NEBRASKA NATURAL RESOURCES COMMISSION

Water Sustainability Fund

Application for Funding

Section A.

ADMINISTRATIVE

PROJECT NAME: *Estimating Recharge toward Sustainable Groundwater and Agriculture, Central Platte NRD*

PRIMARY CONTACT INFORMATION

Entity Name: *Central Platte Natural Resources District*

Contact Name: *Duane Woodward*

Address: *215 Kaufman Ave Grand Island, NE*

Phone: *308-385-6282*

Email: *woodward@cpnrd.org*

Partners / Co-sponsors, if any: USGS Nebraska Water Science Center; San Francisco State University

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

   Grant amount requested. $ $151,680

   Loan amount requested. $ Click here to enter text.

   If Loan, how many years repayment period? Click here to enter text.

   If Loan, supply a complete year-by-year repayment schedule.
   Click here to enter text.

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?

   YES☐ NO☒

   If yes attach a copy to your application. Click here to enter text.

   If yes what is the population served by your project? Click here to enter text.

   If yes provide a demonstration of need. Click here to enter text.

   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? Click here to enter text.

   If yes, describe the changes that have been made since the last application. Click here to enter text.

No, I certify the application is a true and exact copy of the previously submitted and scored application. (Signature required) Click here to enter text.

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

Attach all substantiating documentation such as invoices, cancelled checks etc. along with an itemized statement for these expenses. Click here to enter text.

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.
$ Click here to enter text.

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);
Click here to enter text.

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

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

A description of any necessary water and land rights and pertinent water supply and water quality information, if appropriate (004.01 D);
Click here to enter text.

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

Required geologic investigation (004.01 E 1); Click here to enter text.

Required hydrologic data (004.01 E 2); Click here to enter text.

Design 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.

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

A discussion of the plan of development (004.02 A);
The overarching goal of the proposed project is to obtain more accurate estimates and understanding of groundwater recharge rates and water quality beneath rangeland, irrigated, and non-irrigated (dryland) agricultural lands across the east to west precipitation gradient of the CPNRD. The proposed project includes the continued monitoring of the 8 recharge sites that have been installed on an ecosystem, resource-based, and regional approach. For example, the 8 recharge sites are located in some of the most common land use in Nebraska, including irrigated and dryland corn, irrigated

alfalfa, and rangeland. Findings from this study can be extrapolated to similar land use in other parts of Nebraska. The 8 recharge sites are also located across much of the Central Platte River Basin (CPRB) and along the dominant east-west precipitation gradient in Nebraska. Findings from the proposed project benefit the CPNRD and the State by providing measured recharge data. These data provide calibration information and input to Hydrologic Water Budget analysis. COHYST has developed modeling tools for doing Hydrologic Water Budget analysis will benefit from these data and in turn help in analysis of water supply for Agricultural use, Municipal and Industrial use, Recreational use, and flow for endangered and threatened species use in the Platte River of Nebraska.

A description of field or research investigations utilized to substantiate the project conception (004.02 B); *To overcome the challenge associated with measuring recharge in aquifers with deep water tables, such as in the Central Platte NRD, the U.S. Geological Survey (USGS) developed an innovative and successful approach using dedicated recharge installations across the High Plains aquifer in parts of Colorado, Nebraska, Kansas, and Texas (see the 9 existing USGS recharge sites in Figure 1; shown in Part D) (McMahon et al., 2003, 2006; Gurdak et al., 2007, 2009, 2012). The USGS recharge installations use a wide range of instrumentation to measure multiple water, chemical, and climatic factors that control recharge. The success of the USGS approach was recently demonstrated during the High Plains regional groundwater (HPGW) study (McMahon et al., 2007; Gurdak et al., 2009). The USGS recharge network represents a scientific investment in data monitoring and collection that resulted in a unique and valuable data set critical for the better regional-scale understanding of groundwater sustainability across the High Plains aquifer. However, only 2 of the USGS recharge sites were located inside the COHYST model area and these two sites don't provide the adequate spatial and temporal recharge measurements needed to improve the COHYST groundwater-flow models. Therefore, between 2008 and 2010 a cooperative partnership between the CPNRD, USGS, and San Francisco State University (SFSU) installed 8 new recharge sites within the CPNRD portion of the CPRB (Figure 1, shown in Part D). These new recharge sites were designed on the USGS approach, expand on the existing USGS High Plains recharge network (Figure 1, shown in Part D). The continued collection data will provide a unique opportunity to model the flux of water within the unsaturated zone to determine the suitability of areas for managed aquifer recharge (MAR) and provide the necessary recharge information to improve the recharge inputs to the COHYST groundwater-flow models. Figure 2 (Part D) shows a recharge site that was installed in 2009 next to a dryland corn field near Shelton, Nebr.*

A description of the necessary water and/or land rights, if applicable (004.02 C); *Each of the eight recharge stations has been installed on*

private lands where long-term agreements between the individual landowner and the CPNRD have already been put in place.

