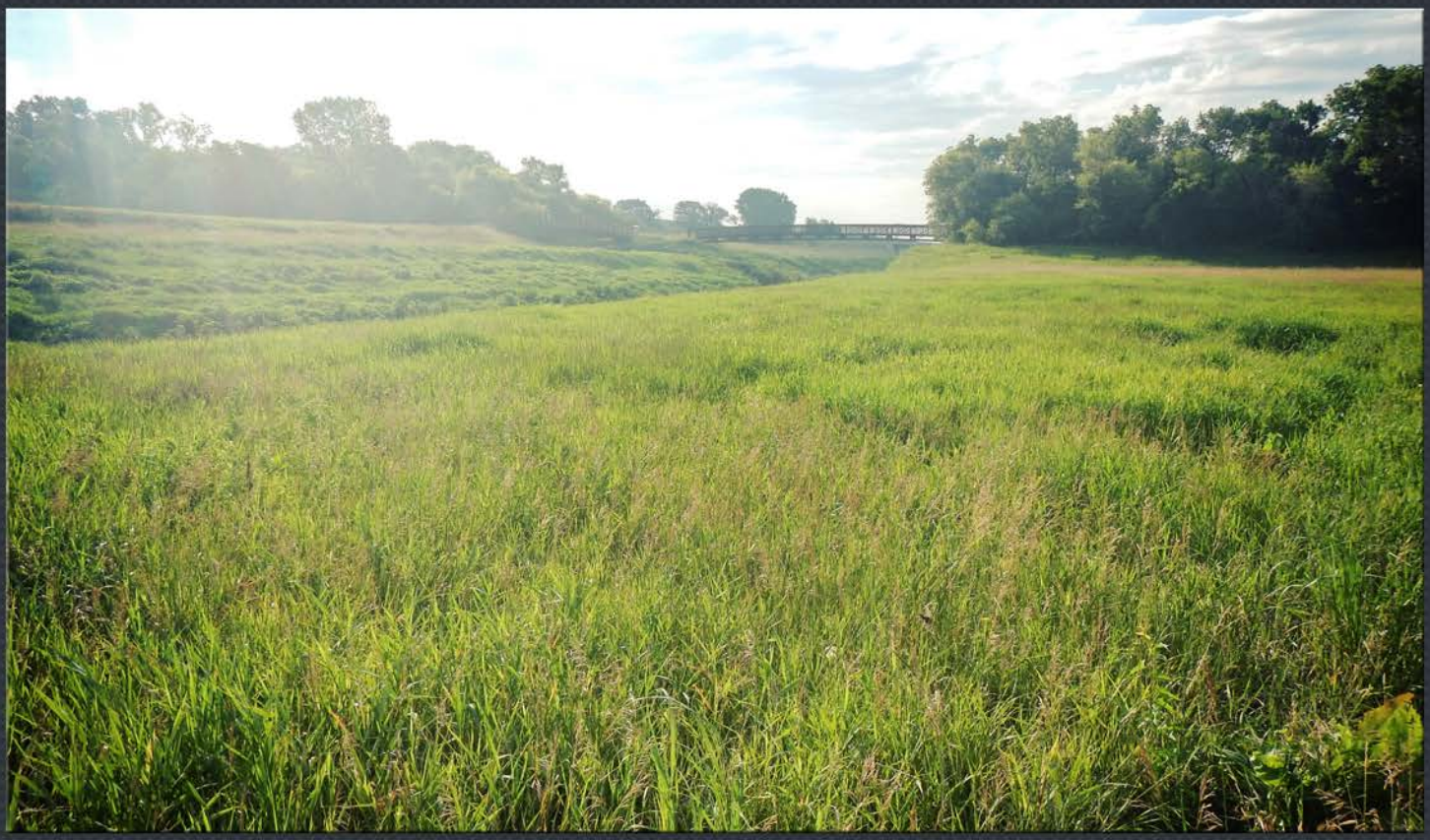


Water Sustainability Fund Application
Lower Loup NRD Aquifer Mapping
December 30, 2015

Enclosed in this document, in its entirety, is an application for the Nebraska Natural Resources Commission's (NRC) Water Sustainability Fund that has been divided into four categories.

The **Cover Letter** introduces the project and states the Applicant's intent.

The **Application** follows the format in the Application Form provided by the NRC answering all questions and requests for information in Sections A, B, C and D. The responses and information provided are intended to address the information requested as directly as possible.

The Application references the **Supplemental Information Attachment (SIA)** where supporting documentation and additional information is contained. The SIA provides additional data and references to support the responses offered in the Application. The information in the SIA is provided in the same order and is numbered the same manner as in the Application. Note that not all sections of the Application will have information included in the SIA.

At the end of the SIA is a **Bibliography** for all external reports, design guidance or other material referenced in the Application. This Bibliography provides the reviewer with additional references relevant to the Application. The combined size of these references prohibits the inclusion of the references within the SIA PDF. Digital copies of the references have been included as part of this submittal. The information provided in the Bibliography is alphabetical, but each entry is cross referenced back to the Application/SIA section to which it pertains and is referenced.

2620 Airport Drive
Ord, Nebraska
68862-1002
(308) 728-3221
(308) 728-5669 FAX
llnrd.org

December, 2015

Mr. Jeff Fassett, P.E.

Director, Nebraska Department of Natural Resources

via Electronic Submission

Re: Lower Loup NRD Application for Water Sustainability Fund Grant

The Lower Loup Natural Resources District (LLNRD) submits the included application to the Water Sustainability Fund for the collection of hydrogeologic information through Airborne Electromagnetic Mapping (AEM). The Board of Directors of the Lower Loup NRD recognizes the importance of detailed hydrogeologic information to the conservation and protection of the water resources. This type of information is necessary for the Board to make the science based management decisions utilizing the best available data. The LLNRD Board has approved this application to the Water sustainability Fund and committed to providing the necessary matching funds to the grant.

The LLNRD hopes that the Natural Resources Commission shares the Board of Directors recognition of the importance of detailed hydrogeologic information to conservation and protection of the water resources of the state. The LLNRD has and will continue to working with the partner agencies, including other Natural Resource Districts, the University of Nebraska Conservation and Survey Division, NDNR and other state, city, and county agencies to protect our groundwater resources for the continued beneficial use of the citizens of Nebraska. Should the Department or the Natural Resource Commission require any additional information or clarification regarding this application, please contact me directly and I will ensure that your request is met. Thank you for your consideration of this grant application.

Sincerely,

Leon “Butch Koehlmoos
General Manager

Application

Section A
Administrative

NEBRASKA NATURAL RESOURCES COMMISSION

Water Sustainability Fund

Application for Funding

Section A.

ADMINISTRATIVE

PROJECT NAME: Lower Loup NRD Aquifer Mapping

PRIMARY CONTACT INFORMATION

Entity Name: Lower Loup Natural Resources District

Contact Name: Tylr Naprstek, Water Modeling Coordinator

Address: 2620 Airport Drive, Ord, NE., 68862

Phone: (308) 728-3221

Email: tnaprstek@llnrd.org

Partners / Co-sponsors, if any: Eastern Nebraska Water Resources Assessment, Lower Elkhorn NRD, Lower Platte North NRD, Lower Platte South NRD, Papio-Missouri River NRD, University of Nebraska Conservation and Survey Division

1. Dollar amounts requested: (Grant, Loan, or Combination)

   Grant amount requested. $ 250,000

   Loan amount requested. $ N/A

   If Loan, how many years repayment period? N/A

   If Loan, supply a complete year-by-year repayment schedule. N/A

2. Permits Needed - Attach copy for each obtained (N/A = not applicable)

Nebraska Game & Parks Commission (G&P) consultation on Threatened and Endangered Species and their Habitat N/A☒ Obtained: YES☐ NO☐

Surface Water Right	N/A☒	Obtained: YES☐	NO☐
USACE (e.g., 404 Permit)	N/A☒	Obtained: YES☐	NO☐
Cultural Resources Evaluation	N/A☒	Obtained: YES☐	NO☐
Other (provide explanation below)	N/A☒	Obtained: YES☐	NO☐

Click here to enter text.

3. Are you applying for funding for a combined sewer over-flow project?

   YES☐ NO☒

   If yes, do you have a Long Term Control Plan that is currently approved by the Nebraska Department of Environmental Quality? N/A

   YES☐ NO☐ N/A☒

   If yes attach a copy to your application. N/A

   If yes what is the population served by your project? N/A

   If yes provide a demonstration of need. N/A

   If yes and you were approved for funding in the most recent funding cycle, then resubmit the above information updated annually but you need not complete the remainder of the application.

4. If you are or are representing an NRD, do you have an Integrated Management Plan in place, or have you initiated one?

   N/A☐ YES☒ NO☐

5. Has this application previously been submitted for funding assistance from the Water Sustainability Fund and not been funded?

   YES☐ NO☒

   If yes, have any changes been made to the application in comparison to the previously submitted application? N/A

   If yes, describe the changes that have been made since the last application. N/A

   No, I certify the application is a true and exact copy of the previously submitted and scored application. (Signature required) N/A

6. Complete the following if your project has or will commence prior to next July 1st.

As of the date of submittal of this application, what is the Total Net Local Share of Expenses incurred for which you are asking cost share assistance from this fund? $0.00

Attach all substantiating documentation such as invoices, cancelled checks etc. along with an itemized statement for these expenses. N/A

Estimate the Total Net Local Share of Expenses and a description of each you will incur between the date of submittal of this application and next July 1st for which you are asking cost share assistance from this fund.

$125,000. The Consultant requires payment of 30% of the total contract cost at the time of signing for the initial flight planning and coordination.

Application

Section B
DNR DIRECTOR'S FINDINGS

Section B.

DNR DIRECTOR'S FINDINGS

Does your project include physical construction (defined as moving dirt, directing water, physically constructing something, or installing equipment)?

YES☐ NO☒

1(a). If yes (structural), submit a feasibility report (to comply with Title 261, CH 2) including engineering and technical data and the following information:

A discussion of the plan of development (004.01 A); N/A

A description of all field investigations made to substantiate the feasibility report (004.01 B); N/A

Maps, drawings, charts, tables, etc., used as a basis for the feasibility report (004.01 C); N/A

A description of any necessary water and land rights and pertinent water supply and water quality information, if appropriate (004.01 D); N/A

A discussion of each component of the final plan including, when applicable (004.01 E);

Required geologic investigation (004.01 E 1); N/A

Required hydrologic data (004.01 E 2); N/A

Design criteria for final design including, but not limited to, soil mechanics, hydraulic, hydrologic, structural, embankments and foundation criteria (004.01 E 3). N/A

1(b). If no (non-structural), submit data necessary to establish technical feasibility including, but not limited to the following (004.02):

A description of field of research investigations utilized to substantiate the project conception (004.02 B);

The Eastern Nebraska Water Resources Assessment (ENWRA) is a coalition of six eastern Nebraska Natural Resources Districts with the purpose of studying the water resources of eastern Nebraska to develop a three-dimensional geologic framework and water budget for the glaciated portion of the state. Approaches to Airborne Electromagnetics (AEM) of aquifer characteristics were tested within the glaciated portion of eastern

Nebraska starting in 2006 by ENWRA with pilot studies completed in Oakland, Ashland, and Firth Please refer to "*Eastern Nebraska Water Resources Assessment (ENWRA) Introduction to a Hydrogeological Study in the Bibliography.* AEM utilizes a helicopter to carry transmitting and receiving equipment along a predetermined flight path. The ENWRA pilot studies and additional follow up work tested multiple types of AEM techniques in geologically diverse settings. In all types of AEM, the equipment remotely senses the electrical characteristics of the subsurface materials which can be used to interpret the type of subsurface materials that are in place such as clay, silt, sand, or gravel. This provides a nearly continuous set of subsurface information, a virtual borehole approximately every 50 feet, along the flight lines. The pilot studies conducted by ENWRA determined the effectiveness of the various AEM approaches for measuring aquifer characteristics. (US Geological Survey Scientific Investigations Report 2011-5228)

Due to the aquifer depths and variability of overlying material, Time-Domain Electromagnetics (TDEM) AEM has become the standard for large scale remote sensing of aquifer characteristics in Nebraska. TDEM has been successfully implemented in much of Nebraska with extensive flights in 2014 and 2015 across the eastern portion of the state. ENWRA, the Nebraska Department of Natural Resources (NDNR), and the University of Nebraska Conservation and Survey Division (CSD) assisted the local Natural Resources Districts (NRD) with the funding, data collection, and interpretation as well as the test hole drilling to ground truth the interpretations. A map of the ENWRA flight lines is included as Figure B.1 - ENWRA Flight Lines in the Supplemental Information Attachment (SIA). Water quality and water quantity concerns in Platte County, specifically in the city of Columbus area require additional data and interpretation of the hydrogeologic setting through the collection of additional AEM (Project). The proposed Project is an extension of the recent AEM work done by ENWRA.

