LOWER LOUP
NATURAL RESOURCES DISTRICT

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llnrd.org

July 23, 2018

Nebraska Department of Natural Resources
via Electronic Submission

Re: Lower Loup NRD Application for Water Sustainability Fund Grant
Cover Crop Impact Study

Dear Mr. Fassett,

The Lower Loup Natural Resources District (LLNRD) and co-sponsor Central Platte Natural Resources District (CPNRD) submits the following information in support of an application to the Water Sustainability Fund for a Cover Crop Impact Study.

The Boards of Directors for both the LLNRD and CPNRD understand the importance of cover crops. Although the benefits of cover crops are well-documented, there is limited research about the impacts of cover crops on water availability and groundwater quantity. The ability to quantify the influence of cover crops on soil moisture balance, groundwater recharge, and movement of nitrate through and below the root zone is necessary for the Boards to make the science based management decisions utilizing the best available data. The LLNRD and CPNRD Boards have approved this application to the Water Sustainability Fund and are committed to providing the necessary matching funds to the grant.

The LLNRD and CPRND hope that the Natural Resources Commission shares the Board's recognition of the importance of understanding impacts of cover crops on water availability and groundwater quantity. The LLNRD has and will continue to work with partner agencies, including other Natural Resource Districts, the Natural Resources Conservation Service, and other state, city, and county agencies to protect our groundwater resources for the continued beneficial use of Nebraskans.

Should the Department or the Natural Resource Commission require any additional information or clarification regarding this application, please contact me directly, and I will ensure that your request is met. Thank you for your consideration of this grant application.

Sincerely,

Russell Callan
General Manager

NEBRASKA NATURAL RESOURCES COMMISSION

Water Sustainability Fund

Application for Funding

Section A.

ADMINISTRATIVE

PROJECT NAME: Cover Crop Impact Study

PRIMARY CONTACT INFORMATION

Entity Name: Lower Loup Natural Resources District

Contact Name: Tylr Naprstek

Address: 2620 Airport Drive, Ord, NE, 68862

Phone: 308-728-3221

Email: tnaprstek@llnrd.org

Partners / Co-sponsors, if any: The Central Platte Natural Resources District is a co-sponsor and project partners include the Natural Resources Conservation Service (NRCS), Klein Sales and Service, and private agricultural producers (landowners)

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

   Grant amount requested. $ 250,000

   Loan amount requested. $ N/A

   Are you requesting less than 60% cost share from the fund? Yes
   If so what %? 59.5%

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☐

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

YES☐ **NO☒**

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☒**

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(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);

In addition to detailed information provided below, please see attached supplemental information:

- **Attachment A: Literature Review dated August 2017**
- **Attachment B: Study Design dated September 2017**
- **Attachment C: Letters of Support**
- **Attachment D: Funding Opportunity Loss Letters**

Managing groundwater declines is of tremendous economic importance to Nebraska. For example, groundwater levels within the High Plains Aquifer (Ogallala Aquifer) continue to decline at alarming rates, particularly in Texas, Kansas, and southwest Nebraska as published in USGS report SIR 2017-5040 (McGuire, 2017). The need for a clear understanding regarding the issues impacting groundwater level declines is urgent and critical to prevent serious depletion of such a valuable resource, as currently experienced in these other states. The primary need for the proposed Cover Crop Impact Study is LLNRD and CPNRD's concern regarding groundwater declines in Buffalo, Custer, Howard, and Sherman counties.

The NRDs have identified a need for additional understanding regarding the effects of cover crops on water quantity. Cover crops have many positive impacts on the environment, such as improved soil health, reduced soil erosion, increased soil organic matter development, and improved water quality through the sequestration of unused nitrogen. Although these benefits are well-documented, research on the effects of cover crops on groundwater quantity is unclear. NRDs would consider expanding the implementation of cover crops to gain the water quality benefits but hesitate in areas of groundwater declines because of unknown effects of cover crops on soil moisture.

A Literature Review (Attachment A) directed by the LLNRD and CPNRD in 2017 revealed several key data gaps, such as the impact of cover crops:

1) On water use, soil moisture, and recharge,

2) On increased infiltration rates, and

3) Under different management and tillage practices.

Furthermore, the literature review revealed that the results of existing research were heavily influenced by local conditions (precipitation, soils, management practices, etc.), and local studies on the impacts of cover crops to groundwater quantity would be far more valuable to NRDs in making management decisions.

Currently, the amount of research and information on cover crops near the LLNRD and CPNRD is limited. The ultimate objective of this Cover Crop Impact Study is to develop and implement a scientifically defensible and practical study that will increase understanding of the general influence of cover crops on soil moisture, groundwater recharge, and movement of nitrates vertically through and below the root zone, thus providing for more informed NRD management strategies in support of long-term groundwater sustainability.

The project focus area is within the South Loup River and Central Platte River Basins, encompassing Buffalo, Custer, Howard, and Sherman counties, Nebraska. Three main objectives have been proposed to achieve the goal of the Cover Crop Impact Study:

1) Increase understanding of the impact of cover crops on water use, infiltration rates, and recharge by determining whether cover crops reduce, increase or have no effect on water use and groundwater recharge,

2) Increase understanding of the impact of cover crops under the conditions that exist in Central Nebraska, thus providing immediate and tangible guidance for NRD informed management,

3) Demonstrate the effectiveness of emerging innovative and automated methods for collection of soil moisture data through this large-scale application across the study area.

This study involves the installation of soil moisture sensors within three agricultural fields through three cropping seasons. The resulting soil moisture data will be used to determine the impact of the use of cover crops on:

1) Water use, soil moisture infiltration rates and groundwater recharge.

2) Water quantity and quality under the specific conditions present in the central Nebraska region, such as precipitation, cover crop management practices, tillage practices, etc.

Soil moisture at multiple depths, soil temperature, and rainfall data will be collected to study the impacts of cover crops through the root and vadose zone. Soil samples will be collected for laboratory analysis of nitrates, moisture content, and texture.

In 2017, the NRDs expended resources to carefully develop the Study Design (Attachment B) to ensure the desired objectives would be achieved. The Study Design provides a detailed description of methods and procedures, sequence of activities, external data sources, coordination with other organizations, reporting strategies, and comprehensive project schedule. The Study Design plan provides that monitoring fields will be approximately half cover crop and half without cover crop. The study will include two irrigated and one dryland field. The target size of each field is approximately 120 to 160 acres, and each field will consist of eight sites for data collection. The local NRCS field offices will assist the NRDs in selecting the fields and will assist as a technical advisor over the course of their regular activities during the project.

Field collection will consist of two primary elements:

1) Continuous soil monitoring: initial installation of moisture sensors at multiple depths, soil surface temperature sensors, rainfall measurement, remote data acquisition and transmission, maintenance and temporary removal of equipment, and final removal of equipment upon completion of the study.

2) Soil sample collection: includes the collection of multiple soil samples to a depth of 15-feet, laboratory analysis of soil samples for nitrate, soil moisture content and texture; and coordination with NRCS to obtain supplement field data, including soil health.

This innovative approach allows for continuous soil monitoring and wireless transmission of data using the Irromesh System.

Response References:

McGuire, V.L., 2017, Water-level and recoverable water in storage changes, High Plains aquifer, predevelopment to 2015 and 2013–15: U.S. Geological Survey Scientific Investigations Report 2017–5040, 14 p., https://doi.org/10.3133/sir20175040.

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

As aforementioned, a 2017 literature review sponsored by the LLNRD and the CPNRD revealed several key data gaps in understanding the effects of cover crops on groundwater quantity. Specifically, there is limited research on the impact of cover crops on water use, soil moisture, and recharge; on increased infiltration rates; and under different management and tillage practices being

used in the region. Based on these findings, the NRDs determined that it is imperative to develop a better understanding of the general influence of cover crops on groundwater quantity through this study to better support the goals of the Integrated Management Plans. Subsequently, a Study Design was completed to outline the project goals and technical implementation.

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

No legal water and/or land rights will be required for the study; however, privately owned study fields meeting the study criteria will require landowner permission, participation, and a willingness to commit to the full three-year duration of the study. The LLNRD, CPNRD, and the local NRCS will identify potential landowners with suitable fields who are willing to participate in the study and acquire signed land access agreements. Outreach activities will be conducted to promote project awareness and disseminate project findings to stakeholders, landowners, the general public, and other key entities that would benefit.

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).

This study does not involve the construction or development of new structures and will not have an impact on existing structures or infrastructure. The anticipated outcome of the Cover Crop Impact Study will be a better understating of the impact of cover crops on soil moisture, leaching of nitrate, and recharge below root zone to better promote cover crop practices with a clear understanding of the true impacts of cover crops on water quantity and quality. The study will enable the refinement of existing models to better simulate management scenarios that compare influence of cover crop programs.

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

Presently, the NRDs rely on wide-scale conservation practices in management areas where the water source may be at risk. In addition to addressing a documented research data gap, the data collection method proposed for this study serves as a proof of concept for innovative techniques in data collection. The innovation will result in labor cost savings that may be applied by other NRD study efforts and water management projects across Nebraska in the future. Innovative equipment and technology will be used to automate continuous soil monitoring which will be wirelessly transmitted through the Irromesh system. Watermark soil moisture sensors will be installed to record readings every 30 minutes and transmit to a central location using a self-routing, self-initializing, and self-healing network. Data will be remotely

retrievable via website and reviewed on a weekly basis to ensure the equipment is operating properly. The next best alternative relies on costly and inefficient daily labor-intensive data collection by hand, which would prolong the duration of the study, the collection of necessary data to resolve a documented data gap in support of more proactive groundwater management in the region, and the realization of innovative technology and future cost-savings to other NRDs and researchers resulting from this study.

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)].

- 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).

The Cover Crop Impact Study will provide many short- and long-term benefits, that will be diverse and lasting. Direct, quantitative environmental benefits of this study will be realized through the sequestration of nitrates, groundwater recharge, and soil health.

The 2017 Literature Review revealed that there is limited research on the impact of cover crops on water quantity in Nebraska. This data gap may result in substantial economic losses to local and state agencies due to lack of scientific support in properly managing the finite groundwater resources of the High Plains Aquifer in an area that is densely agricultural. Substantial aquifer water declines in other states, such as parts of Kansas and southern Texas, have resulted in economic loss related to crop production from declines in water reserve yield. Terrell and Johnson (1999) found that economic impacts of groundwater depletion in agriculturally dependent regions can be measured directly through crop production, indirectly through regional industries affected by crop production, and through induced economic impacts such as changes in regional household income generated by the direct and indirect economic impacts. The authors concluded that decreased agricultural production related to water decline will affect the statewide economy through interdependence between all industries and multiplier effects of economy changes (Terrell and Johnson 1999). Since there is no generally accepted method to accurately calculate the regional economic impacts from water decline, or benefits of increased water sustainability, this substantiates the crucial need for scientifically defensible understanding of crop cover impact on groundwater levels to reduce or prevent possible economic loss in Nebraska.