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). *The overarching goal of the proposed project is to obtain more accurate estimates and understanding of groundwater recharge rates and water quality beneath rangeland, irrigated, and non-irrigated (dryland) agricultural lands and the east to west precipitation gradient across the CPNRD. To achieve this overarching goal, we will use a combination of field data from the 8 project recharge sites (Figures 1 and 2) and numerical modeling to answer the fundamental questions about sustainable surface water and groundwater management plans and project, including the suitability for managed aquifer recharge (MAR in the CPNRD. MAR is an increasingly common approach for increasing groundwater supplies, but is still in the early stages of development and implementation across Nebraska and the CPNRD. MAR can use several methods, including injection wells, aquifer storage and recovery (ASR), and infiltration basins. Here, we refer to MAR as surface infiltration, which generally requires less engineering and lower operating costs than injection wells or ASR systems.*

2. Provide evidence that there are no known means of accomplishing the same purpose or purposes more economically, by describing the next best alternative. *There are no known means of accomplishing the same purpose more economically. The proposed project has many study design considerations to maximize cost effectiveness. These include:*
   - *The proposed recharge study uses 8 recharge sites that were installed between 2008 and 2010 at a range of irrigated and non-irrigated land use by an on-going collaboration between the Central Platte NRD, U.S. Geological Survey, and San Francisco State University (SFSU). The proposed study is cost effective because it builds on data collection activities as these sites since 2008-2010. The experience from USGS and SFSU partners will ensure the recharge modeling and estimates maximize cost effectiveness for the best scientifically-defensible understanding of recharge to improve the COHYST models.*
   - *The recharge installations are self-contained, relying on solar panels and batteries for power supply. Additionally, all instrumentation data, except for the suction lysimeter measurements, are collected remotely using data loggers, and subsequently sent back to the USGS Lincoln office on a daily time-step using a digital modem and cell phone connection. The recharge sites are cost effective by minimizing travel costs to collect supplemental data.*
   - *The supplemental data collection activities will be performed by a combination of personnel from the USGS Lincoln office to minimize the*

amount of travel between sites, which will minimize the number of days spent in the field by personnel. This will reduce overall travel costs, as well as reduce the number of personnel hours required for site operation and maintenance.

- *The proposed modeling is the only know means of understanding how recharge fluxes and water storage in the vadose zone respond to historical and future variations in weather and climate.*

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). *The total estimated costs for this project total $290,600. This total covers all project work for 3 years FY 2017 thru 2019 which includes continued monitoring of the 8 recharge sites, additional soil coring and chemical analyses, vadose zone modeling, and the publication of peer-reviewed journal article.*
   - 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). *There is no tangible direct benefit as a result of this project; however, an improved understanding of groundwater recharge with-in the CPNRD will lead to improved decision-making tools such as the COHYST 2010 models which are used for GW quantity and integrated management decisions. These tools are also being used by the Platte River Program for water supply analysis and scoring to develop a effective water management for the threatened and endanger species.*
   - 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). *No direct tangible benefit versus cost has been provided for this project.*

- 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). *NA*

4. Provide evidence that sufficient funds are available to complete the proposal. *The CPNRD has budgeted funds for this project sense 2008 and will continue to budget $30,000 to $35,000 during the next 3 years. The CPNRD 2015/ 2016 FY property tax collected is $6,115,709.65. The USGS, through its Cooperative Water Program, is able to put money in the amount of $37,800 towards the proposed work. A letter of support has been included with this application in attachment 1.*

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

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

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

Minimal environmental impact is anticipated as a result of this project. All sediment coring and soil water sampling will adhere to the USGS chemical hygiene plan that requires the safe disposal of chemicals or materials needed for sample collection, preservation, and equipment cleaning.

