NEBRASKA NATURAL RESOURCES COMMISSION

Water Sustainability Fund

Application for Funding

Section A.

ADMINISTRATIVE

PROJECT NAME: Mapping and Modeling for Water Balance in the MRNRD

SPONSOR'S *PRIMARY CONTACT INFORMATION* **(Not Consultant's)**

Sponsor Business Name: Middle Republican Natural Resources District

Sponsor Contact's Name: Alex Boyce

Sponsor Contact's Address: 208 Center Ave, P.O. Box 81, Curtis, NE 69025

Sponsor Contact's Phone: : 308-367-4281

Sponsor Contact's Email: aboyce@mrnrd.org

1. **Funding** amount requested from the Water Sustainability Fund:

   Grant amount requested. $1,222,899.17

   - If requesting less than 60% cost share, what %? n/a

   If a loan is requested amount requested. $ n/a

   - How many years repayment period? n/a
   - Supply a complete year-by-year repayment schedule. n/a

2. **Neb. Rev. Stat. § 2-1507 (2)**

   Are you applying for a **combined sewer overflow project**? YES☐ NO☒

   If yes:

- Do you have a Long Term Control Plan that is currently approved by the Nebraska Department of Environmental Quality? YES☐ NO☐
- Attach a copy to your application. n/a
- What is the population served by your project? n/a
- Provide a demonstration of need. n/a
- **Do not complete the remainder of the application.**

3. **Permits Required/Obtained** Attach a copy of each that has been obtained. For those needed, but not yet obtained (box **"NO"** checked), 1.) State when you will apply for the permit, 2.) When you anticipate receiving the permit, and 3.) Your estimated cost to obtain the permit.

(N/A = Not applicable/not asking for cost share to obtain)
(Yes = See attached)
(No = Might need, don't have & are asking for 60% cost share to obtain)

G&P - T&E consultation (required)	N/A☒	Obtained: YES☐	NO☐
DNR Surface Water Right	N/A☒	Obtained: YES☐	NO☐
USACE (e.g., 404/other Permit)	N/A☒	Obtained: YES☐	NO☐
FEMA (CLOMR)	N/A☒	Obtained: YES☐	NO☐
Local Zoning/Construction	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.

4. **Partnerships**

List each Partner / Co-sponsor, attach documentation of agreement:

Conservation and Survey Division, School of Natural Resources, University of Nebraska-Lincoln; Aqua Geo Frameworks (consultant)

Identify the roles and responsibilities of each Partner / Co-sponsor involved in the proposed project regardless of whether each is an additional funding source.

Middle Republican NRD (MRNRD): The MRNRD will administer the grant and secure a subaward contract with AGF to carry out the geophysical surveys, and a subaward with CSD for geologic/hydrostratigraphic modeling. The MRNRD will provide assistance with project logistics and land access when necessary. MRNRD will also secure a contract with a groundwater modeling consultant of their choice, under the advice of CSD, to ensure tight project collaboration and transfer of knowledge. The consultant will be experienced in model development for the Republican River Basin and will have the necessary competencies to carry out the work plans set out in this proposal.

Aqua Geo Frameworks (AGF): AGF is a Nebraska-based small business offering geophysical surveying and groundwater mapping services. AGF geologists and geophysicists will perform all necessary planning and logistics related to the AEM survey, including defining system specifications, securing technical details in agreements with contractors, coordinating the work items with the subawardees, and processing, editing, and inverting the acquired AEM data. In addition, AGF with work with CSD to gather existing data for the area.

Conservation and Survey Division (CSD): CSD is a key partner tasked with implementing a sound scientific investigation. CSD geologists will work closely with AGF to include developing software projects, handling data, and conducting modeling work. CSD will coordinate the preparation of reports and publications. CSD will manage all data associated with the project and provide long-term security of the data via Nebraska GeoCloud.

5. 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.

	Year 1	*Year 2*	*Year 3*	*Year 4*	*Total cost*
WSF REQUEST	$247,660.85	$268,009.03	$394,779.18	$312,450.11	$1,222,899.17
MRNRD COST SHARE	$165,107.23	$178,672.69	$263,186.12	$208,300.07	$815,266.11

TOTAL PROJECT COST	**$412,768**	**$446,682**	**$657,965**	**$520,750**	**$2,038,165**

There are no other sources of funding for cost share other than MRNRD cash match. The NRD match is confirmed.

6. **Overview**

In 1,000 words *or less*, provide a brief description of your project including the nature/purpose of the project and its objectives. Do not exceed one page!

The purpose of this project is to build hydrogeological tools that help the Middle Republican NRD (MRNRD) implement its Integrated Management Plan (IMP). The tools will be used to evaluate water use offsets and permanent transfers of irrigated acres. The overall goal of the IMP is to sustain a balance between water uses and supplies for the economic, social, and environmental well-being of the river basin. Given the fully appropriated status of the Republican River Basin, the MRNRD has implemented a moratorium on permits for new water wells and on new or expanded irrigated acres. Variances may be granted, however, on the basis of offsets, substitutions, or transfers, as long as there are no new impacts to existing users and that the sum of consumptive uses does not increase. A key objective of the IMP is to develop a program to provide for these offsets so that new water uses are balanced by reductions in use elsewhere.

The MRNRD currently uses a simple scoring system for evaluating offsets, but this system has conceptual limitations which introduce substantial uncertainties. These uncertainties can result in risks related to costs, economic impacts, and compliance with the Republican River Compact. A more sophisticated evaluation system is needed to reduce these risks and uncertainties. A cost-effective way of reducing and quantifying uncertainty is by applying hydrogeological mapping tools and characterization techniques.

This project will generate the most sophisticated, detailed, and up-to-date hydrogeological tools for this portion of the Republican River Basin. The project will include 1) aquifer mapping and characterization using airborne electromagnetics (AEM); 2) hydrostratigraphic models capable of quantifying uncertainties; and 3) numerical (MODFLOW) groundwater models built from the AEM-derived hydrostratigraphy. The detailed AEM mapping will provide unprecedented detail in

the hydrogeologic framework, which will reduce the risks associated with uncertainties in numerical modeling. This framework will be input to MODFLOW, allowing the MRNRD to use the best available science to calculate offsets based on the location, amount, and timing of pumping reductions and new uses.

7. Project Tasks and Timeline

Identify what activities will be conducted to complete the project, and the anticipated completion date.
For multiyear projects please list (using the following example):

Task	Year 1	Year 2	Year 3	Year 4	Total amount
Airborne electromagnetic survey (AEM), processing, inversion, and modeling of geophysical data	$412,768.08	$446,681.72	$539,021.29	$422,650.18	$1,821,121.28
Geological interpretation and modeling, development of model input layers and parameters	--	--	$68,944.00	$48,100.00	$117,044.00
Groundwater model development	--	--	$50,000.00	$50,000.00	$100,000.00
WSF REQUEST	$247,660.85	$268,009.03	$394,779.18	$312,450.11	$1,222,899.17
MRNRD COST SHARE	$165,107.23	$178,672.69	$263,186.12	$208,300.07	$815,266.11
TOTAL PROJECT COST	**$412,768.08**	**$446,681.72**	**$657,965.29**	**$520,750.18**	**$2,038,165.28**

8. IMP

Do you have an **Integrated Management Plan** in place, or have you initiated one? YES☒ NO☐ Sponsor is not an NRD☐

Section B.

DNR DIRECTOR'S FINDINGS

Prove Engineering & Technical Feasibility
(Applicant must demonstrate compliance with Title 261, CH 2 - 004)

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

YES☐ NO☒

If you answered "YES" you must answer all questions in section 1.A.
If you answer "NO" you must answer all questions in section 1.B.

If "YES", it is considered mostly structural, so answer the following:

1.A.1 Insert a feasibility report to comply with Title 261, Chapter 2, including engineering and technical data; Click here to enter text.

1.A.2 Describe the plan of development (004.01 A); Click here to enter text.

1.A.3 Include a description of all field investigations made to substantiate the feasibility report (004.01 B); Click here to enter text.

1.A.4 Provide maps, drawings, charts, tables, etc., used as a basis for the feasibility report (004.01 C); Click here to enter text.

1.A.5 Describe any necessary water and/or land rights including pertinent water supply and water quality information (004.01 D); Click here to enter text.

1.A.6 Discuss each component of the final plan (004.01 E); Click here to enter text.

1.A.7 When applicable include the geologic investigation required for the project (004.01 E 1); Click here to enter text.