NRDs utilize management areas that have additional requirements (i.e. soil sampling, water sampling, reporting, etc.) to help protect the water supplies for communities and private wells. The NRDs rely on wide-scale conservation practices in management areas where the water source may be at risk. The NRDs and NRCS are already cost-sharing and promoting the implementation of cover crops. This study will help maximize the limited resources of the NRDs to achieve long-term sustainability of agricultural irrigation and domestic water. Improvements may be made to existing best management practices related to cover crops by maximizing groundwater recharge and irrigation efficiency, extending the life of the aquifer, and reducing the amount of groundwater that requires treatment systems to remove nitrates.

This study will be the first to use the Irromesh System and to use the Cellular Gateway to transmit data directly to a collection site at this scale. Wireless data collection will reduce site visits and labor costs. This innovation may serve as a model for future projects, resulting in immediate tangible benefits.

Response References:

Terrell, B. L., & Johnson, P. N. (1999, August). Economic impact of the depletion of the Ogallala aquifer: a case study of the Southern High Plains of Texas. In American Agricultural Economics Association annual meeting in Nashville, TN (pp. 8-11).

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

The total proposed budget for the three-year cover crop impact study is $420,000, of which $250,000 is being requested from the WSF. The LLNRD and the CPNRD have each allocated $33,500 cash and $50,000 in-kind services for the project totaling $167,000, and Klein Sales has agreed to provide in-kind services of $3,000. Klein Sales and Service will provide a discount on equipment purchase and provide a limited amount of additional technical and outreach support that Klein Sales and service can provide as a no-cost, in-kind service. In-Kind letters of support are provided in Supplemental Information Attachment C.

To efficiently and effectively complete this project, the LLNRD and CPNRD are proposing to use in-kind services by staff from the NRD's as part of the local match requirement to complete the field implementation, analysis and reporting, and the public outreach. Table B-1 demonstrates the cost-savings to the fund by the use of the in-kind services. If the use of in-kind services is denied, the NRD's will move forward with the project and use cash to replace the $100,000 identified for in-kind services.

The LLNRD has a 2018 property tax levy of 0.030083 resulting in approximately $4,997,283.13 of local property taxes. Property tax accounts for approximately 38.6% of the total budget. The CPNRD has a 2018 tax levy of 0.03239 resulting in approximately $5,639,132.09 of local property taxes. Property tax accounts for approximately 25.0% of the total budget.

Table B-1. Cost Savings to the Fund by use of In-Kind Services					
		NRD Staff		Consultant	
	Estimated Hours	Hourly Rate (including benefits)	Total	Hourly Rate (including benefits)	Total
Field Implementation	1,600.0	$34.50	$55,200.00	$64.00	$102,400.00
Data Analysis and Reporting	515.9	$34.50	$17,800.00	$64.00	$33,020.29
Public Outreach	500.0	$34.50	$17,250.00	$64.00	$32,000.00
	234.4	$41.60	$9,750.00	$96.00	$22,500.00
			$100,000.00		$189,920.29
				Cost Savings to the Fund	$89,920.29

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

N/A

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

This application is in request of a grant and therefore no additional information on loan repayment is provided.

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

The installation of soil sensors and soil sample collection over the course of the three-year study will be conducted in established agricultural fields. Therefore, no impacts on the natural environment are anticipated. The need for clear understanding of cover crop influence is urgent and critical in understanding groundwater level declines to prevent the serious depletion of valuable natural resources as currently experienced in other states within the High Plains Aquifer footprint. This study will provide key information in evaluating known data gaps related to the impact of cover crops on groundwater quantity, soil moisture, recharge, and infiltration rates under local agricultural management practices. This will allow the LLNRD and CPNRD to effectively identify ways to minimize present impacts to water resources and prioritize responsible management in support of long-term groundwater sustainability.

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

The LLNRD and CPNRD have the statutory responsibility to manage and conserve surface and groundwater. The existing Groundwater Management Plans and Integrated Management Plans along with the Rules and Regulations supporting those plans, supply the legal capability and statutory requirements to both Districts to conduct and support this study. The proposed study fulfills reaching goals outlined by LLNRD's Voluntary Integrated Management Plan dated March 24, 2016. These goals aim to promote and support a water supply and use inventory based on the best available data and analysis; maintain an efficient and economical balance between current and future water supplies and demands; develop water policies and practices in support of protecting existing groundwater uses while allowing for future water development; and educate the public on water conservation measures. Furthermore, the LLNRD and CPNRD Integrated Management Plans outline the necessary NRD duty in continued groundwater data collection and creating partnerships outside organizations to address current data gaps.

The NRDs have contracted with EA Engineering, Science, & Technology, Inc., PBC to provide technical expertise in support of the study. Key staff proposed in providing project management and technical support include a Senior Environmental Scientist, Natural Resource Specialist, and Senior Engineer with more than 85 combined years of project-related expertise and experience, with specialized expertise in vadose zone investigations.

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

This cover crop impact study directly aligns with goals and objectives developed by the LLNRD and CPNRD, as outlined in their respective Integrated Management Plans. Furthermore, managing groundwater declines is of tremendous economic importance to the State of Nebraska. Specifically, this study will address identified data gaps in support of responsible surface and groundwater management, and in prioritizing and contributing to the protection of existing surface and groundwater uses while allowing for future water development. Through a LLNRD and CPNRD sponsored Literature Review and Study Design, the NRDs have found that there is limited research documenting the effects of cover crops on groundwater quantity, recharge, infiltration, and under regionally-specific management and tillage practices. This scientifically defensible study will provide increased understanding of cover crop influence through and below the root zone, thus providing the NRDs with more informed management strategy development in support of long term groundwater sustainability.

10. Are land rights necessary to complete your project?

YES☐ **NO☒**

No land rights will be required; however, the LLNRD, CPNRD, and the local NRCS will identify potential landowners with suitable fields who are willing to participate in the study and acquire signed land access agreements.

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

The LLNRD and CPNRD have the authority under Nebraska State Statute Chapter 2 Article 32 to carry out this crop cover impact study under its authorized purpose relating to the development, management, utilization, and conservation of groundwater and surface water. This includes NRD authority 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.

The installation of soil sensors and soil sample collection over the course of the three-year study will be conducted in established agricultural fields. Therefore, no environmental and/or ecological consequences are anticipated. This study will provide key information in evaluating the impact of cover crops on groundwater quantity in the region. This will allow the NRDs to effectively identify ways to minimize impacts to water resources and prioritize management in support of long-term groundwater sustainability, which will result in direct long-term benefits to the environment and regional ecology.

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.

Nitrates in drinking water are a concern for many communities, but water availability can be an even larger issue, especially in times of drought. Approximately 20 communities in Nebraska require expensive treatment to reduce nitrate levels below the maximum contaminant level. Cover crops are well known to uptake excess nitrates, but there is little knowledge on water quantity impacts. Since approximately 90% of public water systems and 76% of agricultural irrigation in Nebraska comes from groundwater, the data retrieved from this study is greatly needed for effective resource management and addresses the need of water availability for public consumption.

A Literature Review by EA Engineering, Science, and Technology, Inc., PBC (EA) was conducted for the LLNRD and CPNRD in August 2017 to summarize existing research on cover crop impact to surface and groundwater quantity. In addition to literature summaries, EA examined the range of impacts that the implementation of a cover cropping system under various management strategies have on leaching of nitrogen below the root zone, soil water balance, evapotranspiration, infiltration runoff and groundwater recharge. The literature review revealed data gaps in the body of work related to impact of cover crops on groundwater recharge, effects of increased infiltration rates due to cover crops compared to amount of water consumed by the cover crop, and the impact of cover crops in no-till systems versus conventional till systems. Furthermore, the existing studies are not reliably applicable to all areas of the country due to differences in precipitation, temperature, length of growing season and soils.

Due to declining groundwater levels and increased levels of nitrates in the NRD management areas, the LLNRD and the CPNRD believe it is essential to gain a better understanding of the outcomes of different management systems on water quality and quantity to achieve the goal of long term sustainability. Based on this, the LLNRD and CPNRD have determined that it is imperative to conduct a localized study of cover crop impact to accurately interpret the local conditions in modeling and develop effective management strategies.

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

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

The LLNRD adopted a voluntary Integrated Management Plan (IMP) on March 24, 2016. The CPNRD adopted an IMP on July 23, 2009. The CPNRD IMP was revised and adopted on March 22, 2012 and became effective on May 21, 2012. The purpose of the LLNRD IMP is to achieve and sustain a balance between water uses and water supplies in the basin for the long-term through a set of goals, objectives, and action items which facilitate sustainable water management in the NRD. The four goals of the LLNRD IMP are to:

1) **Goal 1:** Promote and support a water supply and use inventory based on the best available data and analysis.

2) **Goal 2:** Implement the IMP to maintain an efficient and economical balance between current and future water supplies and demands.

3) **Goal 3:** Develop and implement water use policies and practices that prioritize and contribute to the protection of existing surface and groundwater uses while allowing for future water development.

4) **Goal 4:** Continue public education programs that encourage water conservation measures.

Due to the proximity of the areas with groundwater decline, the LLNRD has partnered with the CPNRD. The six goals of the CPNRD IMP are to:

1.) **Goal 1:** To secure any future water supply projects that are shown to be feasible, beneficial, and desirable.

2.) **Goal 2:** To provide for a total consumption of water that does not exceed a fully appropriated status.

3.) **Goal 3:** To maintain, for present and future generations, the District's water resources while promoting programs that allow economic growth.

4.) **Goal 4:** To provide, for present and future generations, an adequate supply of quality water for feasible and beneficial uses.

5.) **Goal 5:** To minimize and/or resolve conflicts between water users.

6.) **Goal 6:** To ensure that the plan complies with the law and with interstate agreements, and to meet basin-wide goals.

The proposed Cover Crop Impact Study supports the goals outlined in the LLNRD IMP and will specifically serve the following objectives under the aforementioned LLNRD IMP goals:

1) **Goal 1:** The collected water quantity data from the study will support maintenance of the LLNRD's comprehensive inventory of the location and source of the District's current and future water supplies and water uses by collecting groundwater and surface water supply data, estimating groundwater inflow/outflow, and identify data gaps (Objective 1.1), as well as aid in monitoring the current and potential future water demands in the basin (Objective 1.2). The study will serve as a proof of concept in using innovative technology to remotely collect continuous water quantity data, which supports the NRD's object to use the best available science and technology to monitor water supplies (Objective 1.3). The LLNRD will conform with the existing policies and authorities of the District and the Department to conduct this study which will specifically address water quantity issues (Objective 1.4).

2) **Goal 2:** The study will provide the NRD with pertinent data which will aid in monitoring the instream flow needs in the basin and provide key information on understanding existing appropriation priorities and locations, provide a basis for evaluating impacts of existing and future uses (Objective 2.2), and serve in evaluating options for water banking methodologies (Objective 2.3).

3) **Goal 3:** The study will provide scientific data on the cover crop impact on water quantity, fulfilling a known data gap, which will be crucial in supporting the identification of available water storage opportunities throughout the District (Objective 3.1)

4) **Goal 4:** The LLNRD believes it is important to gain a better understanding of the cover crop impact and different management systems on water quantity in the region to achieve the overall goal of long term sustainability in the basin. This impact study will support the NRD's objectives of investigating and promoting water use efficiency and continuing public education and cost-sharing programs to encourage the use of conservation and best management practices through press releases, newsletters, publications, websites, highlights during weekly radio show, presentations to stakeholder groups, and cooperative events with NRCS and the University of Nebraska. (Objectives 4.1 and 4.2).

