Section 2
Data Collection and Development

2.1 Watershed Inventory

The watershed inventory consisted of collecting, compiling and evaluating existing data applicable to the Little Salt Creek watershed study. A data search was conducted to identify existing information to be used by the project team. Most of the information collected is in digital format and is available on the Watershed Inventory CD. Certain items that were collected are referenced here, but the file size made inclusion in the project CDs impractical or the information is readily available on the internet. GIS files collected as part of the Watershed Inventory are included in the GIS Data CD at the City.

The information collected and compiled is summarized below:

- GIS Data
- Microstation Files
- Aerial Photos and Topographic Data
- Planning Documents
- Previous Studies of Little Salt Creek
- Additional Informational Sources
- Structure Survey
- Previous Meeting Minutes

A complete table of the information including the date and source is found in Appendix I – Watershed Inventory Data Table.

2.2 Hydraulic Structure Field Survey

A hydraulic structure field survey was conducted to obtain the necessary hydraulic data along the study reaches. The hydraulic structures, totaling 80, included existing bridges and culverts that drain at least 150 acres. The stream long profile survey was limited to the flowline elevations taken during this hydraulic structures survey. The information was collected using a combination of Global Positioning System (GPS) and total station technology to obtain the required elevations for each drainage structure, while inventory sheets were used to graphically document the data. The drainage structures were categorized based on two types: bridges and culverts.

Figure 2-1: North 1st Street Bridge

Figure 2-2: Concrete box culvert under Waverly Road

Bridges – The types of information collected for each bridge included size and shape of the opening, upstream and downstream channel invert elevations, entrance conditions (i.e. wingwalls, vertical abutments), bridge deck thickness, low steel elevation and bridge parapet, roadway embankment side-slope rate, type and width of roadway pavement, and spot top of road elevations.

Culverts – The types of information collected included size and shape, upstream and downstream channel invert elevations, entrance conditions (i.e. headwall, wingwalls, mitered to slope, projecting), roadway embankment side-slope rate, type and width of roadway pavement, and spot top of road elevations.

The hydraulic structure naming convention matches that of the existing Lancaster County structure naming convention. Site benchmarks for each structure were located or set and indicated on the hard copy printouts found in Appendix F – Drainage Structure Survey Data. Photos of each surveyed hydraulic structures were also taken and are included on the data CD.

Figure 2-3 graphically illustrates the approximate location of each drainage structure surveyed. Appendix A located in Volume II of the report, contains a CD-ROM that includes the electronically recorded survey data and photographs for each drainage structure.

2.3 Base Mapping/Triangular Irregular Network

The base mapping used for the project consists of Light Detection and Ranging (LiDAR) data provided by the City of Lincoln and Nebraska Department of Natural Resources (NDNR) from November and December 2003. South of Rock Creek Road, a 6-foot Digital Elevation Model (DEM) was created from the LiDAR data. North of Rock Creek Road, a 10-meter DEM created from 1972 USGS Quad map, provided by the NDNR, was used. Many of the basins that were delineated for an earlier HEC-1 hydrologic model were maintained with the HEC-HMS hydraulic model. ArcHydro, an extension of ArcMap, was used to develop basin boundaries from both LiDAR and the 10-meter DEM.

All water mapped water surface elevations were developed by performing a steady-state analysis within HEC-RAS 4.0. All of the information used for this hydraulic model was taken from the LiDAR, DEM, and survey data.