1.A.8 When applicable include the hydrologic data investigation required for the project (004.01 E 2); Click here to enter text.

1.A.9 When applicable include the criteria for final design including, but not limited to, soil mechanics, hydraulic, hydrologic, structural, embankments and foundation criteria (004.01 E 3). Click here to enter text.

If "NO", it is considered mostly non-structural, so answer the following:

1.B.1 Insert data necessary to establish technical feasibility (004.02);

This study will use technically robust tools and methods from geophysics, geology, and hydrogeology, including airborne electromagnetics (AEM) and MODFLOW. Airborne electromagnetics (AEM) is a proven, cost-effective method for rapid, high-resolution imaging of the subsurface. Hardware and software system improvements during the past decade have continued to make AEM the best available technology for hydrogeologic mapping, and it will continue to be so for the foreseeable future.

AEM has been used extensively in Nebraska since 2007 with approximately 26,000 miles (over 41,000 km) of AEM acquired. Advances in instrumentation, data processing, and geophysical inversion have made it possible to collect high-resolution data within the upper ~1000 ft of the surface. This is the critical depth range of

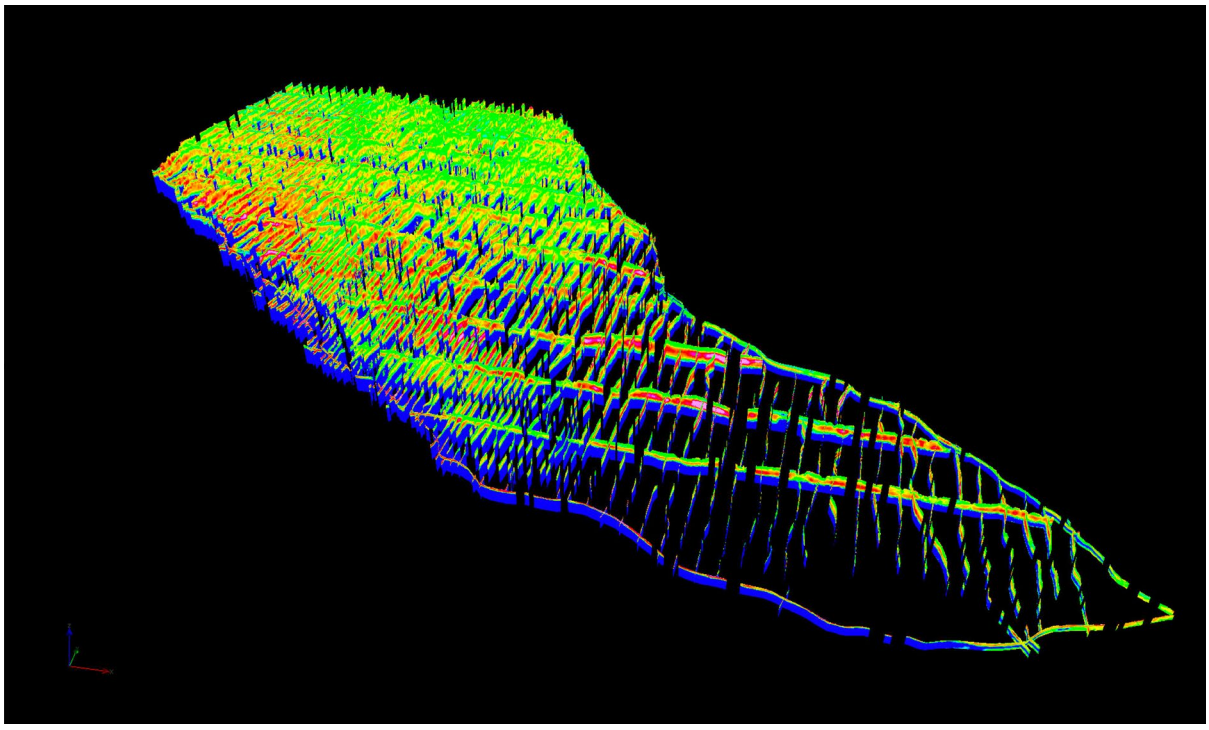

Figure 1. 3D view of AEM resistivity data from the 2020 AEM survey in the MRNRD. View is toward northwest. Distance from west to east is ~50 miles. Vertical exaggeration is 1:10

interest to resource managers and groundwater modelers. In 2020, the MRNRD completed an AEM survey for a portion of the District. Hydrostratigraphic mapping using the AEM results revealed new insights about the Ogallala aquifer that would not have been possible with any other method. The AEM data showed that the geology of the Ogallala is complex and heterogeneous. The results prove that high-permeability pathways and low-permeability hydraulic barriers exist in the Ogallala as well as in overlying units.

MODFLOW is the worldwide standard for groundwater modeling and has been used successfully for decades to simulate the impacts of various management alternatives on aquifer depletion, streamflow, and recharge. For this project, MODFLOW will be used to build a regional-scale groundwater model capable of evaluating water transfers and offsets. The hydrostratigraphic framework of the model will be informed by AEM, and it will be capable of numerically computing the complex interactions between various components of the interconnected groundwater-surface water system. Offsets will be calculated according to the water balance equation (NDNR, 2009):

$$sdf_N \Delta N + C(sdf_O \Delta O) \leq 0$$

Where:
sdf_N = stream depletion factor at new use location
sdf_O = stream depletion factor at offset use location
ΔN = new use
ΔO = offset use
C = confidence factor

The confidence factor is a measure of model certainty (1.0 = 100% certain). Models are, by definition, simplifications of complex natural systems. Thus, all models have uncertainties. These uncertainties are sources of error that need to be accounted for in the water balance calculation. If ignored, these uncertainties can lead to unintended consequences such as over-consumption, streamflow depletions, or undue restrictions. Although uncertainties cannot be eliminated, they can be reduced and quantified. The AEM helps to reduce some of the uncertainties in the analysis.

1.B.2 Discuss the plan of development (004.02 A);

The plan is to complete the AEM mapping over the course of three years to make the project possible within the annual budgetary limits of the MRNRD. AEM surveys will be flown in a series of "blocks". Each block will be surveyed at a density of 1 flight line per kilometer (0.6 miles). Flight lines will be oriented north-south because geological structures in this area tend to be oriented west-east. This approach

maximizes the likelihood that major structures are intersected by the survey flight path. West-east "tie lines" will be flown every ~5 km. The tie lines help survey quality control, model inversion, and in interpolation of 3D grids.

Block 1 will be completed in year 1 of the project. Block 2 will be completed in year 2. Blocks 3 and 4 will be completed in year 3.

This plan is consistent with the District's 2020 AEM survey, which was also flown along north-south lines spaced 1-km apart. The previous project focused on areas of major water-table drawdown and evaluation of potential managed aquifer recharge. The AEM survey completed in 2016 of the NCORPE in the northern portion of the District area will also be integrated into the overall project data. The current project aims to map and model the remaining groundwater systems of the District. At the end of the project, a seamless hydrostratigraphic model will be delivered for the entire MRNRD north of the Republican River. The MODFLOW model will be developed in years 3 and 4. The seamless models will integrate data from all survey areas, allowing water managers to evaluate offsets on a regional basis.