The previously collected AEM data and interpretations and work done as part of this Project will be utilized by the LLNRD in the current update to and ongoing application of the Groundwater Management Plan (GMP) and development of an Integrated Management Plan (IMP). The GMP current is included in the Bibliography (LLNRD GMP 1985). The LLNRD will be completing the update to the GMP and the development of the IMP no later than May of 2017. Specifically, the LLNRD is conducting a detailed study of water availability and impacts in the Columbus vicinity. Interpretation of this AEM data will drastically help determine if new well construction requirements or potential restrictions on existing wells will best protect this public water supply from previously detected high nitrates and potential quantity issues.

A discussion of the plan of development (004.02 A);

Benefitting from the work done by ENWRA and its partners, this Project will utilize TDEM to map the subsurface materials of the Project area. The overall steps of the proposed Project include finalization of the anticipated flight lines, collection of AEM data, analysis and interpretation of the data, incorporation of the interpretation into the existing understanding and overall framework of the hydrogeology of the area, and completion of a report documenting the overall Project.

Preliminary flight line spacing and total flight distance have been estimated for the Project area, see SIA Section B-1(b) Figure B.2a - LLNRD Project Area and Figure B.2b – LLNRD Project Area. Additional refinement of the spacing and flight lines will be needed to ensure efficient data collection and minimal interference from artificial sources such as pipelines or electrical lines. Additionally, an overall plan for mobilization of equipment and the timing of collection will be developed based upon the approvals of similar Watershed Sustainability Fund (WSF) grant applications from the partner NRDs.

The collection and analysis of the AEM data will be done by a geophysical consulting company (Consultant) to determine the electrical resistivity of the subsurface materials from the raw TDEM data. Electrical resistivity is a measure of how well or how poorly the subsurface materials resist the flow of an electrical current. Electrical resistivity can be correlated with the type of subsurface materials such as gravels, sands, silts, and clays. Highly resistive materials are typically sands and gravels where less resistive materials typically are silts and clays. AEM surveys also have the ability to map the location of fresh, brackish and saline water at depth. The processed data will be provided to the LLNRD, ENWRA, and CSD for further interpretation with assistance from the Consultant. An example cross-section showing interpretation results is included as Figure B.3 - Sample Interpreted Geologic Profile of the SIA.

The initial interpretation of the types of subsurface materials will be compared with the known hydrogeologic framework of the area to adjust and verify the initial interpretations. The verification will be done utilizing existing understanding of the hydrogeologic units from traditional sampling techniques and previous AEM work. These interpretations comprise the overall hydrogeologic framework necessary for understanding the location, extents, potential recharge, groundwater flow, hydraulic connection of groundwater to surface water, and discharge characteristics of the aquifer systems. A final report will be provided by the Consultant describing the data collection, processing, and interpretation of the AEM. Included with the final report are Google Earth files that can be readily shared with interested parties to assist landowners, drillers, and local agencies with decisions regarding groundwater resources. A sample landowner report from ENWRA is included as Figure B.4 - ENWRA Sample Landowner Information Map of the SIA.

With the hydrogeologic framework updated through this Project the LLNRD will be better equipped to assess the overall susceptibility of the Project area groundwater resources to impacts from potential contamination sources and increasing use and development. The updated hydrogeologic framework will directly inform the delineation of the groundwater resources to be included in the update of the LLNRD GMP. CSD may use the AEM data to update bedrock maps, transmissivity and specific yield maps, and maps of secondary aquifers.

A description of the necessary water and/or land rights, if applicable (004.02 C);

Remote sensing of aquifer materials requires some ground truth of the aquifer characteristics through traditional drilling and sampling techniques. The existing set of CSD test-holes, as well as existing drilling logs, can be utilized as ground truth locations. Flight lines for this Project will be developed to make use of the existing test-holes and other hydrogeologic information where possible. Where test-holes are not available but the need for ground truth locations is critical, additional test-holes may be drilled. The collected AEM data will allow for optimization of the locations of any critical test-hole needs allowing for efficient use of test-hole drilling expenditures. Should test-holes be required, access agreements with landowners will be needed. Test-hole drilling requires the use of a drilling rig on location for approximately three days to drill and describe the geologic materials. All drilled test-holes are back filled with bentonite grout and the land surface returned to its original condition. Access agreements for this type of work typically are readily obtainable as there are limited impacts to the land surface and the landowners benefit from the findings.

A discussion of the anticipated effects, if any, of the project upon the development and/or operation of existing or envisioned structural measures including a brief description of any such measure (004.02 D).

Results of this mapping project are anticipated to improve well construction in the project area to avoid existing nitrate contaminants. Knowing the depth and locations of the aquifer material furthest away from known groundwater quality impairments will provide well drillers and public water suppliers with enhanced information to drill deeper wells in better locations. If water supplies are found not to be protected from water quality impairments, the LLNRD may consider pursuing other sources for public water supply systems in the area or the potential development of a rural water system.

2. Provide evidence that there are no known means of accomplishing the same purpose or purposes more economically, by describing the next best alternative.

Traditional methods of collecting hydrogeologic information is accomplished through the drilling of test-holes and logging of the geologic materials found and interpreting of the materials found within the test-holes relative to the area geology. Individual test-holes provide a single point of information about the area hydrogeology which can be supplemented with existing drillers logs. The geology and the aquifer materials between these points is interpolated utilizing the experience and expertise of trained hydrogeologists. The interpolation of the hydrogeology between points is simply an estimation of the subsurface materials present but aquifer materials and their properties may change dramatically in as little as a few tens of feet from the individual test-hole locations. Individual points of information, like test-holes, therefore provide limited information about the broader aquifer characteristics.

While limited, test holes have been the best available method for assessing aquifer characteristics until the recent improvement of AEM. AEM essentially provides thousands of virtual test-holes along the flight path thereby collecting a nearly seamless cross-section of the aquifer materials. The AEM survey method can remotely cover large areas of the subsurface in a short amount of time and with great detail. This type of seamless cross-section cannot be collected through any other known method.

All methods of AEM collection require approximately the same level of planning, acquisition, processing, and interpretation costs. Frequency Domain Electromagnetics (FDEM), another form of AEM, is comparable in cost to TDEM. The primary reasons for selecting one method over the other are the type of materials being sensed, the depth of the materials, and the water quality within the aquifer. While comparable in cost, FDEM is limited in depth of investigation and is not appropriate for most of the areas to be flown within the Project area. TDEM has been shown, through the work of ENWRA and the local NRDs, to be the most effective method for the proposed Project area.

Recent experience using AEM for projects with ENWRA has shown that the benefit to cost relationship for developing a hydrogeologic framework is significantly improved relative to traditional methods. The continuous nature of the virtual bore-holes provided by AEM cannot be repeated through any other methods. The average cost per line mile for AEM is $680 which includes collection, interpretation and reporting. A single mile of AEM represents approximately 100 virtual test-holes with an approximate average depth of 1,000 feet, all collected without trespass or ground disturbance. This therefore represents approximately 100,000 feet of traditional drilling and sampling (100 test-holes of 1,000 feet each), a physical and economic impossibility. To make the cost comparison anyway, the current per foot costs of traditional test-hole drilling is $10 to $15 per foot. Even if it were physically and logistically possible to drill 100 test holes

in a one mile line, the cost would be anywhere from $1,000,000 to $1,500,000 as compared to the price of $680 per mile of AEM.

3. Document all sources and report all costs and benefit data using current data, (commodity prices, recreation benefit prices, and wildlife prices as prescribed by the Director) using both dollar values and other units of measurement when appropriate (environmental, social, cultural, data improvement, etc.). The period of analysis for economic feasibility studies shall be fifty (50) years or with prior approval of the Director, up to one hundred (100) years [T261 CH 2 (005)].

- Describe any relevant cost information including, but not limited to the engineering and inspection costs, capital construction costs, annual operation and maintenance costs, and replacement costs. Cost information shall also include the estimated construction period as well as the estimated project life (005.01). N/A
- Only primary tangible benefits may be counted in providing the monetary benefit information and shall be displayed by year for the project life. In a multi-purpose project, estimate benefits for each purpose, by year, for the life of the project. Describe any intangible or secondary benefits separately. In a case where there is no generally accepted method for calculation of primary tangible benefits describe how the project will increase water sustainability, such that the economic feasibility of the project can be approved by the Director and the Commission (005.02). N/A
- All benefit and cost data shall be presented in a table form to indicate the annual cash flow for the life of the proposal, not to exceed 100 years (005.03). N/A
- In the case of projects for which there is no generally accepted method for calculation of primary tangible benefits and if the project will increase water sustainability, the economic feasibility of such proposal shall be demonstrated by such method as the Director and the Commission deem appropriate (005.04).

This Project will collect information necessary to assist the LLNRD Board with decisions regarding the conservation and protection of water resources. Those decisions may result in the establishment of elevated regulations through Groundwater Management Areas for either quantity or quality concerns, the development of additional rural water districts, the prioritization of Wellhead Protection Plans, or programs sponsored by the LLNRD for aquifer protection. As the program, project, or action that may result from the information is not yet known, there is not currently a method for calculating the primary tangible benefits of the Project in a quantitative way. While quantifying the benefits from the Project is not a possibility, there is an ability to discuss the overall benefits from a qualitative standpoint.

The purpose of the mapping through AEM is to identify and define the relationship of the aquifer systems to one another as well as to the land surface and the surface water systems. The water available for use from an aquifer system is dependent upon the relationships among overall use, recharge, and discharge. The Project will improve the overall identification of confining layers between aquifers thereby improving the understanding of the interrelationships of use, recharge, discharge, and potential contamination threats. This improved understanding will be use to inform management decisions regarding the quantity available for the various groundwater demands in the area. The conservation of the water resources would be accomplished with management actions that prioritize use and limit total groundwater withdrawals as and where needed. Prioritization and limits on use would result in greater understanding of the water available to individual users, which improve the user's ability to plan for continued use and development. This ability to plan for use and development will result in a greater ability to allow for additional economic development that is dependent upon the water resource, specifically for the large-scaled water users in the Columbus municipal area.

The relationships among groundwater use, recharge, and discharge also informs potential actions related to groundwater quality. Where groundwater resources are more protected from surface related contaminants, management actions could prioritize use in those areas. Tailoring the locations of groundwater use decreases the potential need for expensive treatment and improves the longevity of capital investments related to water supply. Additionally, the understanding of where the groundwater resources are most susceptible surface contaminants can be used to tailor the approaches to management of activities that can threaten those groundwater resources. This greater understanding of the groundwater/surface water interaction reduces the need for additional, expensive test-hole drilling by those looking to utilize the resource as well as preventing undue regulation resulting from a lack of knowledge of the resource.