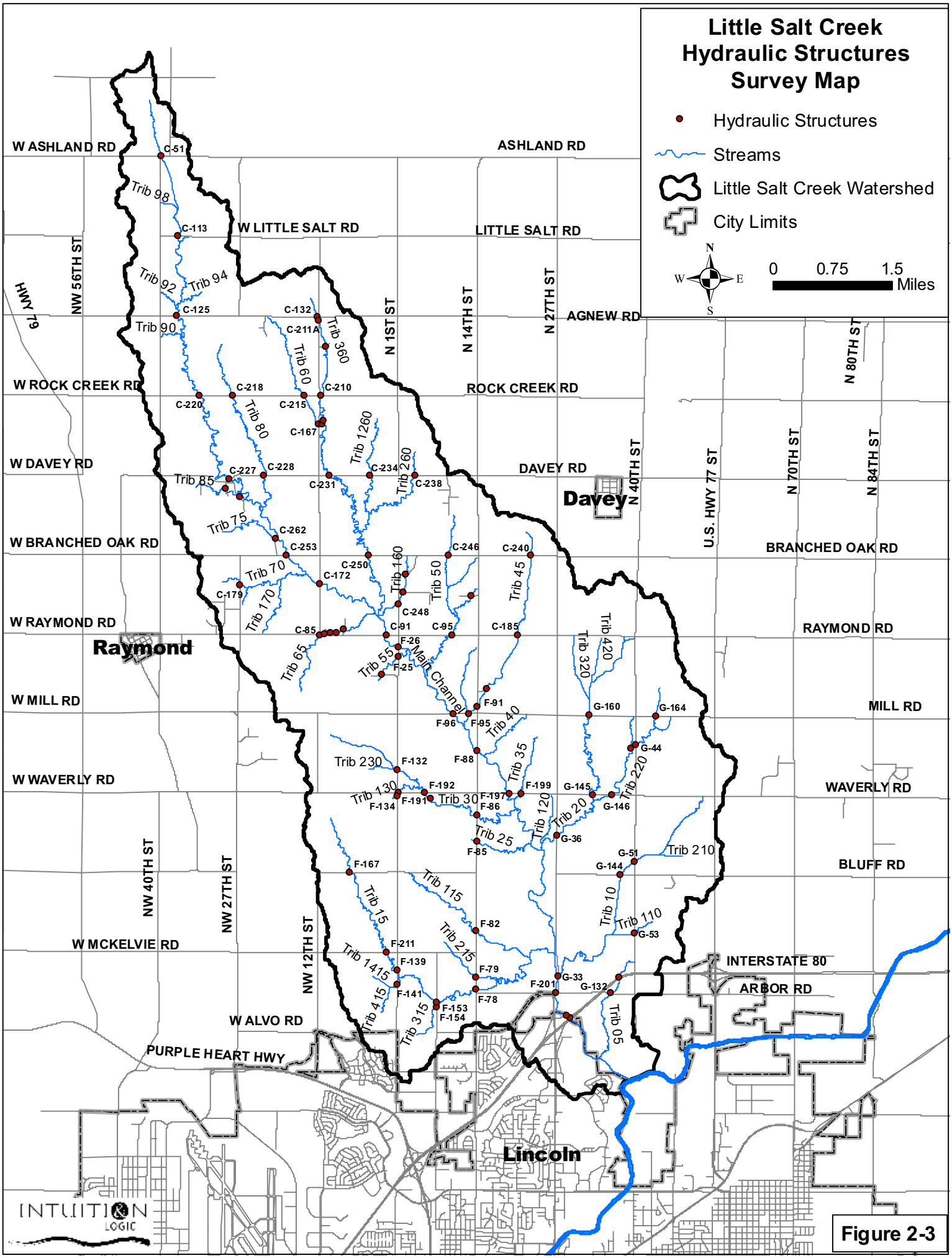

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Figure 2-3

2.4 Geomorphic Investigation

The purpose of the investigation was threefold: first, to evaluate the physical stability of the watershed under current and past conditions; second to make reasonable predictions about how the watershed will change under the proposed future conditions and third to make concept-level design recommendations for managing the watershed.

Geomorphology is a data-intensive endeavor. The selection of data for collection was driven by the choice of analysis and design approaches. There are three commonly recognized approaches to stream design, each with advantages and limitations (Skidmore, et al, 2001). The two simplest approaches, often called analog and empirical methods, explicitly assume equilibrium conditions regarding hydrology and sediment transport. Because Little Salt Creek is not in equilibrium and reliable regional data regarding channel form is not available, data sets consistent with the analytical approach are most appropriate. Analytical methods derive equilibrium conditions based on sediment transport functions, the continuity and roughness equations and hydraulic and hydrologic conditions. The approach does not depend on current or previous channel stability for its validity. In this instance, appropriate data collection focuses on stream process indicators rather than on extensive documentation of channel form.

2.4.1 Geomorphic Background Investigation

The purpose of the background investigation is assessment of basin behavior as a whole. The elements of the evaluation were a drainage basin analysis, plan form analysis and interpretation of historical aerial photographs. The City provided aerial photographs for all three analyses. Both drainage basin analysis and photo interpretation were conducted in general agreement with the methods of Lueder (1959).

The drainage basin analysis provides insight on how local geology influences stream behavior and whether one or more sub-basins behave in ways distinct from the basin as a whole. This may be an indication that such sub-basins require different methods of analysis or management.