The proposed Cover Crop Impact Study supports the similar overall goals of the CPNRD's IMP to achieve and/or maintain sustainable balance between water uses and water supplies in both the near term and long term. This study will provide data in support of providing a sustainable supply of water and meets the CPNRD's objective to use the best data and science in performing analyses, identifying data gaps in their analyses, and, if necessary, determine whether studies should be undertaken to address these gaps. Specifically, the study will serve the following objectives under the aforementioned CPNRD IMP goals:

1) **Goal 1 and Goal 2:** The collected water quantity data from the study will aid NRD staff in monitoring groundwater levels in the basin and provide key information in support of managing existing appropriation priorities and locations. Furthermore, the collected information will support a basis for evaluating impacts of existing and future uses and serve in evaluating options for water storage opportunities and banking methodologies.

2) **Goal 3 and Goal 4:** The NRD strives to balance both maximizing beneficial consumption and limiting the impacts to the State's limited surface and groundwater supplies, while assuring the continued endurance of a thriving and fertile agricultural region which serves as a pillar of Nebraska's economic welfare. By gaining a better understanding of the impacts of cover crops and different management systems on water quantity in the region, this study aims to support the NRD's goal to achieve long term sustainability in the basin by investigating and promoting water use efficiency through conservation and best management practices.

3) **Goal 5:** The study furthers the CPNRD's goal to minimize and/or resolve conflicts between water users by providing a better understanding of the relationship between cover crops and groundwater quantity in the region, thus allowing for more informed stakeholder and producer mitigation or conflict resolution regarding cover crop implementation. Ultimately, this serves to maximize the benefits of local use and groundwater management, as well as, identifying the varying relationships of crop management methods and groundwater quantity.

4) **Goal 6:** The CPNRD must meet its obligation under the PRRIP to provide sufficient water to and through the Central Platte River habitat area to assist in improving and maintaining habitats for endangered species. This study serves this goal by providing data to help maintain sustainable aquifers, address water quantity and soil health issues in support of sustaining the diverse ecology, sensitive populations, and endangered species of Nebraska.

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 Cover Crop Impact Study is clearly and directly aligned with increasing aquifer recharge, reducing aquifer depletion, and increasing streamflow. The study area will span Buffalo, Custer, Howard, and Sherman counties within the LLNRD and CPNRD basin, where groundwater declines have been observed. The outcome of the study will benefit NRDs throughout the State of Nebraska by providing key scientific data to fill a documented water quantity data gap and serve as proof of concept for innovative groundwater data collection technology.

   The primary need for the study is LLNRD and CPNRD's concern regarding groundwater declines. The groundwater levels within the High Plains Aquifer continue to decline at alarming rates, particularly in Texas, Kansas, and southwest Nebraska as published in USGS report SIR 2017-5040 (McGuire, 2017). The need for clear understanding regarding the issues impacting groundwater level declines is urgent and critical to prevent the serious depletion of such a valuable resource as currently experienced in other states.

   Cover crops have many positive impacts on the environment, such as improved soil health, reduced soil erosion, increased soil organic matter development, and improved water quality through the sequestration of unused nitrogen. Although these benefits are well documented, the research on the effects of cover crops on groundwater quantity in the region is unclear.

   The ultimate objective of this study is to develop and implement a scientifically defensible and practical study that will increase understanding of the general influence of cover crops on soil moisture, groundwater recharge, and movement of nitrates vertically and below the root zone. The findings from this study will not only serve the LLNRD and CPNRD basins in decision-making and developing effective water conservation management strategies, but will also provide NRDs across the state with an increased understanding of the impact of cover crops on water quantity, soil moisture, infiltration rate; increased understanding of the local conditions that influence cover crop impacts; and provide demonstrated effectiveness of innovative and automated methods for collecting soil moisture data.

Response References:

McGuire, V.L., 2017, Water-level and recoverable water in storage changes, High Plains aquifer, predevelopment to 2015 and 2013–15: U.S. Geological Survey Scientific Investigations Report 2017–5040, 14 p., https://doi.org/10.3133/sir20175040.

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 study will provide scientifically based information on the impact of crop cover to water quantity, allowing the NRDs to better anticipate declines or increases in certain scenarios, and possibly prevent major, and costly, impacts to agricultural, municipal, industrial, residential, and ecosystem water supplies and well systems through more informed groundwater management. Furthermore, this study will enable the refinement of existing models to better simulate management scenarios that compare the influence of cover crop programs.

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.

Nebraska's water resources are considered a shared resource of the state, where priorities are placed on drinking water, agricultural, and industrial availability and consumption. Both the LLNRD and CPNRD aim to meet the objectives of their IMPs by maintaining water resources for both present and future generations in their Districts, and thereby directly to the state residents. The NRDs strive to balance both maximizing beneficial consumption and limiting the impacts to the State's limited surface and groundwater supplies. This study aims to fill a known scientific data gap in the understanding of how cover crops impact water use, soil moisture, and recharge subject to the specific regional, meteorological, and geological conditions of Nebraska. An increased understanding of these impacts will allow the NRDs to make more informed ground and surface water management decisions in support of water sustainability for the residents of Nebraska. The NRDs will be better equipped

to refine groundwater models, anticipate declines and/or increases under certain conditions and scenarios, understand cover crop interaction with groundwater quantity across the region, and share this increased understanding with other NRDs, pertinent agencies, and stakeholders in Nebraska. This understanding provides both immediate and long-term benefits to current and future residents. Furthermore, the methods proposed to achieve the goals of this study will serve as a proof of concept for innovative and more efficient data collection technology, which will provide immediate economic and labor benefits to other NRDs and agencies across the state, and further to the residents of 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 total proposed budget for the three-year cover crop impact study is $420,000, of which $250,000 is being requested from the WSF. The LLNRD and the CPNRD have each allocated $33,500 cash and $50,000 in-kind services for the project totaling $167,000, and Klein Sales has agreed to provide in-kind services of $3,000. Klein Sales and Service will provide a discount on equipment purchase and provide a limited amount of additional technical and outreach support that Klein Sales and service can provide as a no-cost, in-kind service.

To efficiently and effectively complete this project, the LLNRD and CPNRD are proposing to use in-kind services by staff from the NRD's as part of the local match requirement to complete the field implementation, analysis and reporting, and the public outreach. Table C-1 demonstrates the cost-savings to the fund by the use of the in-kind services. If the use of in-kind services is denied, the NRD's will move forward with the project and use cash to replace the $100,000 identified for in-kind services.

Sustainable groundwater storage and supply is critical to the economic vitality of Nebraska, as such research in support of better managing groundwater declines is of tremendous economic importance and value to the state. Presently, the NRDs rely on wide-scale conservation practices in management areas where the water source may be at risk. In addition to addressing a documented research data gap, the data collection method proposed for this study serves as a proof of concept for innovative techniques in data collection. The innovation will result in labor cost savings that may be applied by other NRD study efforts and water management projects across Nebraska in the future. Innovative equipment and technology will be used to automate

continuous soil monitoring which will be wirelessly transmitted through the Irromesh system. Watermark soil moisture sensors will be installed to record readings every 30 minutes and transmit to a central location using a self-routing, self-initializing, and self-healing network. Data will be remotely retrievable via website and reviewed on a weekly basis to ensure the equipment is operating properly. Alternative methods to achieve the study objectives may rely on costly and inefficient daily, labor-intensive data collection by hand, which would prolong the duration of the study, the collection of necessary data to resolve a documented data gap in support of more proactive and informed groundwater management in the region, and the realization of innovative technology and future cost-savings to other NRDs and researchers resulting from this study.

Furthermore, the CPNRD must meet its obligation under the Platte River Recovery Implementation Program (PRRIP), which is a statewide issue. The state must provide sufficient water to and through the Central Platte River habitat area to assist in improving and maintaining habitats for the endangered species. This study serves the PRRIP obligation by providing data to help maintain sustainable aquifers, address water quantity and soil health issues in support of sustaining the diverse ecology, sensitive populations, and endangered species of Nebraska. These benefits are very real, even if it is difficult to place a quantitative value on them.

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 LLNRD and CPNRD have experienced localized groundwater declines and nitrate contamination within district boundaries. Soil management and subsequent Best Management Practices (BMPs) associated with the project will be used to assess long-term surface and groundwater resources. The CPNRD entered into the PRRIP Agreement in 2006, revised from the original 1997 cooperative agreement. The PRRIP agreement provides that existing and new water related activities including surface water irrigation, hydropower projects, and groundwater uses comply with the Endangered Species Act. LB962, adopted by the Nebraska State Legislature in 2004, which requires integrated management of hydrologically connected waters to achieve state compliance with interstate agreements such as the PRRIP. This study meets the PRRIP obligation of the CPNRD in providing data to help maintain sustainable aquifers, address water quantity and soil health issues in support of

sustaining the diverse ecology, sensitive populations, and endangered species of Nebraska.

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.

This study provides immediate reduction in the risk associated with the LLNRD's and CPNRD's obligation to sustainable and integrated groundwater management in the study area. Sustainable groundwater storage and supply is critical to the economic vitality of Nebraska. The information obtained from this study will aid the NRDs in meeting their IMP objectives by better understanding the effects of cover crops on groundwater quantity in the region. This will allow for better management of the critical water supply infrastructure and natural resources in the region, assuring the continued endurance of a thriving and fertile agricultural region which serves as a pillar of Nebraska's economic welfare. There is great potential value provided by the outcome of the study, including increased NRD understanding of the cover crop impact on groundwater quantity and the large-scale proof of concept associated with the innovative technology proposed for data collection; however, future numerical cost savings at the completion of the study are unable to be determined at this stage.

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.

Cover crops have many positive impacts on the environment. Notably, cover crops improve water quality through the sequestration of unused nitrogen. The main goal of this study is to better understand the impact of cover crops on

groundwater quantity in the region, as there is limited information in the body of literature. Collected soil moisture data will be used to determine the impact of cover crops on water use, soil moisture infiltration, and on water quantity and quality under the specific conditions present in the Central Nebraska region, such as precipitation, cover crop management practices, and tillage practices.

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

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

The LLNRD and CPNRD devote substantial time and resources to the assessment of the overall water quality and sustainability of the groundwater resources of the districts. This proposed project was discussed and voted on by the LLNRD Board of Directors during the March 2017 meeting. The motion to pursue resources to proceed with this project was passed by a vote of 18 'yes' to 0 'no', with three directors absent. Both NRDs have expended financial resources to conduct a thorough Literature Review in August 2017 and develop a focused study design in September 2017.

The total project cost for this proposed cover crop impact data collection, analysis, and reporting is $420,000. Of that total project cost, the LLNRD and CPNRD will use general funds, project partners, and in-kind services to cover the local match of $170,000. The remaining $250,000 of funds needed for the project are being requested as a grant for the WSF.

The LLNRD has a 2018 property tax levy of 0.030083 resulting in approximately $4,997,283.13 of local property taxes. Property tax accounts for approximately 38.6% of the total budget. The CPNRD has a 2018 tax levy of 0.03239 resulting in approximately $5,639,132.09 of local property taxes. Property tax accounts for approximately 25.0% of the total budget.