The Project improves the LLNRDs ability to provide tailored approaches to management to ensure the long-term conservation and protection of the water resources. These tailored approaches can assist the users of the water resources with understanding their capacity for continued development and protect existing and future development. One form of benefit from this Project could be realized by the ability to avoid constructing replacements of wells impacted by the migration of high nitrates or avoidable interference. Mapping through the AEM process will also give the LLNRD a better understanding of potential cross contamination threats of multiple aquifers. Further benefits are realized from the public use of the data and enhanced management of the quality and quantity of groundwater.

4. Provide evidence that sufficient funds are available to complete the proposal.

The LLNRD's budget for July 1, 2015 to June 30, 2016 is $9,616,354.00 with a property tax levy of 0.024184 resulting in approximately $4,974,011.33 of local property taxes. Property tax accommodates approximately 52% of the total budget. This proposed Project is considered part of the surface and groundwater quality program and a Board Motion to pursue resources to conduct the AEM data collection was passed by the LLNRD Board of Directors at the November 19th meeting by a vote of 14 yes to 2 no, with 5 directors being absent.

5. Provide evidence that sufficient annual revenue is available to repay the reimbursable costs and to cover OM&R (operate, maintain, and replace). N/A

6. If a loan is involved, provide sufficient documentation to prove that the loan can be repaid during the repayment life of the proposal. N/A

7. Describe how the plan of development minimizes impacts on the natural environment.

Data collected during the AEM flight is remotely sensed and has no potential impact to the natural environment.

8. Explain how you are qualified, responsible and legally capable of carrying out the project for which you are seeking funds.

The Nebraska Ground Water Management and Protection Act, passed in 1975, established the NRDs as the preferred local entities for groundwater regulation and protection. NRDs work cooperatively with cities, counties, state, and federal agencies to accomplish groundwater resource protection through programs, projects, and regulations. Each NRD is required to have in place a Groundwater Management Plan (LLNRD GMP 1985), based upon the best available information, and approved by the Director of the Nebraska Department of Natural Resources. The LLNRD also is in the process of completing a voluntary Integrated Management Plan hereafter referred to as the IMP, for the hydrologically connected surface water and groundwater.

The District voluntarily entered into the IMP development process with NDNR to take a proactive approach to the protection of the interconnected water resources. The staff, management, and Board of Directors (Board) of the LLNRD devote significant time and resources toward their duties to understand and manage the groundwater resources. The District's existing, previously collected groundwater data will be combined by the staff and

management of the LLNRD with the information collected during this Project. The LLNRD Board will utilize the full set of information regarding the groundwater resources to inform future decisions about the management and protection of the groundwater resources.

9. Explain how your project considers plans and programs of the state and resources development plans of the political subdivisions of the state.

The data collected by the Project will be submitted to the NDNR as the "best available" information for use in the Annual Evaluation of Availability of Hydrologically Connected Water Supplies (FAB Report). The FAB Report is a statutory requirement of the NDNR which evaluates the long-term availability of the hydrologically connected water supplies of the State. The previous collection of AEM data done by ENWRA was partially funded by the NDNR for use in modeling efforts to determine the impacts of groundwater use on surface water availability in hydrologically connected reaches. The results of those modeling efforts, when complete, will be incorporated into the FAB Report which determines if a basin is fully appropriated or not. The Project will update the overall hydrogeologic framework and improve upon the previous AEM work that supports the FAB Report.

All Natural Resources Districts are statutorily required to have a completed GMP which includes information about the aquifers of the NRD, supplemental supplies, integrated and coordinated use, and the boundaries of management areas. The LLNRD has an adopted GMP, last revised in 1985 (LLNRD GMP 1985). Results of this Project specifically meet the objectives of the GMP to address specific problems of groundwater quality. Groundwater quality monitoring conducted the LLNRD has shown the southeastern portion of Platte County to have elevated levels of nitrates. The area is also experiencing rapid development of municipal expansion which will be dependent upon groundwater as their source of drinking and industrial water. The LLNRD is in the process of developing a detailed study of the Columbus municipal area and will incorporate the Project information into that update to determine the need for and type of groundwater management protection areas (Protection Areas). Protection Areas are a management tool available to NRDs to improve the protection and conservation of the groundwater resources. The LLNRD GMP refers to the groundwater reservoir and its management multiple times throughout the document. The AEM data give the LLNRD a contiguous view of the aquifer and will allow management and flexibility in dealing with localized issues for both water quality and quantity.

The LLNRD is developing a voluntary IMP in conjunction with the NDNR. Draft goals outlined in the IMP include protecting existing groundwater users while allowing for future development as well as continued development of water supply and use inventories based upon the best

available data and analysis. Other draft goals of the voluntary IMP are to better manage hydrologically connecter ground and surface water. Obtaining a better understanding of aquifer connectivity, through activities like this Project, is a critical component to achieving these goals. Both the IMP and GMP are meant to be adaptive in nature, the collection of new information is a critical path to keeping the GMP up to date and effective now and in the future.

As mentioned, the LLNRD is currently undergoing a detailed study of the unique water resource needs for the community of Columbus. While simultaneously being the largest community and water user in the Loup Basin, it's location along the junction of the Loup and Platte Rivers is of interest to all parties involved. Additionally, there are many large commercial and industrial users in the area and the city wishes to expand, bringing more of these types of users to the area. Through this study, the LLNRD is working with the City to proactively develop a greater understanding of the valuable water resources in the vicinity. Including the AEM mapping in southeastern Platte County would be invaluable to the study as it would provide a comprehensive look at the connectivity and aquifer availability over bedrock within the area. Additionally, such detail from the AEM mapping could be utilized by both the hydrogeology modeling work and 3-D Model being developed in conjunction with this study. In addition to the Columbus Study, the AEM mapping would be beneficial to the ENWRA project taking place in the area surrounding the city of Columbus. Although the LLNRD is not an ENWRA NRD, the LLNRD AEM work may reduce the mobilization costs of the planned ENWRA flights and provide data about the western glacial limit that is useful to ENWRA. The ENWRA coordinator, as stated in the ENWRA LRP, may provide coordination services for secondary projects (NRD-specific projects like this one) as long as they further the overall ENWRA objectives and are part of an ENWRA NRD project effort. The ENWRA Long Range Plan addresses eight objectives relating to understandings gained from the AEM that are applicable for each of the NRDs such as estimating recharge, assessing groundwater surface water connections, calculating water budgets, and characterizing natural and anthropogenic groundwater concerns.

10. Are land rights necessary to complete your project?

YES☐ NO☒

If yes, provide a complete listing of all lands involved in the project. N/A

If yes, attach proof of ownership for each easements, rights-of-way and fee title currently held. N/A

If yes, provide assurance that you can hold or can acquire title to all lands not currently held. N/A

11. Identify how you possess all necessary authority to undertake or participate in the project.

The LLNRD is a political subdivision of the State of Nebraska with authority to levy property taxes and enter into contracts and Inter-local Cooperation Act agreements. The contract for professional services with the Consultant to collect the AEM data will require approval from the LLNRD Board of Directors and be signed on behalf of the LLNRD by the General Manager.

12. Identify the probable environmental and ecological consequences that may result as the result of the project.

Remote sensing projects such as AEM do not have a physical impact on the environment or ecologic communities. There are no known environmental or ecological consequences from AEM data collection. There are no human health impacts from this type of survey.

Application

Section C
NRC SCORING

Section C.

NRC SCORING

In the NRC's scoring process, points will be given to each project in ranking the projects, with the total number of points determining the final project ranking list.

The following 15 criteria constitute the items for which points will be assigned. Point assignments will be 0, 2, 4, or 6 for items 1 through 8; and 0, 1, 2, or 3 for items 9 through 15. Two additional points will be awarded to projects which address issues determined by the NRC to be the result of a federal mandate.

Notes:

- The responses to one criterion *will not* be considered in the scoring of other criteria. Repeat references as needed to support documentation in each criterion as appropriate. The 15 categories are specified by statute and will be used to create scoring matrixes which will ultimately determine which projects receive funding.

- There is a total of 69 possible points, plus two bonus points. The potential number of points awarded for each criteria are noted in parenthesis. Once points are assigned, they will be added to determine a final score. The scores will determine ranking.

- The Commission recommends providing the requested information and the requests are not intended to limit the information an applicant may provide. An applicant should include additional information that is believed will assist the Commission in understanding a proposal so that it can be awarded the points to which it is entitled.

Complete any of the following (15) criteria which apply to your project. Your response will be reviewed and scored by the NRC. Place an N/A (not applicable) in any that do not apply, an N/A will automatically be placed in any response fields left blank.

1. Remediates or mitigates threats to drinking water;

   - Describe the specific threats to drinking water the project will address.
   - Identify whose drinking water, how many people are affected, how will project remediate or mitigate.
   - Provide a history of issues and tried solutions.
   - Provide detail regarding long range impacts if issues are not resolved.

   The proposed Project area includes the community of Columbus and it's wellhead protection area (see SIA Section B-1(b) Figure B.2a - LLNRD Project Area and Figure B.2b – LLNRD Project Area) serving a combined population of

approximately 22,533 (2013). Water quality sampling since 1978 in and around the Project area has indicated that there are elevated levels of nitrate ranging over 20 parts per million (ppm) in the Quaternary aged formation. Potential mitigating actions which may occur as a result of this study include deeper domestic well construction, future well construction modification, enhanced groundwater recharge information and management, and improved water quality monitoring.

Detailed information collected from AEM combined with traditional hydrogeologic information that is incorporated into an aquifer framework provides a far more complete understanding of the physical extents and potential interactions of the local and regional aquifers and surface waters. A hydrogeologic framework includes not only the depth to the top of the aquifer and extents of the aquifer materials but also the depth to the bottom of the aquifer. Beyond the information collected about the aquifer, information about the materials that overlay the aquifer area are also important in providing greater understanding of how the recharging water migrates to the aquifer system. If AEM data is collected in a dense flight pattern of 900 feet or less between flight lines, a determination of aquifer volume and groundwater in storage can be calculated. For an example of how AEM can be used to determine aquifer volume refer to Figure C.1 - Sample Interpreted Voxel Display in the SIA.

Water quality problems in aquifer systems that can impact drinking water are often related to activities at or near the land surface. A particular aquifer's susceptibility to surface contaminants is partially determined by the type of overlying materials. An understanding of the overlying materials, whether the materials readily allow percolating water to recharge the aquifer or not, determines the rate at which surface contaminants can reach the aquifer. Sandier materials above an aquifer with limited clay content allow more rapid recharge, whereas thick sections of clay reduce the rate of downward migration and recharge. Other sources of information about the overlying materials, such as soils maps, only include the very near surface materials. The standard soil mapping practices also only typically sample the soil every 2.5 acres versus the data rich sampling done with the virtual bore-holes of AEM. AEM provides information about the full sequence of material that overlays and aquifer. Greater understanding of the extents of materials that limit or transmit percolating water can provide LLNRD with the ability to tailor management activities intended to protect drinking water quality.

Typically, contamination from the land surface tends to remain in the uppermost portion of the aquifer system versus mixing more deeply in the aquifer. Nitrate is a good example as it tends to stratify in the upper aquifer. The mapping of shallow clay zones through AEM helps delineate areas protected from contaminate transport from the surface. Locating future domestic and municipal drinking water supplies in areas where these protected aquifer units exist can help with well head protection and limit the impacts of the downward migration of contaminates.

Through an understanding of the full depth of the aquifer, LLNRD can establish best management practices to be used by well drillers during the construction of new drinking water wells. Typical domestic well construction occurs in the uppermost portion of the aquifer as, once the driller has encountered enough water

bearing sands, the drilling is stopped and the well is completed. Additional depth of drilling is considered an unnecessary expense once a sufficient quantity of water bearing sands are encountered. The additional drilling can however provide a domestic well with greater longevity and reduced impact from surface contaminants. Where sufficient depth of aquifer materials is available, recommendations for drilling to a deeper portion of the aquifer for well completion could be made. Completing the drinking water well in the deeper portion of the aquifer and sealing off the upper portion of the aquifer is an effective way to limit the wells susceptibility to contaminants. A deeper drinking water well also reduces the potential interference from nearby wells as they draw down the aquifer during use. A deeper drinking water well also has greater protection from water level declines that occur during times of drought.