The historical photo interpretation provides insight into how the land uses and channel conditions have changed over time. It also provides useful information on the relative intensity and duration of channel process for a given set of stresses. The City supplied historical aerial photographs for the years 1940, 1949, 1959 and 1971. The analysis did not include photogrammetry but did include notation of channel adjustment such as changes in meander amplitude, wavelength or radius of curvature, scour and deposition patterns, tree scrolls and altered lag sections.

2.4.2 Geomorphic Field Investigation

2.4.2.1 GIS and Metadata

Engineers with extensive geomorphic training and experience collected field data on approximately 33 miles of channel. Most of the data collection occurred in March and April 2008. To improve the efficiency of data collection and reduce the likelihood of transcription errors, all field data is collected using HP iPAQ pocket PCs with ArcPad 7.1 using GRS 1980

Traverse Mercator coordinate system projection. GlobalSat BT-338 GPS units relay field location data to the pocket PC computers via Bluetooth® interface. The City supplied base data and projection files. Immediately after field collection, all data is downloaded to ArcMap 9.2 for analysis.

Metadata was viewed and edited in ArcCatalog using the FGDC ESRI metadata format. Metadata was added to the field data collection layers created by Intuition & Logic. Metadata information included: keywords, abstract, purpose, status of data, time period for which data is relevant, publication information, data storage and access information, and who completed the metadata document. Metadata was not added to the GIS files provided by the City and County, nor was existing City and County metadata modified.

2.4.2.2 GIS Data Themes

The following ten themes shown in Table 2.1 represent the collected field data. The themes include 109 data parameters. An electronic version of the data is available in Appendix A.

Table 2.1 Geomorphic Field Data Themes

1	Channel Dimensions (ch dim)
2	Material
3	Vegetation
4	Photos
5	Erosion and mass wasting
6	Profile Features
7	Bar
8	Outfalls
9	Notes
10	Crossings

The data organization is a modification of the approach described by Johnson, Gleason and Hey, (2001). Dr. Johnson's team developed an approach of rapid, efficient data collection that is oriented towards assessing stability in streams affected by infrastructure. The paragraphs below detail the data collected and their relevance to channel process.

Channel Dimensions

The Channel Dimensions theme is essentially channel cross-section information. In this theme, there are 27 parameters, including bed width, bank height, bank angle, top of bank width, scour line elevation, and lower limit of woody vegetation. The combined bank height and angle data are useful in distinguishing between fluvial and geotechnical causes of bank failure and therefore the appropriate approach to management.

Material

The Material theme consists of 14 bed and bank material parameters, including bed or bank material type, bed material shape, degree of consolidation or imbrication, approximate bed material gradation (D_{90}, D_{60}, etc.) and the height and type of seeps. These data and their distribution through the project reach inform assessments of present and future resistance to

erosion. The size of particles on the bed surface, expressed as D_{90} and D_{50}, are indicators of stream power. In addition, consolidation and imbrication of bed material is used in conjunction with bar data to evaluate sediment transport competency.

Vegetation

The Vegetation theme contains 16 elements. Vegetative data include the quality, size and structure of the riparian forest, percent of canopy cover and presence or absence of invasive species. Native vegetation plays a role in stabilizing stream systems through mechanical reinforcement of stream banks by plant roots, soil moisture management through evapotranspiration and hydraulic roughness at the bank toes. Vegetative conditions such as surfed or toppled trees, freshly exposed or barked over roots are useful in estimating the degree of instability and progress towards recovery.

Dominant and sub-dominant tree species and the successional status of the riparian corridor are also important to urban stream management. Invasive non-native species can interrupt the succession of more desirable tree and under story species that would not only provide greater habitat and ecological benefits, but also provide improved bank stability and scour resistance. The timing and degree of disturbance is reflected in the same vegetation characteristics. For example, sudden changes in vegetation type often accompany localized problems, which help distinguish between systemic and local concerns. Vegetative status also indicates how well the stream banks will respond to soil biostabilization and provides insight into the potential for habitat recovery.

Photos

Photos are taken at regular intervals, not only for internal QA/QC practices, but also to provide the user with a virtual walk-through of the study reach.

Erosion and Mass Wasting

The Erosion and Mass Wasting theme includes both quantitative and qualitative data used to identify lengths of channel experiencing active erosion or mass wasting, as well as the dominant mode of failure, such as scour, toppling, flow, wedge, or circular failure. Identifying the type of mass wasting is essential to understanding the failure mode and to distinguish between systemic, local, and geotechnical failures. Scour patterns are also helpful in determining the systemic process driving the erosion.

