saline wetlands conservation partnership

Arbor Lake Complex Wetland Restoration Planning and Design Project

Conceptual Design Memorandum

August 2009

THE FLATWATER GROUP INC.

MEMORANDUM

To: Tom Malmstrom, City of Lincoln – Saline Wetland Project Coordinator

From: Gordon Coke, The Flatwater Group, Inc.

Copy: Dan Schulz, Lower Platte South NRD – Natural Resources Coordinator
Randy Stutheit, NGPC – Wildlife Biologist
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Date: 5 August 2009

Re: **Conceptual Design Memorandum for Arbor Lake Complex Wetland Restoration Planning and Design**

PROJECT BACKGROUND

The City of Lincoln's Arbor Lake Complex (ALC) is a unique 132-acre property on the north edge of Lincoln, Nebraska that contains a diverse habitat of saline wetland and grassland areas. The City of Lincoln acquired the original Arbor Lake site as mitigation to offset the impacts of wetland fill resulting from the construction of the Capital Parkway West bypass in west Lincoln. In 2004, the City of Lincoln purchased an additional 69 acres of property to the east and south of the original Arbor Lake site with funding provided by the Nebraska Environmental Trust. The additional property includes saline flats, grassland areas and a meandering tributary to Little Salt Creek. It provides a buffer that protects the fragile saline wetland areas from future land uses associated with a developing community. The City of Lincoln and the Nebraska Game and Parks Commission (NGPC) manages the ALC.

The Saline Wetlands Conservation Partnership (Partnership) was formed in 2003 as a result of a 2002 grant received by the City of Lincoln from the Nebraska Environmental Trust. The Partnership uses the *Implementation Plan for the Conservation of Nebraska's Eastern Saline Wetlands* (2003) as guidance. The goal of the Implementation Plan is "no net loss of saline wetlands and their associated functions with a long-term gain in sustaining wetland functions through the restoration of hydrology, prescribed wetland management, and watershed protection." Full partners of the Partnership include the City of Lincoln, Lancaster County, the Lower Platte South Natural Resources District, The Nature Conservancy and the Nebraska Game and Parks Commission. Other partners include private landowners, USDA-Natural Resources Conservation Service, Ducks Unlimited, the Wachiska Audubon Society, the Nebraska Sierra Club, the Home Builders Association of Lincoln, Pheasants Forever, , University of Nebraska-Lincoln, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Nebraska Department of Environmental Quality, and the Nebraska Wildlife Federation.

PURPOSE

The purpose of this design memorandum is to present the proposed conceptual design plan for wetland and habitat restoration and improvement measures at the ALC. Proposed design measures include wetland enhancement and improvement; shallow excavations and sediment removal; in-stream grade control structures; stream widening and bank slope adjustment; stabilization of critical stream bank sections; streambed elevation adjustment; installation and modification of water level control structures; vegetation management techniques; primitive trail development; and providing pedestrian and small vehicle access (including bridge).

In order to optimize the conceptual design and develop a list of feasible restoration and improvement measures, The Flatwater Group, Inc. (TFG) completed a detailed topographic survey of the entire project area (see Appendix A). The topographic information collected on the project site has allowed TFG to develop concepts that will achieve the project goals as well as construction feasibility. This information provides baseline data and helps to shape the physical constraints of site restoration. In addition to topographic information, data on soil and groundwater salinity were collected throughout the site and a preliminary plant species inventory was conducted.

This design memorandum will assist the partners of the Saline Wetlands Conservation Partnership in moving forward into the final design phase. The ALC restoration project will improve and enhance Nebraska's Eastern Saline Wetlands and address the Comprehensive Strategies and Landscape Objectives of the Implementation Plan.

DESIGN CONCEPTS

The overall conceptual design approach required careful consideration of the sensitive ecological nature of the area. TFG addressed the ALC project in a manner similar to the nearby Shoemaker Marsh wetland restoration project. At Shoemaker Marsh, TFG's design and construction management philosophy catered to the sensitive ecosystem on the property. For the ALC project, TFG will again limit the amount of intrusive components traditionally incorporated into heavy construction projects, a "less-is-more" design concept has been employed by concentrating structures on fringe areas away from sensitive species and by naturalizing structures to the extent possible. This design philosophy minimizes impacts to the area during construction and allows a faster assimilation of the improvements into the ecosystem once they are complete.

The conceptual design for the ALC Wetland Restoration Planning and Design Project incorporates specific design elements to restore and enhance the property. The specific design components include: 1) Wetland improvements; 2) Habitat enhancements; 3) In-stream improvements; 4) Primary berm removal and replacement; and 5) Pedestrian and small vehicle access improvements.

Specific activities that fall under each of the design element categories include the following:

WETLAND IMPROVEMENT MEASURES

1. *Wetland Enhancement*. The property is split approximately in half by a berm/access road. Due to the berm's orientation and the location of Category 1

saline wetland on both sides, the site has two primary wetland areas; the existing wetland to the north of the berm and potential wetland areas in the south-central area of the property.

2. *Berm Removal, Replacement and Outlet Modification*. The existing primary berm material should be removed and hauled off-site. The berm is comprised of unknown base material, concrete rubble with voids, non-compacted fill, etc. The City of Lincoln Public Works Department repaired a portion of the primary berm in 2006 due to structural failure associated with dispersive soils and hydrology. In the spring of 2008, a section of the berm breached just west of the outlet structure due to heavy rain in the watershed. The berm was again repaired with fill material and broken concrete. Construction of a new berm shall include suitable construction material that will be built to Nebraska Department of Roads Class III compaction standards. New berm construction should be phased in the construction project so as to allow for wetland site evaluation following the berm removal. The berm alignment and footprint should not be significantly changed due to restrictions of the Category 1 saline wetlands adjacent to the primary berm. In addition to berm replacement, the existing outlet structure will be removed and replaced. The current concrete outlet structure has a sluice-gate for water elevation control and a drawdown elevation limitation of about 2 feet above the toe elevation of the berm. However, the structure limits the ability of site managers to control water levels. The concrete structure should be replaced with a pre-fabricated water level control structure that will allow for complete Arbor Lake drawdown.

3. *Shallow Excavation/Sediment Removal*. Shallow excavation of sediment within wetland areas will re-establish micro-topography and undulating bottom elevations within each cell. Side slopes could be shaped and stabilized as part of the design measures. Locations and depth of sediment removed should be determined by observing existing vegetation, other surface indicators (e.g., salt flats), electromagnetic survey data collected by the NRCS and field investigation.

4. *Sediment Control Dike Construction*. Two sediment control dikes could be constructed to capture future sediment prior to entering wetland areas. Sediment could be removed from behind sediment dikes as part of long-term management of site. These structures help to minimize and control impacts of future development.

5. *Water Level Control Structure(s)*. Multiple prefabricated water level control structures should be added to each wetland area to manage surface water and provide flexibility to management techniques. The structures typically contain drop-boards ranging from four to eight inches in height that allow for varying water levels and flexibility in water level management. This type of structure allows for complete water drawdown maximizing the ability to manage the hydrologic regime.

6. *Vegetation Management*. Undesirable vegetation should be removed during berm construction and excavation/sediment removal. Once the unwanted vegetation is removed, future management techniques (e.g., prescribed burns) could be used to minimize establishment of undesirable vegetation.

7. *Supplemental Water Supply*. UNL researchers will install deep wells and data could be collected from both deep and shallow wells. Well data collected could be used for an evaluation of construction of a deep artesian well to re-establish a salt conduit to the surface if it is determined that the incised Little Salt Creek channel is effectively impeding flows to Arbor Lake.

IN-STREAM IMPROVEMENT MEASURES

A key component of the ALC restoration project involves work to be conducted within the tributary and along its banks. Modifications to the existing degraded tributary will include grade controls, channel reshaping, and stream bottom elevation adjustment. These in-stream modifications could help stabilize and restore Salt Creek tiger beetle (SCTB) habitat. The SCTB and its habitat are discussed in further detail in a later section of this memorandum.

1. *Grade Control Structure(s)*. Control of existing stream grade within the boundaries of ALC is imperative to the prevention of further down-cutting of the stream bed and degradation of stream banks. The box culvert under North 27th street is the hard point structure on the tributary. The channel is head-cutting to the east of the property from this box culvert flow elevation.

