incorporate supplemental parameters into a summary report for stakeholders.

Tolerance limits exist primarily for laboratory analyses, where data quality indicators are defined in DWQ's QAPP in terms of acceptability criteria. This information is summarized in **Table 2-4**. The DWQ QAPP defines procedures that specify minimum QA/QC objectives for sample measurements based on the sample matrix.

Table 2-4. 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*	Sites selected from four categories of fringe wetlands to help define the bias we anticipate from natural variability	Variability in sampling data is accounted for by evaluation of site characteristics	100% compliance
and	Calibration of field water quality instruments	Documentation of successful instrument calibration	100% compliance
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*	SOPs for environmental data collection	Qualitative determination of adherence to SOPs, and field audits	All data collected following SOPs & 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 sampling point, or environmental condition*	SOPs	Qualitative determination of adherence to SOPs and field audits	All data collected following SOPs
	SAP requirements	Adherence to sampling location, time, and conditions	100% compliance unless approved by Project Manager a noted in field notes
	Field photos/notes	Document any variation from SAP/SOP	100% compliance
	Holding times	Holding times	100% compliance
	Field replicates	RPD	Water samples: ±20%; Sediments:

Data Quality Indicator	QC Check/QC Sample	Evaluation Criteria	Goal
	Field/trip/equipment blanks	Detection Limit	±40%; *For results above lab reporting limits* < 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) Holding times Analytical methods Similar frequency and types of QC samples (field dups, blanks, lab QA)	Qualitative determination of SOP adherence and field audits Holding times DWQ or EPA-approved methods Verify	All data collected following SOPs or procedures described in this SAP 100% compliance 100% use of approved methods 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 = $\{(X_1 - X_2)/(X_1+X_2)\}/2 \times 100$, where X_1 = result from first sample and X_2 = result from second sample

3.0 Field Sampling Methods

This section summarizes the work flow and methodology for environmental sample collection of fringe wetland sites and incorporates the DQOs outlined in previous sections.

An example of sample location setup for a fringe wetland site is shown in **Figure 3-1**. The guidance on sampling locations, given above, should be used to identify and sample the most appropriate area within the fringe wetland that best represents the conditions of the aquatic features of that wetland site.

Each wetland will be sampled using a frame as shown in **Figure 3-1**. This sampling frame is designed to allow comparison between fringe wetland sites at a similar scale; therefore, the size and length of transects have been standardized (i.e., 100 m to each side of main flow path. The beginning of the sampling frame (i.e., 0 m location) should be considered as the point where the open channel penetrates the upland and enters the lakeshore, the end of pipe or the weir that is contributing flow to the wetland, the downstream edge of the dike that has multiple weirs contributing flow, or the groundwater spring that is located at the highest elevation below the transition from upland to lakeshore that is discernibly discharging. If the end of pipe, weir, or groundwater spring is located upstream of the transition from upland to lakeshore, then the beginning of the sampling frame should be located where the resulting flow penetrates the transition from upland to lakeshore.

3.1 Safety Precautions and Plan

Field personnel will take appropriate precautions when operating watercraft and working on, in, or around water; 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, it is recommended for staff to reschedule the sample visit. 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.

Take care to reduce the possibility to contracting diseases carried by insect vectors such as West Nile virus (mosquitoes) and tularemia (horse flies). Other factors to consider are dehydration, weather exposure, stings, and potential site access issues such as barbed-wire fences, broken glass, steep slopes, and mud.

3.2 Field protocols by Parameter Group

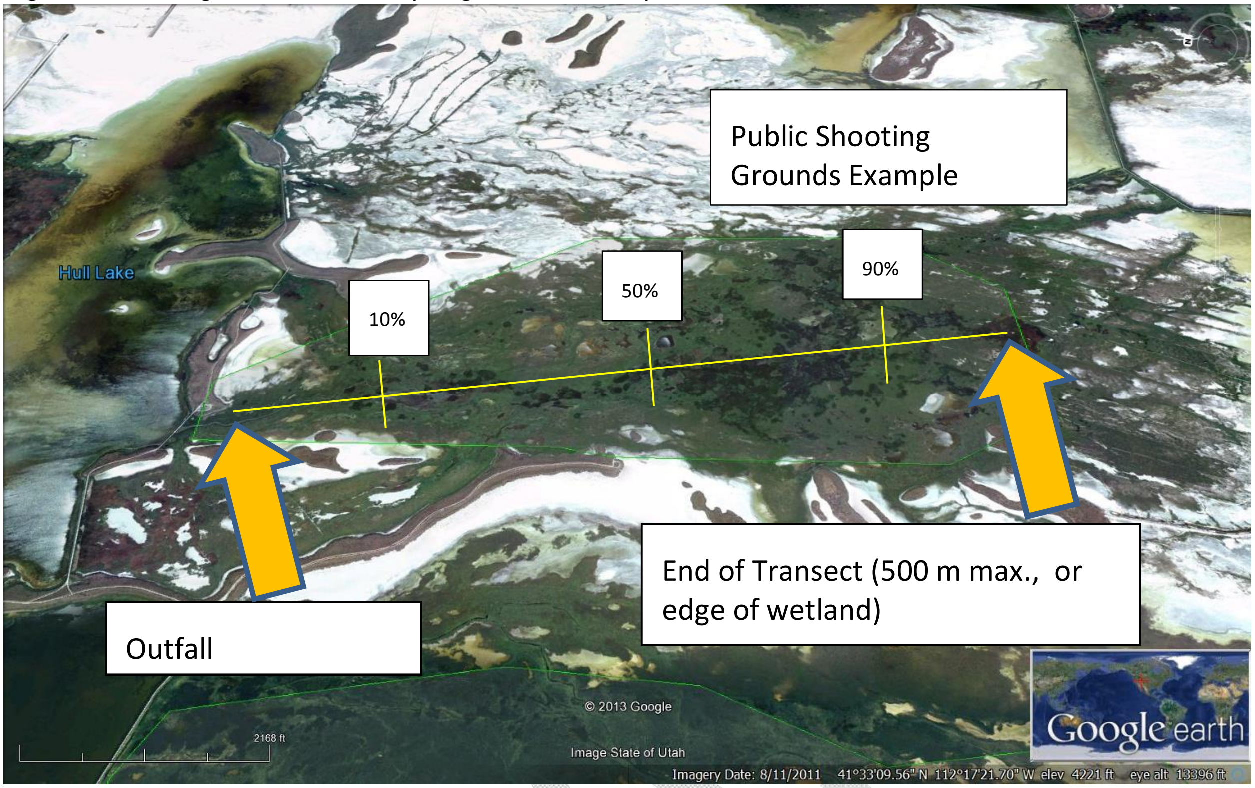
This section provides a brief overview of the field sampling activities to be performed at each site. Specific instructions, including required equipment and procedures, are located in the SOPs attached to this document. The sampling workflow is described in Section 3.3, while the general sampling layout is as follows.

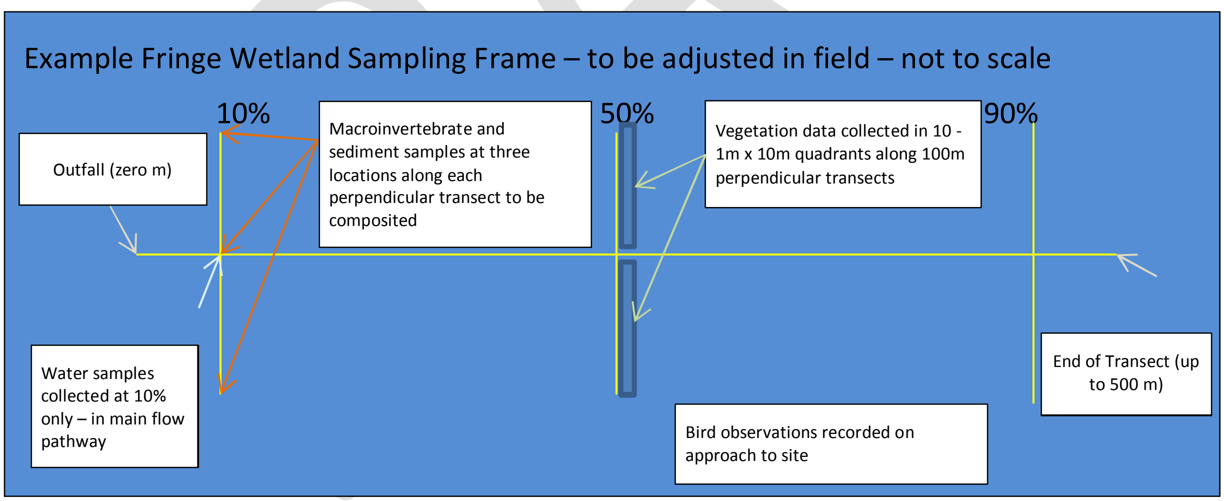
The fringe wetland class, as defined in this document, contains a wide range of both aquatic and terrestrial features. As such, the sampling layout for this preliminary survey will include measurements of both *open water* and *emergent* components of this ecosystem type. The open water, or aquatic, elements of the sampling layout are based on identifying the predominant flow path based on desktop-based geographic information system (GIS) reconnaissance of each site. Since these wetlands can range in size from approximately 10 to over 1,500 hectares, *aquatic* environmental data collections will occur at three locations representing 10 percent, 50 percent, and 90 percent of the flow path length. (Note that due to the size of some of the wetland sites, flow path lengths will be capped at 500 m in this project). Water chemistry, sediment chemistry, and benthic macroinvertebrate samples will be collected at each of these locations, as described below.

The *emergent*, or terrestrial, elements of the sampling layout are based on two 100 m transects oriented perpendicular to the flow line for each flow path segment. Vegetation cover, including emergent and floating aquatic plants as well as algal mats, will be estimated visually along a 1 m-wide belt for each transect. Vegetation transects will be broken up into 10- or 20 m segments during sampling due to the dense nature of marsh vegetation within this wetland type. At the terminus of each transect, samples will be collected for sediment (soil) chemistry and benthic macroinvertebrates. Supplemental data will be collected along each transect, including changes in the thickness of organic soil vs. mineral horizons, depth of inundation, and the presence of salt crusts, etc.

In general, sampling will occur via a two-tiered approach with a focus on both the aquatic as well as the terrestrial features of this wetland class. Sediment (soil) and macroinvertebrate sampling methods will be standardized to allow for comparison of metrics within and across wetlands.

Figure 3-1. Fringe Wetland Sampling Frame Example





The flow path is defined as the area where the predominant flow concentration travels across the fringe wetland and will typically start at some sort of emanation point (i.e., an outfall culvert or channel). The perpendicular transects will begin at the center of the main flow path at approximately 10 percent, 50 percent, and 90 percent of the total wetland length up to 500 m.

3.2.1 Water Chemistry Sampling

Sampling of water chemistry parameters involves two separate activities, as shown in **Table 2-3**. *Field parameters* are measured using a multi-parameter probe (Hydrolab or similar). This is typically one of the first activities performed during a site visit. Procedures for (daily) calibration and use of the multi-parameter probe are provided in the SOP (**Appendix B**). This project will use the temperature, specific conductance, pH, and DO probes. Multi-parameter probe data will be recorded on field sheets once the results have been verified as acceptable by the field crew and stored on the instrument; field sheets will also include any notes about site conditions observed during the measurement.