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

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

- Identify who benefits from this project.

The LLNRD adopted a voluntary Integrated Management Plan (IMP) on March 24, 2016. The CPNRD adopted an IMP on July 23, 2009, followed by a revised IMP on May 21, 2012. The purpose of the LLNRD IMP is to achieve and sustain a balance between water uses and water supplies in the basin for the long term through a set of goals, objectives, and action items which facilitate sustainable water management in the NRD. The four goals of the LLNRD IMP are to:

1) **Goal 1:** Promote and support a water supply and use inventory based on the best available data and analysis.

2) **Goal 2:** Implement the IMP to maintain an efficient and economical balance between current and future water supplies and demands.

3) **Goal 3:** Develop and implement water use policies and practices that prioritize and contribute to the protection of existing surface and groundwater uses while allowing for future water development.

4) **Goal 4:** Continue public education programs that encourage water conservation measures.

Due to the proximity of the areas with groundwater decline, the LLNRD has partnered with the CPNRD. The six goals of the CPNRD IMP are to:

1.) **Goal 1:** To secure any future water supply projects that are shown to be feasible beneficial and desirable.

2.) **Goal 2:** To provide for a total consumption of water that does not exceed a fully appropriated status.

3.) **Goal 3:** To maintain, for present and future generations, the District's water resources while promoting programs that allow economic growth.

4.) **Goal 4:** To provide, for present and future generations, an adequate supply of quality water for feasible and beneficial uses.

5.) **Goal 5:** To minimize and/or resolve conflicts between water users.

6.) **Goal 6:** To ensure that the plan complies with the law and with interstate agreements, and to meet basin-wide goals.

The proposed Cover Crop Impact Study supports the goals outlined in the LLNRD IMP, and will specifically serve the following objectives under the aforementioned LLNRD IMP goals:

5) **Goal 1:** The collected water quantity data from the study will support maintenance of the LLNRD's comprehensive inventory of the location and source of the District's current and future water supplies and water uses by collecting groundwater and surface water supply data, estimating groundwater inflow/outflow, and identify data gaps (Objective 1.1), as well as aid in monitoring the current and potential future water demands in the basin (Objective 1.2). The study will serve as a proof of concept in using innovative technology to remotely collect continuous water quantity data, which supports the NRD's objective to use the best available science and technology to monitor water supplies (Objective 1.3). The LLNRD will conform with the existing policies and authorities of the District and the Department of Natural Resources to conduct this study which will specifically address water quantity issues (Objective 1.4).

6) **Goal 2:** The study will provide the NRD with pertinent data which will aid in monitoring the instream flow needs in the basin and provide key information on understanding existing appropriation priorities and locations, provide a basis for evaluating impacts of existing and future uses (Objective 2.2), and serve in evaluating options for water banking methodologies (Objective 2.3).

7) **Goal 3:** The study will provide scientific data on cover crop impacts on water quantity, fulfilling a known data gap, which will be crucial in supporting the identification of available water storage opportunities throughout the District (Objective 3.1)

8) **Goal 4:** The LLNRD believes it is important to gain a better understanding of the impacts of cover crops and different management systems on water quantity in the region to achieve the overall goal of long term sustainability in the basin. This impact study will support the NRD's objectives of investigating and promoting water use efficiency and continuing public education and cost-sharing programs to encourage the use of conservation and best management practices through press releases, newsletters, publications, websites, highlights during weekly radio show, presentations to stakeholder groups, and cooperative events with NRCS and the University of Nebraska. (Objectives 4.1 and 4.2).

The proposed Cover Crop Impact Study supports the similar overall goals of the CPNRD's IMP to achieve and/or maintain sustainable balance between water uses and water supplies in both the near term and long term. This study will provide data in support of providing a sustainable supply of water and meets the CPNRD's objective to use the best data and science in performing analyses, identifying data gaps in their analyses, and if necessary, determine whether studies should be undertaken to address these gaps. Specifically, the study will serve the following objectives under the aforementioned CPNRD IMP goals:

1) **Goal 1 and Goal 2:** The collected water quantity data from the study will aid NRD staff in monitoring groundwater levels in the basin and provide key information in support of managing existing appropriation priorities and locations. Furthermore, the collected information will support a basis for evaluating impacts of existing and future uses and serve in evaluating options for water storage opportunities and banking methodologies.

2) **Goal 3 and Goal 4:** The NRD strives to balance both maximizing beneficial consumption and limiting the impacts to the State's limited surface and groundwater supplies, while assuring the continued endurance of a thriving and fertile agricultural region which serves as a pillar of Nebraska's economic welfare. By gaining a better understanding of impact of cover crops and different management systems on water quantity in the region, this study aims to support the NRD's goal to achieve long term sustainability in the basin by investigating and promoting water use efficiency through conservation and best management practices.

3) **Goal 5:** The study furthers the CPNRD's goal to minimize and/or resolve conflicts between water users by providing a better understanding of the relationship between cover crops and groundwater quantity in the region, thus allowing for more informed stakeholder and producer mitigation or conflict resolution regarding cover crop implementation. Ultimately, this serves to maximize the benefits of local use, groundwater management, and in identifying the varying relationships of crop management methods and groundwater quantity.

4) **Goal 6:** The CPNRD must meet its obligation under the PRRIP to provide sufficient water to and through the Central Platte River habitat area to assist in improving and maintaining habitats for endangered species. This study serves this goal by providing data to help maintain sustainable aquifers, address water quantity and soil health issues in support of sustaining the diverse ecology, sensitive populations, and endangered species of Nebraska.

The Cover Crop Impact Study area will span Buffalo, Custer, Howard, and Sherman counties within the LLNRD basin, where groundwater declines have been observed sporadically. The outcome of the study will benefit the agricultural water users in the entire LLNRD (5,070,720 acres) and the CPNRD (2,136,304 acres) as well as NRDs throughout the State of Nebraska by providing key scientific data in fulfilling a documented water quantity data gap and serve as proof of concept for innovative groundwater data collection technology that supports agriculture.

Stakeholders involved in the project will include the Board and staff of the LLNRD and CPNRD, the NRCS, and private agricultural producers.

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.

Understanding the relationship between cover crops and groundwater quantity serves a statewide purpose as managing sustainable groundwater is of tremendous economic importance to the state of Nebraska. Nebraska's water resources are considered a shared resource of the state, and local NRDs are tasked with meeting the objectives of their IMPs by maintaining water resources for both present and future generations. The High Plains Aquifer, which underlies a large swath of the state has had intermittent declines over the last century, particularly in Texas, Kansas, and southwest Nebraska. The need for clear understanding regarding issues which impact groundwater levels are urgent and critical in sustainable management across the state. This study aims to provide scientific information to address an identified data gap, provide the local NRDs with the best available data to monitor water supplies, address water quantity issues, and identify available water storage opportunities. The understanding of cover crops gained from this study will aid and benefit other NRDs across the state in sustainable groundwater management, and thereby directly benefit stakeholders and state residents.

Furthermore, the CPNRD must meet its obligation under the PRRIP, which is a statewide issue. The state must provide sufficient water to and through the Central Platte River habitat area to assist in improving and maintaining habitats for the endangered species. This study serves the PRRIP obligation by providing data to help maintain sustainable aquifers, address water quantity and soil health issues in support of sustaining the diverse ecology, sensitive populations, and endangered species of Nebraska.

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 total cost of the project is $420,000 with 59.5% intended to be funded from the Water Sustainability Fund (WSF), and 40.5% from project partners with funding confirmed from each partner. The funding partners are shown in Table C-1. Evidence of each commitment is included in Supplemental Information Attachment C. Except for those listed in Table C-2, there are no other funding sources at this time and hence, the study will not commence if Water Sustainability Funds are not obtained.

To efficiently and effectively complete this project, the LLNRD and CPNRD are proposing to use in-kind services by staff from the NRD's as part of the local match requirement to complete the field implementation, analysis and reporting, and the public outreach. Table C-1 demonstrates the cost-savings to the fund by the use of the in-kind services. If the use of in-kind services is denied, the NRD's will move forward with the project and use cash to replace the $100,000 identified for in-kind services.

Table C-1. Cost Savings to the Fund by use of In-Kind Services

		NRD Staff		Consultant	
	Estimated Hours	Hourly Rate (including benefits)	Total	Hourly Rate (including benefits)	Total
Field Implementation	1,600.0	$34.50	$55,200.00	$64.00	$102,400.00
Data Analysis and Reporting	515.9	$34.50	$17,800.00	$64.00	$33,020.29
Public Outreach	500.0	$34.50	$17,250.00	$64.00	$32,000.00
	234.4	$41.60	$9,750.00	$96.00	$22,500.00
			$100,000.00		$189,920.29
				Cost Savings to the Fund	$89,920.29

Table C-2. Funding Matrix

Project Partner	2019-2020	2020-2021	2021-2022	Total
Water Sustainability Fund	$108,200.00	$63,900.00	$77,900.00	$250,000.00
LLNRD	$29,700.00	$21,650.00	$32,150.00	$83,500.00
CPNRD	$29,700.00	$21,650.00	$32,150.00	$83,500.00
Klein Sales and Service	$3,000.00	$0.00	$0.00	$3,000.00
	$170,600.00	$107,200.00	$142,200.00	$420,000.00

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 study area spans Buffalo, Custer, Howard, and Sherman, Counties within the Lower Loup and Middle Platte Watersheds. The data collected will benefit these watersheds by providing key information in understanding the impacts of cover crops on groundwater levels of the region. Addressing identified data gaps to obtain the best available data is pertinent in long-term sustainable management of groundwater; thus, the data obtained in this study will assist the NRDs in monitoring groundwater levels, a core component of watershed health and function, and benefit future watershed planning activities in the South Loup and Middle Platte Basins.

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 following objectives as outlined in the Annual Report and Plan of Work for the Nebraska State Water Planning and Review Process submitted to the Governor and Legislature in September 2017 are met by this study:

- *Maintain data, information, and analysis capabilities for water planning, including specific programs for collecting, maintaining, and distributing information on streamflows, as well as analyzing water uses and water supplies across the state;* The study will meet this objective through collection of water quantity data to support NRD's management and maintenance of data related to water uses, groundwater inflow/outflow, and identifying data gaps. This will aid both NRDs in monitoring current and potential future water demands in the region.

- *Provide staff and resources to support planning and implementation of water resources projects;* The study will provide the NRDs with pertinent data which will aid staff in monitoring groundwater levels in the basin with the best available science. The study will provide key information in support of managing existing appropriation priorities and location, support a basis for evaluating impacts of existing and future uses, and serve in evaluating options for water storage opportunities and banking methodologies.

- *Support locally developed water management plans for conjunctively managing hydrologically connected ground and surface water supplies;* The study will provide a better understanding of cover crop impact and

the various management systems on water quantity in the region to achieve the overall goal of long-term sustainability in the basin, which meets the objective stated here and the objectives outlined by the LLNRD's and CPNRD's Integrated Water Management plans.

- *Participate in interagency collaboration with federal agencies, state agencies, local natural resources districts (NRDs), and other water interest entities on various water resources programs and projects;* The LLNRD and CPNRD have partnered in completing this study due to their proximity and shared need to better understand the impact of cover crops on water quantity. Furthermore, the LLNRD and CPNRD will collaborate with the NRCS and private agricultural producers over the three-year study.