2. *Stream Bank Reshaping*. Bank reshaping and restoration should be considered at selected areas as part of the in-stream improvement measures. Measures may include selected slope modification, benching, re-vegetation, etc. Any reshaping activities should also minimize impacts to existing SCTB habitat (along the stream banks), and if possible, attempt to enhance or increase the extents of those areas. SCTBs have been identified by UNL researchers in these new habitat features. A photo of a new habitat feature at Shoemaker Marsh is shown in Figure 1. Any stream bank reshaping areas at ALC should be approved by site review from UNL entomologists, NGPC Heritage Program managers and other members of the Core Project Team.

Figure 1

3. *Stream Bottom Elevation Adjustment*. Prior to Little Salt Creek's channelization, the tributary meandering through the ALC property had a higher streambed elevation. A combination of sheet pilings and riprap could be installed to raise the water surface elevation in the channel with the intention that over time, sedimentation in the channel behind the grade control structures would raise the streambed. This would affect the water table within the wetland property, with the intention of improving SCTB habitat.

PEDESTRIAN, UPLAND AND OTHER IMPROVEMENT MEASURES

1. *Pedestrian/Small Vehicle Bridge*. A pedestrian bridge would be located in the southeast corner of the property, crossing the main tributary through the property. This will include the addition of new bridge abutments and a new pre-fabricated pedestrian bridge that will span the existing stream width. The crossing is important to access areas of the site for management purposes.

2. *Primitive Trails*. A primitive trail system would improve site use, educational opportunities, and accessibility to the entire site. The trail would also provide management access to the southeast and east side of the property.

3. *Vegetation Management*. Undesirable vegetation (such as cattails and smooth brome grass) should be removed during construction from selected areas. Native seed mixes will be selected for reseeding. Prescribed burning and grazing should be considered as a vegetation management technique.

DESIGN INPUTS

TFG evaluated a number of site conditions in development of the conceptual design measures identified above, including local topography, hydrology and hydraulics, general geology and geotechnical aspects of the site, existing and potential habitat, and existing plant communities. The existing site conditions and their potential for improvement are the primary driver for restoration design measures.

HYDROLOGY & HYDRAULICS BACKGROUND

The City of Lincoln and the LPSNRD are in the process of developing a watershed master plan for the Little Salt Creek. This effort includes development of hydrologic and hydraulic models to support comprehensive planning for storm water management within the watershed. The report is scheduled to be completed in the summer of 2009. Preliminary copies of the hydrologic and hydraulic models (dated 4-14-09) were obtained from the City of Lincoln. These models combined with a separate modeling effort conducted by TFG were used to evaluate current storm runoff conditions to the wetland areas and the tributary, which flows through the ALC to Little Salt Creek.

In the 1930's, Salt Creek's channel was straightened and a uniform channel was constructed. Little Salt Creek was also channelized from its confluence with Salt Creek upstream to the section west of ALC along N. 27th Street. Many of the Salt Creek tributaries, including Little Salt Creek, responded by eroding the stable stream bed and creating incised channels. The incised channels intercept shallow groundwater in addition to forming head-cuts in the banks of the main channel. The loss of shallow groundwater and head-cuts drained many of the wetland areas or significantly altered the natural hydrology of the system.

The stage and storage capacity of Arbor Lake was analyzed using the TFG hydrologic model and field survey data. Maximum capacity of the lake was estimated to be 80-acre feet at an elevation of 1142-feet based on existing ground conditions. This capacity correlates to the runoff volume produced by a 5-year storm event. The current top of berm elevation at Arbor Lake has suffered some degradation; therefore this capacity assumes a berm elevation of 1142-feet.

The preliminary Little Salt Creek Master Plan model (LSCMP) provided a hydraulic model, which was used to determine water surface elevations, stream flow velocities and flood flow widths based on channel and valley physical characteristics. This model included three stream cross sections of interest located at the downstream end, through the middle and upstream of the project site. By using the LSC MP and TFG hydrologic models, 100-, 50-, 10-, 5- and 2-year return intervals were analyzed using peak flow data. . The 2-year storm is contained within the existing channel of the property. The 5-year storm event is generally at or just above the channel capacity within the ALC. An important design consideration is the "bankfull" discharge of the stream. Bankfull stage is generally associated with the flow that fills the channel to the top of the banks where water begins to overflow to the adjacent floodplain. For the Little Salt Creek watershed, this will generally be an event that corresponds to a 2- 5 year storm event. This is an important consideration because the 2 and 5 year storm events generally correspond to the maximum sediment load of the stream and produce enough energy to effect shape and slope of the channel.

In-stream check structures were incorporated into the hydraulic model to assess their potential effects on flooding. These check structures consist of hard armoring that would raise the minimum channel elevation by a total of 2 to 4-feet within the project site. After construction, shallow ponding zones upstream of these structures are designed to slowly sediment-in and raise the stream profile. Results from the LSCMP hydraulic model show that these structures may cause a rise in the floodplain of less than 0.05 and 0.10feet for the proposed 2 and 4feet structures, respectively, for storm events with a return interval greater than 5-years.

Primary use of the hydrologic and hydraulic models would be in the Final Design. The design will include an analysis of the effects of any channel or floodplain modification in order to determine if regulatory requirements can be met. To meet regulatory requirements, channel modifications may not cause more than a 1-foot rise in the base flood elevation. The bankfull discharge will also be analyzed to determine in-stream elevations and possible mitigation measures.

GEOLOGY & GEOTECHNICAL BACKGROUND

1. *General Soil Assessment*. Saline soils, while supporting an exotic ecosystem, contribute to the geotechnical issues of susceptibility to internal erosion and heightened susceptibility to external erosion. External erosion is caused by water flowing rapidly over an exposed soil surface, whether the surface is bare or vegetated. External erosion occurs with all soils to varying degrees, depending on susceptibility of the soil. Internal erosion is the formation of caverns and pipe-like channels within a soil mass and almost exclusively occurs where dispersive soils exist.

   Soil dispersion is characterized as the dissociation of clay particles under the action of slowly-moving water in cracks or small holes or, at the extreme limit, spontaneous dissociation in the presence of water. It is related to the sodium concentration in the pore water and a predominance of exchangeable sodium ions on the surfaces of clay particles.

   Saline wetlands generally have dispersive clay soils. Dispersive clay soils are

expected to occur adjacent to and possibly within the existing berm and in an area, which is south of the berm. Evidence of internal and external dispersive erosion was found along the creek banks, on the floodplain adjacent to the creek, near low embankments on the site, and in active headcuts on the southwest portion of the property. Dispersive "jugs" or sinkholes have formed on the level ground leading away from the creek.

2. *Geotechnical Considerations*. Treatment of dispersive clays will be necessary for low embankments to hold water and for the level areas near the creek and gullies to act as wetlands. Selected gullies and washouts will need to be plugged or otherwise stabilized and the creek channel gradient will need to be stabilized to prevent even higher gradients than currently exist. Embankments to plug gullies will need treatment. Importation of non-dispersive soils for placement as cover for dispersive soils is not as drastic as chemical modification, but can be used to encourage a change in the type and quality of vegetation. In addition, the imported soil will be susceptible to eventual modification to the dispersive condition by the saline groundwater that caused the salt marsh in the first place.

3. *Geologic Investigation*. The project site is located on alluvial bottomlands and loess topped terraces adjacent to a tributary of Little Salt Creek. Geologic logs were reviewed during the installation of three monitoring wells on the site (see Appendix A for well locations). Two wells were installed in the alluvial areas of the property; one well within the wetland on the north end of the project site and another in the central portion of the site adjacent to the Little Salt Creek tributary. The third monitoring well was installed on the eastern edge of the property in an upland area. Well locations are identified in Appendix A. The alluvial well logs were comprised of alluvium consisting of alternating layers of sands, silts and clays of varying color, texture and thickness. The upland well consisted primarily of thick layers of silty clay and fine silty sand. The boring logs for the three well installations are included in Appendix B. In the summer/fall of 2009, three additional monitoring wells will be installed. A medium depth well (40-60 feet) will be installed alongside each of the three shallow wells.

4. *Soil Conductivity Investigation*. In addition to the soil borings from the well installation, staff from the NRCS conducted two field investigations of the site using an EM-38 sampling device. The EM-38 (EM is **e**lectro-**m**agnetic) device provides measurement of ground conductivity within an effective range of 1.5m below the ground surface. This device is useful for mapping variations in soil salinity and moisture content. The unit was used throughout a portion of the project site to collect readings. Several thousand data points can be obtained in one hour. The data measurements of the EM-38 collected by the NRCS during two field visits are presented in Appendix C. Further EM-38 data collection on other areas of the ALC may be conducted by the NRCS. It is important to note that both salinity and soil moisture content are recorded by the EM-38. Additional soil sampling that may be conducted by the National Soil Survey Laboratory (through the NRCS) at the ALC site is outlined in Appendix D.