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

The States 88th Nebraska Legislature change the State's Groundwater Management and Protection Act through LB 1106 to require Natural Resources Districts to prepare a Groundwater Management Plan. This was completed for the CPNRD in December 1985. That Plan has been in place and revised several times since 1985. The latest being the addition of the Integrated Management Plan (IMP) in July 2009. One focus of the IMP is continued groundwater data collection and creating partnerships with outside organizations to address current data gaps.

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

The project provides supporting data for the Integrated Management Annual Report and Plan of Work for the Nebraska State Water Planning and Review Process document (dated September 2014). This project seeks to fill a critical data gap in understanding the effects of various land cover and land use on groundwater

recharge and will provide a means to study the effectiveness of Managed Aquifer Recharge MAR projects. Additionally, this project will provide data to the COHYST 2010 integrated models, which is the primary decision-making tool for GW quantity and integrated management in the CPNRD for the Platte River Recovery and Implementation Program (PPRIP).

10. Are land rights necessary to complete your project?

    YES☐ NO☒

    If yes, provide a complete listing of all lands involved in the project.
    Click here to enter text.

    If yes, attach proof of ownership for each easements, rights-of-way and fee title currently held.
    Click here to enter text.

    If yes, 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. *The CPNRD also has the authority under Nebraska State Statute Chapter 2 Article 32 to carry out this project under its authorized purposes relating to the development, management, utilization, and conservation of groundwater and surface water. This includes the CPNRD's authorities to enter into contracts or agreements, budget and expend levied property taxes, and own and operate property or equipment.*

12. Identify the probable environmental and ecological consequences that may result as the result of the project. *Sound integrated management of groundwater and surface water is critical to maintaining flows of the Platte River needed by endangered and threatened species. Integrated management relies on decision making tools such as the COHYST model and supporting data sets. This project seeks to fill a critical data gap in understanding the effects of various land cover and land use on groundwater recharge and will provide a means to study the effectiveness of MAR projects which could enhance and retime flows needed by endangered and threatened species.*

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.

Within the CPNRD, groundwater supplies drinking water for its 112,000 residents, which can be vulnerable to over pumping and over use, especially in the Districts over appropriated areas. Water quality is also a concern within the CPRND

primarily in intensively farmed areas with shallow depth to water and sandy soils. These conditions, which are typical in the Platte River Valley, mean that most of the groundwater in the CPNRD is vulnerable to contamination. Developing more accurate estimates and understanding of the controls on groundwater recharge rates and water storage in the vadose zone will lead to better integrated management of surface water and groundwater resources in the CPNRD. Integrated management relies on decision making tools such as the COHYST model and supporting data sets. This project seeks to fill a critical data gap in understanding the effects of various land cover and land use on groundwater recharge. Without accurate recharge estimates, the predictive accuracy of management tools such as the COHYST model may suffer as a result, potentially leading to improper water resources management and potentially unsustainable use.

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 proposed project to estimate recharge directly benefits the CPNRD's groundwater management plan, which is dated December 1985. The proposed project directly benefits CPNRD's groundwater management plan by improving estimates and understanding of recharge rates and quality beneath the dominant land use in the CPNRD. Such understanding will directly improve the groundwater management plan and maintain groundwater resources that are directly tied to the long-term agricultural sustainability in the CPNRD.

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 proposed project will develop more accurate estimates of groundwater recharge and water storage in the vadose zone beneath rangeland, irrigated, and non-irrigated (dryland) agricultural lands and the east to west precipitation gradient across the Central Platte NRD (figure 1). Quantifying the amount of increased streamflow that will result from this project is difficult to do. The benefit of this project is the improvement of predictive tools such as the COHYST model for integrated management

of groundwater; furthermore, the results from this project can be used to evaluate MAR projects within the CPNRD as a means to increase streamflow. The primary cross basin benefit of this project is providing a study design that can be readily transferred to other parts of the state where a detailed assessment of recharge rates is needed for integrated management.

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.

The overarching goal of the proposed project is to obtain more accurate and long-term measurements and understanding of the controls on groundwater recharge rates and water storage in the vadose zone beneath rangeland, irrigated, and non-irrigated (dryland) agricultural lands and the east to west precipitation gradient across the CPRB. To achieve this overarching goal, we will use a combination of field data from the 8 project recharge sites (Figures 1 and 2) (Steele et al., 2014) and numerical modeling to provide important foundational knowledge that is necessary for future suitability assessments for managed aquifer recharge (MAR) in the CPRB. MAR is an increasingly common approach for increasing groundwater supplies, but is still in the early stages of development and implementation across Nebraska and the CPRB. MAR can use several methods, including injection wells, aquifer storage and recovery (ASR), and infiltration basins. Prior to future planning and implementation of MAR systems in the CPRB or elsewhere in Nebraska, fundamental understanding of controls on water flux and storage in the vadose is needed. This study will successfully address that need for the CPRB. The proposed project would directly benefit the CPNRD's groundwater management plans, which are vital in reaching long-term groundwater sustainability.