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 (**Appendix C**). Several volumes of surface water will be collected for six different types of analysis. Five bottles will be filled for *Total Nutrients*, *General Chemistry*, Total Metals, *Sulfide*, and BOD_5. One or more "transfer bottles" will also be filled and filtered and the residue collected for *Chlorophyll-α* analysis (**Appendix D**).

Both multi-parameter probes and field water samples (bottles) will be collected at each flow path segment (10 percent, 50 percent, and 90 percent of path length).

3.2.2 Emergent Vegetation Sampling

Emergent vegetation and ground cover is sampled by visual estimation of aerial cover within a 1 m band along each 100 m transect. Each transect can be broken up into 10- or 20 m segments to facilitate species identification and cover measurements in thick marsh vegetation. These data, along with other pertinent observations, such as cover of algal mats or evidence of soil disturbance, are recorded on a field sheet (Vegetation SOP in Appendix?).

3.2.3 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates are collected from an undisturbed area within the open water flow path and at the end of each vegetation transect, using a "stovepipe" method. Briefly, five cylinders will be driven into the soil/sediment to a depth of 5-7 centimeters. The sediment material will be composited among cylinders at each sampling location; in addition, the two "outer" samples from the terminal ends of vegetation transects will be composited. Procedures are described in the SOP (**Appendix H**).

3.2.4 Sediment Chemistry Sampling

Sediment available nutrients and total metals 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 (10 percent, 50 percent, and 90 percent of flow path length). Briefly, the goal is to collect the top 10 centimeters of the loose sediment (or mucky soil) from 5-centimeter-diameter cores.

The 0- to 10-centimeter core will be split along the length axis in the field, using a soil spatula, and each half of the core placed in separate 1-gallon sample bags. One-half of the core will be placed in a labeled bag for nutrients; the other half of the core will be placed in another labeled bag for acid-soluble metals. Samples from each vegetation transect at a given sampling location (10, 50, or 90 percent of path length) will be composited, creating two bags per transect. Thus, six samples will be collected per site, three nutrient samples and three metals samples. **[Appendix I]**

3.2.5 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.

3.3 Field Sampling Workflow

The flow of activities at the sampling site will generally occur in the following order:

1. Determine if sampling is feasible at selected fringe wetland sites, check coordinates, determine appropriate location for transects.
2. Gather equipment and maps for transect work in sleds/float tubes – recheck before leaving staging area. Check batteries for all equipment and GPS.
3. Warm up properly to avoid injury and discuss safety issues before beginning work.
4. Count birds easily visible by eye while en route to first sampling point, and mark on forms by guild. Also note birds within the sampling frame (100 m by 500 m) as you are walking toward downstream.
5. Using GPS for navigation, walk approximate center of main transect that parallels water flow to end of sampling frame (see **Figure 3-1**) and note birds by guild or form.
6. Move out into the wetland, towards the furthest perpendicular transect (500 m).
    a. Start at furthest perpendicular transect (500 m) and work upstream.
    b. Ensure transect is placed approximately perpendicular to main flow pathway.
    c. If you encounter end of flow or open water (GSL) before 500 m, shorten main transect and select location for perpendicular transect at approximately 90 percent of total length. Note length on maps and take GPS points and lines at all locations.
    d. Describe representative vegetation and hydrologic conditions at sampling locations.
7. Record the fringe-wetland transect location and take any relevant pictures illustrating habitat and water conditions.
8. Vegetation cover will be assessed along 100 m belt-transects perpendicular and moving out from the main transect.
9. Macroinvertebrate sediment samples will be collected between and at the end of each perpendicular transect (three locations) – both ends of 100 m transects and in the center (main flow pathway).
10. Work back upstream and collect same data at 50 percent and 10 percent perpendicular transects.
11. Collect water quality and field parameters at 10 percent perpendicular transect at location of most concentrated flow pathway. Note hydrology information such as water depth and flow estimates.

12. Once transect collections and observations are made, return to the vehicle and process the samples.
13. Label all samples according to the SOP and use proper preservative until samples are delivered to appropriate lab.

3.4 Special Training

Field crews are required to read this SAP and *all applicable* SOPs prior to conducting the field work described in this SAP and acknowledge they have done so via a signature page (see **Appendices B** through **I**) 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.

3.5 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 (1) the site meets the project target wetland class, (2) DWQ has received explicit permission to access sites located on private property, and (3) 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.

If a historically evaluated site no longer represents the sample target for this study during the 2013 sampling period (July 10 through August 20), then the field crew should contact the DPM and continue on to the next site to be sampled that day. The nontarget site will be labeled as "NON-SAMPLE" in the site database, and a new site will be selected from the survey list following the procedure described in Section 2.2. If the nontarget site was successfully sampled in the past but conditions have drastically changed so that there is no feasible sample location within the fringe wetland, then the site must be dropped. If a site is dropped, this information will be added to the site database, including a description of why the site was dropped.

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, lightning storms may represent dangerous conditions within large areas around the GSL, and wind 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. Wind-induced turbidity may subside within a day or two for most fringe 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 and described in the method-specific SOP (see **Appendices B** through **I**). **Table 4-1** lists the required container type, sample volume, preservatives (if any), and the allowable holding time for all sample collections in this project.

Table 4-1. Sample Container Requirements

Sample Type/Analyte	Container Type	Volume	Preservative	Holding Time	Receiving Lab
Benthic Macroinvertebrates					
Five-sample composite (stovepipes) from each of the three open water and "transect" locations (10, 50, 90) at each site	Plastic jar	1 quart, wide-mouth	95% Ethanol	NA	Gray Lab, UVU
Water Chemistry					
Total (Unfiltered) Nutrients	Plastic bottle	500 milliliters	H_2SO_4 *	28 days	State Lab
Total (Unfiltered) Metals	Plastic bottle	250 milliliters	HNO_3 *	28 days - 6 months	State Lab
General Chemistry (Unfiltered)	Plastic bottle	1.8 liters	Ice chest and fridge at the shop	7 days	State Lab
Sulfide	Plastic bottle	120 milliliters	Ice chest and fridge at the shop	7 days	State Lab
Chlorophyll-α	Filter membrane wrapped in Aluminum foil	100 to 500 milliliters	Dry ice and freezer at the shop	3 weeks	State Lab
~~5-day Biochemical Oxygen Demand~~	~~Plastic bottle~~	~~2 liters~~	~~Ice chest and fridge at the shop~~	~~48 hours~~	~~State Lab~~
Sediment Nutrients					
Nine Samples – One each along the main [flowpath] transect, and along the termini of each perpendicular transect	Plastic bag	1 gallon	Ice chest/lab freezer	NA	USU Isotope lab
Sediment Metals					
Nine Samples – One each along the main [flowpath] transect, and along the termini of each perpendicular transect	Plastic bag	1 gallon	Ice chest/lab freezer	NA	UU ICP-MS Lab

NOTES:
NA = not applicable
*State Lab will supply preservative in the sample container

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

Gray Lab

Department of Biology, Utah Valley University
Contact: Dr. Larry Gray
800 West University Parkway
Orem, UT 84058
(801) 863-8558; email: grayla@uvu.edu; Web: research.uvu.edu/GRAY/

Utah State University Stable Isotope Analysis Laboratory

Contact: Dr. John Stark or Ms. Tasha Prettyman
Logan, UT
(435) 797-0060; email: john.stark@usu.edu; tasha.cosgrove@usu.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 **Table 2-4**.

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 **Table 2-4** 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. Finally, the project design includes a 10 percent oversample to ensure that MMI data are 100 percent complete.

Two types of QC samples will be collected in the field.

Field Replicates: Replicate samples will be obtained for 10 percent of all field collections listed in **Table 2-3** (two 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 *Total Metals* (250-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.

This information is summarized in **Table 5-1**.

Table 5-1. Quality Control Sample Collections

QC Type	***Frequency***	**Emergent Vegetation**	**Water Chem: General Chemistry**	**Water Chem: Total Nutrients**	**Water Chem: Total Metals**	**Water Chem: Sulfide**	**Water Chem: Chlorophyll-a**	**Macroinvertebrates (stovepipe)**	**Sediment Nutrients**	**Sediment Metals**
(1) Field Replicate	One per 10 sites	X	X	X	X	X	X	X	X	X
(2) Field Blanks	1 set per week		X	X	X	X				

5.2 Analytical QC limits

Analytical QC limits are described in each laboratory's QA 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. **Table 5-2** 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 (DQIs) 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 (QAO) 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., nondetectable 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.

Table 5-2. Analytical QC Limits and Reporting Ranges

Sample Type	Parameter	Method #	MRL *	Units	Calibration Range	Precision	Accuracy	Recovery	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%			
	Cd	200.8	10	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				

NOTES: µg/L = microgram per liter; mg/L = milligram per liter.
* 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.

6.0 Data Analysis, Record Keeping, and Reporting Requirements

All field data sheets will be scanned by the field crew (as .pdf files) as part of routine operations in between field sampling trips, and hard copies of sheets will be held at an offsite facility. 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 and all files will be backed up in an appropriate manner.

Once all data have been received and results from all field-collected blanks have been validated, the dataset will be formatted as requested by the contractor (CH2M HILL), who will perform the data analysis for this project. Their report on the validation of the fringe wetland MMI and condition assessment of GSL fringe wetlands is anticipated in July 2014. The DPM will work with the contractor during the data analysis period to evaluate and assess project progress, make suggestions during MMI evaluation and testing, and update other project team members on a routine basis. The results of data analysis will be presented to DWQ via a 305(b)-style assessment on GSL IW condition for inclusion in the 2014 Integrated Report, and will include a proposal for long-term monitoring of GSL fringe wetlands. Once the project report has been reviewed and finalized, this work will be integrated into a report to EPA as a contract deliverable.

7.0 Schedule

Table 7-1. Project Schedule

Task	2013								2014						
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Compile Sampling and Analysis Plan	X														
Site Reconnaissance	X	X													
Sampling - Index Period			X	X											
Sample Analysis			X	X	X	X									
Data Validation							X	X							
Data Analysis									X	X	X	X			
Report Writing												X	X	X	
Final Review															X

This project is funded by a WPDG grant to DWQ (*Contract # CD-96711401*).

Anticipated Equipment. Equipment needs for each sampling type is listed in method-specific SOPs (see **Appendices B** through **I**). 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 8-1 lists key project personnel, identifying responsibilities among project personnel.