5. *Soil Salinity Measurements*. A Delta-T brand W.E.T. (Water content, Electrical conductivity, and Temperature) sensor device (on loan from UNL research team) was used in the field to measure water content, electrical conductivity and temperature at a number of locations north of the berm. The data shows relative

ranges of soil salinity between different vegetation communities and hydrologic regimes. Additional measurements should be collected throughout the entire site and used in conjunction with data collected by the EM-38 unit. The soil salinity data can be useful in determining soil salinity ranges of different plant species. This could be done during the early stage of final design. However, the effort is dependent on NRCS participation and availability.

6. *Monitoring Well Water Sampling*. Well water for each of the three monitoring wells was sampled by TFG staff and a UNL researcher using the same protocol of other well sampling that is part of the broader ongoing research project in the watershed. Data for well samples is provided in Appendix E. Additional sampling could include water chemistry testing of ions, dissolved oxygen and isotopes.

WETLAND PLANT COMMUNITY BACKGROUND

As described above, the Arbor Lake portion of ALC was acquired by the City of Lincoln as mitigation to compensate for the loss of a small saline wetland filled during the construction of Capitol Parkway West. Botanists from UNL and UNO have been visiting the Arbor Lake property dating back as far back as the 1970s. Historical data obtained from the site is included in the attachments. The data includes soil chemistry data and plant identifications throughout the wetland.

The USFWS developed a series of letter and number codes to adapt the national wetland classification system to map form. The existing wetland plant community at ALC includes seven (7) general types of wetlands as classified by the USFWS. The aerial photo and classification map are provided in Appendix F.

OTHER BACKGROUND INFORMATION

A compilation of plant and soil chemistry data from the ALC site is available. Some of the information dates back to the late 1980's. The NGPC and U.S. Army Corps of Engineers compiled soil chemistry data in 1988 and 1992 at the ALC site. Data collection points were recorded on a simple schematic with site features (trees, posts, etc.) as reference points. Plant identification data has been collected along transects at the site since 1992 (subsequent collection years are 1995, 1997, 1999, 2001, 2003, and 2008) by Dr. Thomas Bragg of the University of Nebraska-Omaha. In addition to Dr. Bragg's data, NGPC has a collection of plant information from the year 1990 recorded along transects at the site. The plant and soil chemistry data is available upon request.

HABITAT

The ALC is one of a limited number of wetland sites in Eastern Nebraska's saline wetland system. These saline wetlands are unique ecosystems comprised of salt-tolerant plants that grow in saline soils and saline surface waters. Plant species such as saltwort and sea blite grow in the saline wetlands. In addition to salt tolerant plants and insect species, the ALC property is home to waterfowl, many bird species, and mammals common to eastern Nebraska.

SALT CREEK TIGER BEETLE HABITAT AND DRAFT RECOVERY OUTLINE BY USFWS

The SCTB is a federally endangered insect that lives in the saline environments of the Salt Creek watershed. The beetle inhabits exposed saline mud flats or mud banks of streams and seeps that contain salt deposits and are sparsely vegetated. The saline environments of ALC include salt flats and fringe areas within saline wetlands and saline creek banks of the tributary to Little Salt Creek that traverses the ALC site.

The Nebraska Ecological Service Field Office, which is a local branch of the U.S. Fish and Wildlife Service (USFWS), prepared a Draft Recovery Outline for the SCTB in February 2009 (draft version available on request). The outline assesses SCTB habitat, threats and provides a preliminary recovery strategy. According to the Draft Recovery Outline, the SCTB requires open, barren salt flat areas for construction of larval burrows, thermoregulation, foraging, and as dispersal corridors. The beetle is also adapted to brief periods of high water within the saline stream corridors and highly saline conditions.

According to the Draft Recovery Outline, the "Little Salt Creek-Arbor Lake Population" population contains the largest number of SCTB. It describes the large population as residing across a large, relatively intact saline wetland complex. The described site includes habitat along the saline stream edge of Little Salt Creek, west and across North 27th Street from Arbor Lake and on the barren salt flats of the ALC site. The SCTB habitat on the property can be generally described as salt flats and those areas or zones of the creek bank that are void of vegetation, remain moist but are not continuously inundated, and are in close proximity to the exposed flats within the stream bottom. A number of salt flats are located north of the berm and beetles have been sighted on these flats in the past. There is also a larger salt flat area adjacent to the channel that drains out of the ALC outlet structure. The SCTB has been studied on this salt flat by University of Nebraska-Lincoln entomologists. The population in Little Salt Creek and ALC site averaged 299 individuals per year over an 18-year period with monitoring at a maximum of three survey sites.

Soil moisture and soil salinity are key habitat properties for SCTB. During the Shoemaker Marsh restoration project, University of Nebraska Entomologists Bill Allgeier and Steve Spomer provided the following information regarding preferred soil moisture and soil salinity of two tiger beetles studied at ALC. Salt Creek tiger beetle (*Cicindela nevadica lincolniana*), burrows occur on the saline creek banks. *Cicindela circumpicta* burrows occur both on the upland salt flats and the saline creek banks.

Soil Salinity and Moisture Data for Tiger Beetles Studied at ALC (Allgeier, 2005)

Species	Mean Soil Elec Conductivity	Lower Confidence Interval	Upper Confidence Interval
Cicindela nevadica lincolniana	2,504.1 mS/m	2,016.0 mS/m	2,992.1 mS/m
Cicindela circumpicta johnsoni	7,873.9 mS/m	4,172.4 mS/m	11,575 mS/m
Species	**Mean Soil Moisture**	**Lower Confidence Limit**	**Upper Confidence Limit**
Cicindela nevadica lincolniana	47.6%	43.5%	51.7%
Cicindela circumpicta johnsoni	35.3%	24.4%	46.3%

ENGINEERING AND CONSTRUCTION

Engineering services include: 1) final design (final grant administration and NEPA compliance assistance, and final design and drawing development); and 2) construction phase (bidding services and construction related services).

In order to achieve a successful restoration project, the key is to secure the services of a competent contractor that can bring the design plans to construction. Paramount to this task is development of a concise, clear, set of contract documents that result in a "biddable" project. Well developed contract documents generally lead to greater contractor interest and more competitive prices. Once the contract is awarded, the engineer and contractor will work together to ensure an efficient construction schedule and ultimately a successful final product are completed at ALC. Additionally, we suggest the team use a phased approach for the construction project. This will allow the team to make modifications (such as berm removal) at the site and monitor the changes prior to moving on to subsequent phases.

It is very important that any design efforts for the restoration project that incorporate the stream and associated banks are constructed within a timeframe that accommodates the SCTB's lifecycle. According to the Draft Recovery Outline, adults are first observed as early as the end of May or as late as mid-June, with species numbers peaking two weeks after first individuals appear and begin to mate and feed. Adult populations begin to disappear in late July, and by August, almost all of the adults have died. Keeping this lifecycle timeline in mind, construction activities that will occur adjacent to or within the streambank will not occur between mid-May and the end of July.

MANAGEMENT PLAN

One of the goals of the wetland restoration project is to prepare a design that will improve the wetland site for many years to come. With this in mind, a management plan should be prepared that will ensure the constructed design measures are maximized. The removal of undesirable vegetation is one of the components of the restoration design. If undesirable vegetation is removed and then returns to the site in only a few years, the design measures will not be maximized. After construction, a system of simple vegetation boundary markers could be installed to track plant community boundaries and provide the Partnership with benchmarks of plant community recovery. In addition to plant assessment, gauges for sediment depth could be installed behind sediment dikes. The gauges would give managers data about sediment depth and help determine when sediment should be removed from a sediment trap.

Cattle grazing may be detrimental to the existing limited population of unique saline plants. Additionally, the Draft Recovery Outline sites cattle grazing in the Threats Assessment section. Cattle grazing impacts soil and modifies soil hydrology, gradually drying out a site and making it unsuitable for SCTB adults and larvae. Future grazing extents for management purposes in the wetland and near SCTB habitat should be carefully selected.

The saline wetlands are a unique ecosystem that is within close proximity to the City of Lincoln. Due to the sensitive plant and insect species in the watershed, a variety of federally funded scientific research projects are conducted within these areas. To ensure that managers are equipped with ongoing research results on a "need to

manage" basis, seasonal updates of research results should be obtained by the Partnership. The information will give managers the ability to adapt management methods as more is learned about the saline wetland ecosystem.