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.

Improved decision making tools, like the COHYST model increase beneficial use by providing for a legally and scientifically defensible means to sustainably manage water resources. This project seeks to fill a critical data gap in understanding the effects of various land cover and land use on groundwater recharge and will provide a

means to study the effectiveness of MAR projects which could enhance and retime flows needed by downstream users and endangered species. The proposed project would not directly lead to reductions in beneficial uses. The proposed project is directly beneficial to CPNRD and Nebraska residents by helping to maintain groundwater resources that are directly tied to the long-term agricultural sustainability across the State.

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 project is cost effective. The proposed project has many study design considerations to maximize cost effectiveness. These include:

- *The proposed recharge study uses 8 recharge sites that were installed between 2008 and 2010 at a range of irrigated and non-irrigated land use by an on-going collaboration between the Central Platte NRD, U.S. Geological Survey, and San Francisco State University (SFSU). The proposed study is cost effective because it builds on data collection activities as these sites since 2008-2010. The experience from USGS and SFSU partners will ensure the recharge modeling and estimates maximize cost effectiveness for the best scientifically-defensible understanding of recharge to improve the COHYST models.*
- *The recharge installations are self-contained, relying on solar panels and batteries for power supply. Additionally, all instrumentation data, except for the suction lysimeter measurements, are collected remotely using data loggers, and subsequently sent back to the USGS Lincoln office on a daily time-step using a digital modem and cell phone connection. The recharge sites are cost effective by minimizing travel costs to collect supplemental data.*
- *The supplemental data collection activities will be performed by a combination of personnel from the USGS Lincoln office to minimize the amount of travel between sites, which will minimize the number of days spent in the field by personnel. This will reduce overall travel costs, as well as reduce the number of personnel hours required for site operation and maintenance.*
- *The proposed modeling is the only know means of understanding how recharge fluxes and water storage in the vadose zone respond to historical and future variations in weather and climate.*

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 directly helps CPNRD and Nebraska meet the Plate River Program obligations for GW depletions, improve flows for endangered and threatened species, and assist the NRDs with regulation and management of groundwater.

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 Untied 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.

Water security and public health and safety for Nebraskans is directly tied to clean and sustainable groundwater resources. About 85% of the state's population uses groundwater as drinking water. Groundwater is also a major source of irrigation water for much of the state's agriculture. However, decades of crop production has allowed fertilizers and some agricultural chemicals to reach the groundwater is some parts of the state, causing contamination that may have harmful health implications for local residents. The project will benefit public security, health, and safety by better understanding the controls on how much and how fast water and chemicals applied at land surface reach the groundwater. This information can be used by the CPNRD and other NRDs to improve land management best practices and strategies within their groundwater management plans to better protect vulnerable groundwater resources.

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.

The proposed project will estimate recharge rates and water storage in the vadose zone beneath irrigated and non-irrigated agricultural lands, as well as,

rangeland. The irrigation return-flow, and therefore recharge, beneath many of the land uses in the CPNRD may have relatively elevated concentrations of nitrate. Therefore, by understanding the controls on recharge rates and water storage in the vadose, best management plans can be implemented that limit nitrate from reaching the water table and negatively impacted groundwater quality. By design this project installed the 8 sites in rangeland, irrigated, and non-irrigated (dryland) agricultural lands across the east to west precipitation gradient within the CPNRD. As a result, the water quality benefits realized from this project would cover the entire CPNRD area of 2.1 million acres and its 112,000 residents. Groundwater remediation and management actions are often tied to results from groundwater quality and near surface soil sampling. This project fills an important gap in understanding by studying the movement of nitrate through the vadose zone and documents changes over time. Understanding the rates of movement within the vadose zone can improve best management practices and give managers an idea of when water quality benefits may be realized after new practices or management actions have been initiated.