Table 8-1. Project Team Contact Information

Title	Name	Organizational Affiliation	Key Tasks or Responsibilities	Telephone number/ email
Project Manager	Toby Hooker	UDWQ	Oversees direction of project, data analysis, reporting	(801) 536-4289 tobyhooker@utah.gov
Technical Manager	Jeff Ostermiller	UDWQ	Oversees technical aspects of project, budget, data analysis and reporting	(801) 536-4370 jostermiller@utah.gov
UDWQ QA Officer	Jim Harris	UDWQ	Oversees QA for Division, responds to QA issues, supervises monitoring team	(801) 536-4360 jamesharris@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	Summer Interns	UDWQ	Performs field data collection	Contact Alex Anderson
Laboratory Contact	Sanwat Chaudhuri	State Laboratory	Water analyses	(801) 965-2470
Laboratory Contact	Lawrence Gray	Utah Valley University	Macroinvertebrate analyses	(801) 863-8558 grayla@uvu.edu
Laboratory Contact	John Stark (Tasha Prettyman)	Utah State University	Sediment Nutrient analyses	(435) 797-0060 johnstark@usu.edu
Laboratory Contact	William Johnson	University of Utah	Sediment Metals Analysis	(801) XXX-YYY

UDWQ Project Management Staff

The lead project sponsor is the Utah Department of Environmental Quality (DEQ), DWQ, whose mission is to "protect, maintain and enhance the quality of Utah's surface and underground waters for appropriate beneficial uses." The DWQ Director is Walt Baker, and the Assistant Director of the Engineering and Water Quality Branch is Leah Ann Lamb.

The DWQ Project Manager for this study is Toby Hooker, the DWQ staff Wetlands Scientist. He is responsible for project management, tracking, review of technical reports, and dissemination of project results.

Jeff Ostermiller is the Water Quality Management Section Manager and has extensive experience with the management and implementation of monitoring and assessment programs. In particular, he has created biological assessment tools for numerous state and federal agencies, including oversight and analytical work for Utah's newly developed wetland MMI. He will serve as technical advisor and will be a primary user of the dataset.

James Harris serves the Division 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 ensures that only the current versions of the Division QAPP and associated SOPs are in use. James provides approval for all project SAPs. He is also 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 and logistics 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 uploading of field data and photos to the project folder on the DWQ network drive. Alex provides the DPM weekly updates regarding the status of field sampling progress and initiates discussion of any problem situations encountered. Weekly updates will be limited to a one-page summary of activity, location, observations, and contingency measures.

8.1 Field Activities

Day-to-day field operations will be overseen by Alex Anderson, an experienced member of the DWQ Monitoring Section. He has previous experience monitoring GSL wetlands. The monitoring team will consist of one other DWQ 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 QAO (James Harris) or the QA/QC staff (Trisha Johnson).

Macroinvertebrate and Zooplankton samples will be analyzed by Utah Valley University (Dr. Larry Gray, Department of Biology).

Sediment-Nutrient samples will be analyzed by Utah State University Stable Isotope Analysis Laboratory (Dr. John Stark, see Section 4.1 or **Table 8-1**).

Sediment-Metal samples will be analyzed by the University of Utah ICP-MS laboratory.

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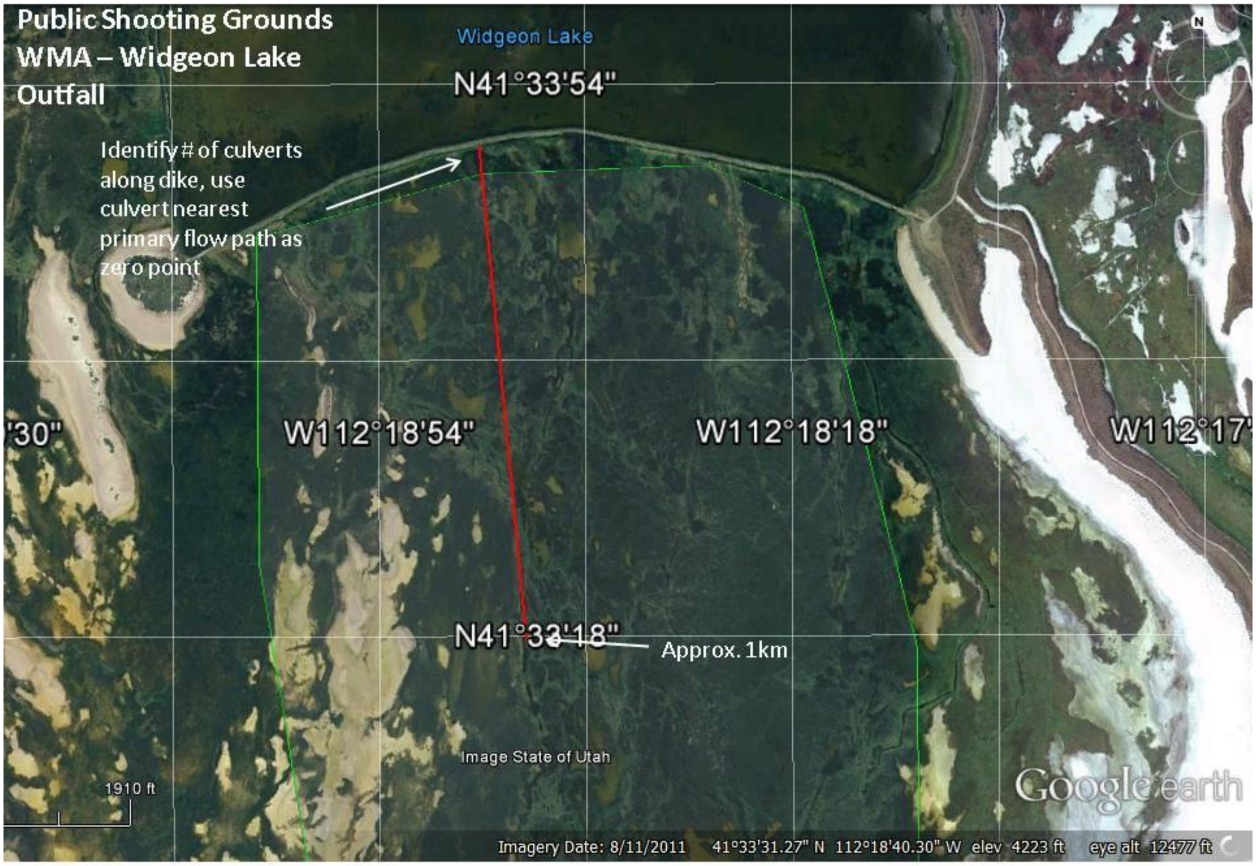
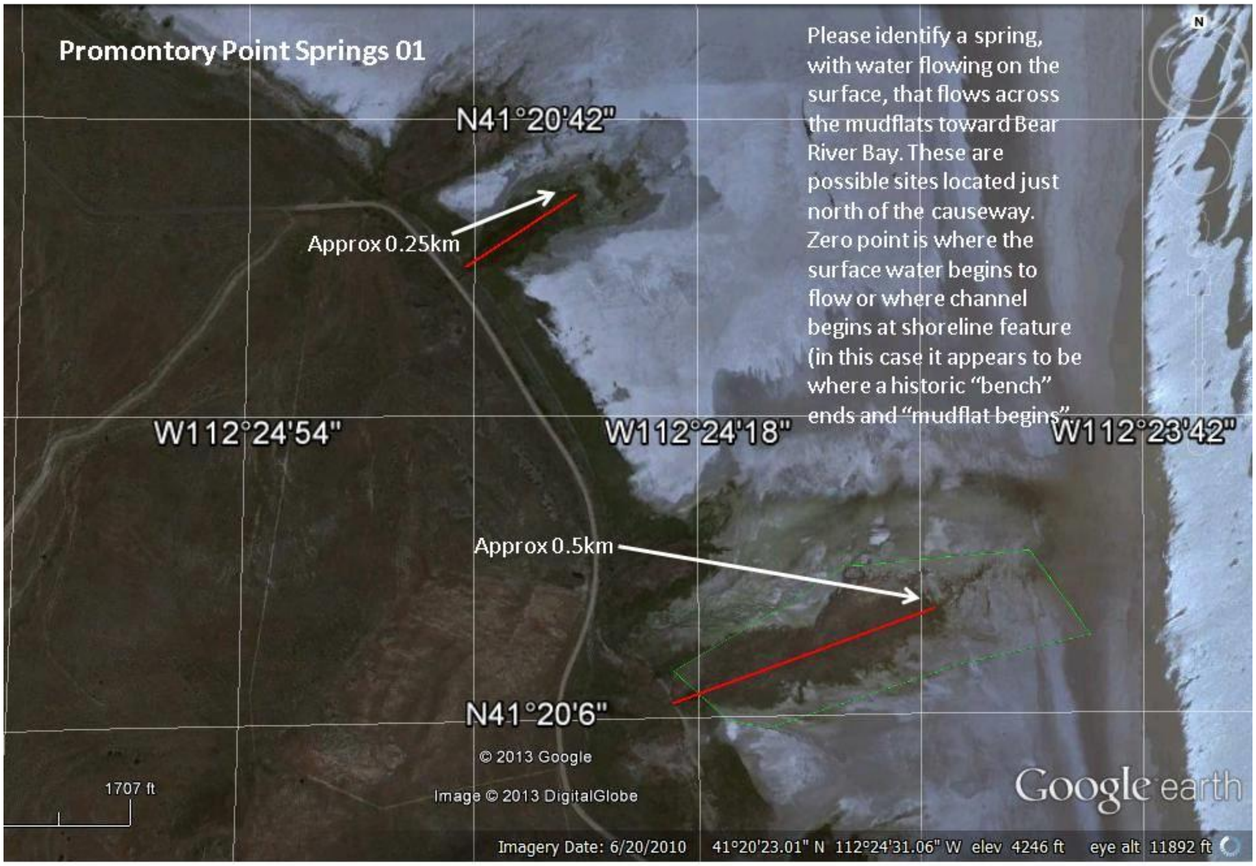
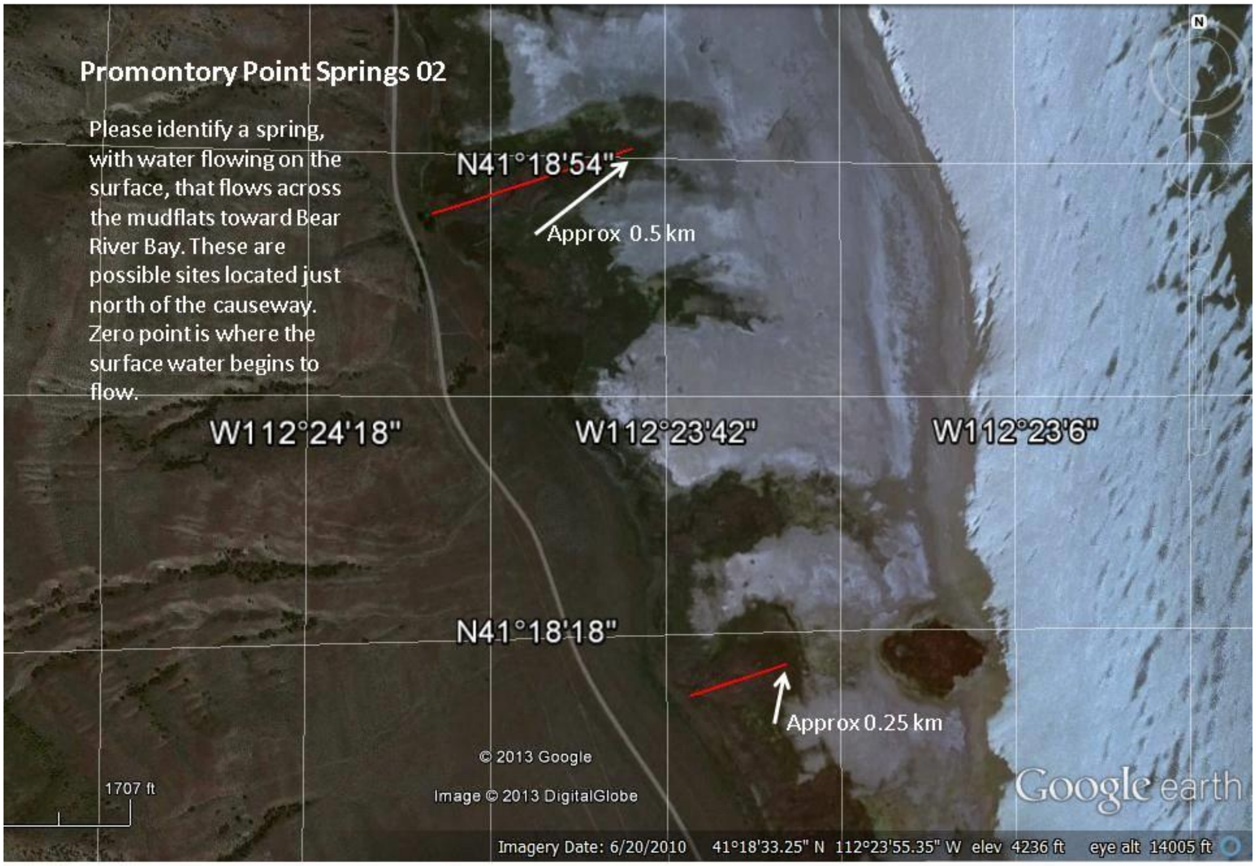
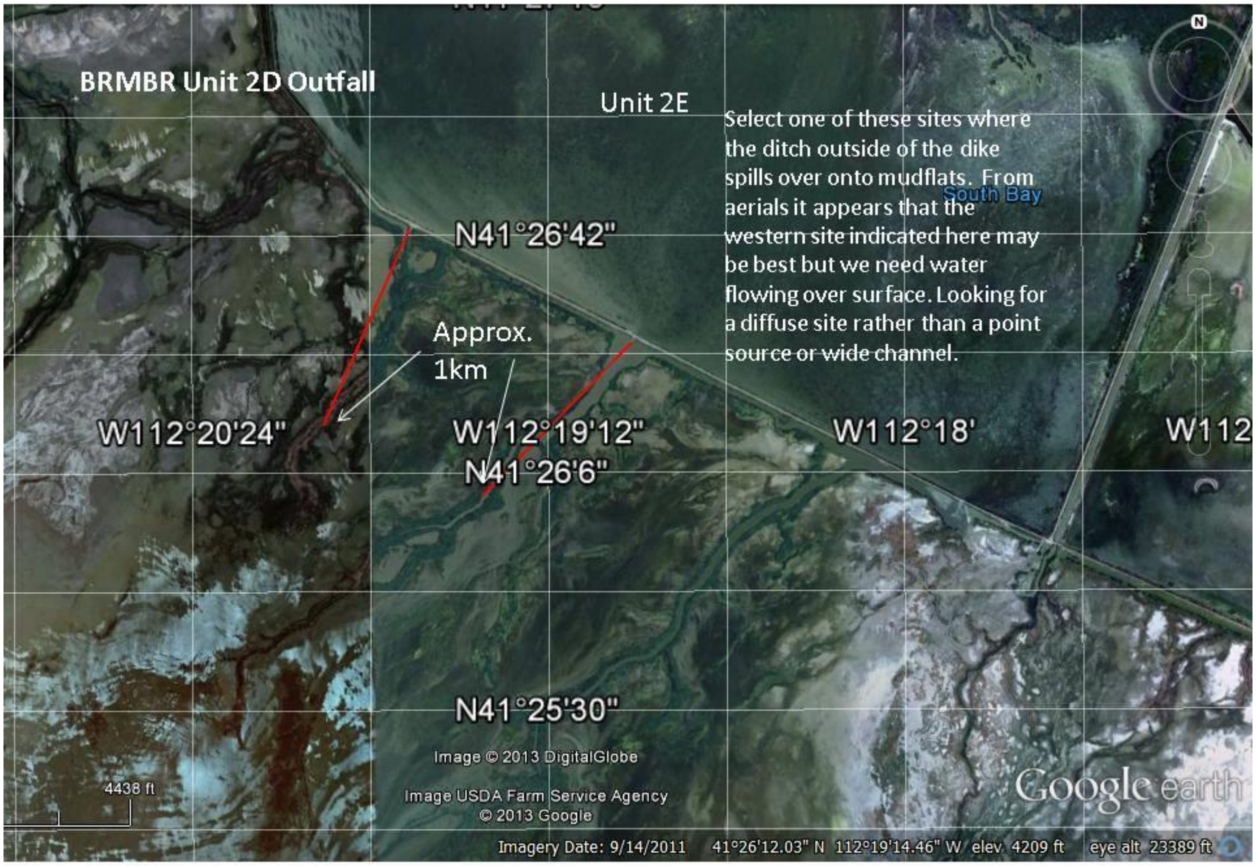
Appendix A Site Maps for Potential GSL Fringe Wetlands Sampling Sites