Profile Features (non-surveyed)

This theme includes the location of knickpoints and the tops of pool-riffle sequences. The height of the knickpoint, bed material type, presence or absence of debris jams, and erosion patterns are all used to distinguish between active and completed channel incision. Evaluation of pool-riffle sequence particularly relative to location in plan form is useful in assessing potential plan form migration.

Bar

The Bar theme is used primarily for developing an understanding of sediment transport, a critically important stream process.

The Bar theme includes 16 parameters. These include extent and type of bed sorting (generally coarse to fine proceeding downstream); pattern of bar placement, bar width relative to stream width, consolidation, vegetative condition and other indicators of potential bar advance. Assessment of bar condition is particularly useful in distinguishing between widening and meander adjustment, two stream processes associated with systemic bank failures. Bar evaluation is also helpful in temporal analysis of stream process and helps distinguish between ongoing and completed channel adjustments.

Outfalls

The Outfall theme locates in-stream or near stream infrastructure. Outfall locations may help explain localized erosion. In additions, the condition of in-stream infrastructure can provide clues to past and present channel conditions in that undermined outfalls indicate the extent of channel incision.

Notes

The notes themes mainly include supporting or miscellaneous information. Notes generally consist of short site descriptions or information that does not otherwise fit into any of the previously mentioned themes.

Crossings

The Crossing theme locates bridges, culverts or exposed utility crossings. The location of crossings is essential when considering design limitations and construction access. In addition, the condition of infrastructure can provide clues to past and present channel conditions in that culverts and crossings can also act as process indicators. Undermined culverts and exposed utility crossings indicate the extent of channel incision while discontinuities in energy distribution and sediment transport can be inferred from the depth and consolidation of deposits in culvert or bridge bays.

2.4.3 Supplemental Geomorphic Aerial Photo Analysis

This section describes the methodology used to assign process to reaches of stream that were not examined in the field. Field investigation was conducted on 33 miles of channels. The field-examined areas included the majority of the main stem and the major tributaries. The field-examined reaches were used for reference for the remaining channels in concert with standard aerial photo interpretation supplemented with GIS-based soils mapping.

The base photograph for the supplemental analysis was the 2007 aerial photo supplied by the City. The historic aerial photo interpretation of the entire watershed conducted as part of the background investigation provided a sound basis for correlating aerial photographic evidence of channel process with the field evidence. For example, correlating the characteristic appearance of erosion, mass wasting or in-channel bars on aerial photos with documented cases of these generated from the field examinations. In most cases, there was a field-examined reach nearby in the same soil type. Dominant process was assigned to the remaining reaches by using the same process indicators in the photo analysis as used in the field work.

2.5 Soil Assessment

A dispersive soils analysis was performed by Terracon Consultants, Inc. on soil samples taken at nine locations throughout the Little Salt Creek watershed that included private property, County ROW, LPSNRD owned property, and Nebraska Game and Parks owned property. Figure 2-4 illustrates the soil boring locations by owner type. The locations were chosen by overlaying the USGS Soil Survey and observed field indicators of dispersive soils. A soil sample was taken where there was a unique soil type and observed dispersive soil characteristics.

2.5.1 Methodology

The soil borings were taken at the top of bank to a depth approximately two to five feet below. The soil located in the upper two to 3 feet was placed into a plastic bag, while the sample collected in the bottom three to five feet was collected in-situ using a Shelby tube sampler. Terracon conducted pinhole dispersion tests on the soil samples along with moisture content, dry density, Atterberg limits and grain size distribution tests.