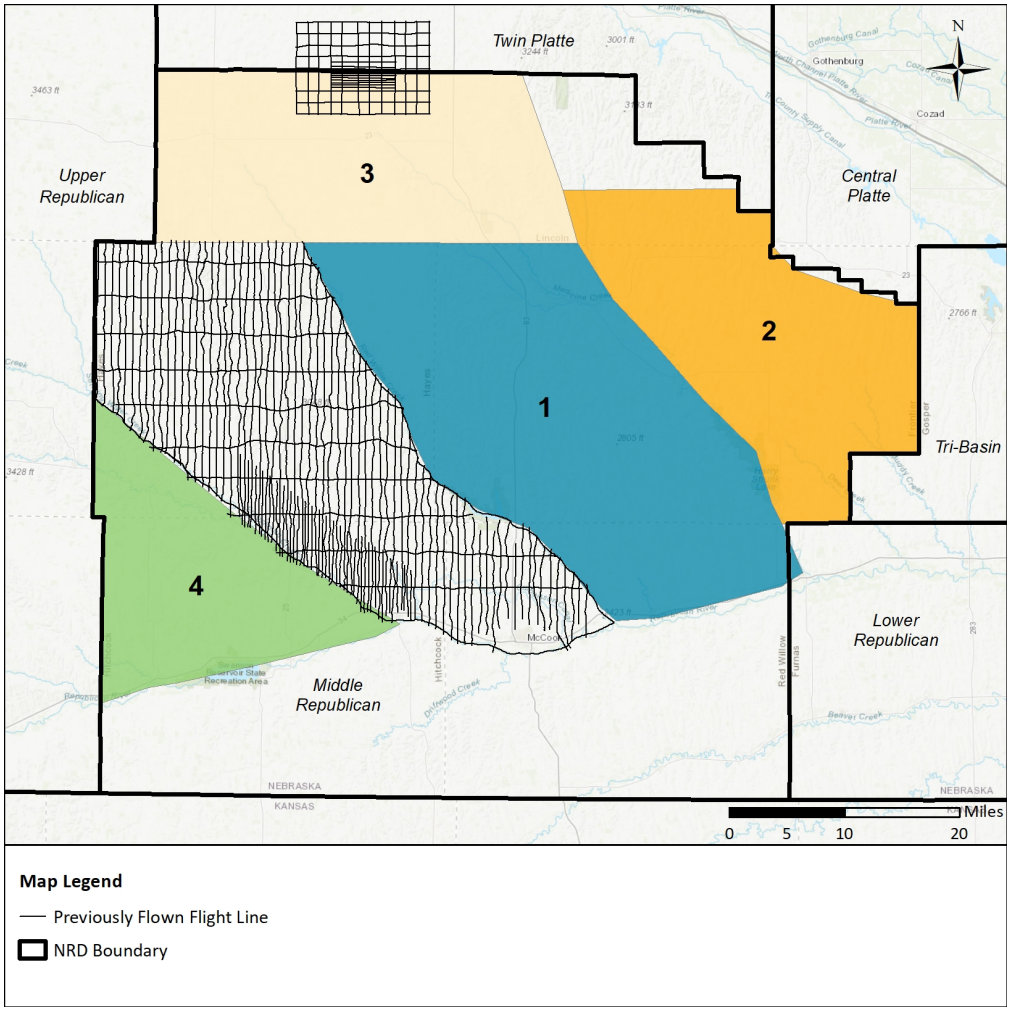

Figure 2. Map of planned AEM survey blocks. Block 1 will be completed in year 1, block 2 in year 2, and blocks 3 and 4 in year 3.

1.B.3 Describe field or research investigations utilized to substantiate the project conception (004.02 B);

Collaboration with Aqua Geo Frameworks

Given the integration of multiple disciplines, close collaboration between experts in various fields is necessary. Geologists at the Conservation and Survey Division (CSD) have worked closely with geophysicists and geologists at Aqua Geo Frameworks (AGF) to develop the project conception. The AGF team has more than 30 years of collective experience conducting geophysical investigations in Nebraska. CSD and the AGF team will collaborate with a consulting firm experienced in Republican River Basin models (Brown and Caldwell of Lakewood, CO has been hired by MRNRD for previous modeling projects). CSD and AGF geologists have local, first-hand

knowledge of the study area, and they have experience in geological and hydrogeological interpretation of AEM data including projects in many other Natural Resource Districts across Nebraska.

Geophysical and Geological Modeling

A key component linking all aspects of this project is the understanding of the subsurface geological structure. The geological framework is essential for thorough handling, assessment, and inversion of the AEM data. Therefore, significant effort is put into producing results that are geologically reasonable. This involves a tight collaboration between the geophysicists and the geologists whereby each group iteratively checks the mutual consistency between the geophysics and the geological expectations. The 3D geological model will focus on interpretations of geological formations, since each formation has unique hydrogeologic properties. The geological model will function as a framework for the development of the hydrostratigraphic models described below.

Hydrostratigraphic and Groundwater Modeling

Hydrostratigraphic units contribute to large uncertainties in many groundwater models. Therefore, improving the realism of the hydrostratigraphic models and estimating uncertainty in the hydrologic properties will be an essential part of the modelling process. With these estimates, the uncertainties can be understood, evaluated, and integrated into the decision-making process.

Advanced modeling techniques will be used to reproduce spatial patterns of subsurface geology in 3D, providing a conceptualization of the geometry and patterns of physical property variation. This will ensure that the hydrostratigraphic models are geologically reasonable in terms of structural appearance. Using these methods, the various contributions of uncertainty, including spatial coverage, borehole lithology, geophysics, and the geophysical-geological correlation, are merged to produce a suite of hydrostratigraphic model realizations. The entire model ensemble reflects the uncertainty of the hydrostratigraphic interpretation and can be used to calculate uncertainties in the MODFLOW simulations.

A basin-wide MODFLOW model will be developed by consultants familiar with Republican Basin models. The various model components will come from recent modeling efforts and other available data. Multiple simulations will be run to test the sensitivity of the model to various hydrostratigraphic inputs. The impacts to the groundwater system, fluxes between aquifers, streams, and canals, and the uncertainties associated with these simulations will be computed. These model runs

will provide the MRNRD with quantifiable options for calculating offsets and managing the interconnected groundwater-surface water system.

1.B.4 Describe any necessary water and/or land rights (004.02 C);

No water or land rights are necessary.

1.B.5 Discuss 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).

Existing operations will not be affected directly by the proposed project.

Prove Economic Feasibility
(Applicant must demonstrate compliance with Title 261, CH 2 - 005)

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

Hydrogeologic mapping at the spatial scale and level of detail proposed herein is not possible in any other way. Geophysics is the only technology for this purpose. While ground-based geophysical surveys could be performed, to cover the extent proposed here would take decades, at best, to complete and cost much more. The next best alternative to achieve the same amount of detail would be to drill boreholes every 100 ft for nearly 4,011 miles, totaling more than 200,000 boreholes. At approximately $4,000 per test hole, the total would exceed $800,000,000 and take hundreds of years to accomplish. Clearly this option is impossible. Another alternative is to forego new data collection altogether, and instead, make groundwater management decisions with very limited knowledge of the hydrogeology. Making uninformed decisions could result in unnecessary consequences such as undue restrictions on pumping and loss of farm income or inadequate measures to ensure proper augmentation of flow to the Republican River.

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 is the project life, up to fifty (50) years; *or*, with prior approval of the Director up to one hundred (100) years, (Title 261, CH 2 - 005).

Budget justification	Year 1	Year 2	Year 3	Year 4	Total Cost	Documentation
Planning and implementation of AEM survey for 1,488 line miles. Geophysical data processing and inversion.	$ 412,768.08	$ 446,681.72	$ 539,021.29	$ 422,650.18	$ 1,821,121.28	Attachment 1
Senior personnel and graduate student hours for geological interpretation and development of model inputs.	$ -	$ -	$ 68,944.00	$ 48,100.00	$ 117,044.00	Attachment 2
Contract with consulting firm to build groundwater model incorporating inputs from AEM survey.	$ -	$ -	$ 50,000.00	$ 50,000.00	$ 100,000.00	Typical hourly rate for consulting hydrogeologist at ~$180/hr for an estimated total of 556 hours

3.A 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).

AEM surveys totaling 4,011 line miles (~6,500 line-km), including assistance with flight planning and data acquisition, QA/QC and data processing, preliminary LCI geophysical inversions and final SCI inversions, and assistance with geological interpretation ($1,821,121.28)

Geological interpretation and hydrostratigraphic modeling, including uncertainty assessment, development of model layers and aquifer characteristics for MODFLOW input ($117,044.00)

Development of MODFLOW groundwater model and incorporation of AEM-derived products, simulation of groundwater-surface water system under various management scenarios ($100,000.00)

There are no annual operation or maintenance costs.

Total ($2,038,165.28)

3.B 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 intangible or secondary benefits (if any) 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, in a way that justifies economic feasibility of the project such that the finding can be approved by the Director and the Commission (005.02).

There is no generally accepted method for calculation of primary tangible benefits; however, the project will increase water sustainability. The results of the hydrogeologic mapping will result in actionable information for the implementation of a program of water offsets. The management actions taken for the MRNRD as a result of the mapping and modeling effort will help reduce or stabilize groundwater-level declines and reduce long-term depletions to streamflow.

3.C Present all cost and benefit data in a table to indicate the annual cash flow for the life of the project (005.03).