- *Consolidate and present information in a form that is understandable and useful to the public and interagency collaborators.* At the completion of the study, knowledge gained on the relationship between cover crops and groundwater quantity will be available to other NRDs, interested non-partner agencies, and the general public to provide a better understanding of the hydrogeologic framework and the importance of addressing data gaps in support of sustainable groundwater management.

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 CPNRD must meet its obligation under the Platte River Recovery Implementation Program (PRRIP), a federal mandate. CPNRD entered into the Agreement in 2006, revised from the original 1997 cooperative agreement. The PRRIP agreement provides that existing and new water related activities including surface water irrigation, hydropower projects, and groundwater uses comply with the Endangered Species Act. LB962, adopted by the Nebraska State Legislature in 2004 requires integrated management of hydrologically connected waters to achieve state compliance with interstate agreements such as the PRRIP. This study meets the PRRIP obligation of the CPNRD in providing data to help maintain sustainable aquifers, address water quantity and soil health issues in support of sustaining the diverse ecology, sensitive populations, and endangered species of Nebraska.

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.

Although the benefits of cover crops are well-documented, there is limited research about the impacts of cover crops on **water availability** and **groundwater quantity**. The objective is to quantify the influence of cover crops on soil moisture balance, groundwater recharge, and movement of nitrates through and below the root zone. To quantify the effects of cover crops on groundwater, soil moisture sensors will be installed in agricultural fields through three cropping seasons. Soil moisture at multiple depths, soil temperature, and rainfall will be collected remotely using an innovative technology to study the impacts of cover crops through the root and vadose zones. Soil samples will also be analyzed for nitrates, moisture content, and texture. The study area has experienced groundwater declines. The LLNRD and CPNRD are charged with managing groundwater quantity and quality and have expended resources to conduct a thorough Literature Review and develop a Study Design. Furthermore, the study results will help Nebraska water managers make informed decisions for their constituents and increase the longevity of groundwater resources for future generations.

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.

Table D-1 summarizes the project tasks and timeline.

Table D-1. Project Tasks and Timeline	
Month/Year	**Task Description:**
YEAR 1	
July 2019	Field selection
July 2019	Finalize Study Design with field location and site locations
August 2019	Purchase monitoring equipment
October 2019	Initial installation of monitoring equipment, begin data collection, begin weekly quality control checking of data
November 2019	Collect soil samples
April 2020	Temporary removal of equipment before planting and re-installation following planting
June 2020	Prepare and submit Year 1 Data Summary Report
YEAR 2	
October 2020	Temporary removal of equipment before harvest and re-installation following harvest
November 2020	Collect soil samples
April 2021	Temporary removal of equipment before planting and re-installation following planting
June 2021	Prepare and submit Year 2 Data Summary Report
YEAR 3	
October 2021	Temporary removal of equipment before harvest and re-installation following harvest
November 2021	Collect soil samples
April 2022	Temporary removal of equipment before planting and re-installation following planting
May 2022	Final removal of equipment
June 2022	Prepare and submit Year 3 Data Summary Report
June 2023	Complete data analysis and submit Study Report
July 2019 – June 2022	Conduct outreach activities throughout life of project

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 Cover Crop Study Project is being conducted by multiple NRDs in cooperation with state and federal agencies. The LLNRD is a participating agency for this proposed project and applicant to the Water Sustainability Fund (WSF). The CPNRD is a project partner and is providing funding. Other public and private partners will collaborate to ensure the success of this project. Partners include Natural Resources Conservation Service (NRCS), Klein Sales and Service, and private agricultural producers (landowners). Maintaining

favorable relationships with landowners of the selected fields will be imperative throughout the duration of the study as the landowners will need to be cooperative partners in the project. The LLNRD, CPNRD, and the local NRCS office will identify potential producers with suitable fields who are willing to participate in this study. The NRCS will also provide technical guidance/support and supplemental data collection. The remote data collection system (Irromesh) is an innovative approach; therefore, Klein Sales and Service will provide a discount on equipment purchase and provide a limited amount of additional technical and outreach support that Klein Sales and Services can provide as a no-cost, in-kind service. Letters of Support are provided in Supplemental Information Attachment C.

Funding opportunities have been sought through both the NRCS Conservation Collaboration Grant (CCG) and The Nebraska Environmental Trust (NET) in Fiscal Year 2018. The Cover Crop Impact Study was not recommended for funding through either opportunity. Detailed information regarding these funding opportunity losses are summarized in the rejection letters provided in Supplemental Information Attachment D.

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 is $420,000 with 59.5% intended to be funded from the Water Sustainability Fund (WSF) and 40.5% from project partners with funding confirmed from each partner. The funding partners are shown in Table D-2. Except for those listed in Table D-2, there are no other funding sources at this time and hence, the study will not commence if Water Sustainability Funds are not obtained.

To efficiently and effectively complete this project, the LLNRD and CPNRD are proposing to use in-kind services by staff from the NRD's as part of the local match requirement to complete the field implementation, analysis and reporting, and the public outreach. Table D-3 demonstrates the cost-savings to the fund by the use of the in-kind services. If the use of in-kind services is denied, the NRD's will move forward with the project and use cash to replace the $100,000 identified for in-kind services.

Table D-2. Funding Matrix				
Project Partner	**2019-2020**	**2020-2021**	**2021-2022**	**Total**
Water Sustainability Fund	$108,200.00	$63,900.00	$77,900.00	$250,000.00
LLNRD	$29,700.00	$21,650.00	$32,150.00	$83,500.00
CPNRD	$29,700.00	$21,650.00	$32,150.00	$83,500.00
Klein Sales and Service	$3,000.00	$0.00	$0.00	$3,000.00
	$170,600.00	$107,200.00	$142,200.00	$420,000.00

Table D-3. Cost Savings to the Fund by use of In-Kind Services					
		NRD Staff		**Consultant**	
	Estimated Hours	**Hourly Rate (including benefits)**	**Total**	**Hourly Rate (including benefits)**	**Total**
Field Implementation	1,600.0	$34.50	$55,200.00	$64.00	$102,400.00
Data Analysis and Reporting	515.9	$34.50	$17,800.00	$64.00	$33,020.29
Public Outreach	500.0	$34.50	$17,250.00	$64.00	$32,000.00
	234.4	$41.60	$9,750.00	$96.00	$22,500.00
			$100,000.00		$189,920.29
				Cost Savings to the Fund	$89,920.29

5. Support/Opposition

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

Full support for this project is available from the LLNRD and CPNRD and their Board of Directors. We have letters of support from Craig Derickson, the Nebraska NRCS State Conservationist, Bryce Bauer, NRCS District Conservationist, and Klein Sales and Service included in Supplemental Information Attachment C. There is no identified opposition to the study, as the overall goal is to simply gain a better understanding of the relationship between cover crops and groundwater quantity in the region. Additionally, this study would help with long-term groundwater management and soil moisture availability. The NRDs and NRCS are already cost-sharing and promoting the implementation of cover crops, and this study would serve to maximize the benefits of local use, groundwater management, and in identifying the varying relationships of crop management methods and groundwater quantity.

TECHNICAL MEMORANDUM
LITERATURE REVIEW

IMPACT OF COVER CROPS ON SOIL MOISTURE AND NITRATES

FOR

LOWER LOUP NATURAL RESOURCES DISTRICT

AND THE

CENTRAL PLATTE NATURAL RESOURCES DISTIRCT

Prepared by:

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August 2017

EA Project No. 6320401

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APPENDIX

1. INTRODUCTION

Purpose

This literature review was prepared by EA Engineering, Science, & Technology, Inc., PBC (EA) as part of the Cover Crop Study on behalf of the Lower Loup and Central Platte Natural Resource Districts. This Technical Memorandum summarizes the results of the literature review, identifies data gaps in literature, and provides recommendations for the Cover Crop Study Design.

Cover crops have been promoted in Nebraska for various reasons including:

- Improvement of soil health through increased biological and microbial activity
- Improvement of soil organic matter
- Improvements in crop yields
- Best management practice for water quality improvement
- Best management practice for reducing soil erosion.

While the above reasons present many obvious benefits to the addition of cover cropping system to an existing crop rotation, there is growing concern if there is a clear understanding of the potential impacts of cover crops on surface and ground water quantity. Several areas of concern include:

- How much water is used by the cover crop?
- How much surface evaporation is reduced by the cover crop?
- How much nitrogen is trapped by the cover crop and kept from leaching to groundwater?
- Are groundwater recharge rates increased or decreased when using cover crops?
- How much is runoff reduced and soil moisture increased by using a cover crop?

Rainfall in Nebraska varies from greater than 34 inches in the south-east corner of the state to less than 16 inches in the northwest corner of the state. It seems reasonable that the impacts of cover crops would be heavily influenced on the rainfall, temperature, typical growing season and typical crop rotations that are used. Different management scenarios could alter the impact of cover crop implementation to mitigate or offset any perceived negative impacts.

The potential impact of cover crops on additional crop water use is very important to the Lower Loup and Central Platte Natural Resource Districts and the State of Nebraska because of their responsibilities of managing ground water levels and surface water flows. The NRDs have decided to focus the Cover Crop Study on the impacts of cover crops on soil moisture, recharge, and nitrate transport.

The purpose of this literature review it to summarize existing research and examine the range of impacts that the implementation of a cover cropping system under various management strategies have on leaching of nitrogen below the root zone, soil water balance, evapotranspiration, infiltration runoff and groundwater recharge.

Organization
The first step of the literature review was to complete a literature screening to compile a list of potentially related literature sources, organize the sources by topic, and rank each source according to its applicability to the project. The literature screening is attached to the memorandum as Appendix A.

The second step was to review the articles and summarize the key points of the most relevant literature sources. These summaries are provided in the following sections, organized by topic.

2. GENERAL DISCUSSION OF COVER CROPS

2.1. Reference Number CC 1

Johnson, T.J., T.C. Kasper, K.A. Kohler, S.J. Corak, and S.D. Logsdon. Oat and Rye Overseeded into Soybeans as fall cover crops in the Upper Midwest. Journal of Soil and Water Conservation. 53(3):276-279.

Key points:

- Corn grain yields following soybean with an overseeded oat cover crop were not significantly reduced.
- Rye and oat-rye cover crops significantly reduced corn yield compared to no cover and the oat cover crop by an average of 25 bushels per acre.
- Field measurements show that the yield reduction was not the result of lower soil water content in the rye cover crop.
- Overseeding a cover crop into soybean in mid-August was more effective over post-harvest planting of cover crops.
- Overseeded cover crop plants will produce more dry matter in the fall than those planted after harvest because of a longer growing season.
- An oat cover crop has several major advantages over rye. It will winter-kill so it eliminates the need for herbicide treatment in the spring, seed is inexpensive and will produce as much shoot dry matter as rye in the fall but does not decrease the next year's corn yield.

3. INTERACTION BETWEEN COVER CROPS AND NITROGEN BALANCE

3.1. Reference Number N 1

Dabney, S.M., J.A. Delgado, J.J. Meisinger, H.H Schombe, M.A. Liebig, T. Kaspar, J. Mitchell, and W. Reeves, 2010. Using cover crops and cropping systems for nitrogen management. Chapter 9 In: J.A. Delgado and R.E. Follett (eds.), Advances in Nitrogen Management for Water Quality. Soil and Water Conservation Society, 424 pp.