2.5.2 Dispersive Soils

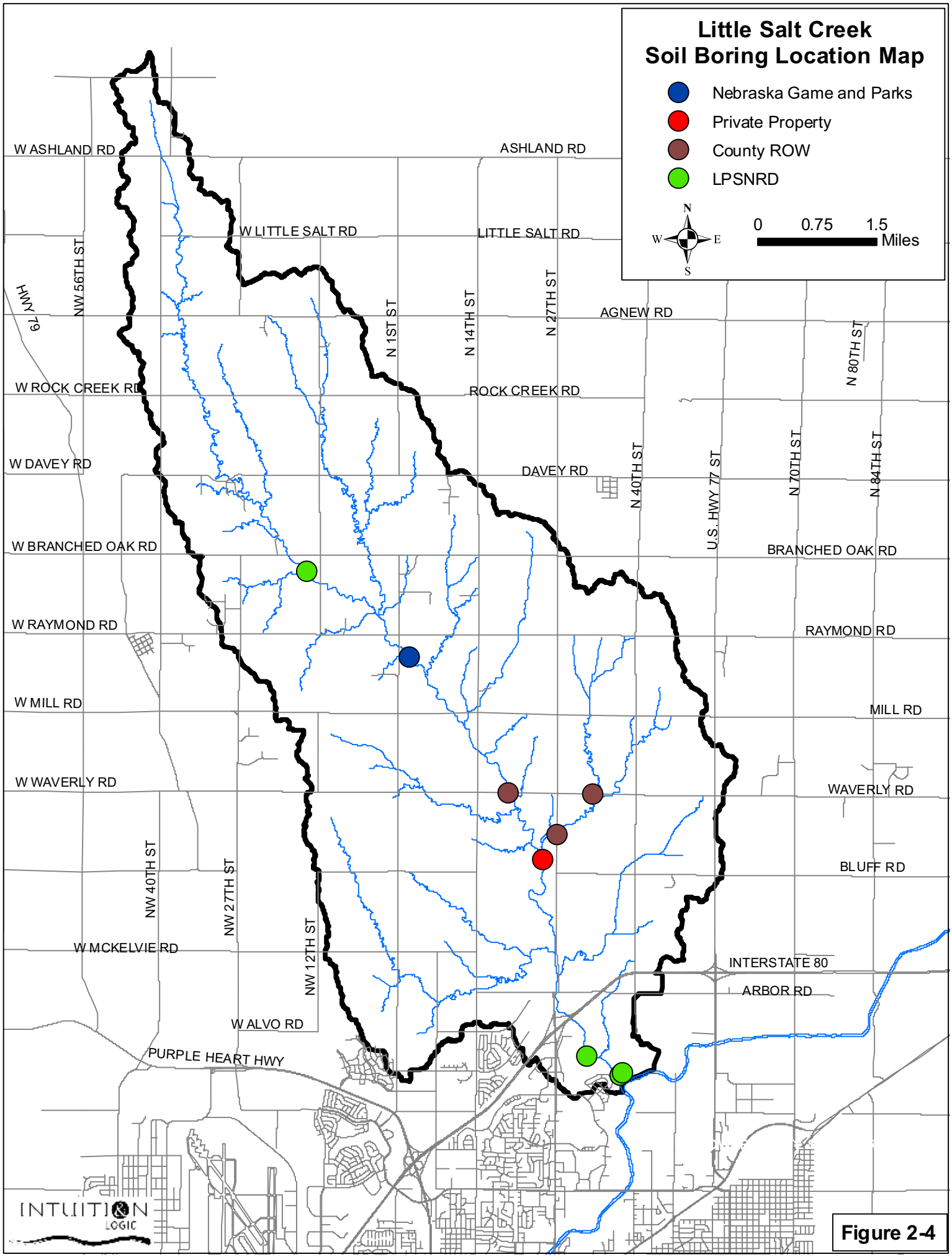
The pinhole dispersion test (ASTM D 4647) was developed to qualitatively measure the dispersibility and consequent colloidal erodibility of clay soils by flowing water through a small hole punched in a specimen. Three alternative procedures for classifying the dispersibility of clay soils are provided. Method A and Method C classify soils into six categories of dispersiveness as: dispersibility (D1, D2), slight to moderately dispersive (ND4, ND3), and nondispersive (ND2, ND1). Method B classifies soils into three categories of dispersiveness as: dispersibility (D), slightly dispersive (SD), and nondispersive (ND).

2.5.3 Saline Seeps

Visually apparent seep locations were identified on the 33 miles of channel that were walked during the geomorphic field data collection. The seeps were visually classified as saline if the seeps possessed obvious indicators of salinity. The indicators for a saline seep include the presence of evaporites and salt tolerant plants or the absence of salt intolerant plants.

2.5.4 Summary and Recommendations

Four of the nine soil samples were found to be slightly to moderately dispersive clays with the five other samples non-dispersive. The slightly to moderately dispersive clays were found near 27th Street just north of Bluff Road, along the Little Salt Creek Mainstem near Waverly Road, near the confluence with Salt Creek, and along the Little Salt Creek Mainstem just south of West Branch Oak Road. Figure 2-5 illustrates the locations of the dispersive clays.