The LLNRD has monitored groundwater quality in the Project area for the past several decades as part of its current GMP. Based on sampling of the domestic and irrigation wells throughout the area, the LLNRD has seen increasing levels of nitrate contamination that approaches the limit of current drinking water standards. Results from the sampling were shared with the owners of domestic wells in the area along with information about nitrate contamination and treatment options.

High levels of nitrogen, as nitrate, in drinking water can be harmful to young infants or young livestock. Excessive nitrate can result in restriction of oxygen transport in the bloodstream. Infants under the age of 4 months lack an enzyme necessary to correct the restricted oxygen transport resulting in what is known as "blue baby syndrome". The long-term impacts from not fully understanding the sources of nitrate contamination and the susceptibility of the aquifer system to contamination can potentially put human health at great risk.

2. Meets the goals and objectives of an approved integrated management plan or ground water management plan;

- Identify the specific plan that is being referenced including date, who issued it and whether it is an IMP or GW management plan.
- Provide the history of work completed to achieve the goals of this plan.
- List which goals and objectives of the management plan the project provides benefits for and how the project provides those benefits.

The LLNRD has begun the process of developing a Voluntary Integrated Management Plan starting in August 2014, in conjunction with the NDNR. While the plan is currently only in draft form, actions to meet the goals and objectives are underway.

The overall draft goals of the LLNRD voluntary IMP are to better manage hydrologically connected water through a greater understanding of aquifer connectivity between surface water and groundwater, and potential aquifer components that may have an impact on the resource.

This Project will address objectives and action items that these goals in the draft version of the IMP by: (1) utilizing the best available data and analysis tools to estimate consumptive water use, (2) assess the need for additional monitoring, (3) continue to gather and analyze hydrogeologic data, (4) evaluate the need to develop new rural water systems, and (5) coordinate with public water supplies to enhance education and conservation.

In addition to developing the voluntary IMP, the LLNRD has an adopted GMP, last revised in 1985 (LLNRD GMP 1985). Results of this project specifically meet the objectives of the GMP to address specific problems of groundwater quality. Groundwater quality monitoring conducted by LLNRD staff has shown the southeastern portion of Platte County to have elevated levels of nitrates.

3. Contributes to water sustainability goals by increasing aquifer recharge, reducing aquifer depletion, or increasing streamflow;

   List the following information that is applicable:

   - The location, area and amount of recharge;
   - The location, area and amount that aquifer depletion will be reduced;
   - The reach, amount and timing of increased streamflow. Describe how the project will meet these objectives and what the source of the water is;
   - Provide a detailed listing of cross basin benefits, if any.

The collection of hydrogeologic data and assembly of that data into an overall aquifer framework provides the information necessary to help determine area recharge characteristics, aquifer extents, volume of available groundwater, interconnection with other aquifers, and stream-aquifer interactions. AEM, along with interpretation of the collected data, provides highly detailed information about the materials within the aquifer as well as the materials above, below, and adjacent to the aquifer. An example of the type of aquifer delineation that AEM can provide is included in SIA Section C-1, Figure C.1 - Sample Interpreted Voxel Display.

Aquifer recharge is determined by the water available from precipitation for deep percolation after taking into account runoff, evapotranspiration, soil characteristics, and other factors. Recharge also is impacted by the materials that overlay the aquifer which influence the way in which the deeply percolating water reaches the aquifer. Generally speaking, the sandier the materials that overlay the aquifer, the faster the recharge will be, while more clay rich materials will tend to slow the recharge. AEM can be utilized to improve the LLNRD's understanding of recharge potential by delineating the layers of material types overlying an aquifer. Recharge potential can then be utilized by the LLNRD to better assess projects designed to increase recharge as well as inform the LLNRD's management of preferred development zones in areas where recharge is higher.

Preferred development areas can be used to tailor development of additional uses of groundwater to those areas where recharge more readily replenishes withdrawals, where aquifer thickness is greatest, where effects from aquifer

extents are reduced, or where well impacts to streams are minimized. Management decisions for Groundwater Management Areas (GMA) would seek to balance the needs for groundwater development with the existing uses of groundwater in and area. A more complete framework of the hydrogeology will improve the LLNRD's ability to make those management decisions and improve the sustainability of the overall water resources. Potential management decisions to utilize allocations, rotation, limits on development, well spacing requirements, or other groundwater controls as part of a GMP or IMP can be better tailored to protect existing users and promote sustainable use of the water resources.

4. Contributes to multiple water supply goals, including, but not limited to, flood control, agricultural use, municipal and industrial uses, recreational benefits, wildlife habitat, conservation of water resources, and preservation of water resources;

   - List the goals the project provides benefits.
   - Describe how the project will provide these benefits
   - Provide a long range forecast of the expected benefits this project could have versus continuing on current path.

Conservation and preservation of water resources for the beneficial use of the residents of the state requires detailed information about the aquifer characteristics and interactions of the groundwater and surface water resources. Sound strategies for conservation and preservation in this area, whether management actions, programs, or projects, depend on that detailed information to understand the volume and distribution of available groundwater and water quality concerns.

AEM data collection in this area of southeastern Platte County will not only benefit the largest community of the Loup basin, Columbus, through a greater understanding of the aquifer resource as a whole, but also provide invaluable amount of data for the various studies taking place to better understand and potentially conserve water resources through informed management recommendations. Some of those studies include, but are not limited to; Columbus Water Resources Assessment, Elkhorn-Loup (ELM) Model, Central Nebraska (CENEB) Model, USGS High Plains Aquifer Water-level Monitoring Study, and ENWRA.

5. Maximizes the beneficial use of Nebraska's water resources for the benefit of the state's residents;

   - Describe how the project will maximize the increased beneficial use of Nebraska's water resources.
   - Describe the beneficial uses that will be reduced, if any.
   - Describe how the project provides a beneficial impact to the state's residents.

The beneficial use of Nebraska's water resources is established and prioritized in the Nebraska constitution with drinking water use being the highest priority and agricultural use and industrial use following from there. Water is considered a natural want and a shared resource of the State. The LLNRD has long worked with other area NRDs and the State to best manage the water resources for beneficial use. The aquifer framework developed through this AEM collection project will further the District's understanding of the aquifer systems and their interaction with the land surface and area streams. This understanding will be shared with other NRDs as well as state agencies including NDNR and CSD. The shared understanding of the water resources will allow the agencies tasked with understanding and managing Nebraska's water resources the best available information to make the best possible decisions regarding the beneficial use of the water resources.

The primary impact to beneficial use from the proposed Project is to the protection of groundwater used as a drinking water source from potential contamination. Understanding the susceptibility of the aquifer systems to surface contaminants will allow the LLNRD to tailor approaches to programs, projects, and actions by the Board to provide greater protection of the water resources. The need for GMAs with best management practices for activities that may contribute surface contaminants to the groundwater can be more readily assessed and implemented. GMAs may also have restrictions or limitations on activities in areas particularly susceptible to groundwater contamination. The LLNRD may also provide recommendations for preferred development areas to minimize development in areas where the potential for surface contaminants reaching the aquifer system is highest.

Additional protection of the beneficial uses of the groundwater resources can be addressed through better recognition of the limited availability of groundwater in the aquifer system. Understanding the limits to the groundwater supply in the Project area will allow the LLNRD to tailor any potential best practices or limits to use to accommodate the available supply.

6. Is cost-effective;

- List the estimated construction costs, O/M costs, land and water acquisition costs, alternative options, value of benefits gained.
- Compare these costs to other methods of achieving the same benefits.
- List the costs of the project.
- Describe how it is a cost effective project or alternative.

AEM data collection and interpretation provide an understanding of the aquifer systems that cannot be developed through traditional drilling and sampling techniques. The only real alternatives to consider for the collection and interpretation of data that provides a hydrogeologic framework are the different methods of AEM. The work of the USGS have provided the necessary studies to review of the methods of AEM data collection to conclude that TDEM, the method

proposed for this Project, is the most effective method given the types of overlaying materials.

The total cost of the Project for collection, processing, interpretation, and reporting is $416,666 (Figure C.3 – Cost Letter of the SIA). Other forms of AEM data collection would be nearly identical in price but would lack the ability to differentiate the subsurface materials to a sufficient depth for the development of a hydrogeologic framework. The benefits, as mentioned in Section B-2, are potentially many and economically substantial. Without the full hydrogeologic framework, the LLNRD does not have the ability to make science based decisions regarding the need for specific programs, projects, or actions. Once complete, the hydrogeologic framework will inform the activities of the LLNRD which will result in the conservation and protection of the water resources for the beneficial use of drinking water, agricultural, and industrial users maintaining the resource for continued development.

7. Helps the state meet its obligations under interstate compacts, decrees, or other state contracts or agreements or federal law;

   - Identify the interstate compact, decree, state contract or agreement or federal law.
   - Describe how the project will help the state meet its obligations under compacts, decrees, state contracts or agreements or federal law.
   - Describe current deficiencies and document how the project will reduce deficiencies.

N/A

8. Reduces threats to property damage or protects critical infrastructure that consists of the physical assets, systems, and networks vital to the state or the United States such that their incapacitation would have a debilitating effect on public security or public health and safety;

   - Identify the property that the project is intended to reduce threats to.
   - Describe and quantify reductions in threats to critical infrastructure provided by the project and how the infrastructure is vital to Nebraska or the United States.
   - Identify the potential value of cost savings resulting from completion of the project.
   - Describe the benefits for public security, public health and safety.

Information resulting from this Project will help protect critical infrastructure; primarily the municipal and domestic drinking water wells which serve approximately 22,533 people including the City of Columbus. This data can help protect these drinking water supplies by helping to protect future overuse of the aquifer and reducing the threat of contamination. Understanding the entire aquifer

framework is essential to prevent future drinking water supply contamination and ensuring a reliable public water supply for the future development of this area. Cost savings resulting from the completion of this project are unknown at this time.

9. Improves water quality;

- Describe what quality issue(s) is/are to be improved.
- Describe and quantify how the project improves water quality, what is the target area, what is the population or acreage receiving benefits, what is the usage of the water: residential, industrial, agriculture or recreational.
- Describe other possible solutions to remedy this issue.
- Describe the history of the water quality issue including previous attempts to remedy the problem and the results obtained.

Groundwater quality in the Project area, specifically nitrate contamination, has been an ongoing problem for the area drinking water supplies (Figure C.2 - LLNRD Nitrate Levels in the SIA). Other drinking water users in the Project area are susceptible to the same type of nitrate contamination to varying degrees depending upon the location and depth of the municipal or domestic wells. Where drinking water supplies are impacted, and the owners of those wells aware of the impacts, costly filtration systems are needed to remove the contamination. Creation of a hydrogeologic framework that delineates the extents, thickness, and interaction of the area aquifer systems allows the Board of the LLNRD to make science based decisions regarding the protection of the water resources.

The project would provide the information necessary for those science based decisions. The LLNRD would be able create programs or projects that directly impact water quality, protect the water resources from further degradation, and protect the health of the resident dependent upon the groundwater for their drinking water supply. 22,533 people get their drinking water from groundwater supplies, municipal or domestic, in the Project area. While the primary benefit from the Project is the improvement of groundwater quality, an understanding of the water quantity available is also a concern. Large scale uses, such as agricultural or industrial, have withdrawals that can potentially impact other users. The understanding of the extents and interaction of the aquifer system also allows for science based decision for the conservation of the water resources for the long term beneficial uses of the residents and businesses.