PROJECT SUMMARY

As indicated in the project background section of this memorandum, TFG prepared and followed a detailed scope-of-work under this contract. In general the scope-of-work included three primary service areas: 1) Project initiation, 2) Data collection and field investigation, and 3) Conceptual Design. Associated with each of these service areas were both core and technical team meetings and coordination. The preparation of this conceptual design memorandum is a compilation of those tasks comprising the three service areas.

A large component of this contract was the data collection/field investigation and subsequent development of a topographic map for the ALC (Appendix A). The site topography is essential for final design development and construction services and also serves as one of the design inputs analyzed at the conceptual level. Temporary survey benchmarks are maintained throughout the project site in strategic locations to aid in final design and construction.

In addition to topographic data, subsurface data was collected during monitoring well installation and subsequent monitoring well sampling efforts. These monitoring wells allow for further investigation of saline groundwater beneath the site and the reliance of the saline wetlands on this groundwater source. The monitoring wells were equipped with transducer devices to monitor water levels within each of the monitoring wells. These water level devices are managed by a UNL research team studying the saline wetlands. Additionally, these monitoring wells can be used to observe changes in groundwater levels after restoration measures are in place.

The design concepts developed and discussed during this conceptual phase of the ALC project are presented in the concept plan in Appendix G. The design concepts are identified with consideration to the various design inputs and overall site conditions present at the ALC.

TFG has prepared a preliminary cost estimate to help the Partnership plan for future project development and prioritization of restoration measures. The cost estimate is comprehensive of the design concepts and depicted on the concept plan (Appendix G). The preliminary cost estimate can be found in Appendix H.

While the ALC project is the enhancement and restoration of an existing wetland, it will still be necessary to prepare and submit a Department of the Army Section 404 permit application upon completion of final design. In addition to Section 404 permitting, the project will need Lancaster County Floodplain Development Permit, Nebraska Department of Environmental Quality and Nebraska State Historical Society review.

The primary berm replacement would need to comply with Nebraska DNR's Rules for Safety of Dams and Reservoirs. The berm at Arbor Lake is not permitted. Therefore, a dam safety permit for berm construction will be needed as well as a permit for storage of water from the impoundment. Due to the proximity of Arbor Lake to the city limits of Lincoln, a dam breach analysis will need to be conducted by a professional engineer

prior to dam permit approval. Lastly, in conjunction with dam permitting, considerations will need to be made for potential depletions to the Platte River Basin from the impoundment.

The ALC wetland restoration project final design will likely include construction techniques that will call for large earth-moving equipment. Due to the use of large earth-moving equipment on and adjacent to known habitat of the SCTB, a USFWS Incidental Take Permit may need to be considered prior to construction. A Habitat Conservation Plan must accompany an application for an Incidental Take Permit.

With the completion of these conceptual engineering services, there is ample information for the Partnership to structure and develop a final design scope-of-work that will best fit the goals and objectives of the ALC wetland restoration project.

APPENDICES

Appendix A Topographic Map and Well Locations
Appendix B Well Installation Boring Logs
Appendix C EM-38 Conductivity Maps
Appendix D ALC Soil Sampling Outline from NRCS / National Soil Survey Laboratory
Appendix E Monitoring Well Water Sampling Results
Appendix F Wetland Classification and Map
Appendix G Concept Map
Appendix H Preliminary Cost Estimate

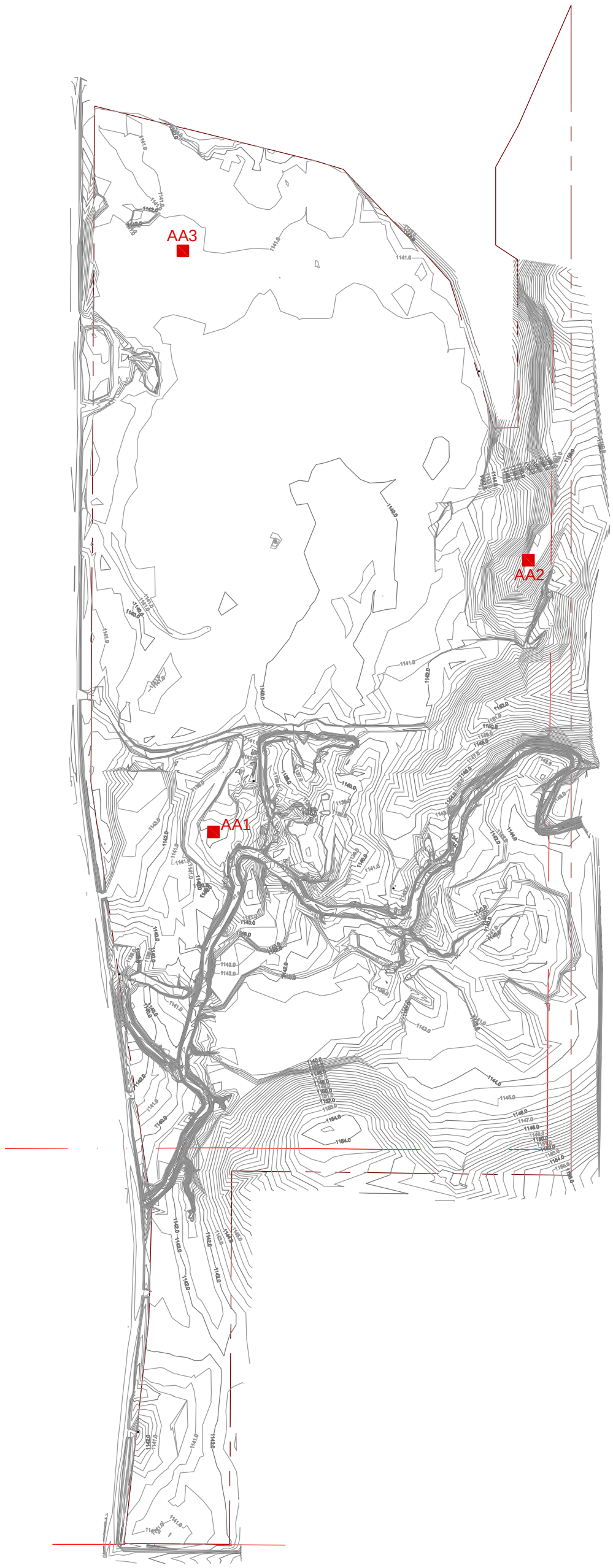
REFERENCES

Allgeier, William J. “The Behavioral Ecology and Abundance of Tiger Beetles Inhabiting the Eastern Saline Wetlands of Nebraska”. M.S. Thesis. University of Nebraska-Lincoln. 2005.

HWS Consulting Group. “Geotechnical Engineering Report: Frank Shoemaker Marsh Wetland Restoration Project, Lincoln, Nebraska.” October 2005.

U.S. Fish and Wildlife Service – Mountain-Prairie Region. “Draft Recovery Outline for the Salt Creek Tiger Beetle (*Cicindela nevadica lincolniana*). Nebraska Ecological Services Field Office.. February 2009.

APPENDIX A



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SCALE

APPENDIX A
CONTOUR MAP WITH WELL LOCATIONS
MAY 2009

ARBOR LAKE COMPLEX
RESTORATION PROJECT
LINCOLN, NE

APPENDIX B

RECORD OF SUBSURFACE EXPLORATION

Boring / Well # :	**AA-1**	Date Drilled:	**10-Dec-08**
Depth of Boring:	28 feet	Depth of Well:	28 ft
Water Level			
Time	12:00pm to 1:30pm		
Date			
Reference			

Project: Arbor Lake-Anderson Property

TOC Elevation : 100

Project NO.