Little Salt Creek
Soil Boring Location Map
Nebraska Game and Parks
Private Property
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BRANCHED OAK RD
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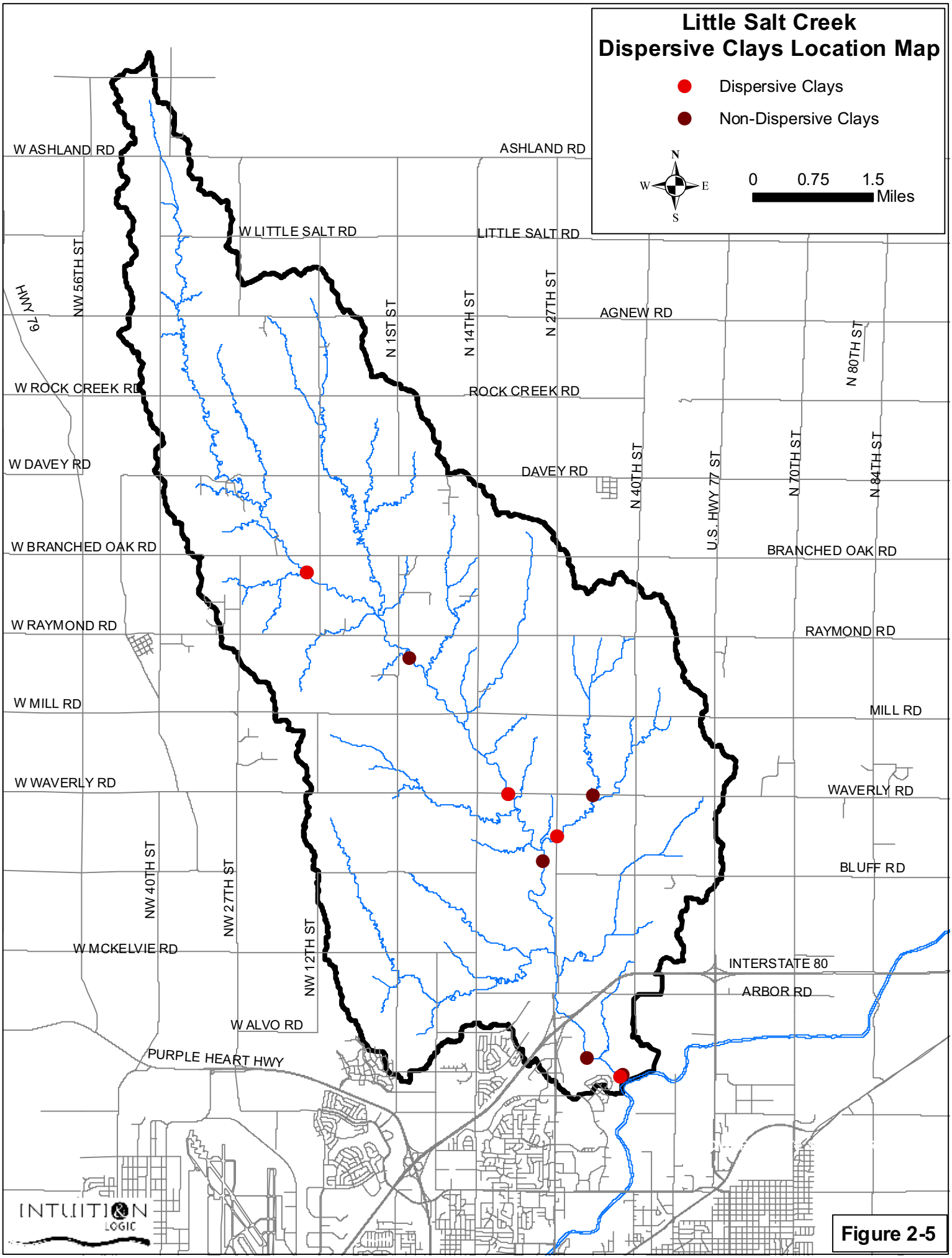
Figure 2-4


Little Salt Creek
Dispersive Clays Location Map
Dispersive Clays
Non-Dispersive Clays
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INTUITION LOGIC

Figure 2-5

2.6 Existing Projects and Conservation Easements

Throughout the Little Salt Creek watershed, existing conservation easements and projects are found both on public land and private property. Wetlands and Salt Creek Tiger Beetle habitat are found within on these properties. The existing conservation easement and projects are shown in Figure 2-6 Little Salt Creek Existing Projects Locations Map.

Arbor Lake, located at N. 27th Street and Arbor Road, is a 62.5 acre site owned by the City of Lincoln. Recent activity includes noxious weed control, repair of the water control structure by the City of Lincoln Public Works and Utilities Department, and insect research projects on the salt flat area by the University of Nebraska – Lincoln. In 2006, miscellaneous construction material and debris were removed from the site along with noxious weeds and woody debris. In 2007, the City of Lincoln repaired a portion of the south berm due to structural failure associated with dispersive soils and site hydrology. The City repaired the water control structure also in 2007. The overhead high voltage transmission line running through the property was removed and rerouted around the property. In 2008 design began on a wetland restoration project with possible completion in 2010.