Given the known levels of contamination of the groundwater in the Project area, the LLNRD has a dedicated, full time staff member available to work with the city of Columbus on developing their Wellhead Protection Plan (WPP). Nebraska's Wellhead Protection Program is a voluntary program which assists communities in preventing contamination of their water supplies through active planning in conjunction with The Department of Environmental Quality and local NRD. At this time, Columbus does not have an approved WPP, the data obtained through the AEM process would be absolutely paramount in the key features of the WPP. These features include identifying potential sources of groundwater contamination

and delineation of the protection area based on approximate paths groundwater would take on a 20-year flow line. AEM data emphasizing connectivity would be a great benefit to development of WPP.

10. Has utilized all available funding resources of the local jurisdiction to support the program, project, or activity;

- Identify the local jurisdiction that supports the project.
- List current property tax levy, valuations, or other sources of revenue for the sponsoring entity.
- List other funding sources for the project.

The LLNRD devotes substantial time and resource to the assessment of the overall water quality of the groundwater resources of the district. This proposed Project was discussed and voted on by the LLNRD Board of Directors during the November 2015 meeting. The motion to pursue resources to proceed with this Project was passed by a vote of 14 yes to 2 no, with 5 directors absent. Past financial input from the LLNRD to support these type of projects include annual water quality and quantity monitoring, installation of monitoring wells including the three within the project area and partnerships with CSD, NDNR and other local NRDs to collect data of this sort.

The total Project costs for this proposed AEM data collection, interpretation and reporting is $416,666. Of that total Project cost, the LLNRD will use general funds to cover the required local match of 40%, or $166,666. The remaining $250,000 of funds needed for the Project are this grant request.

11. Has a local jurisdiction with plans in place that support sustainable water use;

- List the local jurisdiction and identify specific plans being referenced that are in place to support sustainable water use.
- Provide the history of work completed to achieve the goals of these plans.
- List which goals and objectives this project will provide benefits for and how this project supports or contributes to those plans.
- Describe and quantify how the project supports sustainable water use, what is the target area, what is the population or acreage receiving benefits, what is the usage of the water: residential, industrial, agriculture or recreational.
- List all stakeholders involved in project.
- Identify who benefits from this project.

The LLNRD has an adopted GMP, last revised in 1985. Results of this project specifically meet the objectives of the GMP to address specific problems of groundwater quality. Groundwater quality monitoring LLNRD staff, as part of the GMP, has shown this southeastern portion of Platte County to have elevated levels of nitrates. The LLNRD is just beginning the process to develop a voluntary IMP with the NDNR, this project will help to establish measurable goals and targets for

managing this aquifer. The results of this project will support sustainable water use by creating an aquifer framework to better manage domestic, municipal, agricultural, and industrial water supplies and water quality. Benefits of the project will address the threat of nitrate contamination for an estimated population of approximately 22,533. Stakeholders involved in the project will include the Board and staff of the LLNRD, NDNR, City of Columbus, UNL-CSD, and local residents.

12. Addresses a statewide problem or issue;

- List the issues or problems addressed by the project and why they should be considered statewide.
- Describe how the project will address each issue and/or problem.
- Describe the total number of people and/or total number of acres that would receive benefits.
- Identify the benefit, to the state, this project would provide.

N/A

13. Contributes to the state's ability to leverage state dollars with local or federal government partners or other partners to maximize the use of its resources;

- List other funding sources or other partners, and the amount each will contribute, in a funding matrix.
- Describe how each source of funding is made available if the project is funded.
- Provide a copy or evidence of each commitment, for each separate source, of match dollars and funding partners.
- Describe how you will proceed if other funding sources do not come through.

N/A

14. Contributes to watershed health and function;

- Describe how the project will contribute to watershed health and function in detail and list all of the watersheds affected.

The AEM data collection area designated by the LLNRD encompasses the eastern half of Groundwater Management Area 28 in Platte County, east to the Colfax County line. The Project area includes the junction of the Loup and Platte Rivers and the city of Columbus as well. This Project will not only contribute to the on-going study in the largest city in the Loup Basin, Columbus, the data resulting from this Project will benefit both the Platte and Loup watersheds. The Loup River is the largest contributing tributary in the Lower Platte Basin corridor, any water resource inventory study conducted at the confluence of the Loup and Platte Rivers would be absolutely imperative for future Watershed Planning development of either basin.

15. Uses objectives described in the annual report and plan of work for the state water planning and review process issued by the department.

- Identify the date of the Annual Report utilized.
- List any and all objectives of the Annual Report intended to be met by the project
- Explain how the project meets each objective.

The Annual Report and Plan of Work for the Nebraska State Water Planning and Review Process (NDNR 2015) lists the following objectives:
1) Maintain data, information, and analysis capabilities for water planning, including specific programs for collecting, maintaining, and distributing information on streamflows, as well as analyzing water uses and water supplies across the state;
2) Provide staff and resources to support planning and implementation of water resources projects;
3) Support locally developed water management plans for managing hydrologically connected water supplies;
4) Provide resources to map and identify areas vulnerable to flood damage; and
5) Provide coordination of federal agencies, state agencies, local natural resources districts (NRDs), and other water interests for the development of water resources programs and projects.
The collection of AEM data and the incorporation of that data into an overall aquifer framework directly supplements Objective 1 through improved data, information, and analysis capabilities. The data collected provides greater understanding of the extents, thickness, and interconnectedness of aquifer systems. That greater understanding directly informs analysis of streamflows in the hydrologically connected water resources of the State. Water uses and supplies are analyzed as part of the FAB Report, done annually by the NDNR, through modeling of those hydrologically connected areas. The AEM data and the resulting interpretation and framework will be submitted to the NDNR as the best available data for use in the FAB Report.

The Project directly supplements the staff and resources of the State for planning and management of the water resources of the state. The Project partners will utilize the data collected and the interpretation of that data to further their expertise in the local hydrogeologic framework. That expertise is utilized by the management and Board of the LLNRD to develop the appropriate plans, programs, and projects for the protection and conservation of the water resources. The LLNRD partners with many agencies of the state including NDNR, NDEQ, DHHS, NG&PC, and others with an interest in the protection and conservation of the state's water resources.

The Project partners represent local, regional, and state level interests, cooperatively studying the water resources of the state. Additionally, the data

collected is shared with other non-partner agencies and the general public to provide an overall greater understanding of the hydrogeologic framework. That understanding is fundamental to any program or project undertaken to protect and conserve the water resources.

16. Federal Mandate Bonus. If you believe that your project is designed to meet the requirements of a federal mandate which furthers the goals of the WSF, then:

- Describe the federal mandate.
- Provide documentary evidence of the federal mandate.
- Describe how the project meets the requirements of the federal mandate.
- Describe the relationship between the federal mandate and how the project furthers the goals of water sustainability.

N/A

Application

Section D
PROJECT DESCRIPTION

Section D.

PROJECT DESCRIPTION

1. Overview

In 1,000 characters *or less*, provide a brief description of your project including the nature and purpose of the project and objectives of the project.

The process of proactively identifying and evaluating water resources through the use of both traditional and state of the art techniques is critical to the state's water planning activities. Equipped with the best available information, state and local agencies are most able to develop the necessary plans to ensure the sustainability and protection of the state's water supply. Traditional techniques of aquifer characterization rely upon assessments of subsurface materials from numerous individually drilled borehole locations. The remote sensing technique of Airborne Electromagnetics (AEM) has the capability of collecting many thousand virtual boreholes at a fraction of the cost of traditional drilling. AEM is then combined with existing information about aquifer characteristics to provide an overall three dimensional framework of the aquifer extents and interactions. This Project seeks funding to collect AEM data and interpret the results into that three dimensional framework.

2. Project Tasks and Timeline

Identify what activities will be conducted by the project. For multiyear projects please list what activities are to be completed each year.

The Project will map a flight block across the Project areas in southeastern Platte County, covering 608 miles of AEM survey (see SIA Section B-1(b) Figure B.2a - LLNRD Project Area and Figure B.2b – LLNRD Project Area) to develop a three dimensional view of the aquifer in the vicinity of the City of Columbus and confluence Loup and Platte Rivers. The Project will consist of the planning of flight lines within the block area, collection of AEM data along the flight lines, processing of the raw AEM data, interpretation of the processed data, and reporting of the overall results. The AEM survey results will be incorporated into a Geographic Information System (GIS) spatial database for use by LLNRD and Project Partners. The resistivity data from the processed results will be tied to local geologic interpretations from traditional subsurface mapping.

This block area is a high priority area targeted for AEM by the LLNRD where on-going groundwater quality problems are occurring and potential use conflicts may occur that traditional methods of investigation have not resolved. Mapping results produced for these blocks through this Project will provide three-dimensional subsurface views of the aquifer materials and estimates of the extents and volumes of the ground water resources available in the block areas (see SIA Figure

C.1 - Sample Interpreted Voxel Display). The primary flight lines conducted for the blocks will be spaced approximately 250 meters apart perpendicular to the estimated trend of the aquifer units. Additionally, “tie lines” will be spaced approximately 1,500 meters apart (oriented 90 degrees relative to the primary flight lines). Similar spacing has produced successful results previously in eastern Nebraska (Divine and Korus 2012).

CSD geologists will evaluate the AEM survey results with CSD cross section and ancillary data to make interpretations of the regional geologic setting types encountered, evaluate how well the AEM results match-up relative to the cross sectional data. The resulting map publication and conclusions will provide those interested in the hydrogeology of eastern Nebraska a comprehensive an improved understanding of the varying hydrogeological settings. That interpretation will follow the approach used for previous ENWRA block areas. The NRDs will use groundwater reservoir delineations and associated maps to address groundwater quality problems occurring in this block and to help mitigate potential quantity concerns in the area.

Upon notice of award of the WSF grant, the LLNRD will contract with the Consultant to refine proposed block area and develop the detailed flight lines. Payment of 30% of the total contract amount of $416,666, or $125,000 will be due at the time of contract signing. The Consultant, working with the LLNRD will develop the grid of flight lines maximizing the coverage area while avoiding infrastructure that creates ground interference. The Consultant will combine all block areas and flight lines from the additional awarded partner WSF grants into an efficient flight plan to minimize mobilization, de-mobilization, and logistical costs for the data collection.

The single year of this Project grant request will include the collection, processing, and interpretation of AEM data with a final report of the Project completed by June 2017. An additional 50% of the total contract amount of $416,666, or $208,333, will be due to the Consultant at the end of the AEM data collection. The remaining 20% of the total contract amount, or $83,333, will be due at the delivery of the final report.

The interpretations and GIS spatial database will be provided to ENWRA, CSD, and NDNR at the time of the final report delivery. CSD and NDNR will incorporated the findings of the Project into existing datasets and models, as appropriate and at their schedule. The work required for incorporation of the datasets into the overall hydrogeologic framework is not included in the funding from this grant application.

3. Partnerships

Identify the roles and responsibilities of agencies and groups involved in the proposed project regardless of whether each is an additional funding source. List any other sources of funding that have been approached for project support and that have officially turned you down. Attach the rejection letter.

The Project is being done in cooperation with several local and state agencies with coordinated data collection to improve efficiency and gain economy of scale. The LLNRD is a participating agency for this proposed Project and application to the Water Sustainability Fund (WSF). Additional WSF grant applications are being submitted by LENRD, P-MRNRD, LPNRNRD, and LPSRNRD for similar AEM projects. The planning and coordination of all flights, data collection, test-hole drilling, processing, interpretation, and data products will be done through the use of a single geophysical consulting firm. The use of a single Consultant allows the NRDs to share the overhead costs of mobilization and de-mobilization of the data collection equipment as well as creating efficiency in data processing and reporting. This shared use reduces the overall costs for all partners with approved WSF grant applications. The CSD, along with the ENWRA, will provide technical support to all of the grant applications. Technical support will include incorporation of the completed data products into the existing datasets that comprise the overall framework of hydrogeology. Additionally, any test-holes necessary for interpretation of the AEM data will be completed by CSD and incorporated into the statewide test-hole database. After the completion of the data collection, interpretation, and framework update, the information about the aquifer characteristics and extents will be provided to the NDNR for incorporation into the existing models as the “best available” information in the FAB Report.