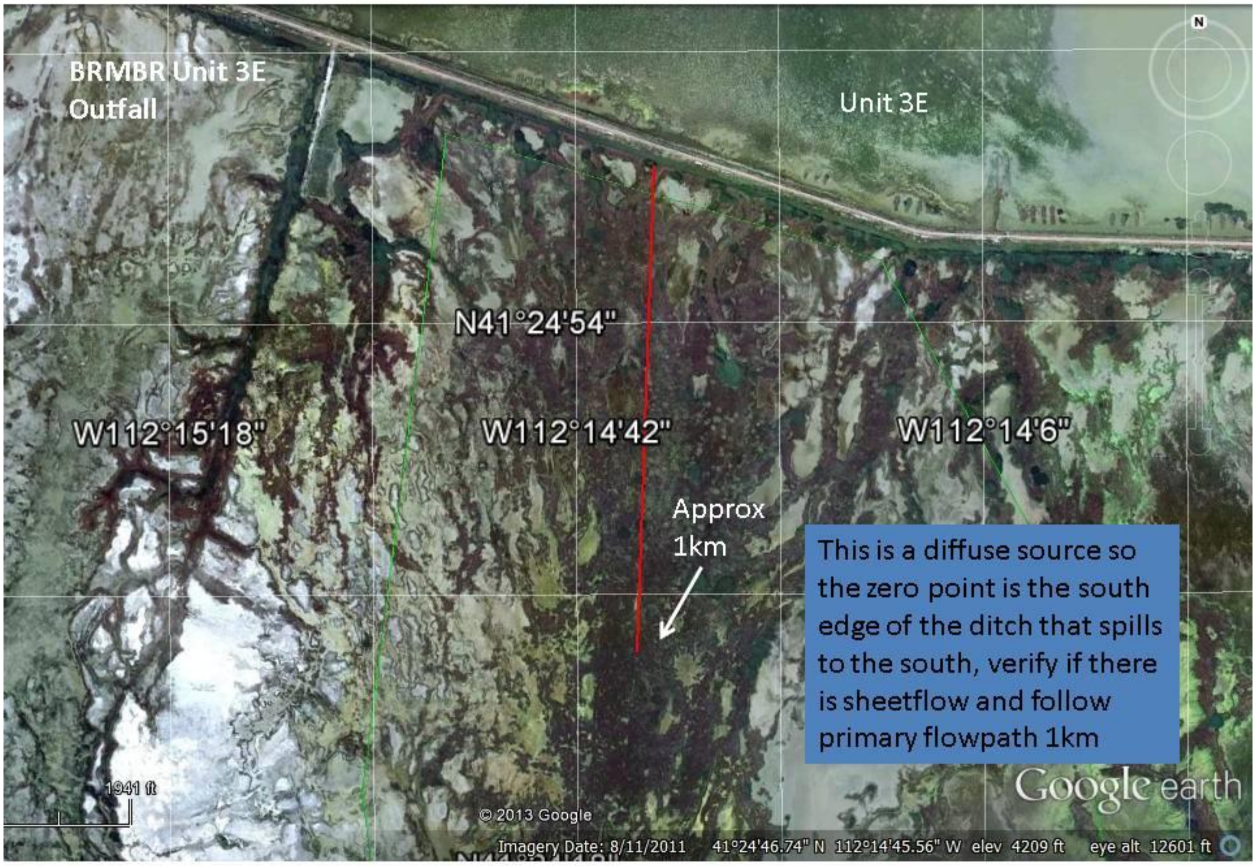

Public Shooting Grounds
WMA – Widgeon Lake
Outfall
Widgeon Lake
N41°33'54"
Identify # of culverts along dike, use culvert nearest primary flow path as zero point
W112°18'54"
W112°18'18"
N41°33'18"
Approx. 1km
Image State of Utah
1910 ft
Google earth
Imagery Date: 8/11/2011 41°33'31.27" N 112°18'40.30" W elev 4223 ft eye alt 12477 ft