Geologist:

Drilling Co.: **Contract Exploration Drilling (CED)**

Driller: Rick Kuehn

Grout | Sand Pack | ∇ Water Level

Screen | Bentonite Seal | Concrete

Drilling Method: **4 1/4" HSA with Standard 2 ft split spoon**

Depth Feet	GEOLOGIC DESCRIPTION	USCS LOG	Well an Completion	PID ppm	Analyte Sample	Remarks
0.0	Brown topsoil		Flush Mount			
1.0						
2.0	Very dark, plastic clay material					
3.0						
4.0						
5.0	Wet - grayish wet silty clay					
6.0						
7.0			∇ Water Level			
8.0						
9.0						
10.0						
11.0						
12.0						
13.0						
14.0						
15.0						

RECORD OF SUBSURFACE EXPLORATION

Project: **0**	Boring / Well # : **AA-1**	Date Drilled: **10-Dec-08**

Depth Feet	GEOLOGIC DESCRIPTION	USCS LOG	Well Completion	PID ppm	Analyte Sample	Remarks
16.0	Grayish silty clay					
17.0						
18.0						
	Dark greenish clay					
19.0						
				Bentonite seal		
20.0				2 feet thick above		
	Sand intermixed					
21.0	Fine, med sands and some gravel with some silt					
				Sand pack		
22.0				2 feet above		
				screen		
23.0						
24.0				5 foot		
	Thin harder material - dense clay			screen		
25.0						
26.0	Brownish/slightly orangish sand					
	Clean sand on bottom 1.5 foot					
27.0	Stopped on harder coarser material layer (weathered Dakota?)					
28.0						
29.0						
30.0						
31.0						
32.0						
33.0						
34.0						
35.0						
36.0						
37.0						

RECORD OF SUBSURFACE EXPLORATION

Boring / Well # :	**AA-2**	Date Drilled:	**10-Dec-08**
Depth of Boring:	41 feet	Depth of Well:	41 ft
Water Level			
Time	2:30 to 4:00pm		
Date			
Reference			

Project: Arbor Lake-Anderson Property

TOC Elevation : 100

Project NO.

Geologist:

Drilling Co.: **Contract Exploration Drilling (CED)**

Grout | Sand Pack | ∇ Water Level

Driller: Rick Kuehn

Screen | Bentonite Seal | Concrete Pad

Drilling Method: **4 1/4" HSA with Standard 2 ft split spoon**

Depth Feet	GEOLOGIC DESCRIPTION	USCS LOG	Well an Completion	PID ppm	Analyte Sample	Remarks
0.0	Dark topsoil					
1.0	----------					
2.0	Light brown silty clay					
3.0	Fat clay with grayish colors intermixed					
4.0	----------					
5.0	Very moist at 4.5 feet Silty clay light brown					
6.0						
7.0						
8.0						
9.0						
10.0						
11.0						
12.0						
13.0			∇ Water Level			
14.0						
15.0						

RECORD OF SUBSURFACE EXPLORATION

Project: **0**	Boring / Well # : **AA-2**	Date Drilled: **10-Dec-08**

Depth Feet	GEOLOGIC DESCRIPTION	USCS LOG	Well Completion	PID ppm	Analyte Sample	Remarks
16.0						
17.0						
18.0	----------					
	Rich brown soft clay with some grayish color					
19.0	Not as moist compared to around 4.5 feet					
20.0						
21.0						
22.0						
23.0						
24.0	----------					
	Harder clay material					
25.0	----------					
26.0	Fine silty sand					
	Very light brown/tan color					
27.0						
28.0						
29.0						
30.0						
31.0	Silty sand					
32.0						
				Bentonite seal		
33.0				2 feet thick above		
34.0						
				Sand pack		
35.0				2 feet above		
				screen		
36.0						
37.0						

RECORD OF SUBSURFACE EXPLORATION

Project: **0**	Boring / Well # : **0**	Date Drilled: **11-Dec-08**

Depth Feet	GEOLOGIC DESCRIPTION	USCS LOG	Well Completion	PID ppm	Analyte Sample	Remarks
	----------					
38.0	Sub-medium sandy silt		5 foot screen			
38.0	Harder dark chip pieces intermixed (1/2 pea size)					
39.0						
40.0						

41.0	Harder coarser material tight clay gray color					
42.0						
43.0						
44.0						
45.0						
46.0						
47.0						
48.0						
49.0						
50.0						
51.0						
52.0						
52.0						
54.0						
55.0						
56.0						
57.0						
58.0						

RECORD OF SUBSURFACE EXPLORATION

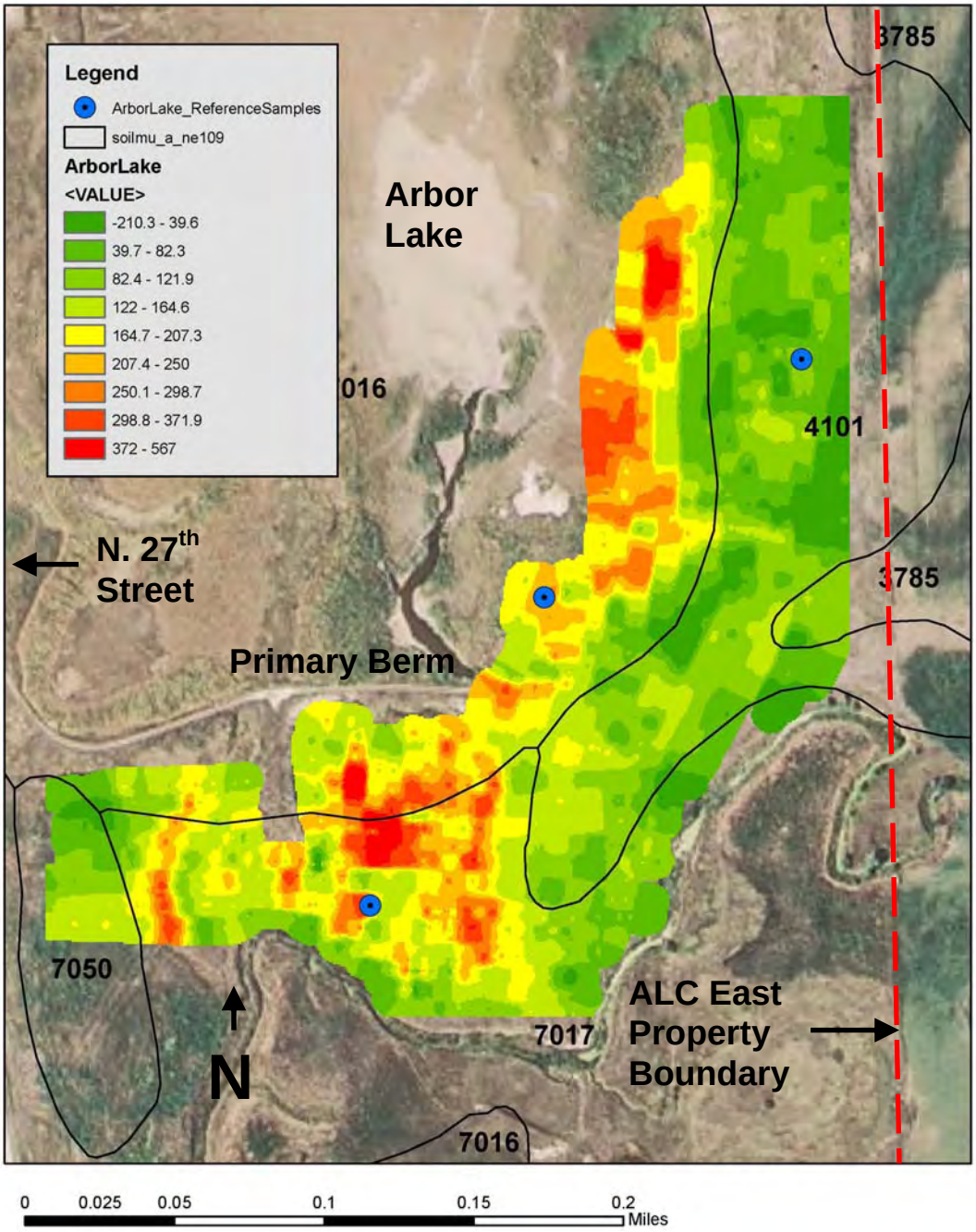
THE FLATWATER GROUP INC.	Boring / Well # : **AA-3**	Date Drilled: **11-Dec-08**	
	Depth of Boring: 14 feet	Depth of Well: 14 ft	
	Water Level		
	Time	8:45 to 11:30am	
	Date		
	Reference		
Project: Arbor Lake-Anderson Property	TOC Elevation : 100		
Project NO.	Geologist:		
Drilling Co.: **Contract Exploration Drilling (CED)**	Grout	Sand Pack	Water Level
Driller: Rick Kuehn	Screen	Bentonite Seal	Concrete
Drilling Method: **4 1/4" HSA with Standard 2 ft split spoon**			