4. Other Sources of Funding

Identify the costs of the entire project, what costs each other source of funding will be applied to, and whether each of these other sources of funding is confirmed. If not, please identify those entities and list the date when confirmation is expected. Explain how you will implement the project if these sources are not obtained.

The sources of funding for the Project are the required local match from the LLNRD of 40% ($160,000) and the WSF application request of 60% ($250,000). No other sources of funding are proposed for this Project. While there are no other sources of funds proposed for this Project, the LLNRD, the other partnering NRDs of ENWRA, and NDNR have spent considerable time, effort, and money to develop this technology and implement it in many areas of the state. The Project partners are committed to utilizing AEM to continue to develop a hydrogeologic framework and block areas necessary for the protection and conservation of the groundwater resources.

5. Support/Opposition

Discuss both support and opposition to the project, including the group or interest each represents.

AEM data collection is supported by numerous NRDs across the state that have utilized this type of detailed information to make improved management decisions.

Over the several years that the NRDs have been collecting this type of information, there have been no instances of opposition. From the earliest collection of AEM data in Nebraska until now, more agencies and organizations have supported the NRD efforts or undertaken their own AEM data collection including the Nebraska Department of Natural Resources and the US Army Corp of Engineers. NDNR was a partner on AEM data collection through ENWRA in 2013 and 2014. The US Army Corps of Engineers collected AEM data to support their efforts at cleanup of the Former Nebraska Ordinance Plant near Mead, Nebraska.

Supplemental Information Attachment

LOWERLOUP NATURAL RESOURCES DISTRICT

FYRA ENGINEERING

SECTION B

B-1(b)

Figure B.1 – ENWRA Flight Lines

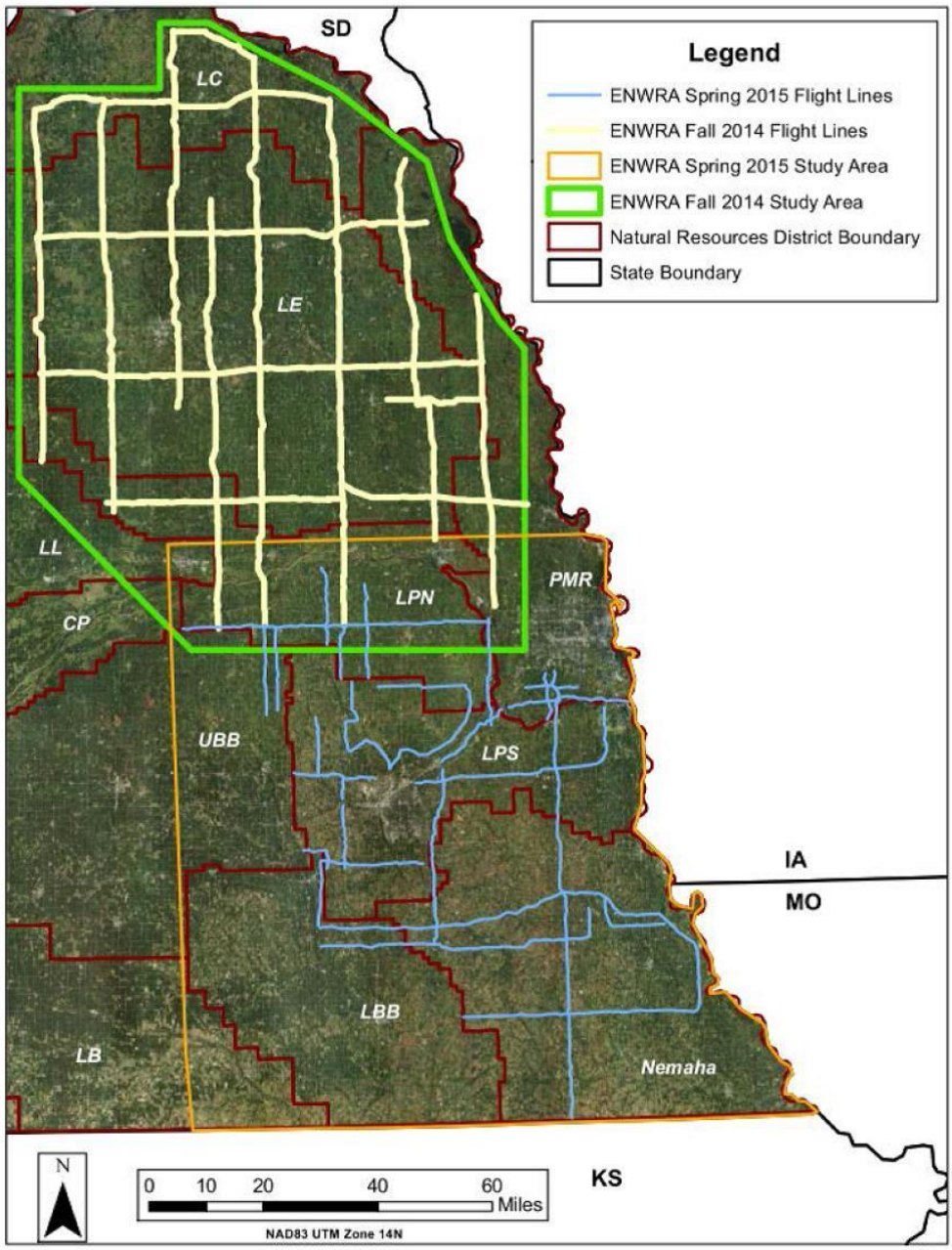


Figure 1-1: Map of the ENWRA project area, with the northern extent of the survey area (Phase I) and flight lines highlighted in green and yellow, respectively. The southern half of the project area (Phase II) is outlined in orange.