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 Central Platte NRD is the local jurisdiction supporting the project. The FY 2015 /2016 Tax Levy for CPNRD is 0.03842, the property tax valuation is $15,919,152,725.00, and the property tax collected is $6,115,709.64. The USGS is also contributing funds to this project from their Cooperative Water Program. Cost share in the amount of $37,800 for the 3 years is available and being programmed by the USGS.

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 local jurisdiction on the project is the Central Platte NRD. The results of the project are better recharge estimates, which will improve the CPNRD's groundwater management plan. Therefore, this project directly benefits all the producers, irrigators,

ethanol producers, cities, industry, municipal and domestic groundwater users within the CPNRD.

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.

The proposed project will provide datasets to improve integrated management of groundwater and surface water to address key statewide water issues. These issues include maintaining water supplies for municipal, domestic, agricultural and industrial uses, ensuring adequate streamflow to comply with the Platte River Program and provide additional information to evaluate managed aquifer recharge (MAR) projects that can enhance groundwater recharge. Understanding the controls on recharge rates and water storage in the vadose zone is beneficial to the state of Nebraska because it provides fundamental knowledge to improve decision making tools such as the COHYST groundwater model. To achieve this overarching goal, we will use a combination of field data from the 8 project recharge sites (Figures 1 and 2) (Steele et al., 2014) and numerical modeling to provide important foundational knowledge that is necessary for future suitability assessments for MAR which can enhance stream flows within the CPNRD and downstream. As a result, the benefits realized from this project would not only cover the entire CPNRD area of 2.1 million acres and its 112,000 residents, but also the water supplies of the cities of Lincoln and Omaha who rely on stream flows in the Platte River.

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.

The USGS, through its Cooperative Water Program, is able to put money in the amount of $37,800 towards the proposed work. A letter of support has been included with this application in attachment 1.

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 proposed project will contribute to the health and function of the Central Platte River Basin (CPRB). The proposed project will provide datasets to improve integrated management of groundwater and surface water in the CPRB. These issues include maintaining water supplies for municipal, domestic, agricultural and industrial uses, ensuring adequate streamflow to comply with the Platte River Program and provide additional information to evaluate Managed Aquifer Recharge (MAR) projects that can enhance groundwater recharge. Understanding the controls on recharge rates and water storage in the vadose zone is beneficial to the CPRB because it provides fundamental knowledge to improve decision making tools such as the COHYST groundwater model. To achieve this overarching goal, we will use a combination of field data from the 8 project recharge sites (Figures 1 and 2) (Steele et al., 2014) and numerical modeling to provide important foundational knowledge that is necessary for future suitability assessments for MAR which can enhance stream flows within the CPRB and downstream. As a result, the benefits realized from this project would not only cover the entire CPNRD area of 2.1 million acres and its 112,000 residents in the CPRB, but also the water supplies of the cities of Lincoln and Omaha who rely on stream flows in the Platte River.

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 Department of Natural Resources, in its Four-Year Work Projection plans on using the COHYST groundwater model and pertinent data sets for future integrated management plan analysis (Annual Report and Plan of Work, dated September 2014). Improving estimates of groundwater recharge and understanding the controls that effect rates of recharge is critical to improving the predictive accuracy of integrated management tools.

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 proposed project is designed to help Nebraska meet the requirement of a federal mandate to protect endangered species. Specifically in 1997, Colorado, Nebraska, Wyoming, and the U.S. Department of the Interior entered into an Interagency Cooperative Agreement (ICA) partnership aimed at addressing issues regarding federally endangered species (such as the whooping crane, piping plover, least tern, and pallid sturgeon) in the Platte River Basin (Platte River Cooperative Hydrology Study, 1998). Critical to the ICA is the provision for maintenance of streamflows in the Platte River and the mitigation of new depletions in the central Platte River area. As a direct result of the ICA, State and local agencies created a Cooperative Hydrology Study [(COHYST), Platte River Cooperative Hydrology Study, 1998] of the Platte River Basin of Nebraska upstream from Columbus, Nebraska. The purpose of COHYST was to assist Nebraska in complying with the ICA (Luckey and Cannia, 2006) through the integrated management of groundwater and surface water. The objectives of COHYST were to develop databases and tools to assist Nebraska in meeting its obligations for streamflow, to analyze proposed activities to improve streamflows for endangered and threatened species, to assist Natural Resources Districts (NRDs) with regulation and management of groundwater, and to provide a basis for establishing and implementing Nebraska policies and procedures governing groundwater and surface-water resources. The proposed project will improve the understanding the controls on recharge rates and water storage in the vadose zone is beneficial to the CPRB because it provides fundamental knowledge to improve the COHYST groundwater model, and thus helps Nebraska meets its obligation to the ICA and the federal mandate of protecting endangered species.