Depth Feet	GEOLOGIC DESCRIPTION	USCS LOG	Well an Completion	PID ppm	Analyte Sample	Remarks
	Soil		Flush Mount			
0.0						
	Dark moist silty clay					
1.0	Rust staining — Salt crust noted at					
	Some very thin fine sandy layering — 12 and 20in after coring dried					
2.0	----------		Water Level			
	Very dark moist clay					
3.0						
4.0	Fine sandy mixed in silty-clay					
	Very thin distinct layering with some thin sand layers					
5.0			Bentonite seal			
6.0	----------		2 feet thick above			
7.0	Light gray uniform color					
	Fine sand intermized with silty-clay		Gravel pack			
8.0	Salt crust noted at about 8 feet when coring dried		2 feet above screen			
9.0	----------					
	Salt crust noted at about 9 feet when coring dried					
10.0	Fine to med greenish sand with silt intermixed					
11.0			5 foot screen			
12.0						
13.0	----------					
	Light gray silty clay					
14.0	Some fine sand intermixed					
15.0						

APPENDIX C

Appendix C1 – EM-38 Conductivity Map

Data Collected 31 October 2008

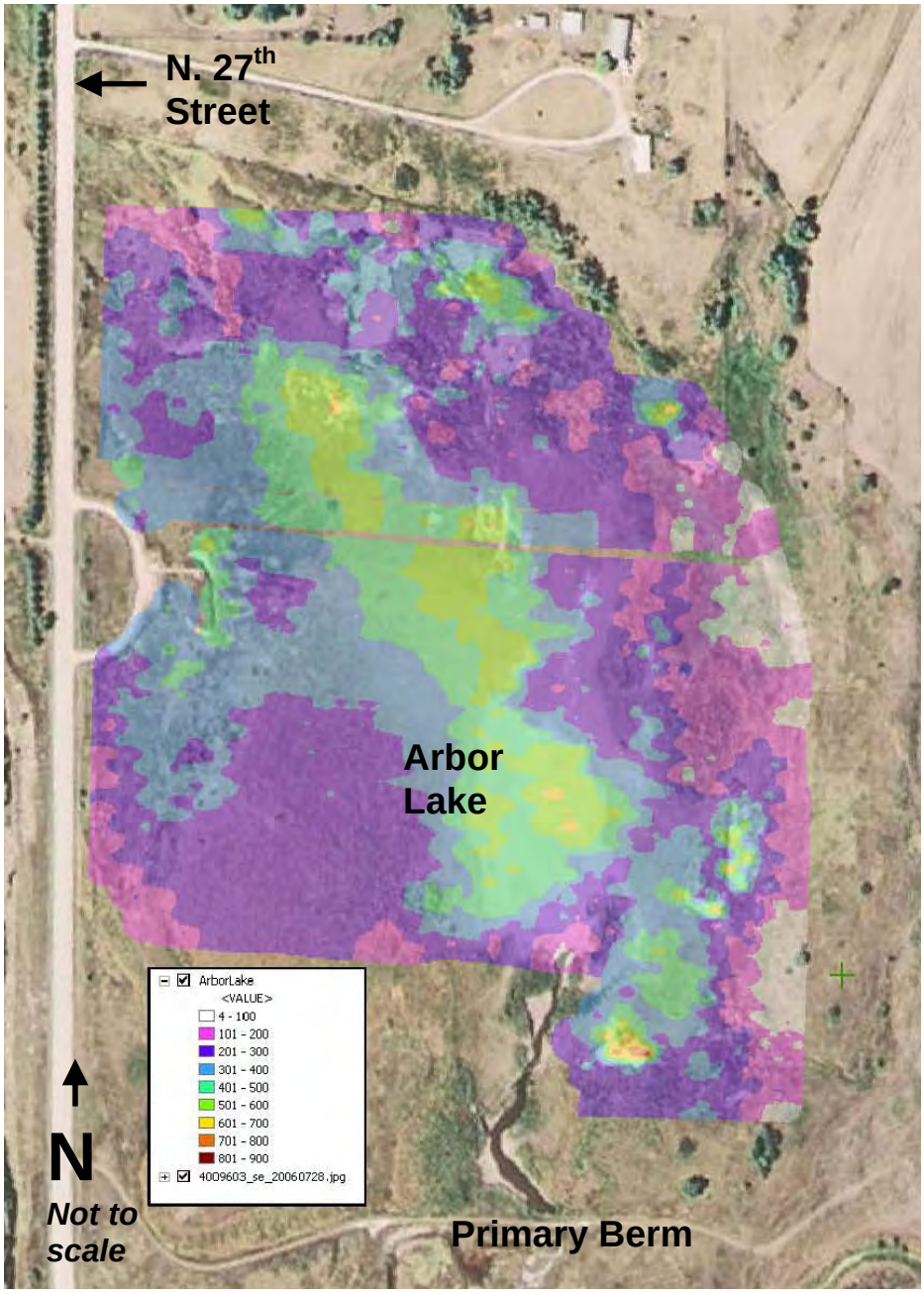


Data Provided by NRCS – Lincoln MLRA Soil Survey Office

Units are mS/m (milli-Siemens/meter). Red color denotes areas of high soil conductivity and green color denotes areas of low soil conductivity. EM-38 measured soil conductivity within soil profile from ground surface to a depth of 1.5m.

Appendix C2 – EM-38 Conductivity Map

Arbor Lake – EM-38 Readings
Data Collected 22 July 2009



Data Provided by NRCS – Lincoln MLRA Soil Survey Office

Units are mS/m (milli-Siemens/meter). Dark red color denotes areas of high soil conductivity and pink color denotes areas of low soil conductivity. EM-38 measured soil conductivity within soil profile from ground surface to a depth of 1.5m.

APPENDIX D

Appendix D

Arbor Lake – Soil Sampling

National Soil Survey Laboratory (NSSL) Sampling

At the current time, we would like to collect samples from three soil map units out at Arbor Lake. These are:

MUSYM	MUNAME
7016	Salmo silty clay loam, channeled, frequently flooded
7017	Salmo silty clay loam, occasionally flooded
4101	Crete variant silty clay loam, 1 to 4 percent slopes

All three of these map units have salinity issues and are commonly associated with the saline wetlands in Lancaster County. It will be important to pick a location that is representative of the map unit for sampling. For the 3 sites selected, holes will be dug to 2 meters in depth with a bucket auger and soil samples collected from each horizon.

The soil samples will be sent into the NSSL as reference samples rather than characterization samples. Reference samples usually are ran within 4 months and allows for quicker return of the data. The following soil properties will be found for each sample:

Sodium Adsorption Ratio (SAR)
Exchangeable Sodium Percentage (ESP)
Electrical Conductivity (EC)
pH
Texture
Total Carbon and Organic Carbon
Cation Exchange Capacity (CEC)
Base Saturation (BS)
Carbonates
Gypsum
1, 2, and 15-bar water retention

When the site is sufficiently dry, soil pits will be dug with a backhoe. These will be sampled and sent into the NSSL. Similar tests as those stated above will be run. Clods will also be collected for bulk density.

EM-38 work

The EM-38 will be run in different areas to determine how variable the electrical conductivity is across the area. Additional soil samples can be collected in those areas showing significant differences in EM-38 readings. EC and pH will be run on these at our office using handheld EC and pH meters. The sites will be georeferenced so samples can be taken later in time to see how EC and pH may be varying throughout different times of the year.

APPENDIX E

Appendix E - Monitoring Well Water Sampling Results (with assistance from James Gilbert, UNL researcher working with Dr. Ed Harvey on the saline wetlands research project)