Whitehead Wetlands located east of N. 27th Street on Wildcat Drive and north of Prairieview Drive, is owned by the Lower Platte South Natural Resource District (LPSNRD). In 2006, activities on the 98.8 acre wetland included management of noxious weed and phragmites. The engineering for restoration/replacement of an existing drop structure adjacent to Little Salt Creek and removal of sediment along 28th Street was also completed in 2006. In 2007, UNL installed monitor wells for research, and construction began on the removal of sediment and replacement of the existing drop structure. Ongoing management of weeds and woody vegetation also continued. In 2008, the construction of a new drop structure was completed.

The Schleich Wetlands is located southwest of Little Salt Creek near the confluence with Salt Creek and east of the Northbridge housing development. This 50.2 acre wetland is owned by the LPSNRD. 2006 activities included engineering to repair the existing drop structure adjacent to Little Salt Creek, managing noxious weeds and bank stabilization along the buffer area adjacent to the Northbridge Subdivision. In 2007, construction to repair the drop structure began; Salt Cedars were removed from the banks of Little Salt Creek and ongoing management of noxious weeds and woody vegetation. The drop structure repair was completed in 2008.

The Frank Shoemaker Marsh, owned by the City of Lincoln, is located at N. 27th Street and Bluff Road. A geotechnical engineering report was completed in October 2005. In 2006, final wetland restoration design was completed, a wetland plant assessment was completed, and restoration of the wetland began. In 2007, the restoration of the wetland was completed and seeps were tested for conductivity with locations marked with GPS. The University of Nebraska – Lincoln installed monitoring wells for research through the Habitat Conservation Planning (HCP) process. Noxious weed management continues in 2008.

King Wetlands, located south of Arbor Road and east of N. 27th Street, is a 61.2 acre site owned by the City of Lincoln. Recent activity includes weed and woody vegetation control. The University installed monitoring wells for research through the HCP process. Past work

included removal of miscellaneous construction and woody debris, and planting of a high diversity native seed mix.

The Schell Property, a 124.3 acres tract of land located southwest of NW 12th Street and W. Branched Oak Road, is owned by the LPSNRD. Purchased midway through 2007, the northeasterly boundary was marked, the LPSNRD established an agreement with Prairie Plains Institute for a high diversity seeding of cropped areas, and the LPSNRD completed an access easement on the west property line off of Branched Oak Road. In 2008, the high diversity seeding was performed on the property.