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 project will provide more accurate estimates and understanding of recharge rates and water storage in the unsaturated (vadose) zone beneath rangeland, irrigated, and dryland agricultural lands in the Central Platte River Basin (CPRB). We will use a combination of field data collected from 8 existing recharge sites and numerical modeling. This approach will allow us to evaluate the relative influence of land-use, weather and climate, and sediment texture on recharge rates and water storage in the vadose zone. Such results are critically important foundational knowledge for sustainable surface water and groundwater management plans and project, including future suitability assessments of managed aquifer recharge (MAR) projects in the CPRB and other regions of Nebraska. The project is also motivated by the 1997 Three-State (CO, NE, WY) Cooperative Agreement and assisting Nebraska's Cooperative Hydrology Study (COHYST) in developing modeling tools to maintain streamflow for endangered species and assist Natural Resource Districts (NRDs) with management of sustainable water resources.

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.

Project Tasks – Estimating Recharge*: Recharge is the amount of water that infiltrates the land surface, moves downward through the soil and unsaturated (vadose) zone, and intercepts the groundwater surface. The process of recharge is how groundwater aquifers are replenished. Understanding rates of recharge (how fast recharge occurs over a given space and time) is vital to the availability and sustainability of groundwater resources, and is universally one of the most important pieces of data for accurate groundwater-flow models. In many aquifers of the western U.S., the rates of recharge are known to vary spatially under differing land-use types, such as irrigated agricultural land, dryland agricultural land, forested land, rangeland, riparian areas (Scanlon et al., 2006), and temporally due to natural climate variability and potential climate change (Gurdak et al., 2007). However, a general lack of recharge studies across the CPRB has led to a poor understanding of the spatial and temporal variability of recharge rates across this basin. Recharge rates are critical information to help best manage the sustainability of groundwater and surface-water resources in Nebraska.*

To overcome the challenge associated with measuring recharge in aquifers with deep water tables, such as in the CPRB, the U.S. Geological Survey (USGS) developed

an innovative and successful approach using dedicated recharge installations across the High Plains aquifer in parts of Colorado, Nebraska, Kansas, and Texas (see the 9 existing USGS recharge sites in Figure 1) (McMahon et al., 2003, 2006; Gurdak et al., 2007, 2009, 2012). The USGS recharge installations use a wide range of instrumentation to measure multiple water, chemical, and climatic factors that control recharge. The success of the USGS approach was recently demonstrated during the High Plains regional groundwater (HPGW) study (McMahon et al., 2007; Gurdak et al., 2009).

The USGS recharge network represents a scientific investment that resulted in a unique and valuable data set critical for the better regional-scale understanding of groundwater sustainability across the High Plains aquifer. However, only 2 of the USGS recharge sites were located inside the COHYST model area and these two sites don't provide the adequate spatial and temporal recharge measurements needed to improve the COHYST groundwater-flow models.

Therefore, between 2008 and 2010 a cooperative partnership between the CPNRD, USGS, and San Francisco State University (SFSU) installed 8 new recharge sites within the CPNRD portion of the CPRB (Figure 1). These new recharge sites were designed on the USGS approach, expand on the existing USGS High Plains recharge network (Figure 1), and provide the necessary recharge information to improve the recharge inputs to the COHYST groundwater-flow models. Figure 2 shows a recharge site that was installed in 2009 next to a dryland corn field near Shelton, NE. Details about the 8 new recharge sites are outlined in a new (2014) USGS report (Steele et al., 2014).