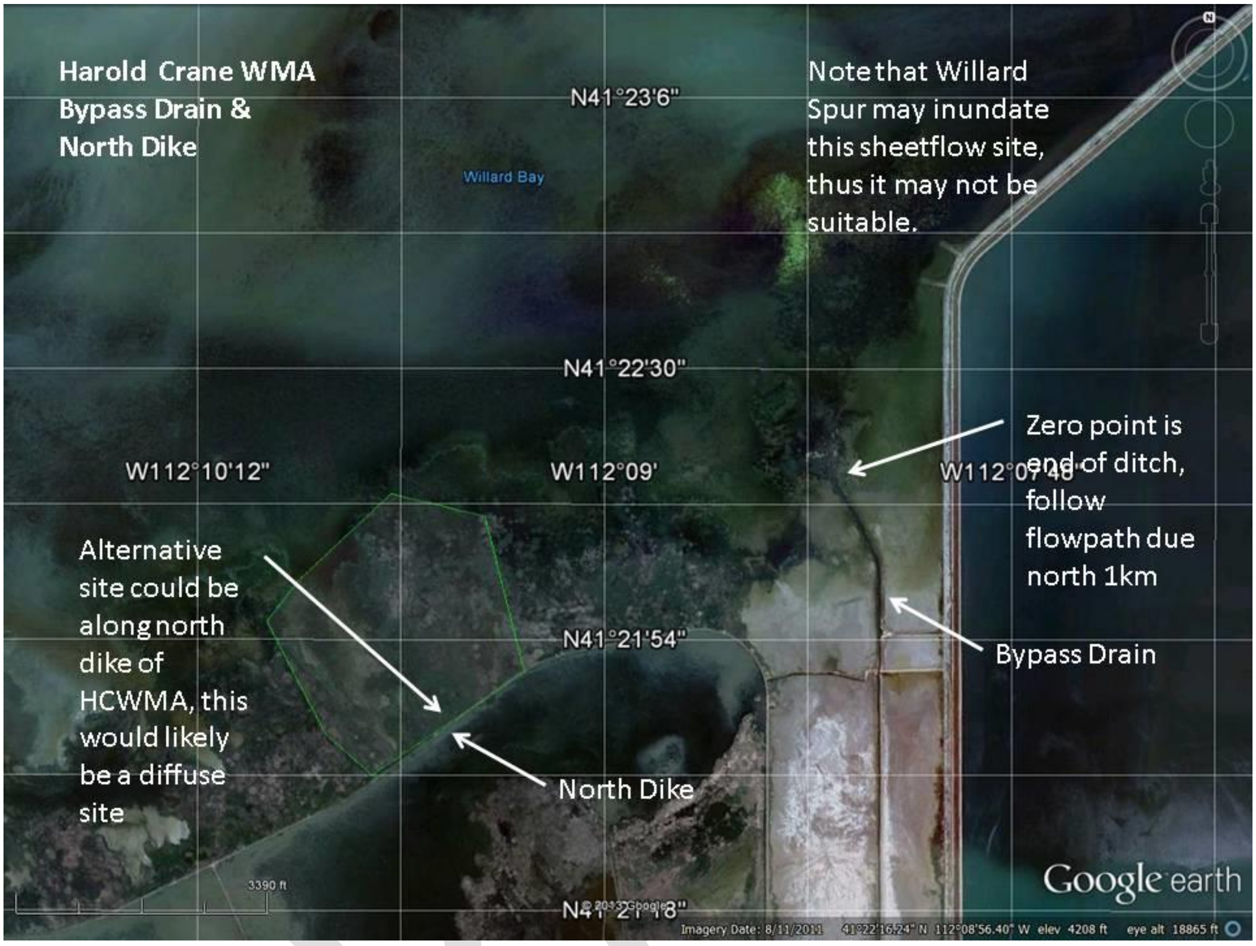

Public Shooting Grounds
WMA – Hull Lake Outfall
Use culvert at road as zero point.
N41°33'54"
W112°17'42"
Approx. 1km
W112°17'6"
Image State of Utah
1990 ft
N41°33'18"
Imagery Date: 8/11/2011
41°33'40.05" N 112°17'29.96" W

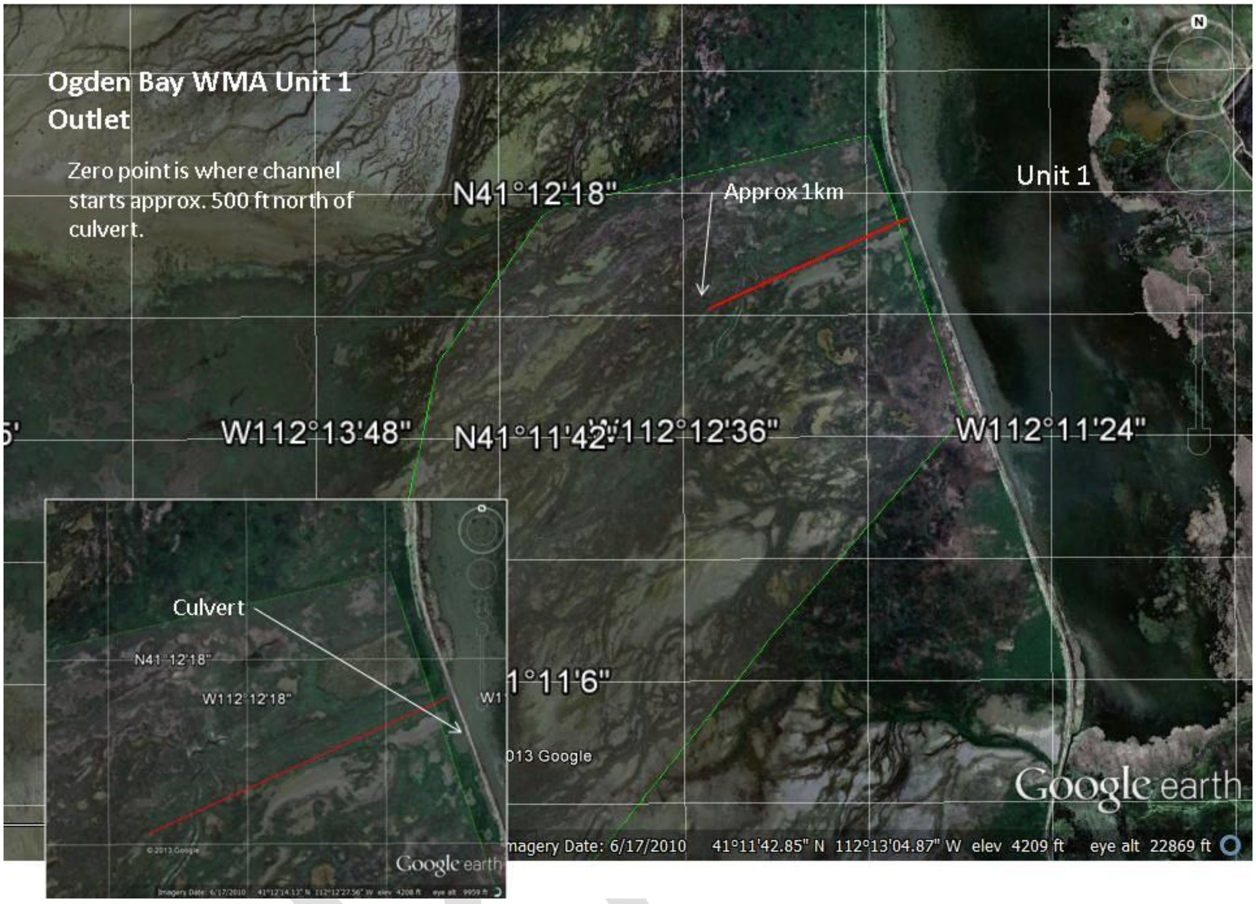

Promontory Point Springs 01
N41°20'42"
Approx 0.25km
Please identify a spring, with water flowing on the surface, that flows across the mudflats toward Bear River Bay. These are possible sites located just north of the causeway. Zero point is where the surface water begins to flow or where channel begins at shoreline feature (in this case it appears to be where a historic "bench" ends and "mudflat begins".
W112°24'54"
W112°24'18"
W112°23'42"
Approx 0.5km
N41°20'6"
© 2013 Google
Image © 2013 DigitalGlobe
1707 ft
Google earth
Imagery Date: 6/20/2010 41°20'23.01" N 112°24'31.06" W elev 4246 ft eye alt 11892 ft

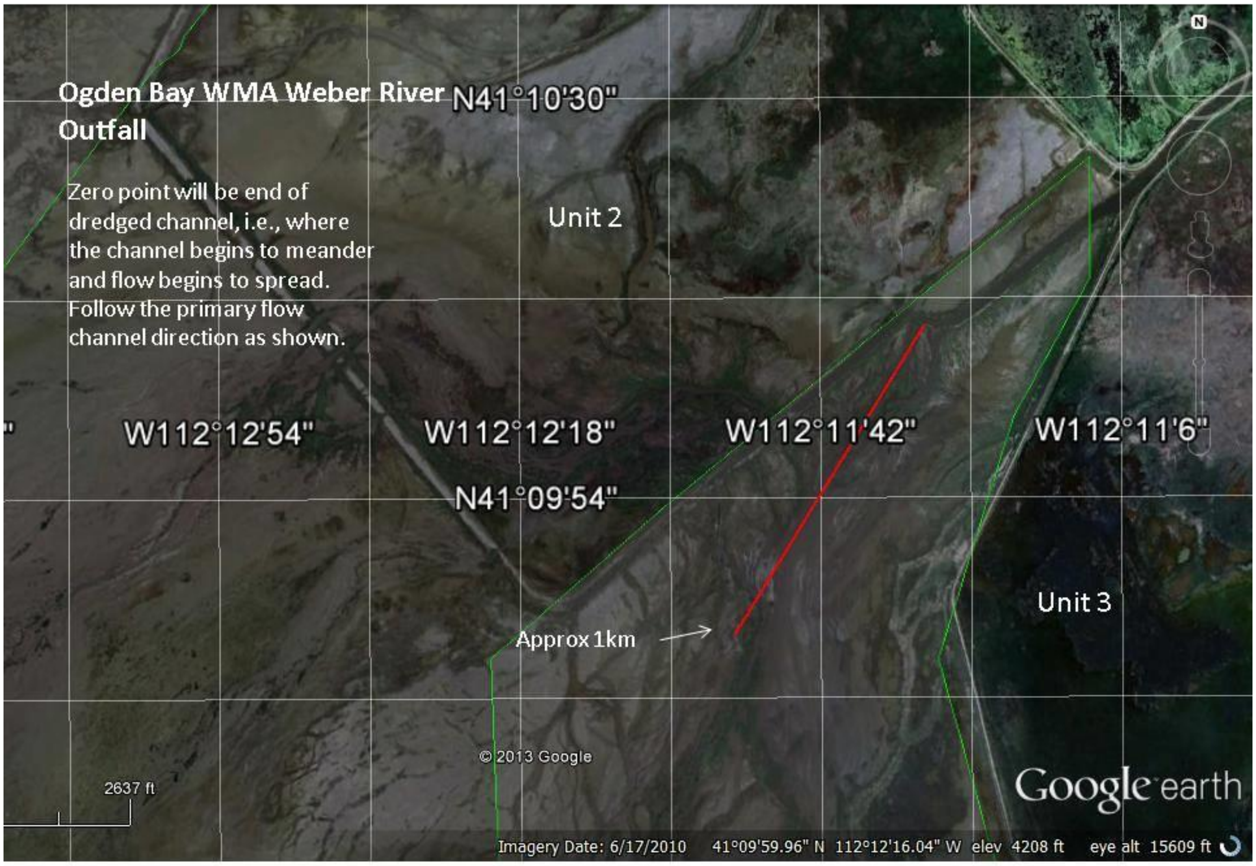

Promontory Point Springs 02
Please identify a spring, with water flowing on the surface, that flows across the mudflats toward Bear River Bay. These are possible sites located just north of the causeway. Zero point is where the surface water begins to flow.
N41°18'54"
Approx 0.5 km
W112°24'18"
W112°23'42"
W112°23'6"
N41°18'18"
Approx 0.25 km
© 2013 Google
Image © 2013 DigitalGlobe
1707 ft
Google earth
Imagery Date: 6/20/2010 41°18'33.25" N 112°23'55.35" W elev 4236 ft eye alt 14005 ft


BRMBR Unit 2D Outfall
Unit 2E
Select one of these sites where the ditch outside of the dike spills over onto mudflats. From aerials it appears that the western site indicated here may be best but we need water flowing over surface. Looking for a diffuse site rather than a point source or wide channel.
South Bay
N41°26'42"
Approx. 1km
W112°20'24"
W112°19'12"
N41°26'6"
W112°18'
N41°25'30"
Image © 2013 DigitalGlobe
Image USDA Farm Service Agency
© 2013 Google
4438 ft
Google earth
Imagery Date: 9/14/2011 41°26'12.03" N 112°19'14.46" W elev 4209 ft eye alt 23389 ft