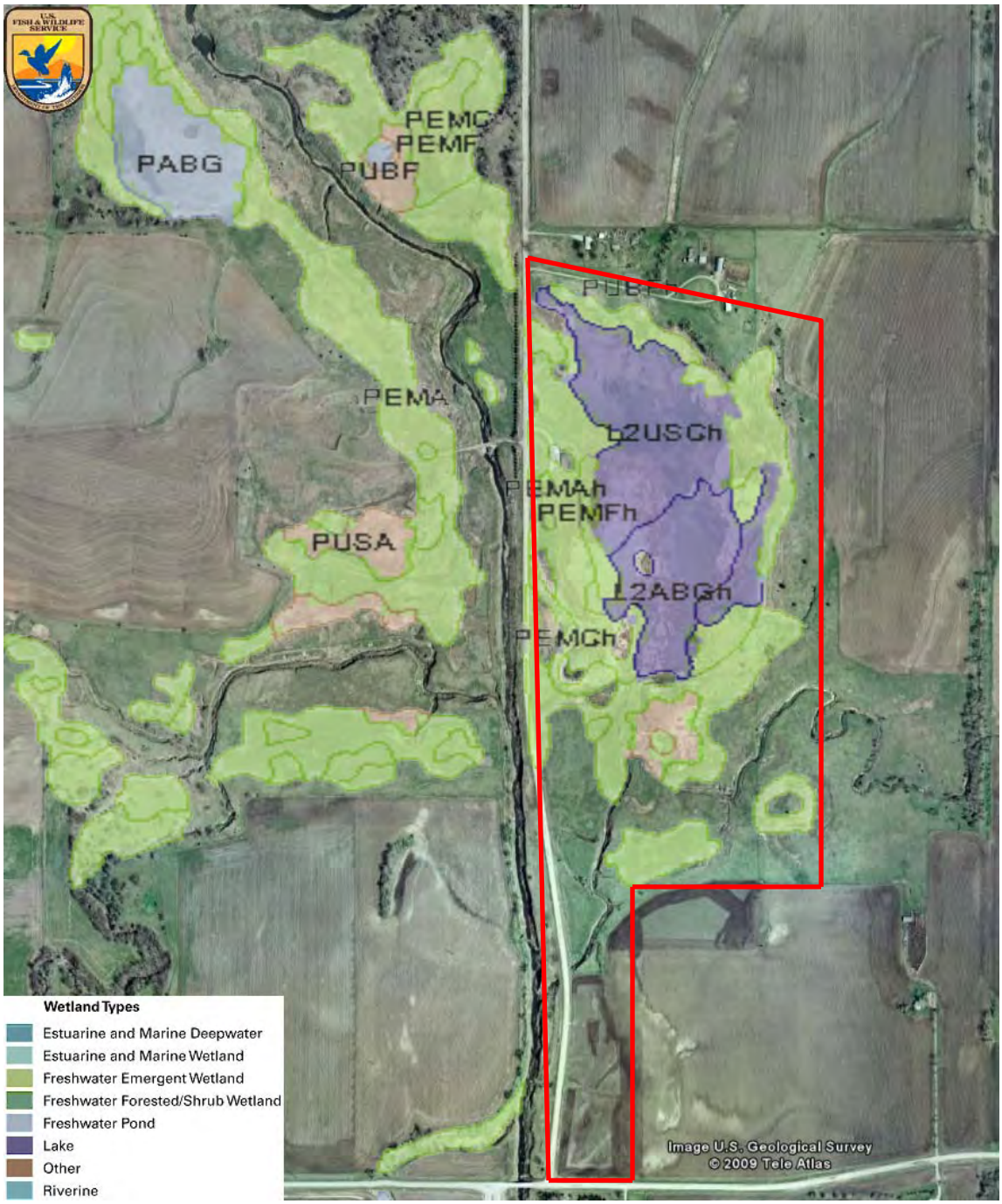
Arbor-Anderson Well AA-1 (south)		Arbor-Anderson Well AA-2 (east)		Arbor-Anderson Well AA-3 (north)
Sample Date: 19 March 2009		Sample Date: 20 March 2009		Sample Date: 20 March 2009
WL= (2.175m or 7.16 ft from top casing)		WL = (4.987m or 16.36ft)		WL = (1.442m or 4.73ft)
Ec = 3,167uS/cm		Ec = 1,532uS/cm		Ec = 18,320uS/cm
Sc = 4,147uS/cm		Sc = 1,996uS/cm		Sc = 24,920uS/cm
pH = 8.83		pH = 7.34		pH = 7.26
Temp = 12.6° C		Temp = 12.8° C		Temp = 12.8° C
Salinity = 2.2 ppt		Salinity = 1.0 ppt		Salinity = 15.2 ppt

Conductivity (Ec): measurement of conductive material in liquid sample without regard to temperature
Specific conductance (Sc): also known as temperature compensated conductivity which automatically adjusts reading to a calculated value which would have been read if the sample had been at 25° C
The results for both Ec and Sc are reported in uS/cm or microsiemens per centimeter.
Salinity: a calculation made by the instrument electronics, based upon conductivity and temperature readings, in parts per thousand (ppt)

THE FLATWATER GROUP INC.

APPENDIX F

Appendix F – Wetland Classifications and Map



Approximate ALC boundary

PUBFh: [P] Palustrine, [UB] Unconsolidated Bottom, [F] Semipermanently Flooded, [h] Diked/Impounded

[P] Palustrine – The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: 1) are less than 8 hectares (20 acres); 2) do not have an active wave-formed or bedrock shoreline feature; 3) have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; 4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

[UB] Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%.

[F] Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water. Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations. For clarification of the extent of impoundment see discussion of Lacustrine System limits.

PEMAh: [P] Palustrine, [EM] Emergent, [A] Temporarily Flooded, [h] Diked/Impounded

[P] Palustrine – The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: 1) are less than 8 hectares (20 acres); 2) do not have an active wave-formed or bedrock shorelinefeature; 3) have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; 4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water. Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations. For clarification of the extent of impoundment see discussion of Lacustrine System limits.

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[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

[F] Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

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PEMCh: [P] Palustrine, [EM] Emergent, [C] Seasonally Flooded, [h] Diked/Impounded

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[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

[C] Seasonally Flooded - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water.
Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations. For clarification of the extent of impoundment see discussion of Lacustrine System limits.

L2USCh: [L] Lacustrine, [2] Littoral, [US] Unconsolidated Shore, [C] Seasonally Flooded, [h] Diked/Impounded

[L] Lacustrine - The Lacustrine System includes wetlands and deepwater habitats with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; 3) total area exceeds 8 hectares (20 acres).

(2) Littoral - All wetland habitats in the Lacustrine System. Extends from shoreward boundary to 2 meters (6.6 feet) below annual low water or to the maximum extent of nonpersistent emergents, if these grow at depths greater than 2 meters.

[US] Unconsolidated Shore - Includes all wetland habitats having three characteristics: 1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock; 2) less than 30% areal cover of vegetation other than pioneering plants; and 3) any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, seasonal-tidal, temporary-tidal, or artificially flooded. Intermittent or intertidal channels of the Riverine System or intertidal channels of the Estuarine System are classified as Streambed. Landforms such as beaches, bars, and flats are included in the Unconsolidated Shore class.

[C] Seasonally Flooded - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water. Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations. For clarification of the extent of impoundment see discussion of Lacustrine System limits.

L2ABGh: [L] Lacustrine, [2] Littoral, [AB] Aquatic Bed, [G] Intermittently Exposed, [h] Diked/Impounded

[L] Lacustrine - The Lacustrine System includes wetlands and deepwater habitats with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; 3) total area exceeds 8 hectares (20 acres).

(2) Littoral - All wetland habitats in the Lacustrine System. Extends from shoreward boundary to 2 meters (6.6 feet) below annual low water or to the maximum extent of nonpersistent emergents, if these grow at depths greater than 2 meters.

[AB] Aquatic Bed - Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in

most years. Aquatic beds generally occur in water less than 2 meters (6.6 feet) deep and are placed in the Littoral Subsystem (if in Lacustrine System).

[G] Intermittently Exposed - Surface water is present throughout the year except in years of extreme drought.

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water. Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations. For clarification of the extent of impoundment see discussion of Lacustrine System limits.

<u>PUSA: [P] Palustrine, [US] Unconsolidated Shore, [A] Temporarily Flooded</u>

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: 1) are less than 8 hectares (20 acres); 2) do not have an active wave-formed or bedrock shoreline feature; 3) have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; 4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

[US] Unconsolidated Shore - Includes all wetland habitats having three characteristics: 1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock; 2) less than 30% areal cover of vegetation other than pioneering plants; and 3) any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, seasonal-tidal, temporary-tidal, or artificially flooded. Intermittent or intertidal channels of the Riverine System or intertidal channels of the Estuarine System are classified as Streambed. Landforms such as beaches, bars, and flats are included in the Unconsolidated Shore class.

[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

PUBFh: [P] Palustrine, [UB] Unconsolidated Bottom, [F] Semipermanently Flooded, [h] Diked/Impounded

[P] Palustrine – The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: 1) are less than 8 hectares (20 acres); 2) do not have an active wave-formed or bedrock shoreline feature; 3) have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; 4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

[UB] Unconsolidated Bottom - Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%.

[F] Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

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PEMAh: [P] Palustrine, [EM] Emergent, [A] Temporarily Flooded, [h] Diked/Impounded

[P] Palustrine – The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: 1) are less than 8 hectares (20 acres); 2) do not have an active wave-formed or bedrock shorelinefeature; 3) have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; 4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

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[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

[F] Semipermanently Flooded - Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land's surface.