- Cover crops conserve nitrogen (N) by converting mobile nitrate-nitrogen into immobile plant protein and by providing timely competition to other nitrogen cycle loss processes, such as leaching or denitrification.
- Fine-tuning nitrogen fertilizer management probably will not reduce nitrate losses

to acceptable levels without other management practices like cover crops.

- Substantial nitrate losses to drainage water or deep percolation occur between maturity and emergence of corn and soybean crops so losses occur during the fall, winter, and early spring when the corn and soybean crops are not taking up water and nutrients.
- Winter cover crops have the potential to increase uptake of nitrate and water during this period in the Midwestern Corn Belt.
- The potential growing season for winter cover crops between harvest and planting of corn and soybean is short and cold and the soil is frozen for some of the time.
- When a small grain winter cover crop is successfully established and moderate growth occurs, it can substantially reduce nitrate nitrogen losses to drainage water or deep percolation in a corn-soybean rotation.
- Cover crops may reduce corn yields by reducing inorganic nitrogen levels in the spring, or if soil water is not replenished before it is needed by the following grain crop or because of allelopathy or a rotation effect.
- Several studies have shown that killing the small grain cover crop two to three weeks before corn planting eliminated the yield reduction
- The estimated total nitrogen uptake for winter cover rye grown in the sandy loam areas was 179 kg ha^{-1} (160 lbs./ac) and the total uptake for loamy sand way 91 kg ha^{-1} (81 lbs./ac).
- Winter cover crops can recover the nitrate nitrogen previously leached from shallower rooted crops and significantly reduce nitrate nitrogen leaching in the following crop while mining nitrate-nitrogen from groundwater.
- Cover crop management varies by region and cropping systems. Benefits are frequently maximized by adopting conservation tillage systems that retain cover crop residues on the soil surface to improve water infiltration.

4. COVER CROP EFFECT ON NITROGEN LEACHING

4.1. Reference Number NL 6

Ball Coelho, B.R., R.C. Roy, and A.J. Bruin. 2005 Long-term effects of late summer overseeding of winter rye on corn grain yield and nitrogen balance. Canadian Journal of Plant Science. 85:543-554

- Residual nitrogen left after harvest and susceptible to spring leaching was significantly reduced using a rye cover crop. A rye cover crop in a no-till rotation reduced residual nitrogen more than the same cover in a conventional tillage system.
- Cover crops influence yield through improvements in soil physical properties. Using cover crops and conventional tillage methods, water holding capacity was increased and resulted in wetter soil even when the rye was actively taking up water. Using cover crops and no till, stability of soil aggregates was increased. Yield improvement could be due to less restricted crop root growth.
- Greater yield with cover cropping may also be due to timely release of nitrogen from cover crop residues.
- Reduction of nitrate leaching due to rye cover crops was greater when the

potential for loss was greater (at higher fertilization rates).

- Long-term groundwater trends confirm initial finding in both the soil solution (below the root zone) and deep soil, that overseeding reduces nitrate movement to groundwater.

4.2. Reference Number NL 11

Kasper, T.C., D.B. Jaynes, T.B. Parkin, and T.B. Moorman. 2007. Rye Cover Crop and Gamagrass Strip Effects on NO_3 Concentration and Load In Tile Drainage. Journal of environmental Quality 36: 1503-1511.

- A reason that fertilizer management alone does not solve nitrate leaching is because most losses to drainage water or deep percolation occur during the fall, winter, and spring when the corn and soybean crops are not taking up water and nutrients.
- A rye cover crop treatment significantly reduced the average annual flow-weighted nitrate concentration of drainage water by 50% or more compared with no cover crop in a 4-year study.
- Annual flow weighted nitrate concentration of the cover crop treatment was below 10 mg N L^{-1}.
- Cover Crops reduced the nitrate load of drainage water from its uptake of soil nitrogen.
- A rye winter cover crop grown after corn and soybeans has the potential to significantly reduce the nitrate loads and concentrations of drainage water delivered to surface water by subsurface drainage systems.
- A 4-year average of flow-weighted nitrate reductions in concentration of 59% and a load reduction 61% were recorded.

4.3. Reference Number NL 14

Meisinger, J.J., and W.L. Hargrove, R.B. Mikkelsen, J.R. Williams, and V.W. Benson. 1991. Effect of Cover Crops on Groundwater Quality. In: W.L. Hargrove (ed), Cover Crops for Clean Water. Soil and Water Conservation Society. 57-58

- The fall and winter period often coincides with high soil nitrate levels resulting from residual fertilizer nitrogen or from the fall mineralization of soil organic matter and crop residues.
- Winter cover crops can influence nitrate leaching and ground-water quality by influencing the water budget, and affecting the soil nitrate content.
- A winter cover crop producing 2000 pounds of dry matter per acre still uses about 2.5 inches of water.
- Cover crops can affect the water budget by reducing surface runoff that will increase infiltration and increase the likelihood of leaching.
- The net effect of ET reducing potential percolation and ground cover increasing potential percolation depends on site-specific factors, such as cover crop dry matter, degree of soil cover, soil infiltration rate, and rainfall intensity.
- Winter cover crops can directly affect groundwater quality by reducing the quantity of soil nitrate available for leaching. The only practical method to reduce nitrate leaching is to reduce the size of the soil nitrate pool entering the winter

recharge season.

- The root system of a cover crop should be given careful consideration because a deep-rooted cover with a high root density will offer the greatest chance for nitrate capture.
- A cover crop with little fall growth but much spring growth is not likely to effectively reduce nitrate leaching because it cannot affect the water budget and nitrogen uptake until after the nitrate has leached into the groundwater.
- The impact of winter cover crops on water quality will be site-specific and will depend on the site's winter rainfall and temperature, the water holding capacity and hydraulic properties of the soil, the soil organic matter and crop residues, and the application time and rate of previous nitrogen additions.
- Average annual results of a 20-year EPIC simulation estimates that cover crops used in a continuous corn rotation at Grand Island, Nebraska reduce nitrate nitrogen concentrations in a range from 25% to 38% depending on soils and cover crop type.

4.4. Reference Number NL 15

Rasse, D.P., J.T. Ritchie, W.R. Peterson, J. Wei, and A.J.M. Smucker. 2000. Rye cover crop and nitrogen fertilization effects on nitrate leaching in inbred maize fields. Journal of Environmental Quality. 29:298-304.

- At fertilization rates of 202 kg N ha^{-1} (180 pounds nitrogen per acre), substantial nitrate leaching to ground water was observed. At this fertilization rate, interseeding a rye cover crop substantially reduced nitrate leaching.
- Fertilization rates of 101 kg nitrogen ha^{-1} showed little reduction of leaching of nitrate because little nitrogen was left to be removed at this fertilization rate

4.5. Reference Number NL 16

Strock, J.S., P.M. Porter, and M.P. Russelle. 2004. Cover cropping to reduce nitrate loss through subsurface drainage in the northern U.S. Corn Belt. Journal of Environmental Quality. 33:1010-1016.

- Cropping system with a rye cover crop following corn showed no yield disadvantage following corn showed no yield disadvantage for the subsequent soybean crop.
- Cover cropping with cereal rye significantly reduced drainage discharge. This would suggest the potential for a decrease in recharge due to cover cropping if no tile drainage was present, as is typically the case in the study area.
- Based on a 3-year average, a cropping system with a rye cover crop reduced subsurface drainage discharge by 11% and nitrate nitrogen loss in a subsurface drainage discharge by 13%.

5. COVER CROP EFFECT ON SOIL WATER BALANCE

5.1. Reference Number SWB 3

Mitchell, J.P., D.W. Peters, and C. Shenan. 1999. Changes in soil water storage in winter fallowed and cover crop soils. Journal of Sustainable Agriculture. 15:19-31.

- Soil water measurements were collected from 15 cm (6 inches) to 210 (83 inches) cm through the winter cover crop growing season October through March.
- Biomass production of the barley and barley/vetch mixes averaged 9000 – 1100 kg/ha (8000 to 9800 lbs./ac).
- Soil moisture was reduced by 7.2 cm (2.8 inches).
- Not likely that any drainage beyond the 210 cm (83 inches) occurred.
- Nitrogen content of the above ground cover crop ranges from 155 – 194 kg/ha (138 to 172 lbs./ac) using barley and 202 to 246 kg/ha (180 – 2019 lbs./ac) using a barley-vetch mix.
- Depletions in stored soil water are small under cover crops such as barley and vetch that are grown as winter cover crops.

5.2. Reference Number SWB 4

Andrea D. Basche, Thomas C. Kaspar, Sotirios V. Archontoulis, Dan B. Jaynes, Thomas J. Sauer, Timothy B. Parkin, Fernando E. Miguez, 2016. Soil water improvements with the long-term use of a winter rye cover crop. Agricultural Water Management 172(2016) 40-50.

- The cover crop did use a measurable amount of water in the spring, but rainfall usually replenished soil water levels after cover crop termination.
- Cover crop water use in this location (Boone County IA) has been estimated to be between 20-60 mm (.8-1.6 inches) by simulation models where soil evaporation is predicted to be reduced by a cover crop between 2 and 18%.
- During the summer period, there were higher mean values of soil water moisture for individual days evaluated at lower depths in the soil profile (15-30 cm) in the cover crop plots.
- In general, there were higher daily soil moisture levels at 15-30 cm depths of the soil profile later in the summer growing season. This could be from reduced soil evaporation because of increased residue cover or could indicate that the long-term use of the cover crop has increased the porosity of the field.
- The cover crop treatment significantly increased the water content at field capacity by 10.9% and 10.0% relative to the no cover crop treatment at the 0-15 cm and 15-30 cm depths, respectively.

6. COVER CROP EFFECT ON EVAPOTRANPIRATION

6.1. Reference Number SWET 2

Sharma, V., S. Irmak, V. Sharma, K Djaman, and L. Odhiambo, 2017. Soil-water dynamics, evapotranspiration, and crop coefficients of cover-crop mixtures in seed maize

cover-crop rotation fields. I: Soil-water dynamics and evapotranspiration. J. Irrig. Drain Eng. 143(9):04017032.

- There is extremely limited data and information existing in the literature of water use of cover crops, especially in the Midwestern United States.
- Results indicated that cover crops did not have a positive or negative impact on reducing or increasing evaporative losses when incorporated as a rotational crop in this study.
- Because cover crop's evapotranspiration and soil water storage are highly site-specific and are influenced by factors such as cover crop species, cover-crop management practices, and climatic conditions of the site, it is expected that the values reported in this study will vary substantially in other locations.

6.2. Reference Number SWET 3

Sharma, V., and S. Irmak, 2017. Soil-water dynamics, evapotranspiration, and crop coefficients of cover-crop mixtures in seed maize cover-crop rotation fields. II: Grass-reference and alfalfa reference single (normal) and basal crop coefficients. J. Irrig. Drain Eng. 143(9):04017033

- Water management is a function of cover crops that can vary substantially with climatic conditions.
- Only a few studies have been reported on ET rates for cover crop mixtures in the United States and globally, and virtually no data or information exists for the Midwestern states.