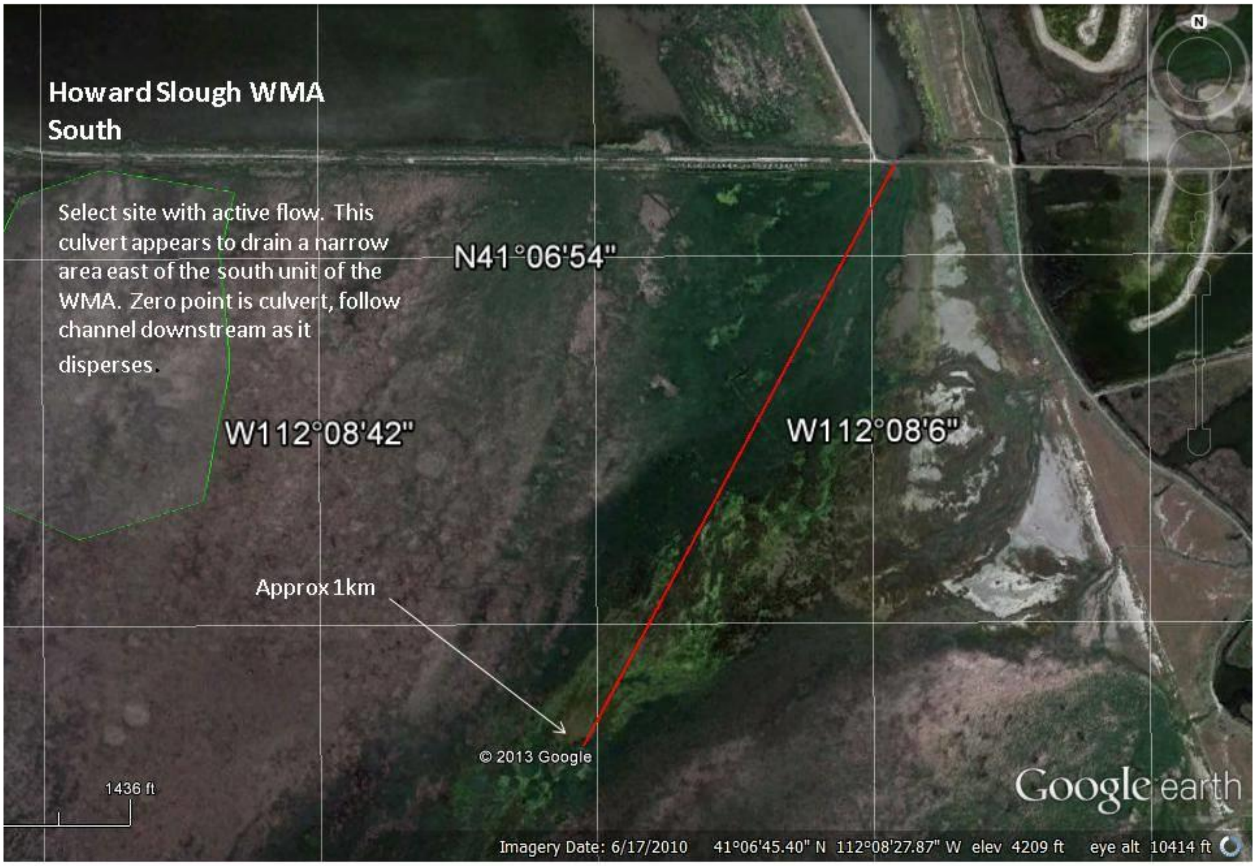

BRMBR Unit 3E
Outfall
Unit 3E
N41°24'54"
W112°15'18"
W112°14'42"
W112°14'6"
Approx
1km
This is a diffuse source so the zero point is the south edge of the ditch that spills to the south, verify if there is sheetflow and follow primary flowpath 1km
1941 ft
© 2013 Google
Google earth
Imagery Date: 8/11/2011 41°24'46.74" N 112°14'45.56" W elev 4209 ft eye alt 12601 ft

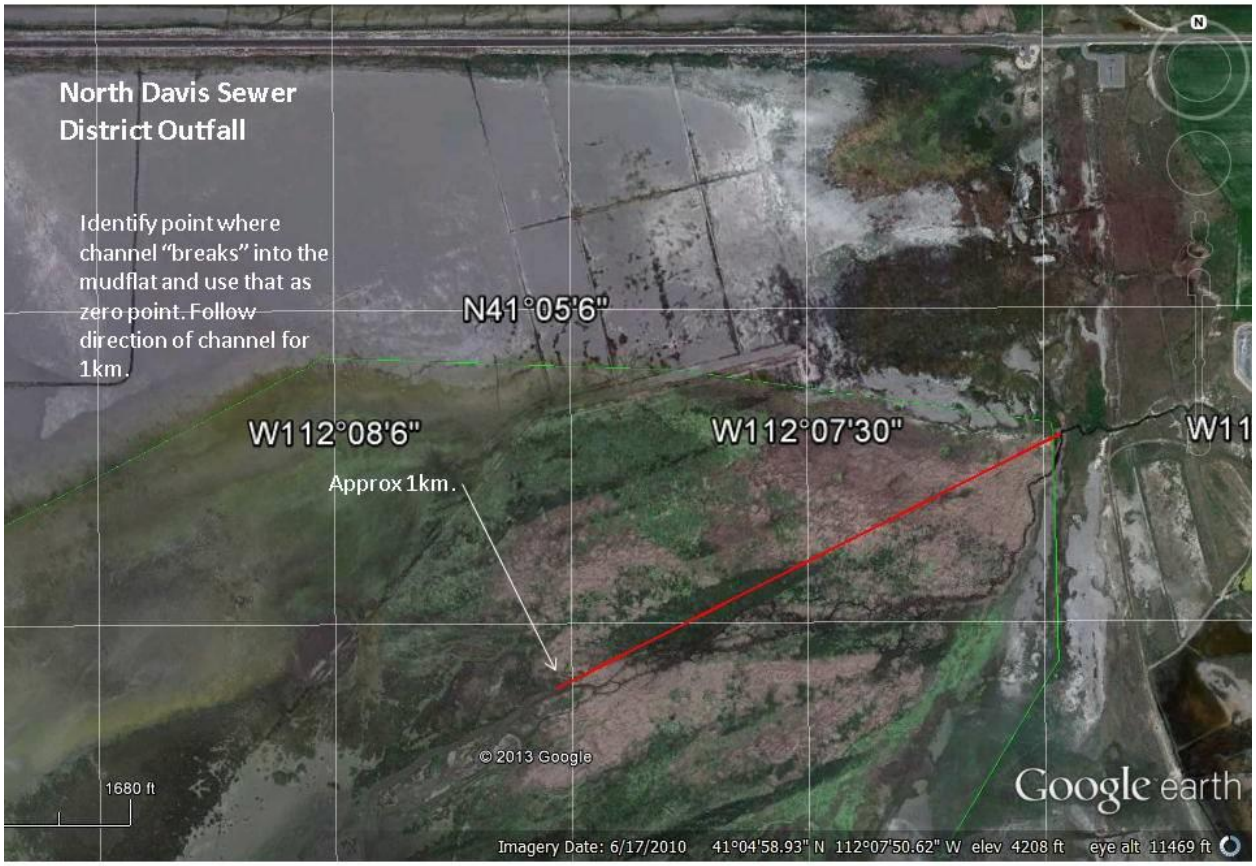

Harold Crane WMA
Bypass Drain &
North Dike
N41°23'6"
Willard Bay
Note that Willard
Spur may inundate
this sheetflow site,
thus it may not be
suitable.
N41°22'30"
Zero point is
end of ditch,
follow
flowpath due
north 1km
W112°10'12"
W112°09'
Alternative
site could be
along north
dike of
HCWMA, this
would likely
be a diffuse
site
N41°21'54"
Bypass Drain
North Dike
Google earth
3390 ft


Ogden Bay WMA Unit 1 Outlet
Zero point is where channel starts approx. 500 ft north of culvert.
N41°12'18"
Approx 1km
Unit 1
W112°13'48"
N41°11'42"
W112°12'36"
W112°11'24"
Culvert
N41°12'18"
W112°12'18"
Google earth
Imagery Date: 6/17/2010 41°11'42.85" N 112°13'04.87" W elev 4209 ft eye alt 22869 ft

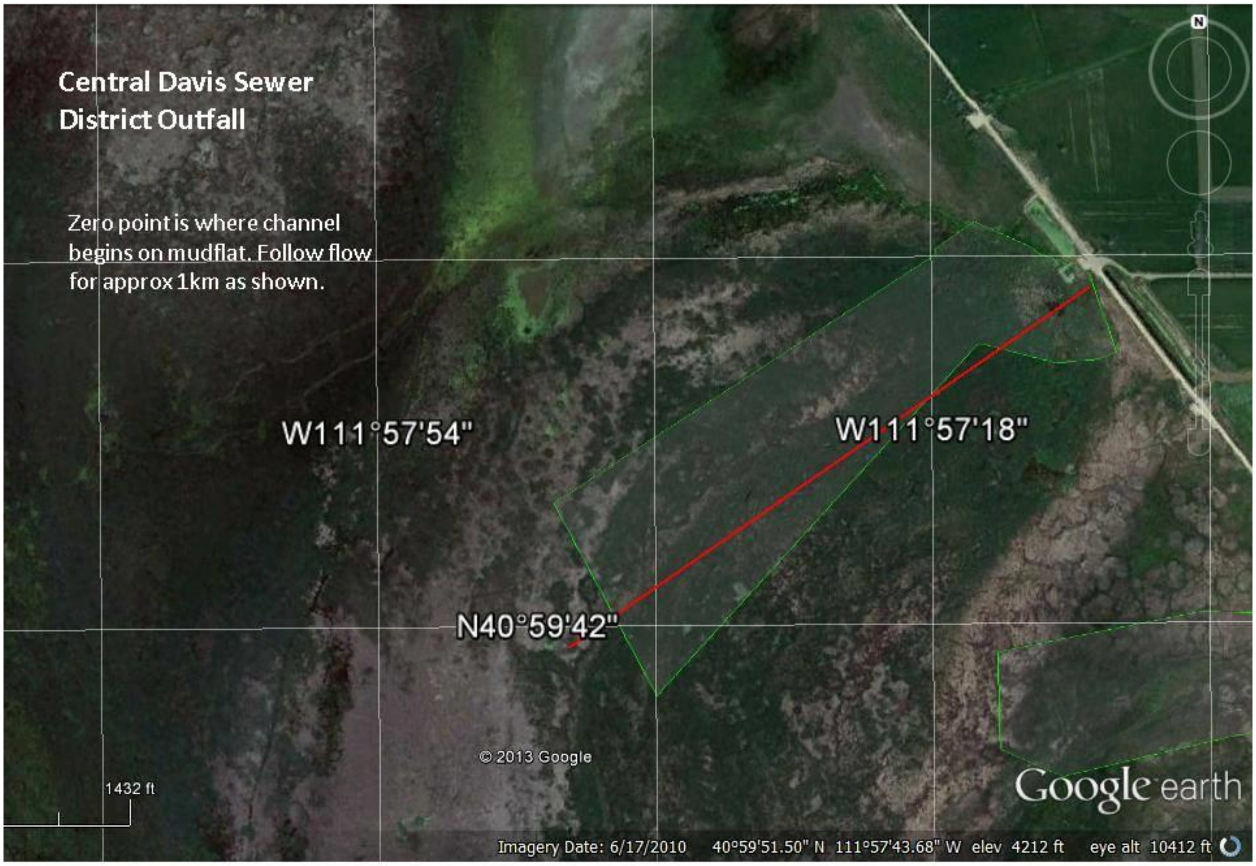

Ogden Bay WMA Weber River Outfall
Zero point will be end of dredged channel, i.e., where the channel begins to meander and flow begins to spread. Follow the primary flow channel direction as shown.
N41°10'30"
Unit 2
W112°12'54"
W112°12'18"
W112°11'42"
W112°11'6"
N41°09'54"
Unit 3
Approx 1km
© 2013 Google
2637 ft
Google earth
Imagery Date: 6/17/2010 41°09'59.96" N 112°12'16.04" W elev 4208 ft eye alt 15609 ft