Budget justification	Year 1	Year 2	Year 3	Year 4	Total Cost	Benefit
Planning and implementation of AEM survey for 4,011 line miles. Geophysical	$ 412,768.08	$ 446,681.72	$ 539,021.29	$ 422,650.18	$ 1,821,121.28	Eliminates the need to drill boreholes over a distance of 4,011 miles,

data processing and inversion.						saving ~$800,000,000.
Senior personnel and graduate student hours for geological interpretation and development of model inputs.	$ -	$ -	$ 68,944.00	$ 48,100.00	$ 117,044.00	Leverages University expertise to carry out investigation, providing state-of-the-art scientific results and improving the reliability of water availability forecasts.
Contract with consulting firm to build groundwater model incorporating inputs from AEM survey.	$ -	$ -	$ 50,000.00	$ 50,000.00	$ 100,000.00	Provides necessary decision-support tool for evaluating groundwater and surface water management scenarios. This provides fair and equitable share of the responsibility for providing flows to the

					Republican River.
WSF REQUEST	$247,660.85	$268,009.03	$394,779.18	$312,450.11	$1,222,899.17
MRNRD COST SHARE	$165,107.23	$178,672.69	$263,186.12	$208,300.07	$815,266.11
TOTAL PROJECT COST	**$412,768.08**	**$446,681.72**	**$657,965.29**	**$520,750.18**	**$2,038,165.28**

3.D 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, demonstrate the economic feasibility of such proposal by such method as the Director and the Commission deem appropriate (005.04). (For example, show costs of and describe the next best alternative.)

The estimated cost of the part of the project that includes AEM surveys, data QA/QC and processing, inversion, and geological interpretation is $1,821,121.28, or $454 per line mile. This cost is in line with similar past projects (~$530 to $681 per line mile). Geological interpretation will be completed by the CSD and will include use of additional geological modeling work especially suited to the geology of southwest Nebraska. This will result in products for building hydrogeological frameworks for MODFLOW models. The cost of groundwater model development is $100,000 and is based on the MRNRD's recent work with consulting firms on similar projects.

Prove Financial Feasibility
(Applicant must demonstrate compliance with Title 261, CH 2 - 006)

4. Provide evidence that sufficient funds are available to complete the proposal. The MRNRD Board of directors has approved a budget allowing the use of funds for this project

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

replace). The MRNRD Board of directors has approved a budget allowing the use of funds for this project

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 (i.e. timing vs nesting/migration, etc.). No physical construction will occur that could seriously impact the environment. The plan of development includes airborne operations. No contact with the land will occur during the survey flights, reducing environmental impact. The modeling work is carried out on computers. The outcomes of this work will benefit the environment by reducing aquifer depletion and providing steady streamflow to the Republican River.

8. Explain how you are qualified, responsible and legally capable of carrying out the project for which you are seeking funds. The MRNRD is the legal entity responsible for regulating and controlling groundwater use within its boundaries. The MRNRD has established a close working relationship with the Conservation and Survey Division (CSD) over the past few years. CSD has developed partnerships with experts at AGF. These collaborations, partnerships, and trusted relationships allow the MRNRD to conduct a thorough, scientifically sound investigation. All geologists and geophysicists are professionally licensed with the Nebraska Board of Geologists and the Nebraska Department of Health and Human Services, Water Well Standards Program.

9. Explain how your project considers plans and programs of the state and resources development plans of the political subdivisions of the state. The Annual Report and Plan of Work for the Nebraska State Water Planning and Review Process provides information on several key areas of Department water planning activities, including current and future activities regarding information, data, and analysis capabilities, as well as water resources planning and management. The Water Resources Cash Fund is used to support water management efforts in fully appropriated or over-appropriated basins. These funds can be utilized to aid management actions taken to reduce consumptive uses of water, or to enhance streamflow or groundwater recharge. This project meets several of the goals within the Water Sustainability Fund, such as

reducing aquifer depletion, mitigating threats to drinking water, the approval of an integrated management plan and groundwater management plan, the contribution of water supply management goals such as agricultural uses, municipal and industrial uses, recreational benefits, wildlife benefits, conservation, and preservation of water resources. The project also meets the goals of enhancing water quality and complying with interstate compacts.

10. Are land rights necessary to complete your project? YES☐ NO☒

If yes:

10.A Provide a complete listing of all lands involved in the project. Click here to enter text.

10.B Attach proof of ownership for each easements, rights-of-way and fee title currently held. Click here to enter text.

10.C Provide assurance that you can hold or can acquire title to all lands not currently held. Click here to enter text.

11. Identify how you possess all necessary authority to undertake or participate in the project. MRNRD has the necessary authority to participate in this project. Nebraska Statute, Chapter 2, Article 32 establishes Nebraska's NRDs and gives them authority to develop and execute plans, facilities, works, and programs relating to water supply and the development, management, utilization, and conservation of groundwater and surface water. The MRNRD and the Nebraska Department of Natural Resources (DNR) jointly developed an Integrated Management Plan (IMP) in accordance with the Nebraska Ground Water Management and Protection Act, Neb. Rev. Stat. 46-701 to 46-753 (Reissue 2004). The current IMP is effective January 15, 2016. The IMP contains goals and objectives consistent with the proposed project. These goals and objectives and how the project will help the MRNRD meet them are explained in Section C, Part 2.

12. Identify the probable consequences (environmental and ecological) that may result if the project is or is not completed. There are no known, negative environmental and ecological consequences that may result as the result of the proposed project.

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 above. 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.

   Degradation of water quality threatens drinking water in the MRNRD. Elevated levels of nitrate-nitrogen have been detected in groundwater in the Republican River Valley

and nearby areas (NDEQ, 2020). The water supply for the City of McCook, population 7,540 (www.census.gov), is affected by nitrate and uranium. Moreover, high concentrations of naturally occurring vadose zone nitrate have been previously identified in loess of south central Nebraska (Boyce et al 1974; Spalding, 1996). Given the high density of irrigated cropland in the area, agricultural nitrate is likely stored in the vadose zone in many areas of the District. Biogeochemical interactions between naturally occurring nitrogen, agricultural nitrate, and accumulations of uranium and arsenic represent a potential threat to public and private drinking water supplies throughout the Middle Republican NRD.

In 1992, the MRNRD enacted a Special Protection Area for groundwater quality in the southern part of the District. The purpose of the area is the reduce nitrate contamination in groundwater. The City of McCook operates a treatment plant to remove nitrate, arsenic, and uranium from its water supply prior to distribution. The MRNRD maintains a network of monitoring wells, conducts periodic sampling of those wells, and has cost share programs for land owners who want to apply practices to improve water quality.

The AEM data collected in this project will provide a substantially improved understanding of the aquifer and vadose zone properties of the MRNRD. New knowledge about the subsurface will be achieved by collecting geophysical data at much higher spatial resolution, and less cost, than traditional data such as test holes or soil cores. This data will result in new maps of aquifer and vadose zone thickness, extent, permeability, and storage properties. The 2020 AEM survey revealed low-permeability units (confining layers), high-permeability pathways, and other characteristics of the subsurface that were previously unknown to hydrogeologists (Fig. 3). We expect that the proposed surveys will reveal additional information for a wider area. This information will be useful for taking mitigating actions, such as: constructing deeper wells or sealing off confining layers to prevent contaminant movement between aquifers; identifying preferential recharge zones and potential contaminant pathways; and constructing better-informed groundwater quality monitoring networks. This can provide MRNRD with the ability to tailor management activities intended to protect drinking water quality.

The long-range impacts of groundwater contamination include degradation of human health, disruptions to the supply of public and private drinking water, and increased treatment costs for the declining population base. Consumption of water with elevated levels of nitrate can be harmful to young infants and young livestock. Excessive nitrate in infants can result in restriction of oxygen transport in the bloodstream, which can result in "blue baby syndrome". There is a growing body of evidence linking nitrate and arsenic levels with increased cancer risk. Furthermore,

elevated nitrate in the vadose zone may be linked to mobilization of naturally occurring contaminants such as uranium and arsenic. Because of the relatively thick vadose zone in many areas of the MRNRD, there will likely be long-term impacts of nitrate on the groundwater system lasting into the foreseeable future. This project provides a state-of-the art hydrogeologic framework for taking proactive approaches to mitigating these threats to drinking water.