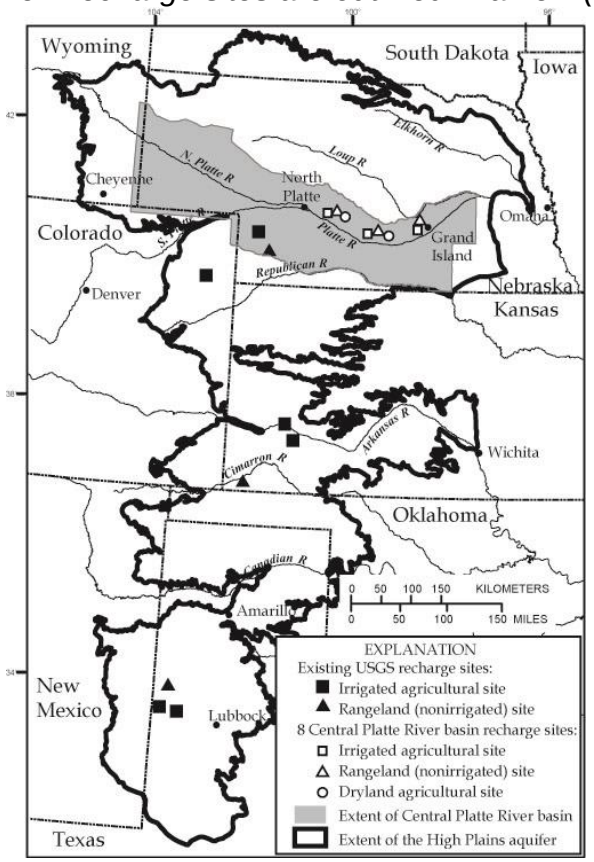

Figure 1

Figure 2

Figure 1*. Approximate location of the 8 project recharge sites within the Central Platte River basin (CPRB).*

Figure 2*. One of the eight project recharge sites that is located at a dryland corn field in the Central Platte River basin (CPRB).*

Goals and Objectives*: The overarching goal of the proposed project is to obtain more accurate and long-term measurements and understanding of the controls on groundwater recharge rates and water storage in the vadose zone beneath rangeland, irrigated, and non-irrigated (dryland) agricultural lands and the east to west precipitation gradient across the CPRB.*

To achieve this overarching goal, we will use a combination of field data from the 8 project recharge sites (Figures 1 and 2) (Steele et al., 2014) and numerical modeling to provide important foundational knowledge that is necessary for future suitability assessments for managed aquifer recharge (MAR) in the CPRB. MAR is an increasingly common approach for increasing groundwater supplies, but is still in the early stages of development and implementation across Nebraska and the CPRB. MAR can use several methods, including injection wells, aquifer storage and recovery (ASR), and infiltration basins. Prior to future planning and implementation of MAR systems in the CPRB or elsewhere in Nebraska, fundamental understanding of controls on water flux and storage in the vadose is needed. This study will successfully address that need for the CPRB.

By answering the following ***questions*** *(**Q1-3**), we will evaluate the relative influence of land-use, weather and climate, and sediment texture in the vadose zone as controls on recharge fluxes and water storage in the vadose zone. Answering **Q1-3** provides the foundation for future efforts to properly evaluate the suitability for MAR across the CPRB and other regions of Nebraska.*

Q1*) What are representative water fluxes and volumes of water storage in the vadose zone beneath different land use of the CPRB?*

Q2*) How do water fluxes and storage in the vadose zone response to seasonal and historic climate variability (i.e., precipitation and air temperature) of the CPRB?*

Q3*) How does sediment texture and layering in the soil and vadose zone affect water flux and storage in the vadose zone?*

*Questions **Q1-3** will be address through the following* ***project tasks*** *(**T1-4**):*

T1) *Address **Q1** by continued data collection at the 8 CPRB recharge sites that were installed between 2008 and 2010.*

The continued measurement of recharge over the proposed 3-year period (2016 to 2018) will greatly improve the predictive ability of the COHYST models. In turn, this will benefit future regulatory and management decisions regarding Platte River water supply and Nebraska's water resources and ecological habitat. Additionally, the study design enables better understanding of how different land use, land cover, and climate gradients across Nebraska affect the rate of recharge and the sustainability of Nebraska's groundwater and surface-water resources. Such knowledge has direct benefit for best environmental

management practices and regulatory decisions. Task 1 will be led by Chris Hobza (USGS, Lincoln, NE).

***T2)** Address **Q2** and **Q3** by developing numerical models of the 8 CPRB recharge sites.*

*To address **Q2** and **Q3**, we will develop site-specific numerical models of the vadose zone beneath the 8 CPRB recharge sites using the HYDRUS-1D modeling environment that solves Richards equation for unsaturated and saturated water flow in one-dimension and the advection-dispersion equation for solute transport (Simunek et al., 2008). The HYDRUS-1D models will be calibrated using data from the 8 recharge sites (see **T1**), including texture, bulk density, matrix potential, and water content of vadose zone sediments beneath each site. Building the site-specific HYDRUS-1D models is necessary to answer **Q3**. The historical recharge rates simulated with HYDRUS-1D will be verified using the tracer-based recharge estimates previously reported by Steele et al. (2014). A 35 year (1980–2015) historical climate data set from the National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center (NCDC) will be used to define the transient atmospheric boundary conditions in the historical HYDRUS-1D models to answer **Q2**. Task 2 will be led by Jason Gurdak (SFSU).*