6.3. Reference Number SWET 5

Nielsen, D.C., D.J. Lyon, G.W. Hergert, R.K. Higgins, F.J. Calderon, and M.F. Vigil. 2015. Cover crop mixtures do not use water differently than single-species plantings. Agronomy Journal. 107(3):1025-1038.

- In semi-arid environment cover crops will use valuable, limited soil water supplies that may influence the available water at planting of the following crop and consequently its yield.
- In this study, cover crop water use was found to be 1.78 times greater than evaporative water loss from the no-till fall treatment with proso millet residue.

7. COVER CROP EFFECT ON INFILTRATION AND RUNOFF

7.1. Reference Number SWIR 2

Kasper, T.C., J.K. Radke, and J.M Laflen, 2001. Small grain cover crops and wheel traffic effects on infiltration, runoff, and erosion. Journal of Soil and Water Conservation. 56:169-164.

- Cover crops increased infiltration and reduced runoff in only one of the three years in the study.
- Wheel traffic compaction had a more dramatic effect on infiltration and runoff than the cover crop treatment.

- Oat and rye cover crops reduced both interrill and rill erosion in some years.
- Residue cover following no-till soybeans without cover crops was usually greater than 74%, cover crops did not significantly increase residue cover.

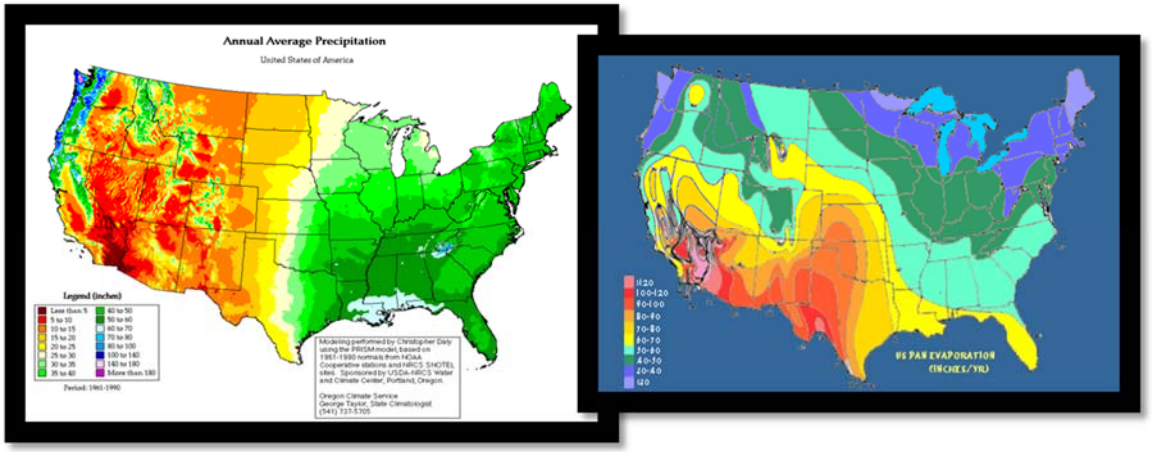
7.2. Reference Number SWIR 4

Zhu, J.C., C.J. Gantzer, S.H. Anderson, E.E. Alberts, and P.R. Beuselinck, 1989. Runoff, soil, and dissolved nutrient losses from no-till soybean with winter cover crops. Soil Sci. Soc. Am. J. 53:1210-1214.

- Cover crop treatments reduced annual runoff from 30% to 36% as compared to the check in one year of the study and by 56% to 79% in subsequent years of the study.
- Soil loss from cover crops was decreased by 92% compared to the check.
- Winter cover crops increased average soil cover by 31% to 40% in comparison to the no-till check.
- Both runoff and soil loss were significantly correlated with the degree of soil cover.
- Nutrient losses were decreased by 74% to 77% for nitrate nitrogen, by 35% to 41% for ammonium, and by 7% to 63% for phosphates from the cover crop treatments due to runoff volume reduction.
- Soil and dissolved nutrient losses from no-till soybean can be reduced by using a winter cover crop.
- Average soybean yields were reduced using a cover crop in this study.

8. DISCUSSION

The problem with reviewing literature on the impact of cover crops is sorting out the varied results that come about because of differences in local climate and soil conditions. In Nebraska, annual rainfall changes as one moves from east to west and potential evapotranspiration rates vary greatly across the U.S. Growing seasons are longer or shorter and the soil water holding capacities change with the soil type.



Simply stated, what works in one place won't necessarily work the same in another. Another consideration is that no single conservation practices stands alone. Adding additional conservation practices modify or complement the impacts of the installed practices. Conservations systems with multiple conservation practices may provide greater impacts than the sum of the impacts from each single practice.

Some of the literature compares the impact of no till vs. conventional tillage using cover crop or no cover crops. Are increases in infiltration rates the results of the use of no-till or the addition of cover crops or a combination both?

Cover crops do use some water, but the ET of the cover crop may not be much different than evaporation from bare soil. This will obviously be different compared to evaporation from residue covered soil and will vary due to differences in weather.

The management of the cover crop plays an important role in the impact of the practice. The species of cover crop, how and when is it planted, how and when it is terminated, all interact to determine its final impact.

Many of the reviewed sources focused on the impact of cover crops within the root zone and at the soil surface. It is well documented that there is a cost of additional soil moisture use on cover crops in the drier areas of the county.

9. DATA GAP

In the following areas, the body of work was found to be limited or absent:

- The impact of cover crops on groundwater recharge.
- Effects of increased infiltrations rates due to cover crops compared to amount of water consumed by the cover crop
- The impact of cover crops in no-till systems versus conventional till systems.

10. CONCLUSIONS

Based on the results of the literature review, the following conclusions are presented:

- In general, a cover crop that is broadcast seeded in mid-August has the opportunity to be actively taking up nutrient when nutrients are still available in the root zone and to sequester them until the following year.
- Cover crops terminated at least 2 weeks prior to planting have less chance in reducing the yield of the primary crop where soil moisture can't be replaced by irrigation.
- The use of no-till will compliment a cover cropping system to:
    - Increase soil moisture holding capacity of the soil;
    - Better capture the reduced runoff and increase infiltration rates;

- Increases in soil water holding capacity and increased infiltration rates could

offset the water consumed by the cover crop.

- The reduction in nitrogen escaping below the root zone could, in time, result in measurable improvements in ground water.
- The results of the studies are not universally applicable to different areas of the country because of differences in the precipitation, temperature, length of growing season and soils.
- Interpretations based on locally collected data will be more accurate when used in local modeling leading to better information for making management decisions.
- Study design need to minimize variables due to management, soils, irrigation and conservation practices to directly compare cover crop to non-cover crop in similar conditions.
- Data from vadose zone should be collected to determine the long-term impact of the use of cover crops on ground water quantity and nitrate sequestration.
- Data from local studies on the impact of cover crops is needed to make decisions based on local conditions.
- Variable weather within the study area impacted the results of all of the studies.

Appendix A

Impact of Cover Crops on Nitrate Leaching and Soil Water Balance

Literature Sources Compiled by Dean E. Eisenhauer, P.E.

July 21, 2017
v.2 August 10, 2017

Nomenclature

Paper Numbering Prefixes

CC – General discussion of cover crops
N – General discussion of the interaction between cover crops and nitrogen balance
NL - Cover crop effect on nitrogen leaching
SWB - Cover crop effect on soil water balance
SWET - Cover crop effect on evapotranspiration
SWIR - Cover crop effect on infiltration and runoff
VZ – Vadose zone sampling

Scoring

A – very applicable to project
B – likely applicable to project
C – less applicable to project because of differences in climate, soils, cropping systems, etc.

Ref. No.	Citation	Notes	Score
CC 1	Johnson, T.J., T.C. Kasper, K.A. Kohler, S.J. Corak, and S.D. Logsdon. Journal of Soil and Water Conservation. 53(3):276-279.	Overview of cereal cover crop options in central Iowa and impacts on the subsequent economic crop yields.	A
CC 2	Journal of Soil and Water Conservation, Special issue on cover crops. 1998. 53(3)	Several papers to consider including those already cited.	C

CC 3	Delgado, J.A., M.A. Dillon, R.T. Sparks, and S. Y.C. Essah. 2007. A decade of advances in cover crops with limited irrigation water can increase yields, crop quality, and nutrient and water use efficiencies while protecting the environment. Journal of Soil and Water Conservation: 62:110A-117A	Review of research and application of cover crops in San Luis Valley, Colorado.	B
N 1	Dabney, S.M., J.A. Delgado, J.J. Meisinger, H.H Schombe, M.A. Liebig, T. Kaspar, J. Mitchell, and W. Reeves, 2010. Using cover crops and cropping systems for nitrogen management. Chapter 9 In: J.A. Delgado and R.E. Follett (eds.), Advances in Nitrogen Management for Water Quality. Soil and Water Conservation Society, 424 pp.	A good literature overview of the role of cover crops as catch crops and as green manure crops (nitrogen fixation). Includes discussion of regional considerations across U.S. including irrigated regions.	A
N 2	Wagger, M.G., M.L. Cabrera, and N.N. Ranells. 1998. Nitrogen and carbon cycling in relation to cover crop residue quality. Journal of Soil and Water Conservation. 53(3): 214-218.	General discussion of the role of cover crops on nutrient cycling. I believe the data that is presented is from the eastern U.S.	C
N 3	Karlen, D.L. and J.W. Doran, 1991. Cover crop management effects on soybean and corn growth and nitrogen dynamics in an on-farm study. American Journal of Alternative Agriculture. 6:71-82.	On-farm trials of nitrogen uptake in corn and soybean near Boone, IA.	C
NL 1	Staver, K.W. and R.B. Brinsfield. 1998. Using cereal grain winter cover crops to reduce groundwater nitrate contamination in the mid-Atlantic coastal plain. Journal of Soil and Water Conservation. 53(3):230-240.	Research shows positive effect of winter cereals on catching nitrogen and reducing nitrate leaching.	B

NL 2	Delgado, J.A., 1998. Sequential NLEAP simulations to examine effect of early and late planted winter cover crops on nitrogen dynamics. Journal of Soil and Water Conservation. 53(3):241-244.	Use of the simulation model NLEAP to show the impact of cover crops on leaching and nitrogen use efficiency for vegetable production in Colorado. Statistical analysis didn't seem to support conclusions.	C
NL 3	Wyland, L.J., L.E. Jackson, W.E. Chaney, K. Klonsky, S.T. Koike, and B. Kimple, 1996. Winter cover crops in a vegetable cropping system: Impacts on nitrate leaching, soil water, crop yield, pests, and management costs. Agriculture, Ecosystems and Environment. 59:1-17.	Cover crops significantly reduced leaching from broccoli production fields in California.	B
NL 4	McCracken, D.V., M.S. Smith, J.H. Grove, C.T. MacKown, and R.L Blevins, 1994. Nitrate leaching as influenced by cover cropping and nitrogen source. Soil Science Society of America J. 58:1276-1483.	Study in Kentucky with corn production. Cover crops show significant reduction in nitrate leaching.	B
NL 5	Brandi-Dohrn, F.M., R.P. Dick, M. Hess, S. M. Kauffman, D.D. Hamphill Jr., and J.S. Selker. 1997. Nitrate leaching under cereal rye cover crop. J. Environ. Qual. 26:181-188.	Study from Oregon with sweet corn and broccoli followed by winder cover crop. Significant reduction in leaching.	B
NL 6	Ball Coelho, B.R., R.C. Roy, and A.J. Bruin. 2005. Long-term effects of late summer overseeding of winter rye on corn grain yield and nitrogen balance. Canadian Journal of Plant Science. 85:543-554.	Canadian study on sandy soils. Good long-term study. Mass of leaching not quantified but impacts of leaching inferred by soil water samples	A
NL 7	Ball Coelho, B.R. and R.C. Roy, 1997. Overseeding rye into corn reduces NO3 leaching and increases yields. Can. J. Soil Sci. 77: 443–451	Earlier part of study discussed in NL 6.	B