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PEMCh: [P] Palustrine, [EM] Emergent, [C] Seasonally Flooded, [h] Diked/Impounded

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: 1) are less than 8 hectares (20 acres); 2) do not have an active wave-formed or bedrock shoreline feature; 3) have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; 4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

[EM] Emergent - Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

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Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations. For clarification of the extent of impoundment see discussion of Lacustrine System limits.

L2USCh: [L] Lacustrine, [2] Littoral, [US] Unconsolidated Shore, [C] Seasonally Flooded, [h] Diked/Impounded

[L] Lacustrine - The Lacustrine System includes wetlands and deepwater habitats with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; 3) total area exceeds 8 hectares (20 acres).

(2) Littoral - All wetland habitats in the Lacustrine System. Extends from shoreward boundary to 2 meters (6.6 feet) below annual low water or to the maximum extent of nonpersistent emergents, if these grow at depths greater than 2 meters.

[US] Unconsolidated Shore - Includes all wetland habitats having three characteristics: 1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock; 2) less than 30% areal cover of vegetation other than pioneering plants; and 3) any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, seasonal-tidal, temporary-tidal, or artificially flooded. Intermittent or intertidal channels of the Riverine System or intertidal channels of the Estuarine System are classified as Streambed. Landforms such as beaches, bars, and flats are included in the Unconsolidated Shore class.

[C] Seasonally Flooded - Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface.

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L2ABGh: [L] Lacustrine, [2] Littoral, [AB] Aquatic Bed, [G] Intermittently Exposed, [h] Diked/Impounded

[L] Lacustrine - The Lacustrine System includes wetlands and deepwater habitats with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; 3) total area exceeds 8 hectares (20 acres).

(2) Littoral - All wetland habitats in the Lacustrine System. Extends from shoreward boundary to 2 meters (6.6 feet) below annual low water or to the maximum extent of nonpersistent emergents, if these grow at depths greater than 2 meters.

[AB] Aquatic Bed - Includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in

most years. Aquatic beds generally occur in water less than 2 meters (6.6 feet) deep and are placed in the Littoral Subsystem (if in Lacustrine System).

[G] Intermittently Exposed - Surface water is present throughout the year except in years of extreme drought.

[h] Diked / Impounded - Created or modified by a man-made barrier or dam which obstructs the inflow or outflow of water. Originally, Diked and Impounded are described as separate modifiers (Cowardin et al. 1979). They have been combined here due to photointerpretation limitations. For clarification of the extent of impoundment see discussion of Lacustrine System limits.

<u>PUSA: [P] Palustrine, [US] Unconsolidated Shore, [A] Temporarily Flooded</u>

[P] Palustrine - The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: 1) are less than 8 hectares (20 acres); 2) do not have an active wave-formed or bedrock shoreline feature; 3) have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; 4) have a salinity due to ocean-derived salts of less than 0.5 ppt.

[US] Unconsolidated Shore - Includes all wetland habitats having three characteristics: 1) unconsolidated substrates with less than 75% areal cover of stones, boulders, or bedrock; 2) less than 30% areal cover of vegetation other than pioneering plants; and 3) any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, seasonal-tidal, temporary-tidal, or artificially flooded. Intermittent or intertidal channels of the Riverine System or intertidal channels of the Estuarine System are classified as Streambed. Landforms such as beaches, bars, and flats are included in the Unconsolidated Shore class.

[A] Temporarily Flooded - Surface water is present for brief periods during growing season, but the water table usually lies well below the soil surface. Plants that grow both in uplands and wetlands may be characteristic of this water regime.

APPENDIX G

SELECTED EXCAVATION (6" - 1')

SELECTED EXCAVATION (1' - 2')

MODIFY EXISTING OUTLET TO ALLOW COMPLETE DRAWDOWN OF ARBOR LAKE

SEDIMENT CONTROL DIKE WITH ROCK OVERFLOW

EXISTING SALT FLATS NOT TO BE DISTURBED (TYPICAL)

SEDIMENT CONTROL DIKE W/ WLCS

REMOVE EXISTING EMBANKMENT AND CONSTRUCT A NEW ONE IN ITS PLACE

SELECTED EXCAVATION (1' - 2')

NEW WLCS

GRADE CONTROL STRUCTURE AT END OF PROPERTY (RAISE STREAMBED ~4')

CREATE SALT FLATS WITH VEGETATED PLATEAUS TO MIMIC EXISTING SALT FLAT AREA NEARBY

EXISTING SALT FLATS

EXISTING FLOW EL = 1132.0'

EXISTING STREAMBED NICK POINT, END OF BACKWATER EFFECT OF 4' CHANNEL RISE

GC = 1136.0'

USE EXISTING SWALE FOR DRAINAGE FROM NEW WLCS

PEDISTRIAN/SMALL VEHICLE BRIDGE

CONSTRUCT/PROMOTE SCTB HABITAT

GC

CONSTRUCT/PROMOTE SCTB HABITAT

GC

REMOVE EXISTING DEBRIS/AUTOS ETC AND STABILIZE THE BANK WITH RIPRAP WHERE NECESSARY

EMBANKMENT W/WLCS

ACCESS EMBANKMENT FOR SMALL VEHICLE TRAFFIC WITH CULVERT(S)

WLCS

REPAIR/PLUG HEADCUTS

ENHANCE OLD OXBOW FOR BACKWATER HABITAT AREA

GC

RAISE THE BOTTOM OF THE CREEK WITH A SERIES OF GRADE CONTROLS/STEP POOLS TO AN ELEVATION OF 1136.0 AT THE OUTLET

CONSTRUCT/PROMOTE SCTB HABITAT

GC

SITE ACCESS ROAD

CONSTRUCT INSTREAM GRADE CONTROL

EMBANKMENT W/WLCS

EXISTING FLOW EL = 1128.6"

SELECTED EXCAVATION (1' - 2')

400' 0 400'

SCALE

THE FLATWATER GROUP INC.

APPENDIX G
CONCEPT MAP
MAY 2009

ARBOR LAKE COMPLEX
RESTORATION PROJECT
LINCOLN, NE

APPENDIX H

Appendix H
Arbor Lake-Anderson Tract Wetland Restoration Planning and Design Memorandum
Conceptual Phase Preliminary Cost Estimate Table

1. **General Bid Items Activity** - includes contractor mobilization, construction fencing, erosion control measures, etc.	**$65,000**
2. **Excavation and Disposal/Vegetation Removal** - sediment and soil removal and spoiling materials on-site to enhance wetland cells, habitat, etc. Materials likely to be spoiled on south and west-central portion of property.	**$162,000**
3. **Sediment Control Measures Construction** - includes construction of low-hazard berms to capture sediment before entering wetland areas	**$30,000**
4. **Primary Berm Reconstruction** - includes removal of existing berm and concrete rubble and construction of new berm with riprap let down structure	**$95,000**
5. **Secondary Berm Construction** - includes two smaller berms with rock overflows and water level control structures	**$25,000**
6. **Grade Control/Stream Bed Elevation Modifications** - in-stream grade control structures including hard armoring, gabions, etc.	**$100,000**
7. **Creek Stabilization Measures** - selected bank grading, composite revetment construction, etc.	**$20,000**
8. **Water Supply / Management** - potential installation of wells, windmills, pumps, etc.	**$18,000**
9. **Head-cut Plugs/Soil Amendment** - plugging selected localized head-cuts and amending the soils as necessary to protect wetlands areas.	**$10,000**
10. **Pedestrian Access Improvements** - includes limited primitive trails (wood chip topped or possibly crushed rock surfacing) to primary restoration areas.	**$20,000**
11. **Pedestrian Bridge** - installation of pre-fabricated structure designed for pedestrian and small truck loading. Includes associated site work, abutments, etc.	**$65,000**
12. **Habitat Restoration** - includes grading improvements to banks, head-cuts, uplands, etc.	**$88,000**
13. **Water Level Control Structures** - includes installation of pre-fabricated, low-maintenance water level control structures.	**$40,000**
14. **Seeding and Planting** - includes seeding all excavation areas, spoil locations, etc.	**$78,000**
15. **Fencing** - barbed wire fence on entire property boundary.	**$24,000**
16. **Misc. Debris Removal/Other** - includes removal of miscellaneous debris located on the site such as old concrete culverts, tires, etc.	**$8,500**
17. **Final Engineering Design** - Professional Engineering Services for final design of restoration measures.	**$105,000**
18. **Construction Phase Engineering Services** - Professional engineer oversight of construction activities	**$52,000**
19. **Subtotal**	**$1,005,500**
25% Contingency	**$251,375**
Preliminary Cost Estimate Total	**$1,256,875**

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