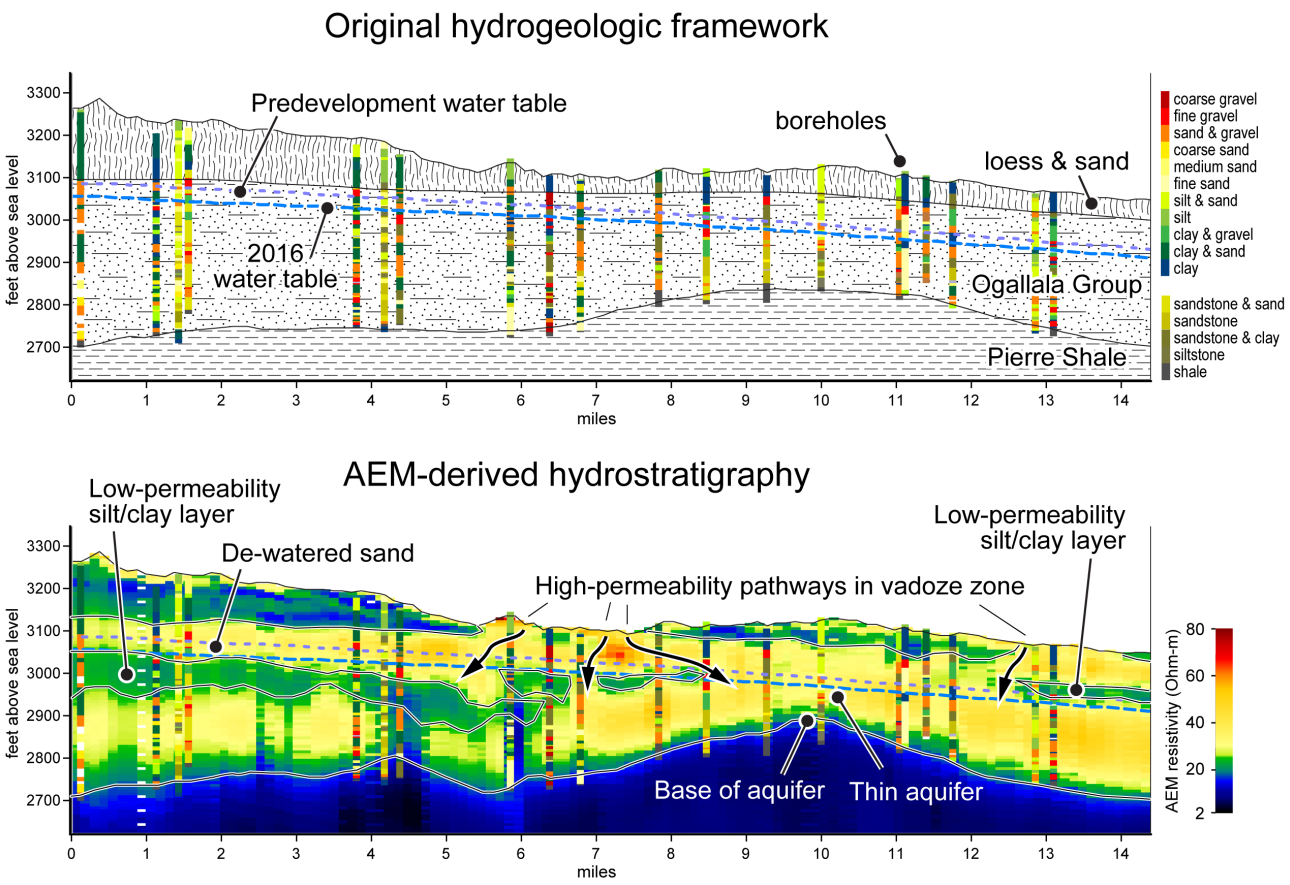

Figure 3. Hydrostratigraphic details revealed by AEM. Such information is useful for identifying potential contaminant pathways, constructing deeper wells, or sealing off confining layers to prevent contaminant movement.

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 MRNRD's Integrated Management Plan (IMP) was jointly developed by the Middle Republican NRD and the Nebraska Department of Natural Resources and is dated January 15, 2016. The current project continues the MRNRD's efforts to meet the goals and objectives of the plan, which aim to protect groundwater and surface water users while maintaining compliance with the Republican River Compact (RRC).

The MRNRD's Integrated Management Plan (IMP) seeks to "develop a program to provide offsets for new consumptive uses of water so that economic development in the district may continue without producing an overall increase in ground water depletions as a result of new uses." It also aims to "increase understanding of the surface water and hydrologically connected ground water system." In addition to achieving the objectives of the IMP, the project is aligned with the goals of the MRNRD Groundwater Management Plan (GMP), which aims to protect groundwater quantity, and the Republican River Basin-Wide Plan (RRBWP), which aims to "implement appropriate offsets for any basin-wide plan action that would exceed Nebraska's allocation under the Compact." By quantitatively evaluating proposed offsets and transfers, the District aims to mitigate the effects of declining groundwater levels in heavily irrigated areas while maintaining economic development and agricultural productivity, as well as staying compliant with the Republican River Compact.

The history of work completed toward these goals and objectives include several regulatory steps, incentive programs, monitoring efforts, and hydrogeologic investigations. The MRNRD has implemented reductions in irrigation acres, moratoriums on new irrigation wells, certification of irrigated acres, limits on expansion of irrigated acres, and required metering of irrigation wells. In addition, the MRNRD has recently installed new monitoring systems. Eighteen new groundwater-level observation wells were installed in the past five years to track groundwater depletions in accordance with section VIII of the IMP. The MRNRD has installed 60 high-tech, wireless irrigation monitoring systems, funded in part by a 2016 Water Sustainability Grant. The use of this technology will reduce consumptive uses of water in the Republican Basin. It provides growers with real-time information about their irrigation systems, allowing them to be more efficient with their water and fertilizer use through irrigation scheduling. Section VIII A of the IMP identifies irrigation scheduling as a potential project to achieve the goals and objectives of the plan. The NRCS Ogallala Aquifer Initiative Project was started in 2016 in Hayes and

Hitchcock Counties to enable voluntary participation in conservation practices. Focus was on converting irrigated to dryland farming, changing from sprinkler to subsurface irrigation systems, and installing soil moisture monitoring equipment. These practices help conserve irrigation water and improve groundwater quality. In 2020 the MRNRD was awarded WSF funds to conduct an AEM survey of the western portion of the District, centered around areas of declining groundwater levels in Hayes County. The survey also sought to evaluate managed aquifer recharge near Culbertson Canal. This work is in line with Goals 1 – 4 of the IMP.

The current project addresses Goal 3 of the IMP:
Provide that MRNRD's share of compliance responsibility and impacts to streamflow be apportioned within the MRNRD in an equitable manner and by minimizing, to the extent possible, adverse economic, social, and environmental consequences.
To apportion the share of compliance responsibility equitably, it is important that offsets to new or proposed water uses be calculated using the best available science with minimal uncertainty. The AEM survey will reduce uncertainty related to the hydrogeologic framework. Given that high-quality boreholes are often separated by ~6 miles, and that AEM surveys record a data point every ~100 feet, the horizontal density of data points will be increased by a factor of 100. Dense data grids reveal previously unknown conditions. For example, the 2020 AEM survey of Hayes County revealed an area where the saturated thickness is less than 50% of what previous models assumed (Fig. 4). Allowing transfer of water use to an area where the saturated thickness is less than expected can result in adverse consequences such as unexpectedly large drawdowns in wells, impacts to surrounding water users, or faster-than-expected depletion to streams. The AEM survey will help reduce potential for such errors.

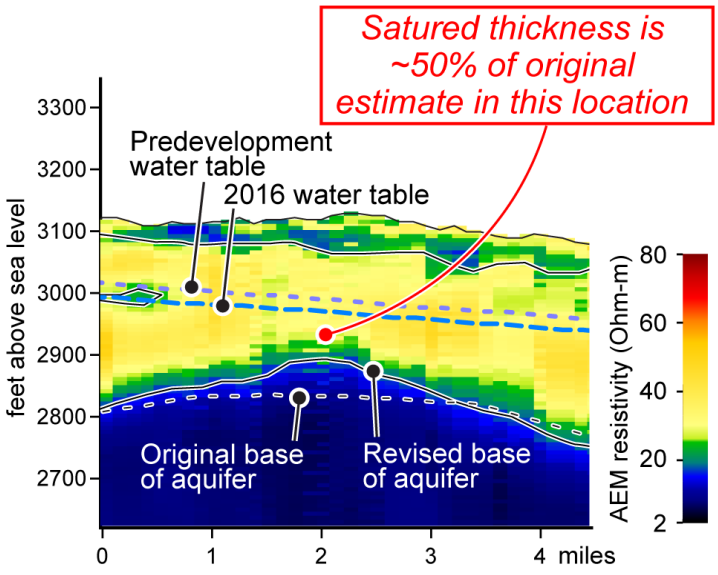

Figure 4. Comparison of base-of-aquifer before and after AEM.