Figure B.2a - LLNRD Project Area

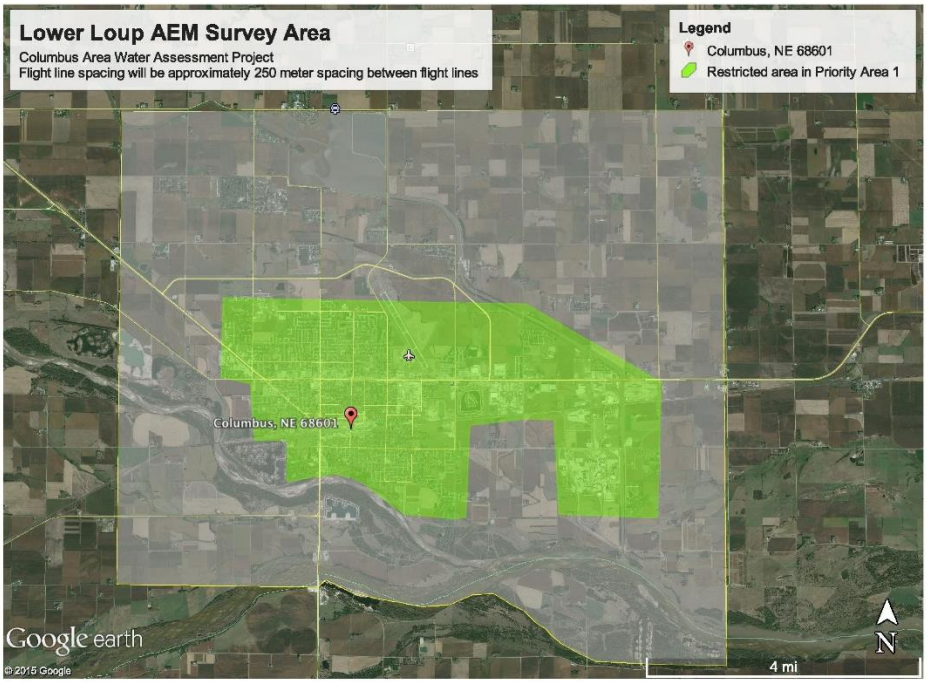


Figure B.2b - LLNRD Project Area

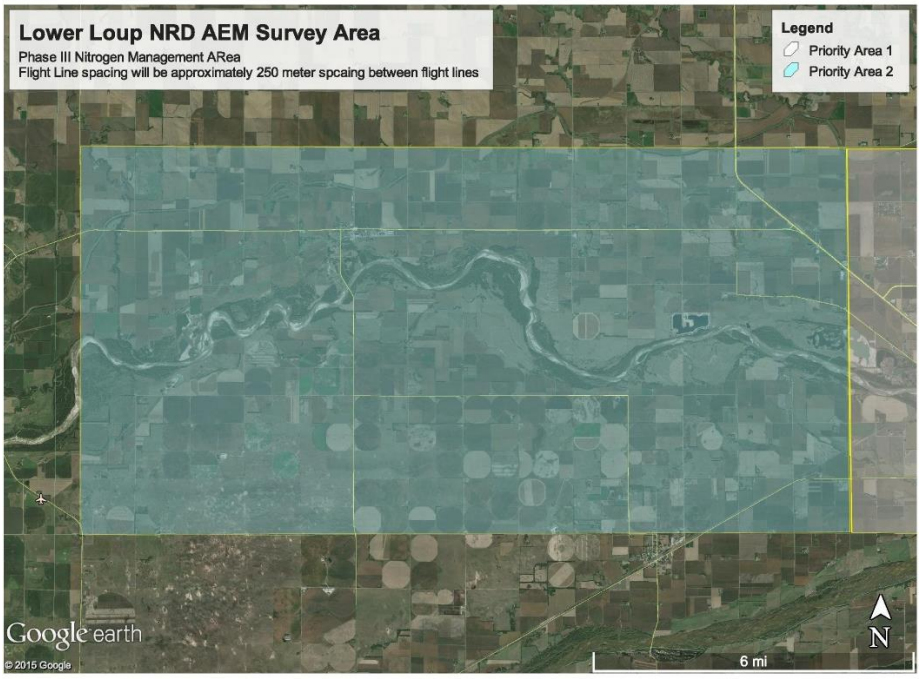


Figure B.3 - Sample Interpreted Geologic Cross-Section of Plans for Dams

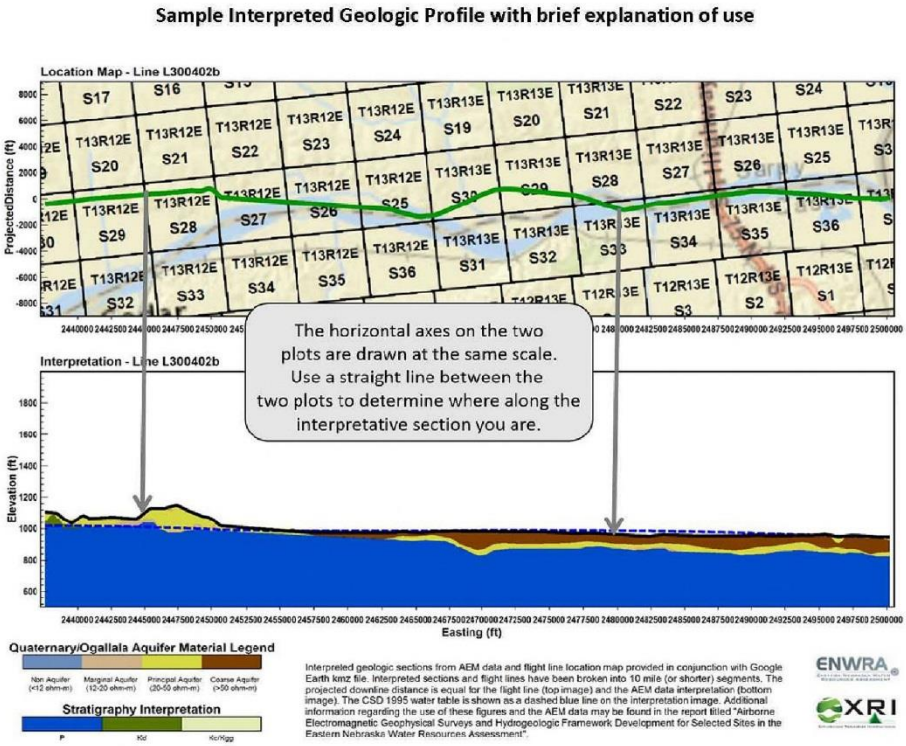
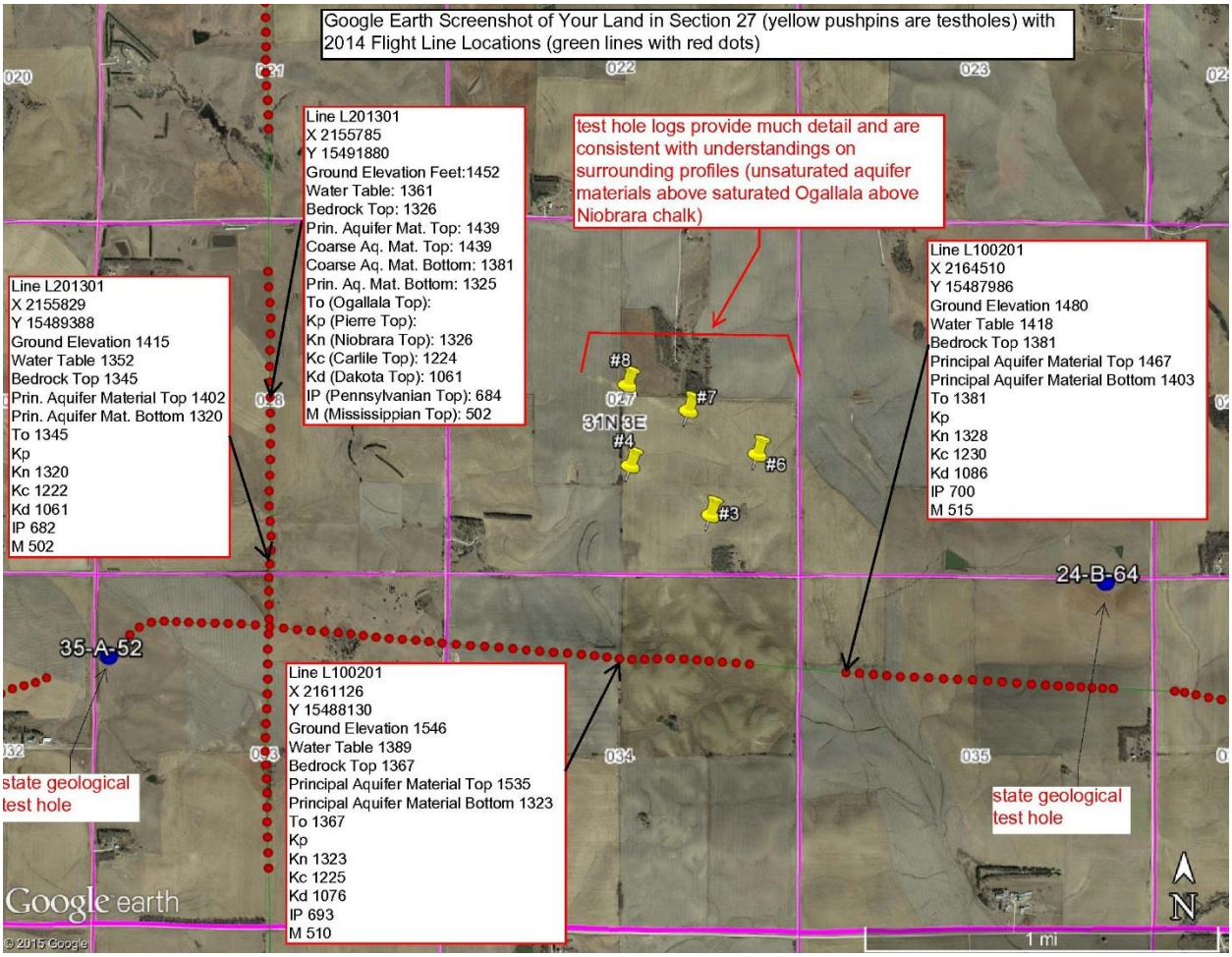


Figure B.4 - ENWRA Sample Landowner Information Map



B-9

Figure B.5 - Groundwater Quantity Management Summary 2014

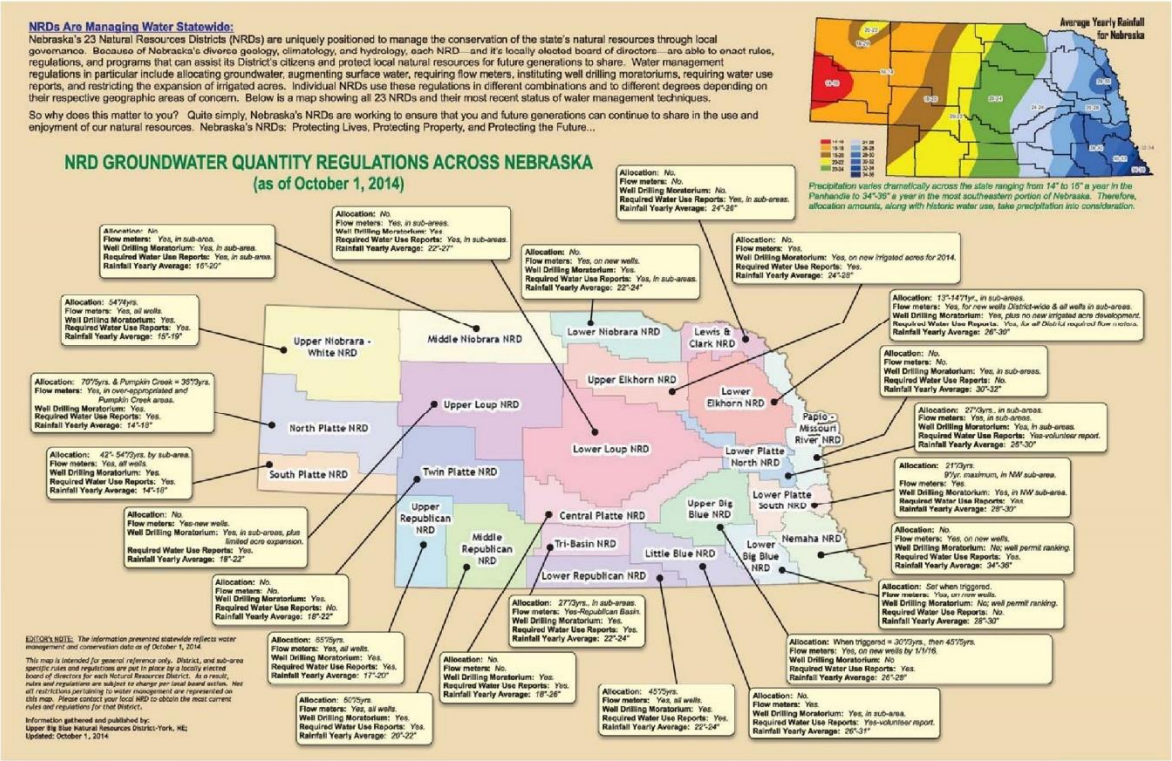


Figure B.6 - Groundwater Quality Management Summary 2014

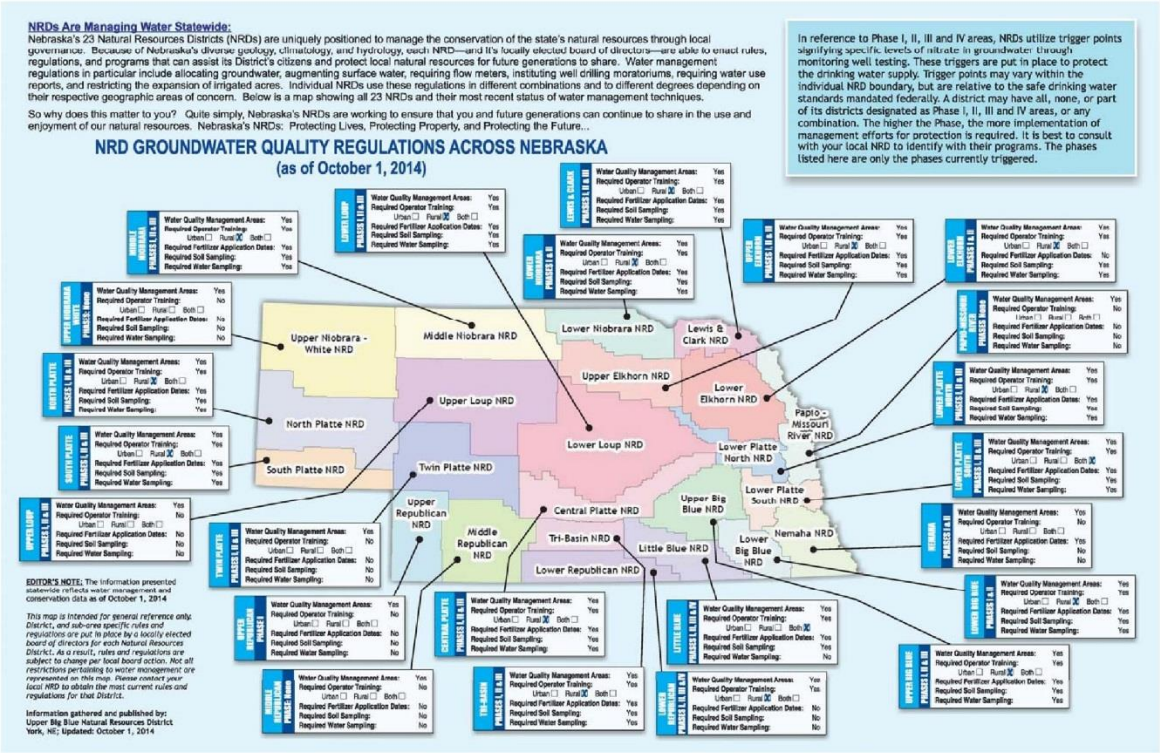


Table B.1 - ENWRA Potential Future Projects (Draft)

Potential Future Projects

DRAFT

Objective/Project		Management Concern	Sponsor	Area (mi^2 / line km)	Potential Funding Sources	Fiscal Years	Estimated Cost*	Notes
4. Assess Potential Connections Between Groundwater and Surface Water								
A.	**Continue to evaluate HCAs and located unidentified HCAs on tributaries**	interrelated water	all 6 NRDs	--	USFWS/ENWRA Dues/WSF/CSD/ NET/county/NRDs	2016-2026	--	update CSD maps; incorporate CSD & DNR & AEM & ENWRA framework
B.	**Map saline groundwater**	interrelated water, quality	LPS/LPN	--	NRDs/ENWRA Dues/NET/ WSF/USFWS	2017-2019	--	map salt spring & stream reaches and salt/fresh boundary in Dakota formation using variety of methods
C.	**Review/incorporate ongoing streambed conductance work**	interrelated water	all 6 NRDs	--	ENWRA Dues/NET/ WSF/NRDs	2016-2026	--	identify gaining/losing reaches
5. Estimate/Calculate Water Budgets		management decisions	all 6 NRDs	--	ENWRA Dues/NET/ WSF/NRDs	2016-2026	$100,000	assimilation, analysis and publication of data, could include variety of assessment tools, part of ultimate goal of a 3-D hydrogeological framework and water budget for all ENWRA
6. Characterize Natural And Anthropogenic Water Quality Concerns		quality/ recharge/ sustainability	all 6 NRDs	--	DEQ/EPA/USGS/ ENWRA Dues/ WSF/NET	2016-2026	$300,000	analyzed constituents vary according to concern, could include age-dating
7. Assemble, Analyze, and Distribute Data								
A.	**Develop online mapping platform for publicizing AEM data**	--	all 6 NRDs	--	ENWRA Dues/ NET/WSF	2017-2026	$100,000	interactive map format - $25,000 will go in as budget item with initial FY 17 for outreach to entity with similar existing platform for guidance and initial steps
B.	**Data input and upload to dnrftp, distribution and notification of results to partners, website updates, presentations**	--	all 6 NRDs	--	--	2016-2026	--	joint effort with Technical Advisors, Data Providers, and Project Coordinator
8. Develop a Variety of Partners and Funding Sources		--	all 6 NRDs	--	--	2016-2026	--	on-going effort as opportunities arise
9. Continue to Assess the Applicability of New Technology and ENWRA Applicable Parallel Projects/Developments/ Precedents		--	all 6 NRDs	--	--	2016-2026	--	this task will occur if potential new technology and potential parallel projects/entities/laws develop

*Geophysical costs are based on ~$500 per line kilometer.