***T3)** Findings from **T1-2** will be disseminated to the public through (i) uploading of all data to the USGS National Water Information System (NWSI) and (ii) publication of an open-source and peer-reviewed journal article in the fourth quarter of project year 3 (Table 1). Task 3 will be led by Chris Hobza (USGS data uploads) and Jason Gurdak (peer-reviewed journal article).*

***T4)** Address **Q1-3** by continued interdisciplinary partnership of local, federal, and academic experts on sustainability of Nebraska's water resources.*

The proposed interdisciplinary partnership between the CPNRD, USGS, and SFSU ensures the successful completion of Tasks 1, 2 and 3. This partnership will combine local hydrogeologic knowledge of this basin (CPNRD and COHYST) with recharge expertise (USGS and SFSU) to provide the best possible scientific information for the advancement of the COHYST models and to support science-based decisions for natural resource management of the central Platte River basin.

Timeline:

Table 1. Tasks, timeline of effort, and schedule of projects.

Task	Year 1 (2017)				Year 2 (2018)				Year 3 (2019)			
	1	2	3	4	1	2	3	4	1	2	3	4
T1	X	X	X	X	X	X	X	X	X	X	X	X
T2	X	X	X	X	X	X	X	X	X			
T3										X	X	X
T4	X	X	X	X	X	X	X	X	X	X	X	X

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 proposed project will be successful because of a strong and nearly 10-year partnership between local, federal, and academic experts on Nebraska's water resources, including Duane Woodward (Engineering Hydrologist, CPNRD and COHYST), Chris Hobza (Hydrologist, USGS NWSC), and Jason Gurdak (Associate Professor of Hydrogeology, SFSU).

Duane Woodward, Central Platte NRD (Grand Island, NE)

- *will continue providing funding and in-kind services for tasks (**T1-3**).*
- *has been an important leader at the Central Platte NRD and is involved on a day to day basis with the COHYST modeling effort.*

Chris Hobza, USGS NWSC (Lincoln, NE office)

- *has more than 10-years experience at the USGS providing sound science that supports best management of groundwater resources in Nebraska.*
- *will continue oversight of providing personnel for tasks **T1**.*
- *will oversee USGS NWSC field personnel (Lincoln and North Platte, NE Offices) that will provide maintenance and data collection activities from the 8 recharge sites and oversee up-loading of all data to the public on the USGS National Water Information System Web Interface (NWISWeb).*

Dr. Jason Gurdak, SFSU (San Francisco, CA) (formerly USGS, Denver, CO)

- *will continue providing technical assistance during **T1**.*
- *has over 15-years experience studying the quantity and quality of groundwater and recharge across the High Plains aquifer and has written extensively on the subject.*
- *has substantial experience needed to complete **T2**, using HYDRUS-1D and building vadose zone models of the High Plains aquifer (e.g., Gurdak et al., 2007; 2008, 2009; 2012).*

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 total cost of the project for the next 3 years is $290,600. We are requesting $151,680 from the WSF and the CPNRD is contributing $101,120 and the USGS $37,800. The Central Platte NRD is the local jurisdiction supporting the project. The FY 2015 /2016 Tax Levy for CPNRD is 0.03842, the property tax valuation is $15,919,152,725.00, and the property tax collected is $6,115,709.64. The USGS is also contributing funds to this project from their Cooperative Water Program. Cost share in the amount of $37,800 for the 3 years is available and being programmed by the USGS. The USGS and CPNRD have supported this project with funding sense 2008 and will

continue to do so with each annual budget. If the project is not funded through a WSF grant we would probably apply for another NET grant in September.

5. Support/Opposition

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

There is a wide support for this project and no known opposition. Support for the project includes the Central Platte NRD, U.S. Geological Survey, and many local land owners who have volunteered the use of their property where the 8 recharge sites are located. The local land owner's interest in the project is viewed a major vote of support for this proposed project. Additionally, the results from tasks #1-4 will likely result in improvements to best management practices the CPNRD has already enacted toward sustainable water resources. These practices are in place to help sustain the quantity and quality of our water resources, which are relied upon by communities to support growth and economic development.

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