The current project addresses Objective 7 of the IMP:
Develop a program to provide offsets for new consumptive uses of water so that economic development in the district may continue without producing an overall increase in ground water depletions as a result of new uses.

The current project improves geologic understanding and hydrologic modeling tools to ensure that offsets are equitable and non-depleting. The District currently uses a simplified scoring system to evaluate offsets. This system is qualitative and considers only the density of certified irrigated acres, stream depletion factor, and groundwater depletion for the location under consideration. The current project provides a significant improvement over the scoring system by providing a more sophisticated and quantitative system for offset calculations, in keeping with the IMP's aim to "increase understanding of the surface water and hydrologically connected ground water system." The improved hydrologic modeling tools will reduce uncertainty in the offset calculations and reduce the risk of unexpected costs, economic or social impacts, and noncompliance.

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 very purpose of the project is to provide the necessary tools to implement management actions and make regulatory decisions that are in line with water sustainability goals. The MRNRD aims to reduce aquifer depletion in heavily irrigated areas while maintaining economic development and agricultural productivity. The hydrogeologic mapping proposed here can be used to optimize placement, timing, and amount of water offsets.

   The largest water-level declines in the MRNRD are in an area from northwestern Hayes County to northeastern Hitchcock County. Groundwater levels have declined an average of 12.7 ft since predevelopment in this area. The maximum decline is 33.5 ft. The 2020 AEM survey of this area revealed a previously unknown layer of silt, clay, and silty sand (Fig. 3). This layer has a lower permeability than is commonly assumed for the Ogallala Aquifer, and therefore the transmissivity assumptions used in previous models are in error. This non-productive layer likely contributes to accelerated aquifer depletion. The AEM data collected in the proposed project will reveal aquifer heterogeneities throughout the District, allowing the MRNRD to transfer groundwater uses to areas less prone to aquifer depletion. It will also reveal

vadose zone properties, identifying locations where the land surface is in hydraulic connection with the aquifer, similar to the 2020 survey (Fig. 5).

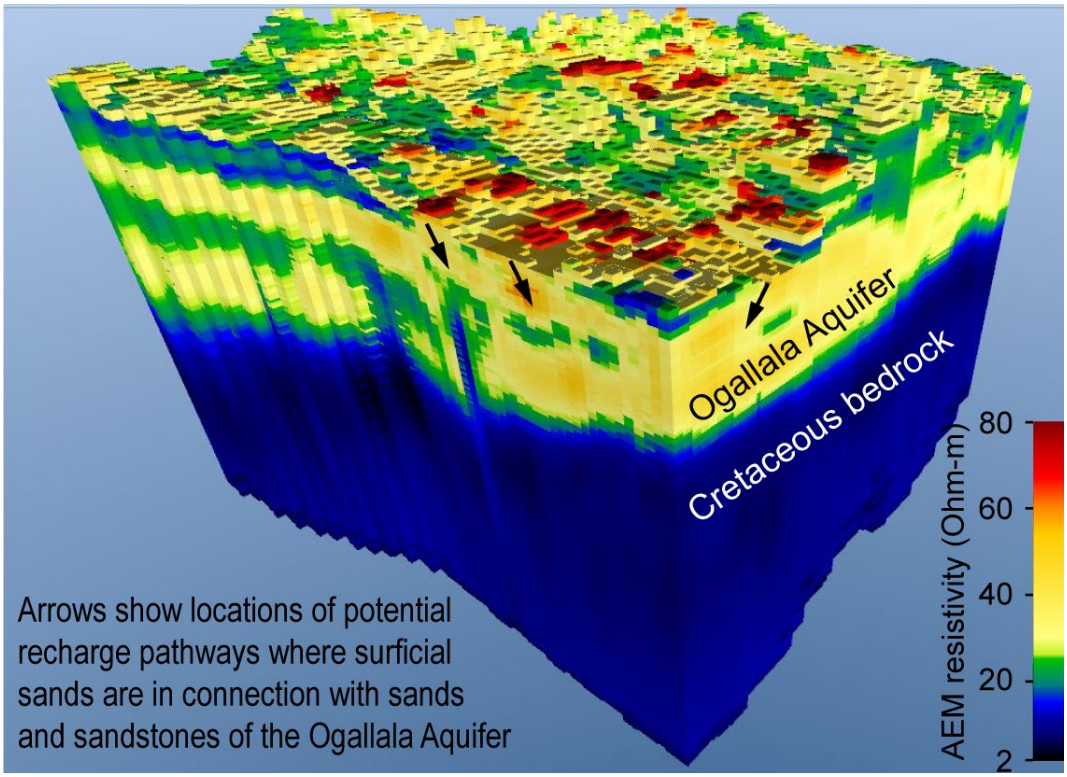

Figure 5. Three-dimensional block model of northwest Hayes county showing potential recharge pathways.

The MRNRD is currently developing a groundwater model for the area between Frenchman Creek and Red Willow Creek based on the AEM survey conducted in 2020. The current project will allow the model to be expanded to other areas of the District, creating a comprehensive modeling tool for evaluating District-wide changes in recharge, streamflow, and depletion.

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.

This project provides tools that help guide the apportionment of groundwater in an equitable and environmentally responsible manner, thereby preserving water supplies for agricultural, municipal and industrial uses. Model analyses will help guide management decisions such that consumptive uses do not increase and streamflows are protected, helping meet water supply goals for recreational and wildlife benefits.

The project lies within the area determined by the Department of Natural Resources to be hydrologically connected surface water and groundwater for fully appropriated designations (DNR, 2018). The proposed hydrogeologic mapping and groundwater model simulations will give the MRNRD information to designate new management areas and determine volumes of water necessary to achieve its IMP goals. This may include pumping restrictions, water use allocations, and targeted voluntary conservation programs to reduce aquifer depletion. By slowing, halting, or reversing the depletions, natural stream flow to the Republican River and its tributaries will be protected, thereby preserving surface water rights.

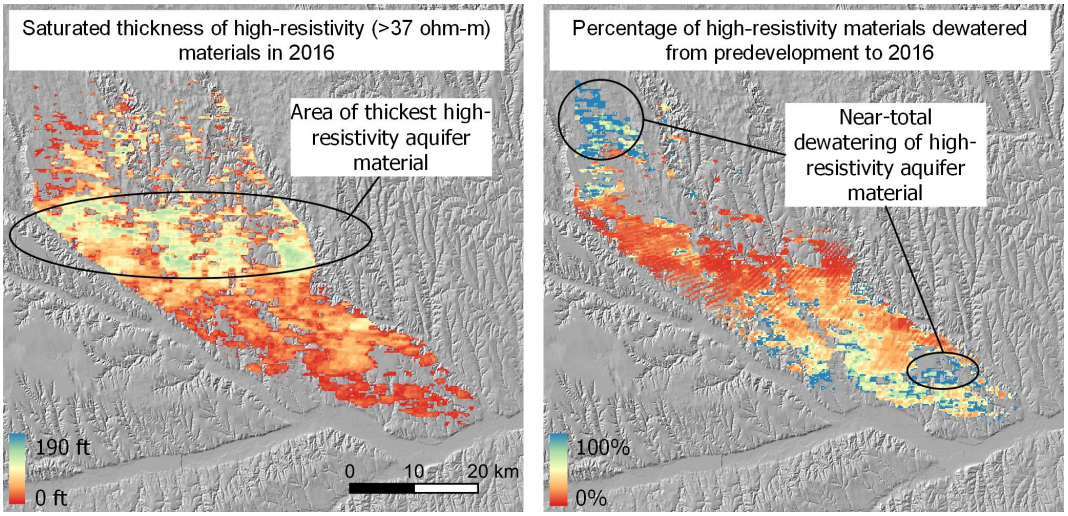

Figure 6. Example groundwater analysis based on 2020 hydrogeologic mapping project. Such maps assist the NRD in attaining its water supply goals.

Natural flows in the Republican River and its tributaries have been impacted by water table declines from groundwater irrigation. Streams have experienced substantial declines in streamflows since the mid-1960s (HDR, 2006). Records at several of the stations showed little or no flow at times in the recent past. Annual diversion volumes to canals have steadily decreased since the 1970's (HDR, 2006). Clearly, continuing on the current path means that surface water supplies are in jeopardy. Successful implementation of science-based management systems such as the proposed AEM investigation will reduce aquifer depletion and contribute to a more stable and secure

surface water supply. A secure water supply means that the goals of the surface water system will be realized well into the future.