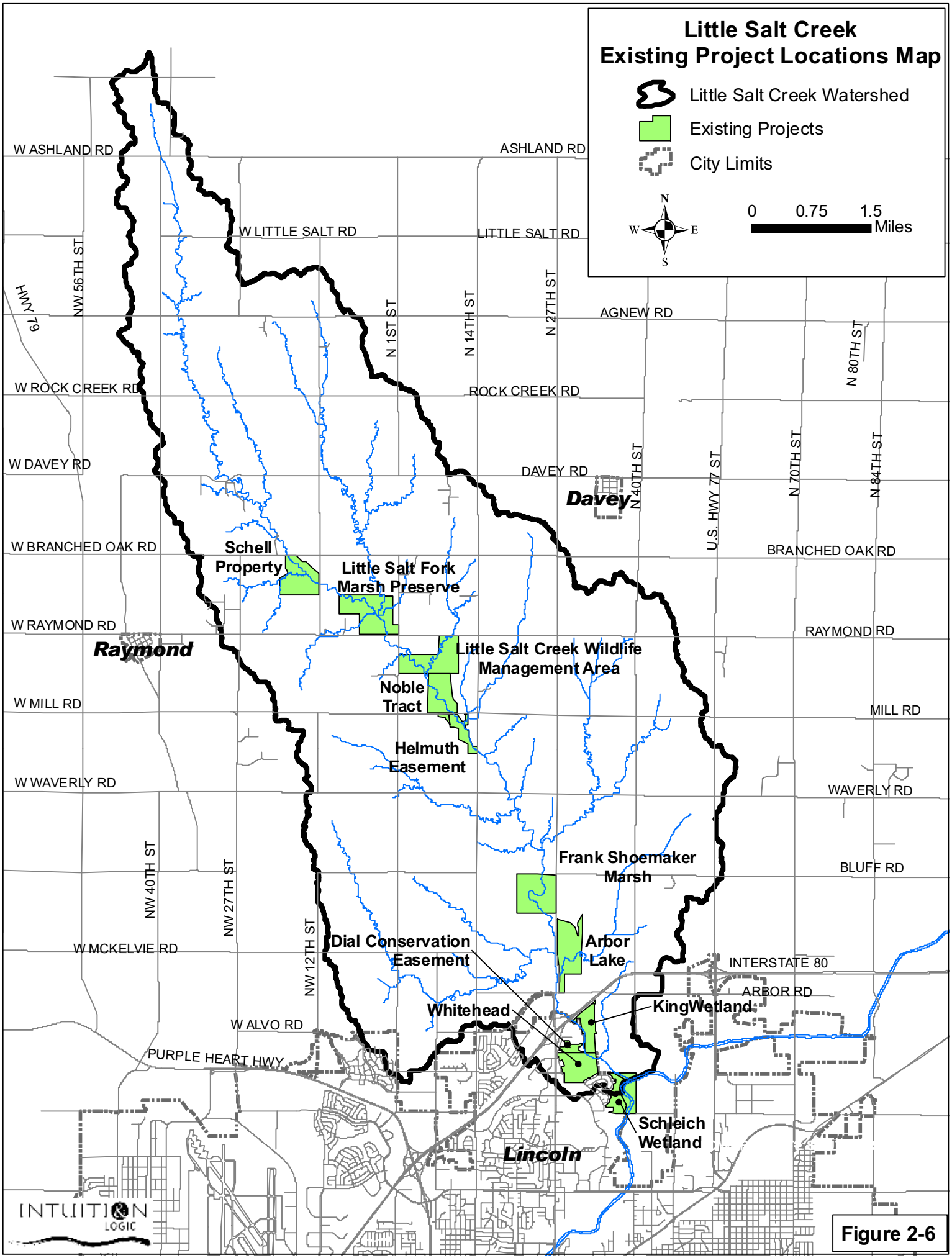
The Little Salt Fork Marsh Preserve is 174.1 acres located northwest of N. 1st and W. Raymond Road and owned by the Nature Conservancy. In 2006, management activities included noxious weed control and woody vegetation removal. In 2007, management activities included noxious weed control, woody vegetation removal, and mowing of a path. Also Salt Cedars were removed from the banks of Little Salt Creek.

The Little Salt Creek Wildlife Management Area located southeast of N. 1st Street and W. Raymond Road is 156 acres in size and owned by the Nebraska Game and Parks Commission. In 2006, site preparation for a prescribed burn and a new perimeter fence was installed. In 2007, UNL installed monitoring wells for research through the HCP process. Perimeter fence installation was completed, grazing was conducted on the site, and some woody vegetation was removed.

The Noble Tract is located between N. 14th and N. 1st Street and north of Mill Road. This 100.5 acre tract, owned by the Nebraska Game and Parks Commission, was purchased March 2007. In May 2000, The Nature Conservancy (TNC) completed a plant community map. In August 2001, dimensions of head-cuts throughout the property were determined and mapped.

Helmuth Conservation Easement, located on the Helmuth property south of Mill Road and west of N. 14th Street. The conservation easement was purchased through NRCS Wetland Reserve Program (WRP). The wetland restoration was completed in 2007 and maintained by the property owner.

Dial Conservation Easement is located along Little Salt Creek, just north of the Whitehead Wetland. This 7.45 acre tract, owned by the City of Lincoln, was purchased through Federal Section 6 on December 31, 2008. The property contains Category 1 saline wetlands and is proposed as Salt Creek tiger beetle critical habitat.


Little Salt Creek
Existing Project Locations Map
Little Salt Creek Watershed
Existing Projects
City Limits
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ASHLAND RD
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W BRANCHED OAK RD
BRANCHED OAK RD
Schell Property
Little Salt Fork Marsh Preserve
W RAYMOND RD
RAYMOND RD
Raymond
Little Salt Creek Wildlife Management Area
Noble Tract
W MILL RD
MILL RD
Helmuth Easement
W WAVERLY RD
WAVERLY RD
Frank Shoemaker Marsh
BLUFF RD
NW 40TH ST
NW 27TH ST
NW 12TH ST
W MCKELVIE RD
Dial Conservation Easement
Arbor Lake
INTERSTATE 80
ARBOR RD
Whitehead
KingWetland
W ALVO RD
PURPLE HEART HWY
Schleich Wetland
Lincoln
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Figure 2-6

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