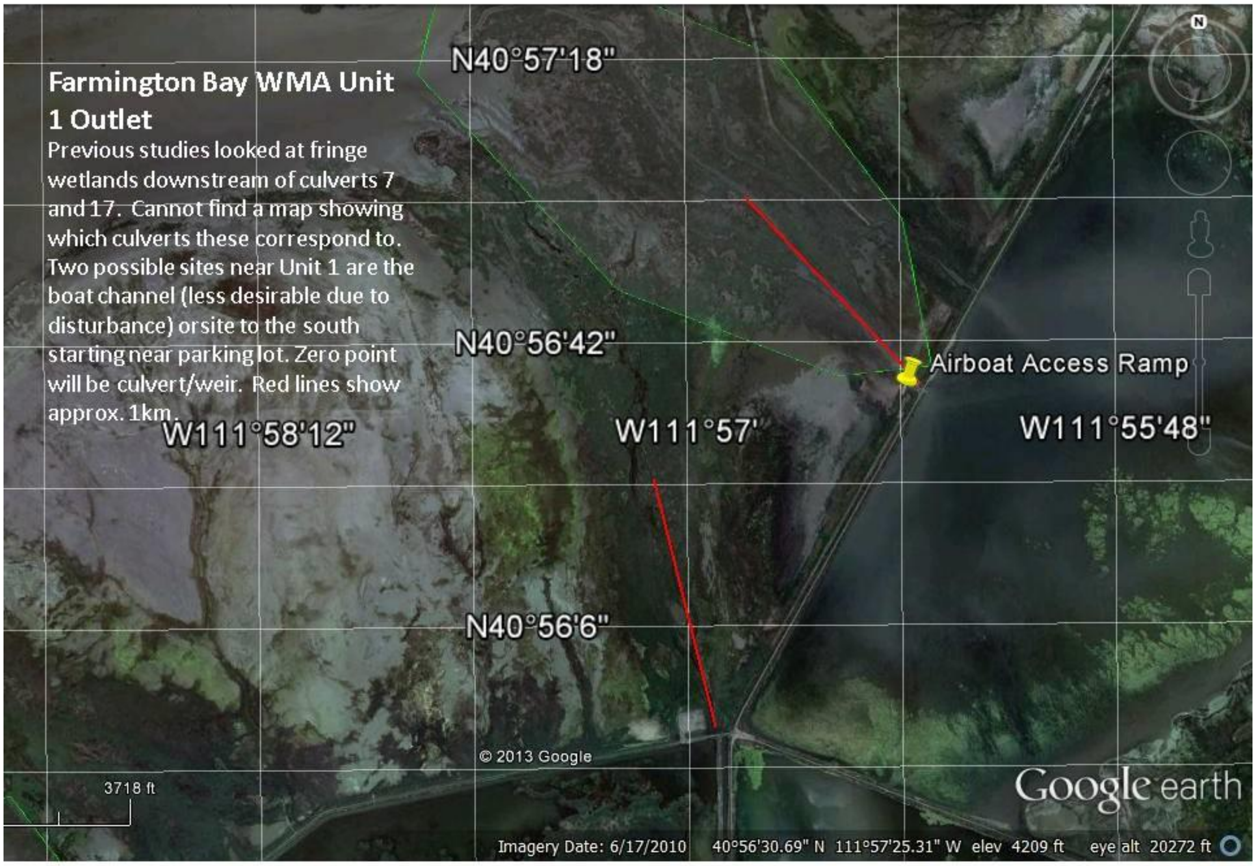

Howard Slough WMA
North Unit Outlet
Zero point is culvert, follow channel downstream as it disperses.
W112°10'30"
W112°09
© 2013 Google
1138 ft
N41°07'30"
Google earth
Imagery Date: 6/17/2010 41°07'45.58" N 112°10'29.19" W elev 4209 ft eye alt 9129 ft

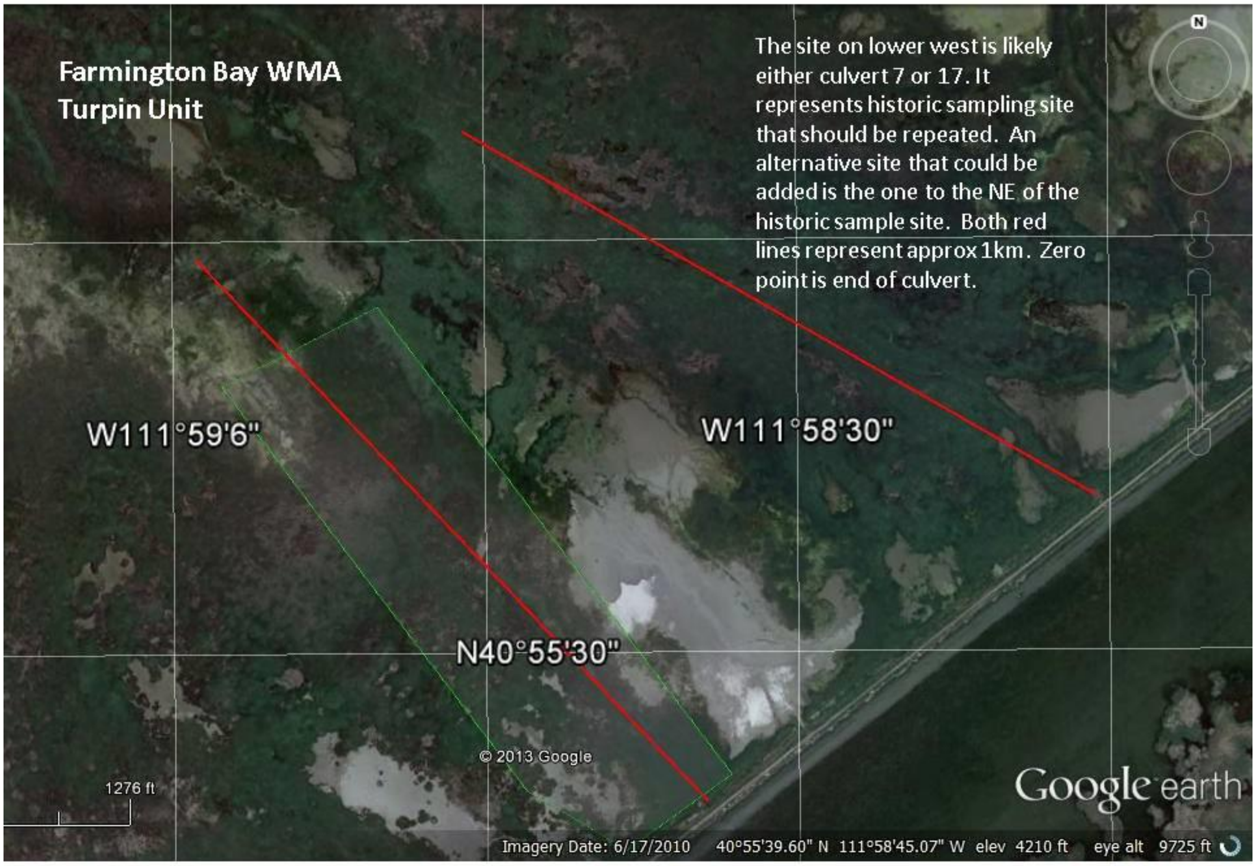

Howard Slough WMA
South
Select site with active flow. This culvert appears to drain a narrow area east of the south unit of the WMA. Zero point is culvert, follow channel downstream as it disperses.
N41°06'54"
W112°08'42"
W112°08'6"
Approx 1km
© 2013 Google
1436 ft
Google earth
Imagery Date: 6/17/2010 41°06'45.40" N 112°08'27.87" W elev 4209 ft eye alt 10414 ft

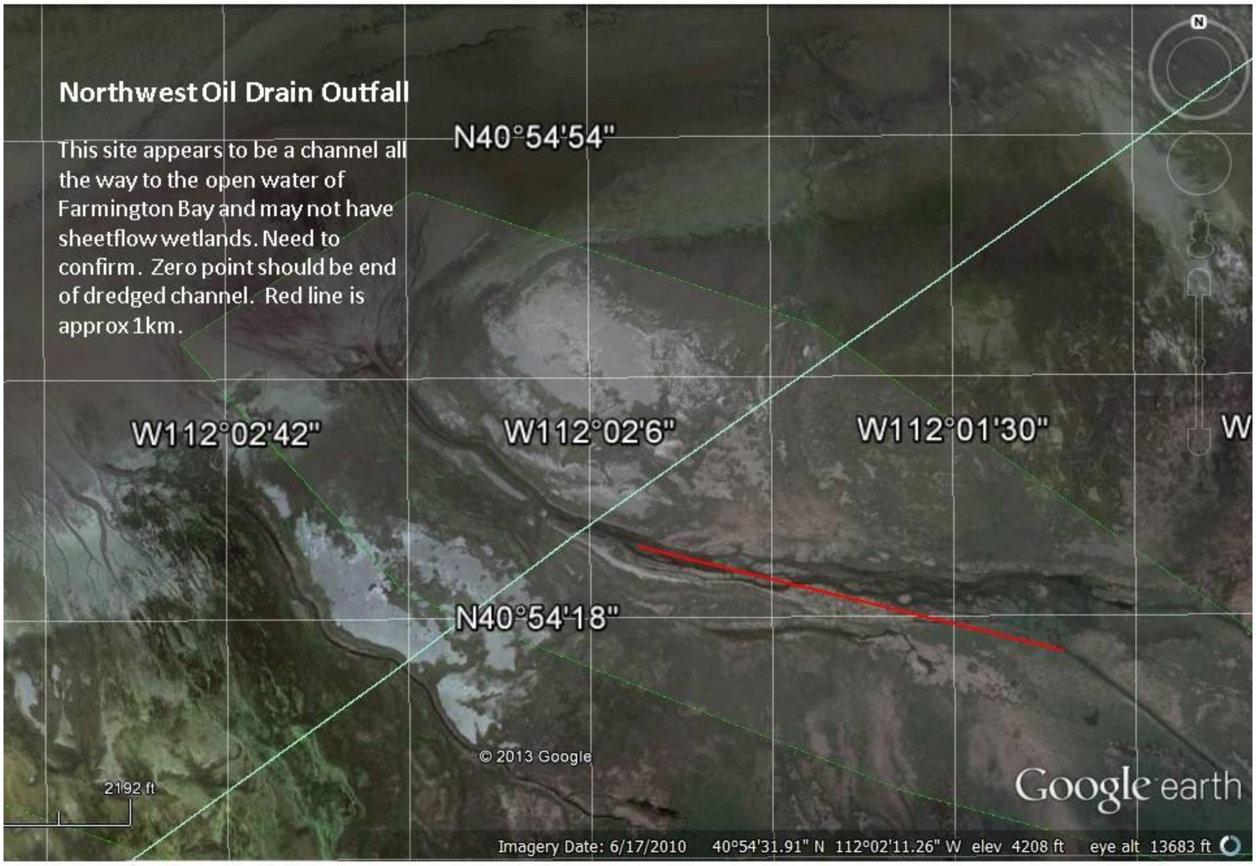

North Davis Sewer District Outfall
Identify point where channel "breaks" into the mudflat and use that as zero point. Follow direction of channel for 1km.
N41°05'6"
W112°08'6"
W112°07'30"
Approx 1km.
© 2013 Google
1680 ft
Google earth
Imagery Date: 6/17/2010 41°04'58.93" N 112°07'50.62" W elev 4208 ft eye alt 11469 ft