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.

   Beneficial use of groundwater will be maximized by quantifying the amount, location, and timing of groundwater pumping that can be sustained under Compact stipulations. Over the long-term, the benefit to future generations of humans and other species will be preserved. Water may be put to use only if it is readily available. Given the downward trends in streamflow and groundwater levels in the Republican River Basin, the long-term security and availability of this water supply is in question. In order to sustain these water supplies for future generations, water managers need choose between various water management options. Making these choices requires the best available scientific information. The geologic, hydrostratigraphic, and groundwater models derived from the proposed project will provide robust, scientifically defensible information for understanding the interconnected groundwater and surface water supplies in the basin.

   Beneficial uses will not be reduced directly as a result of the data collection and modeling. The implementation of offsets, transfers, and retirement of irrigated acres will help preserve and protect the available water for beneficial use. This project, in combination with ongoing efforts in the MRNRD, such as the *High-Tech Irrigation* project, as well as an increasing awareness and willingness of producers to be more water-efficient, decreases in consumptive use are already happening in the District through smart irrigation management. The reductions of beneficial use will have a positive impact on the availability of water for future generations.

   Beneficial impacts includes assisting with Compact compliance, mitigating and offsetting groundwater depletions, and protecting Nebraska's water infrastructure. Future water sustainability projects in the MRNRD will be informed by scientifically sound maps, models, and research products from the proposed project. This science-based management will help guide offsets that keep the basin's water in balance.

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.

The total cost of $2,038,165 includes: 4011 miles of geophysical surveys to include quality control, processing, and inversion; production of a seamless 3D geological and hydrostratigraphic model for the Ogallala aquifer in the MRNRD; and development of a groundwater model to evaluate water management, recharge, and flow augmentation options. These tools will be used to help the MRNRD achieve its IMP goals and maintain Compact compliance. This cost is in line with similar past projects in Nebraska. These past projects were highly cost effective.

The benefits gained include increased ability to comply with the Republican River Compact. The cost of non-compliance would be many millions of dollars in legal fees and payments by the State of Nebraska. As an example, Kansas' most recent lawsuit sought $70 million from Nebraska for noncompliance in 2005-2006. Nebraska paid more than $5 million in the final settlement, but the magnitude of the original litigation request shows what is potentially at stake if Nebraska does not comply with the Compact.

Other methods are not viable. AEM produces "virtual" boreholes every ~100 feet. Drilling an actual borehole every ~100 ft for 4011 miles would total more than 200,000 boreholes. With a conservative estimate of ~$4,000 per borehole, costs would exceed $800,000,000. With current staffing levels and equipment resources, it is possible to drill about one borehole per day. Thus, it would take the Conservation and Survey Division hundreds of years to drill enough holes to match the spatial sampling frequency of AEM soundings. Clearly this option is impossible. Geophysical methods are the only viable option.

Another alternative is to forego data collection. The potential consequences are undesirable and may be much more costly. Making uninformed decisions could lead to inadequate measures to protect aquifer quantity or to provide adequate flow to the Republican River during times of need. It could also result in unnecessary restrictions on water use. Such undue restrictions on pumping could mean loss of farm income.

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.

The proposed project will provide additional groundwater model information for the forecasting of available water supplies and the development of management alternatives. Each year, the DNR forecasts the available short- and long-term streamflow available to comply with the Compact. It utilizes up-to-date information for its groundwater models. The hydrogeologic mapping proposed herein will improve the accuracy of these forecasts. In the event of expected shortfalls, the MRNRD provides DNR with details regarding management alternatives. The proposed study will help the MRNRD develop well-informed management alternatives based on best available science.

The proposed project will help Nebraska meet its obligations under the Republican River Compact. The modeling tools will help the MRNRD address short- and long-term Compact obligation deficits by providing the necessary information to achieve positive water balance and/or effective flow augmentation alternatives in water-short years.

The cost of non-compliance would be many millions of dollars in legal fees and payments by the State of Nebraska. As an example, Kansas' most recent lawsuit sought $70 million from Nebraska for noncompliance in 2005-2006. Nebraska paid more than $5 million in the final settlement, but the magnitude of the original litigation request shows what is potentially at stake if Nebraska does not comply with the Compact.

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.

A secure supply of good quality water is fundamental to public health and safety. This project greatly enhances the accuracy and predictive power of hydrologic models. Accurate models of Nebraska's natural and man-made water systems are necessary to provide a secure supply for all beneficial uses.

Privately owned water wells in the area are used for drinking water, irrigation, and livestock. Groundwater contamination threatens drinking and livestock water supplies for rural residents. Aquifer mapping will help well owners determine effective alternatives such as drilling deeper wells, treating existing wells, or sealing off confining zones to protect water quality. These actions will reduce the threat to well contamination by nitrate-N and other contaminants in the area.

The Frenchman Valley Irrigation District (FVID) and Frenchman-Cambridge Irrigation District (FCID) provide irrigation water supply via a system of canals, laterals, and ditches. These water delivery systems are critical to the local agricultural economy. Reducing aquifer depletion will minimize additional streamflow reductions in the Republican River and its tributaries. This will help preserve natural flows in the streams. These natural flows are critical to the delivery of surface water to the canals and the long-term viability of surface water irrigation in the FVID and FCID.

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.

Elevated levels of nitrate-nitrogen, uranium, and arsenic have been detected in groundwater in the MRNRD. In 1992, the MRNRD enacted a Special Protection Area for groundwater quality in the southern part of the District. The purpose of the area is the reduce nitrate contamination in groundwater. The City of McCook operates a treatment plant to remove nitrate, arsenic, and uranium from its water supply prior to distribution.

The AEM data collected in this project will provide a substantially improved understanding of the aquifer and vadose zone properties of the MRNRD. New knowledge about the subsurface will be achieved by collecting geophysical data at much higher spatial resolution than traditional data such as test holes or soil cores.

This data will result in new maps of aquifer and vadose zone thickness, extent, permeability, and storage properties. The 2020 AEM survey revealed low-permeability units (confining layers), high-permeability pathways, and other characteristics of the subsurface that were previously unknown to hydrogeologists (Figs. 3, 5). We expect that the proposed surveys will reveal additional information for a wider area. This information will be useful for taking mitigating actions, such as: constructing deeper wells or sealing off confining layers to prevent contaminant movement between aquifers; identifying preferential recharge zones and potential contaminant pathways; and constructing better-informed groundwater quality monitoring networks. This can provide MRNRD with the ability to tailor management activities intended to protect drinking water quality. Citizens who rely on public water supplies, as well as private well owners in rural areas, will receive benefits of improved water quality.

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 Middle Republican Natural Resources District (MRNRD) is the local jurisdiction that supports the project. The MRNRD has a 3.1846 mil levy. The Republican River Basin has been found to be fully appropriated and therefore it is subject to irrigated occupation tax. Occupation Tax in the District is as follows:

- 2007 = $7.04 per acre
- 2010 = $4.90 per acre
- 2011 = $8.50 per acre
- 2012 = $9.43 per acre
- since 2013 = $10.00 per acre (maximum limit).

No other sources of funding are available at this time

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 Middle Republican Natural Resources District (MRNRD) and the Department of Natural Resources jointly developed an Integrated Management Plan (IMP), effective January 15, 2016. This plan is in place to support sustainable water use.

The MRNRD has had groundwater allocations since 2005. The allocation periods have been set as 2005 – 2007, 2008 – 2012, 2013 – 2017, and 2018 – 2022. Average usage per year (in inches) was as follows:

- 2005 – 8.81
- 2006 – 10.01
- 2007 – 8.23
- 2008 – 8.90
- 2009 – 8.14
- 2010 – 7.85
- 2011 – 8.44
- 2012 – 16.78
- 2013 – 10.13
- 2014 – 9.07
- 2015 – 9.75
- 2016 – 10.25
- 2017 – 10.84
- 2018 – 7.02
- 2019 – 5.72
- 2020 – 11.64

In brief, the MRNRD's Integrated Management Plan (IMP) goals are to:

- maintain compliance with the Compact
- ensure that groundwater and surface water users assume their share of maintaining compliance with the Compact
- provide compliance responsibility be apportioned in an equitable and environmentally responsible manner
- protect any increases to streamflow from use that would negate its benefit.