Page 3 of 3

SECTION C

C-1

Figure C.1 - Sample Interpreted Voxel Display

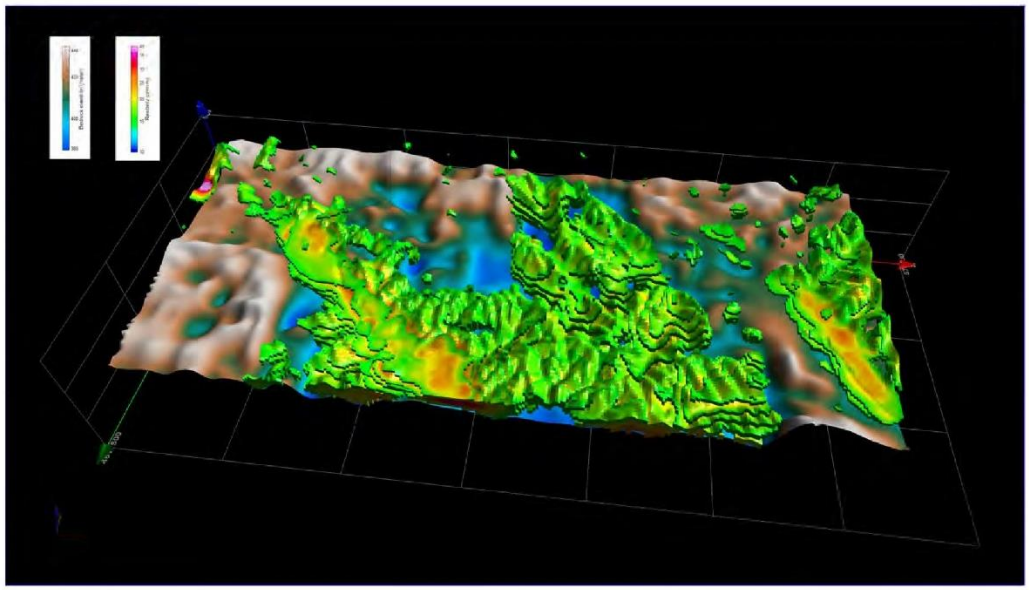
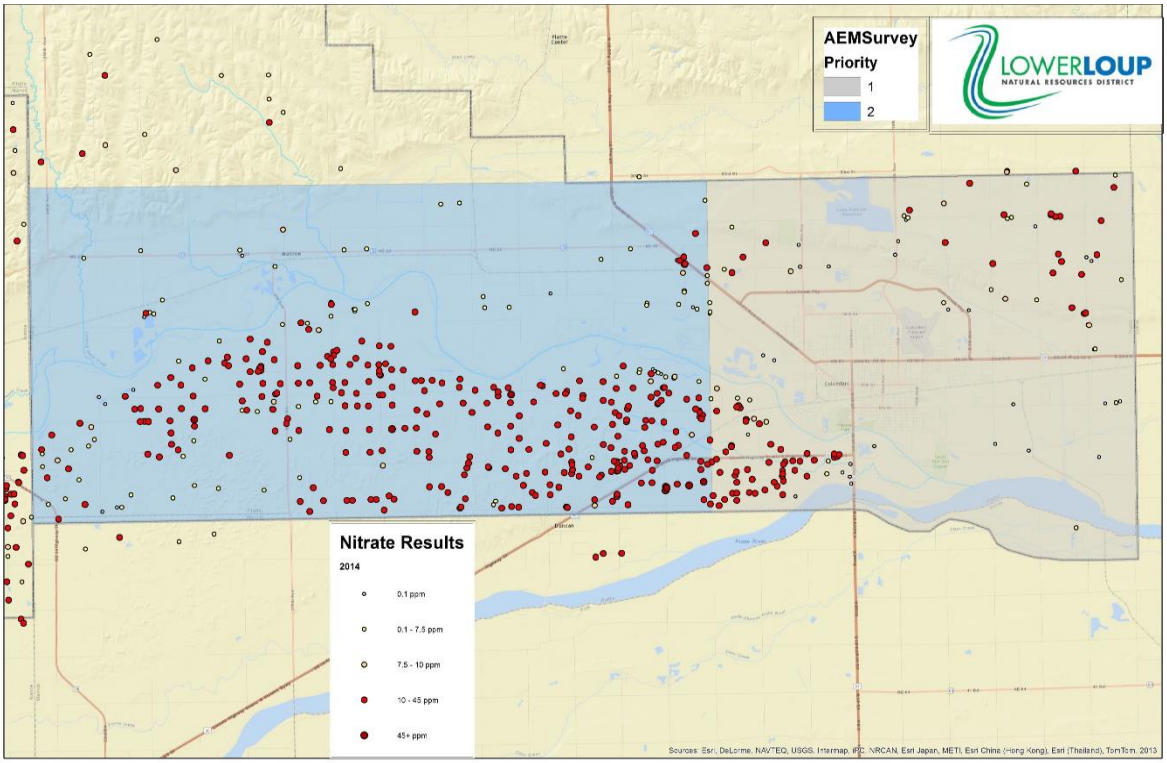


Figure A-6- 3-D voxel display of 15 ohm-m or greater resistivity zones overlying the Cretaceous bedrock surface.

XRI – LENRD AEM Survey Report *31*

Figure C.2 – LLNRD Nitrate Levels



C-6

Figure C.3 - Cost Letter

AQUA GEO FRAMEWORKS

130360 CR D
Mitchell, NE 69357

12/21/2015

Mr. Leon Koehlmoos
General Manager
2620 Airport Drive
Ord, NE 68862

Dear Butch,

As requested the estimated costs associated for a complete Airborne Electromagnetic (AEM) survey of the Columbus Area Water Assessment and Phase III Nitrogen Management project areas is as follows. Approximately 608 miles of AEM data will be collected as part of the project. AGF will build the database, perform the geophysical analysis and inversion, and complete the interpreted hydrogeologic framework and report.

Costs

AEM survey	$191,666
Database Development	$29,167
Geophysical Analysis	$54,167
Hydrogeologic framework and report	$141,666
Total	$416,666

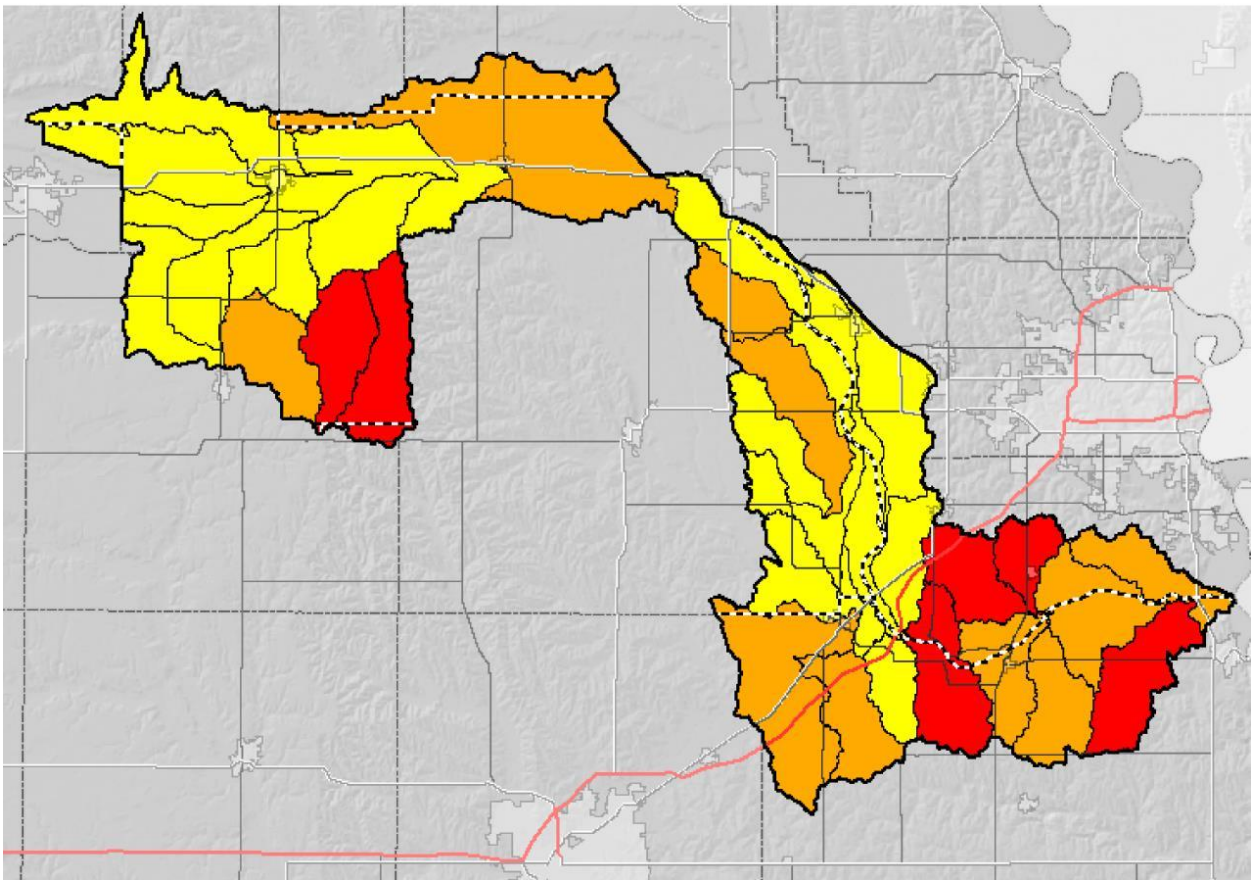
If you have any questions please do not hesitate to call.

Sincerely,

James C. Cannia P.G.

C-14

Figure C.4 - LPRCA Priority Watersheds



Bibliography

BIBLIOGRAPHY

Divine, Dana P. Korus, Jesse T. 2009. Three-dimensional hydrostratigraphy of the Sprague, Nebraska Area: Results from Helicopter Electromagnetic (HEM) mapping in the Eastern Nebraska Water Resources Assessment (ENWRA).

Lower Loup NRD. 2015. Lower Loup NRD Groundwater Management Plan.

Lower Platte River Corridor Alliance. 2014. Water Quality Management Plan for the Lower Platte River Corridor Alliance.

Nebraska Department of Natural Resources (NDNR). 2015. Annual Report and Plan of Work for the Nebraska State Water Planning and Review Process.

University of Nebraska-Lincoln Conservation and Survey Division. 2009. Eastern Nebraska Water Resources Assessment (ENWRA) Introduction to a Hydrogeological Study.

U.S. Geological Survey Scientific Investigations Report 2011-5228. Evaluation of Geophysical Techniques for the Detection of Paleochannels in the Oakland Area of Eastern Nebraska as Part of the Eastern Nebraska Water Resource Assessment.