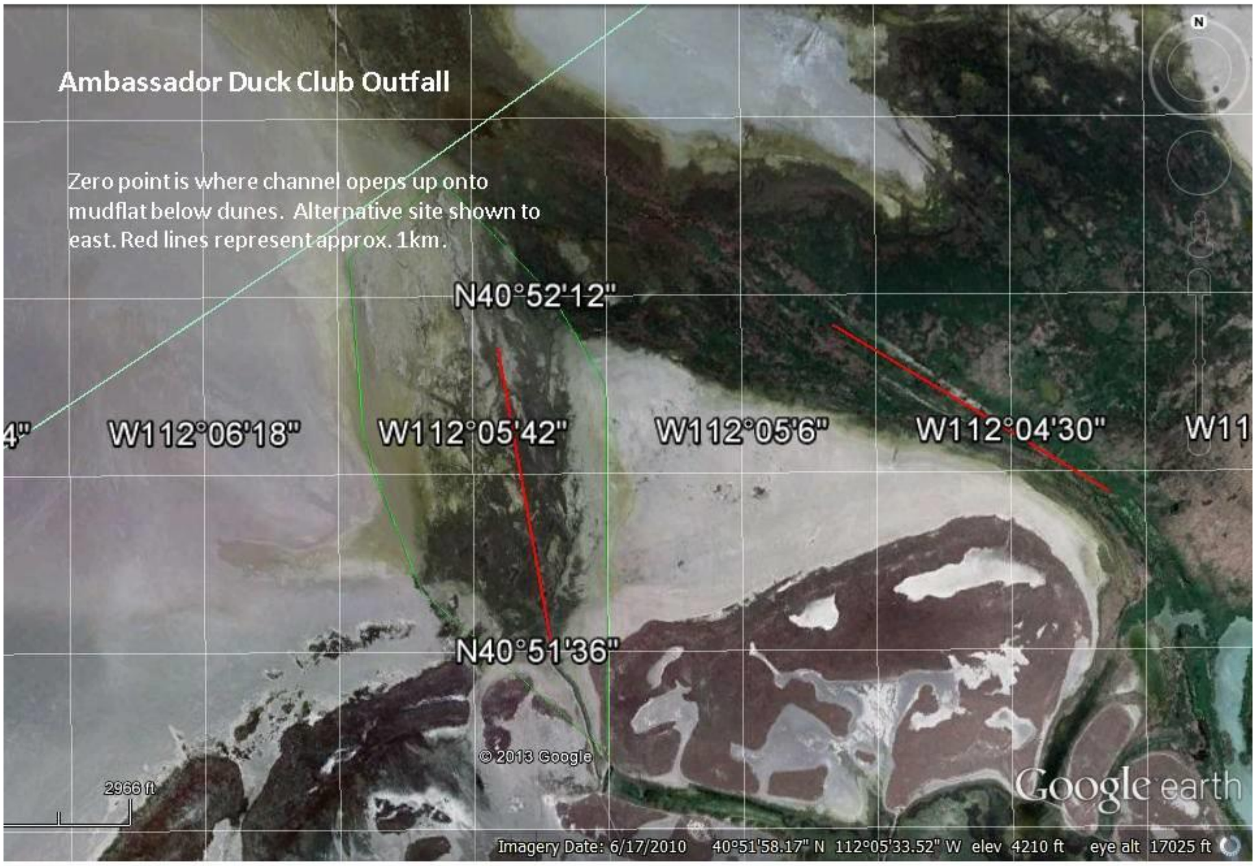

Kays Creek Outfall
This site could be challenging to identify a point where the channel flows onto the mudflats and disperses. Line shown is approx 0.7km long.
W112°00'54"
© 2013 Google
809 ft
Google earth
Imagery Date: 6/17/2010 41°01'42.16" N 112°00'58.38" W elev 4210 ft eye alt 7709 ft

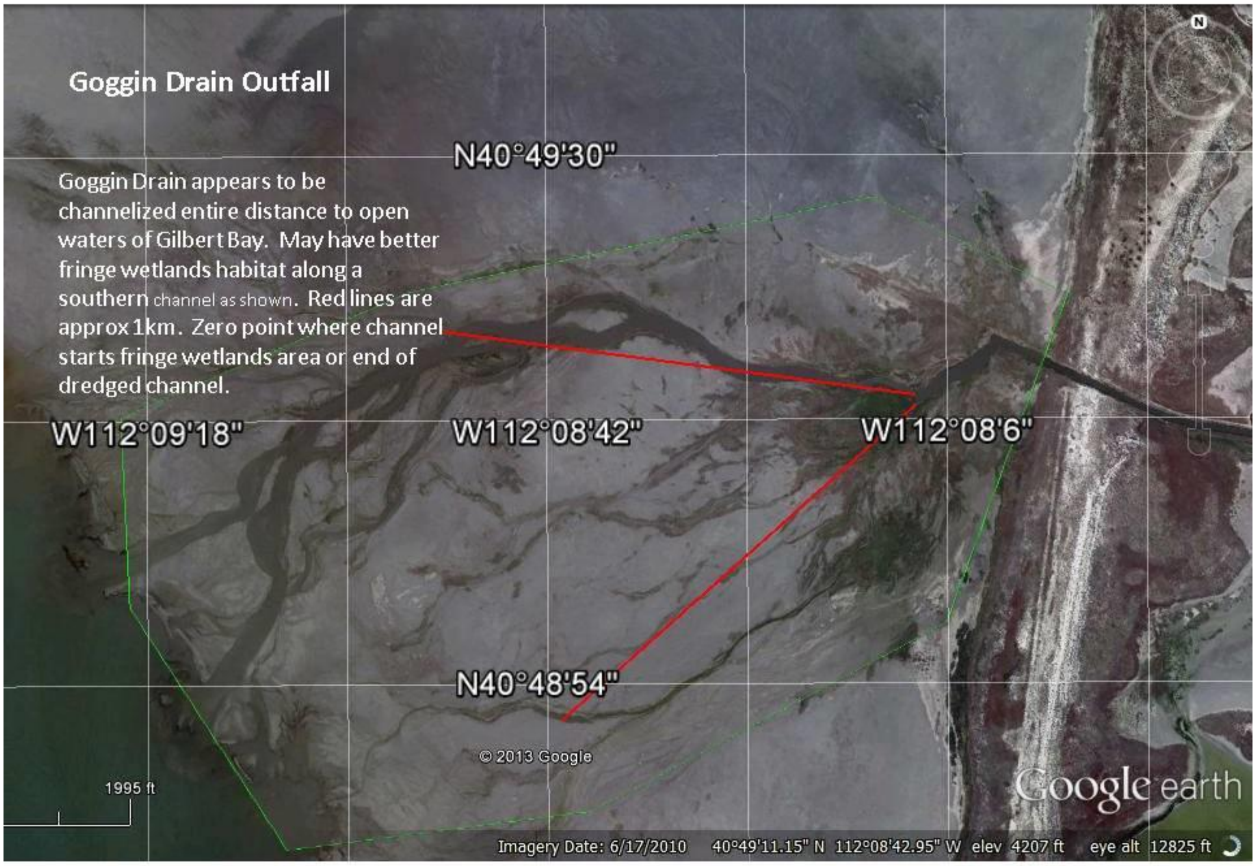

Central Davis Sewer District Outfall
Zero point is where channel begins on mudflat. Follow flow for approx 1km as shown.
W111°57'54"
W111°57'18"
N40°59'42"
© 2013 Google
1432 ft
Google earth
Imagery Date: 6/17/2010 40°59'51.50" N 111°57'43.68" W elev 4212 ft eye alt 10412 ft


Farmington Bay WMA Unit 1 Outlet
Previous studies looked at fringe wetlands downstream of culverts 7 and 17. Cannot find a map showing which culverts these correspond to. Two possible sites near Unit 1 are the boat channel (less desirable due to disturbance) orsite to the south starting near parking lot. Zero point will be culvert/weir. Red lines show approx. 1km.
N40°57'18"
N40°56'42"
N40°56'6"
W111°58'12"
W111°57'
W111°55'48"
Airboat Access Ramp
© 2013 Google
3718 ft
Google earth
Imagery Date: 6/17/2010 40°56'30.69" N 111°57'25.31" W elev 4209 ft eye alt 20272 ft


Farmington Bay WMA
Turpin Unit
The site on lower west is likely either culvert 7 or 17. It represents historic sampling site that should be repeated. An alternative site that could be added is the one to the NE of the historic sample site. Both red lines represent approx 1km. Zero point is end of culvert.
W111°59'6"
W111°58'30"
N40°55'30"
© 2013 Google
1276 ft
Google earth
Imagery Date: 6/17/2010 40°55'39.60" N 111°58'45.07" W elev 4210 ft eye alt 9725 ft


Northwest Oil Drain Outfall
This site appears to be a channel all the way to the open water of Farmington Bay and may not have sheetflow wetlands. Need to confirm. Zero point should be end of dredged channel. Red line is approx 1km.
N40°54'54"
W112°02'42"
W112°02'6"
W112°01'30"
N40°54'18"
© 2013 Google
2192 ft
Google earth
Imagery Date: 6/17/2010 40°54'31.91" N 112°02'11.26" W elev 4208 ft eye alt 13683 ft


Ambassador Duck Club Outfall
Zero point is where channel opens up onto mudflat below dunes. Alternative site shown to east. Red lines represent approx. 1km.
N40°52'12"
W112°06'18"
W112°05'42"
W112°05'6"
W112°04'30"
N40°51'36"
© 2013 Google
2966 ft
Google earth
Imagery Date: 6/17/2010 40°51'58.17" N 112°05'33.52" W elev 4210 ft eye alt 17025 ft


Goggin Drain Outfall
Goggin Drain appears to be channelized entire distance to open waters of Gilbert Bay. May have better fringe wetlands habitat along a southern channel as shown. Red lines are approx 1km. Zero point where channel starts fringe wetlands area or end of dredged channel.
N40°49'30"
W112°09'18"
W112°08'42"
W112°08'6"
N40°48'54"
© 2013 Google
1995 ft
Google earth
Imagery Date: 6/17/2010 40°49'11.15" N 112°08'42.95" W elev 4207 ft eye alt 12825 ft