This project will provide the best available scientific information for evaluating management alternatives to reduce or stabilize aquifer depletion in the MRNRD.

These outcomes will directly help Nebraska maintain compliance with the Compact by reducing near- and long-term depletions to streamflow.

The groundwater model developed from this project will allow hydrologists to compute the impacts of proposed management actions on groundwater levels and streamflows. The model will aid in determining the share of compliance responsibility shared between reductions in consumptive uses and managed aquifer recharge. The hydrogeological mapping and groundwater modeling proposed herein will provide the best available analysis of hydrologic connections between aquifers, streams, and canals in the project area.

Stakeholders that will benefit include groundwater irrigators, surface water irrigators, rural residents that rely on groundwater for domestic purposes, residents in villages and cities who rely on groundwater for municipal supply, as well as those who value recreation and wildlife provided by surface water and groundwater-dependent ecosystems.

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.

Stream depletion and declining groundwater levels are issues of statewide significance because they threaten our ability to comply with Interstate Compacts, Decrees, and Agreements, reduce water available for irrigation, which is key to Nebraska's agricultural economy, and have a negative impact on recreation and wildlife in streams and reservoirs. The proposed project will help the MRNRD achieve its stated goal of assisting in long-term Compact compliance, and reducing its existing groundwater use within the District by 20% from the 1998 to 2002 baseline pumping volumes. When combined with streamflow augmentation and incentive programs, the MRNRD's groundwater deletions will be maintained within its portion of Nebraska's Allowable Groundwater Depletions as computed through use of the Republican River Compact Administration Groundwater Model.

The MRNRD covers 3,843 square miles (2,459,520 acres) of land in southeast Nebraska. Land use comprises 54% rangeland, 33.5% dry land farming, and 12.5% irrigated farming. The benefits of the project will cover all major aquifer areas of the

MRNRD, as well as hydrologically connected surface water throughout the greater Republican River basin.

The proposed project will deliver a new suite of innovative models for water resources management and infrastructure changes. The methods can be adapted to other areas of the state that have experienced problems similar to those in the MRNRD. Hydrologists using these methods and tools will be able to assess water management alternatives using a much-improved understanding of the hydrogeologic framework, drawing upon the latest scientific research and technology.

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.

Funding Matrix

Funding Source	January 1, 2022 to June 30, 2022	July 1, 2022 to June 30, 2023	July 1, 2023 to June 30, 2024	July 1, 2024 to June 30, 2025	Total Cost
WSF REQUEST	$ 247,660.85	$ 268,009.03	$ 394,779.18	$ 312,450.11	$ 1,222,899.17
MRNRD COST SHARE	$ 165,107.23	$ 178,672.69	$ 263,186.12	$ 208,300.07	$ 815,266.11
UNL Conservation and Survey Division*	--	--	--	--	--
TOTAL PROJECT COST	**$412,768.08**	**$446,681.72**	**$ 657,965.29**	**$520,750.18**	**$ 2,038,165.28**

*indicates partner with no direct cash contribution

The MRNRD has a 3.1846 mil levy. The Republican River Basin has been found to be fully appropriated and therefore it is subject to irrigated occupation tax, which is currently maxed out at $10/acre. Funding has been made available in the MRNRD annual budget.

If WSF funding is not approved, MRNRD will continue to collect data and develop models for improved water management. However, the completion of these tasks will be seriously delayed, and water sustainability goals may not be met within the planning timeframe. Furthermore, if WSF funds are not available, many of the innovative methods proposed herein may need to be delayed or cut altogether.

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.

How Project Contributes to Watershed Health and Function

Maintaining stream flow volume is critical to watershed health and function. Stabilizing groundwater levels will help protect stream flows, thereby contributing to the health and function of the Republican River watershed. The subwatersheds affected include Frenchman Creek watershed, Red Willow Creek watershed, and Medicine Creek watershed.

Models of aquifer heterogeneity will be used to map and evaluate hydrological connections (Fig. 7). Understanding groundwater-surface water interactions is critical to evaluating managed aquifer recharge (MAR) options. Understanding these connections and managing groundwater use to minimize pumping impacts on stream depletion will help to preserve natural flows and improve watershed health. MAR can be used to limit the pollution of surface water through geo-purification and natural attenuation. Use of good quality water for aquifer recharge will dilute existing nitrate contamination in the alluvial aquifer and in any return flow to the stream.

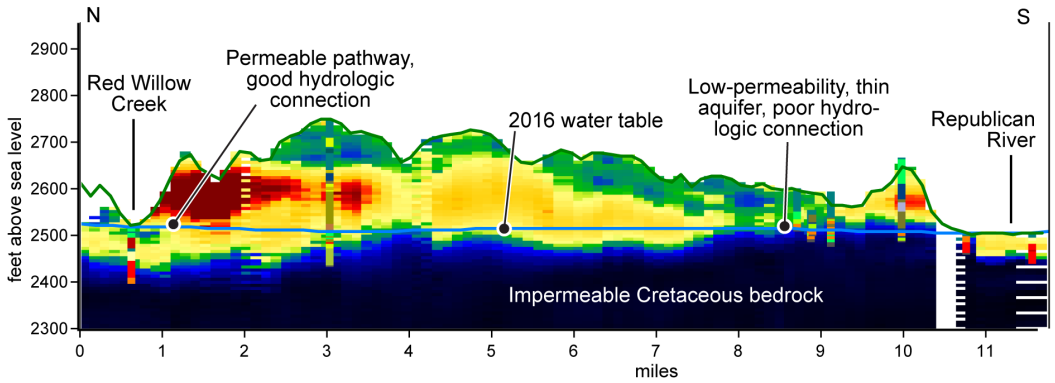

Figure 7. AEM profile from 2020 survey showing example evaluation of hydrological connections between streams and aquifer.

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 most recent Annual Report available on the Department of Natural Resources website is dated September, 2019
https://dnr.nebraska.gov/sites/dnr.nebraska.gov/files/doc/water-planning/statewide/annual-report-to-legislature/2019/20190913_AnnualReportToLeg_final.pdf

The four-year work projection for the Republican basin identifies the following objectives:
Technical analyses to develop and test specific conjunctive management action scenarios via modeling tool outputs
Review of Integrated Management Plans
Annual review of the Basin-Wide Plan
Ensure compliance with the Compact

The project provides technical analyses specifically related to conjunctive management. The mapping and modeling tools will be used to evaluate groundwater transfers and offsets, which will allow the MRNRD to determine best strategies and actions to maintain water balance. The geologic and hydrostratigraphic model results

will be input to a groundwater model to analyze the effects of changing the timing and location of water, so it can be used more efficiently.

The proposed project will deliver a new suite of innovative models for water resources management. These models are pertinent to the IMP jointly developed by the DNR and MRNRD, as well as the 2019 Basin-Wide Plan for the Republican Basin. The underlying goal of these plans is to ensure compliance with the Compact. The tools developed from this project will directly contribute to the state's ability to achieve this goal.

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.

The Republican River Compact is a federal mandate. The Supreme Court rulings, including the Final Settlement Stipulation of 2002 and the Court decisions of 2015, are federal mandates (2 USCS § 1555).
The Republican River Compact is documented in Nebraska Revised Statute 1-106 https://nebraskalegislature.gov/laws/appendix.php?section=1-106
The 2002 Final Settlement Stipulation is available from the Department of Natural Resources https://dnr.nebraska.gov/sites/dnr.nebraska.gov/files/doc/water-planning/upper-platte/republican-river-compact/final-settlement.pdf
The Court decisions of 2015 are available from the Department of Natural Resources https://dnr.nebraska.gov/sites/dnr.nebraska.gov/files/doc/water-planning/upper-platte/republican-river-compact/20150224-kansas-v-ne.pdf

This project will provide the best available scientific information for making management decisions that help the MRNRD do its part to maintain compliance with the Compact. These management actions will be aimed at stabilizing the groundwater levels, maintaining water balance by providing accurate forecasts of water balance, and by decreasing uncertainty associated with these projections. Stabilizing declines will help reduce long-term depletions to streamflow. These outcomes will directly help Nebraska maintain compliance with the Compact by reducing near- and long-term depletions to streamflow.

The primary goal of the IMP is to maintain compliance with the Compact:

Goal 1. In cooperation with the State of Nebraska and the other NRDs, maintain compliance with the Compact as adopted in 1943 and as implemented in accordance with the Settlement Agreement approved by the United States Supreme Court on May 19, 2003.