NL 8	Delgado, J.A., R.R. Riggenbach, R.T. Sparks, M.A. Dillon, L.M. Kawanabe, and R.J. Ristau. 2001a. Evaluation of nitrate-nitrogen transport in a potato-barley rotation. Soil Science Society of America Journal. 65:878-883.	NLEAP simulation study	B
NL 9	Dinnes, D.L., D.L. Karlen, D.B. Jaynes, T.C. Kaspar, J.L. Hatfield, T.S. Colvin, and C.A. Cambardella, 2002. Nitrogen management strategies to reduce nitrate leaching in tile-drained Midwestern soils. Agronomy Journal. 94:153-171.	Good overview of nitrogen management to reduce leaching including a short section on cover crops.	C
NL 10	Francis, G.S., K.M. Bartley, and F.J. Tabley. 1998. The effect of winter cover crop management on nitrate leaching losses and crop growth. Journal of Agricultural Sciences. 131:299-308.	New Zealand study. Contains impacts of cover crops on mass losses of nitrogen	B
NL 11	Kasper, T.C., D.B. Jaynes, T.B. Parkin, and T.B. Moorman. 2007. Rye cover crop and gamagrass strip effects on NO_3 concentration and load in tile drainage. Journal of Environmental Quality 36:1503-1511.	Corn and soybean study of leaching. Has mass flux of both nitrogen and water.	A
NL 12	Kladivko, E.J., J.R. Frankenberger, D.B. Jaynes, D.W. Meek, B.J. Jenkinson, and N.R. Fausey. 2004. Nitrate leaching to subsurface drains as affected by drain spacing and changes in crop production system. Journal of Environmental Quality. 33(5):1803-1813.	Tile drainage study. Includes effects of cover crops on nitrogen leaching.	B

NL 13	Ritter, W.F., R.W. Scarborough, and A.E. M Chirnside. 1998. Winter cover crops as a best management practice for reducing nitrogen leaching. Journal of Contaminant Hydrology. 34:1-15.	Has leaching mass flux which should also include deep percolation.	B
NL 14	Meisinger, J.J., and W.L. Hargrove, R.B. Mikkelsen, J.R. Williams, and V.W. Benson. 1991. Effect of cover crops on groundwater quality. In: W.L. Hargrove (ed), Cover Crops for Clean Water. Soil and Water Conservation Society. 57-68.	Review of literature on cover crops effect on leaching and percolation.	A
NL 15	Rasse, D.P., J.T. Ritchie, W.R. Peterson, J. Wei, and A.J.M. Smucker. 2000. Rye cover crop and nitrogen fertilization effects on nitrate leaching in inbred maize fields. Journal of Environmental Quality. 29:298-304.	Lysimeter study in Michigan where leaching effects of cover crops were measured.	A
NL 16	Strock, J.S., P.M. Porter, and M.P. Russelle. 2004. Cover cropping to reduce nitrate loss through subsurface drainage in the northern U.S. Corn Belt. Journal of Environmental Quality. 33:1010-1016.	Drainage study in southern Minnesota. Corn production. Both water percolation and nitrogen leaching were measured.	A
SWB 1	Unger, P.W. and M.F. Vigil, 1998. Cover crops effects on soil water relationships. Journal of Soil and Water Conservation. 53(3):200-207.	Discussion of the role of cover crops on soil water content. Indicates higher ET with cover crops can lead to lower soil water and subsequent lower yields of economic crop with dryland in semi-arid regions.	B
SWB 2	Clark, A.J., A.M. Decker J.J. Meisinger, and M.S. McIntosh. 1997b. Kill date of vetch, rye, and vetch-rye mixture: II. Soil moisture and corn yield. Agonomy Journal 89:434-444	Includes soil water data as affected by cover crops for study on Coastal Plain in Maryland.	C
SWB 3	Mitchell, J.P., D.W. Peters, and C. Shenan. 1999. Changes in soil water storage in winter fallowed and cover crop soils. Journal of Sustainable Agriculture. 15:19-31.	California study. Good soil water balance data.	A

SWB 4	Basche, A.D., T.C. Kasper, S.V. Archontoulis, D.B. Jaynes, T. J. Sauer, T.B. Parkin, and F.E. Miguez. 2016. Soil water improvements with the long-term use of a winter rye cover crop. Agricultural Water Management. 172:40-50.	Long-term cover crop study (13 years) in central Iowa. Soil water content lower at end of cover crop growing season for cover cropped treatment but precipitation equalized soil water in all treatment prior to planting of economic crop.	A
SWET 1	Prueger, J.H., J.L. Hatfield, and T.J. Sauer. Surface energy balance partitioning over rye and oats cover crops in central Iowa. Journal of Soil and Water Conservation. 53(3):263-268.	Evaporation measurements during dormant season in Iowa. Shows reduction in evaporation with cover crop.	B
SWET 2	Sharma, V., S. Irmak, V. Sharma, K Djaman, and L. Odhiambo, 2017. Soil-water dynamics, evapotranspiration, and crop coefficients of cover-crop mixtures in seed maize cover-crop rotation fields. I: Soil-water dynamics and evapotranspiration. J. Irrig. Drain Eng. 143(9):04017032.	Eastern Nebraska seed corn study. Data for cover crop growing season presented.	A
SWET 3	Sharma, V., and S. Irmak, 2017. Soil-water dynamics, evapotranspiration, and crop coefficients of cover-crop mixtures in seed maize cover-crop rotation fields. II: Grass-reference and alfalfa reference single (normal) and basal crop coefficients. J. Irrig. Drain Eng. 143(9):04017033	Eastern Nebraska seed corn study. Crop coefficient data presented.	A
SWET 4	Bodner, G., W. Loiskandl, and H.-P. Kaul, 2007. Cover crop evapotranspiration under semi-arid conditions using FAO dual crop coefficient method with water stress compensation. Agricultural Water Management. 93:85-98.	Study in Austria. Showed increase in soil water depletion with cover crops.	B

SWET 5	Nielsen, D.C., D.J. Lyon, G.W. Hergert, R.K. Higgins, F.J. Calderon, and M.F. Vigil. 2015. Cover crop mixtures do not use water differently than single-species plantings. Agronomy Journal. 107(3):1025-1038.	Western Nebraska and Eastern Colorado study, semi-arid climate. Compares ET of both dryland and irrigated and multi-species and single species cover crops with fallow.	A
SWIR 1	Dabney, S.M. 1998. Cover crop impacts on watershed hydrology. Journal of Soil and Water Conservation. 53(3): 207-213.	Paper discusses impacts of cover crops on runoff and the impact of scale, plot vs. watershed, on the observed impact. Data is from humid southeastern U.S.	B
SWIR 2	Kasper, T.C., J.K. Radke, and J.M Laflen, 2001. Small grain cover crops and wheel traffic effects on infiltration, runoff, and erosion. Journal of Soil and Water Conservation. 56:169-164.	Useful data on infiltration rate and runoff are presented.	A
SWIR 3	Folorunso, O.A., D.E. Rolston, T. Prichard, and D.T. Loui. 1992. Soil surface strength and infiltration rate as affected by winter cover crops. Soil Technology. 5(3):189-197.	Central California simulated rainfall study showing no effect of cover crop on infiltration at one site but at a second site, infiltration was increased and runoff reduced by cover crops.	B
SWIR 4	Zhu, J.C., C.J. Gantzer, S.H. Anderson, E.E. Alberts, and P.R. Beuselinck, 1989. Runoff, soil, and dissolved nutrient losses from no-till soybean with winter cover crops. Soil Sci. Soc. Am. J. 53:1210-1214.	Runoff studies in Missouri. Plot runoff reduced by cover crops.	A
SWIR 5	Kleinman, P.J. A. , P. Salon, A.N. Sharpley, and L.S. Saporito. 2005. Effect of cover crops established at time of corn planting on phosphorus runoff from soils before and after dairy manure application. Journal of Soil and Water Conservation. 60(6):311-322.	Cover crop system developed for dairy farms in New York to reduce nutrient runoff. Had significant reduction in water runoff volumes due to cover crops.	B

VZ 1	EA, 2015. Vadose Zone Assessment Report in Support of the Little Blue River Basin Water Management Plan. Report prepared for Little Blue and Tri-Basin Natural Resources Districts. April, 2015.	Includes methodology for assessing nitrate-nitrogen movement in the intermediate vadose zone.	B
VZ 2	Republican River Compact Settlement Conservation Committee. 2014. Republican River Basin Impacts of Non-Federal Reservoirs and Land Terracing on Basin Water Supplies. Final Report. June, 2014. Available at http://www.republicanrivercompact.org/misc/20140716_ConservationStudy.pdf	Includes methodology for documenting water movement in the intermediate vadose zone.	B

STUDY DESIGN

IMPACT OF COVER CROPS ON SOIL MOISTURE AND NITRATES

FOR

LOWER LOUP NATURAL RESOURCES DISTRICT

AND THE

CENTRAL PLATTE NATURAL RESOURCES DISTIRCT

Prepared by:

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September 2017

EA Project No. 6320401

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Appendices

1. INTRODUCTION

The Lower Loup Natural Resources District (LLNRD) and the Central Platte Natural Resources District (CPNRD) has contracted EA Engineering, Science, and Technology, Inc., PBC (EA) to research the effects of cover crop management practices within various soil types within the Lower Loup Basin and Central Platte River Basin. The project objective is to design and implement a study to evaluate the effects of cover crops on both water quantity and water quality. The study will evaluate the influence of cover crops, under selected cover crop management practices, on soil moisture, groundwater recharge, and nitrate leaching.

The study area for this project is the Loup and Central Platte River Basins, more specifically, the area between the South Loup River and Wood River that has experienced groundwater declines (Figure 1, page 2). The study areas include regions within both the LLNRD and the CPNRD. This is a cooperative project between the NRDs, with LLNRD as the lead entity.

The LLNRD is in central Nebraska and includes all or portions of Rock, Loup, Garfield, Wheeler, Boone, Platte, Custer, Valley, Greeley, Nance, Sherman, Howard, Butler, Hall, Merrick, and Buffalo counties and covers approximately 5,088,565 acres. Land use in the LLNRD consists of 67 percent range, pasture and grasslands; 19 percent irrigated crops; 10 percent dryland crops; 2 percent forested area; 1 percent open water and wetlands and 1 percent roads and urbanized areas (LLNRD, 2012).

The CPNRD is the southern neighbor to the LLNRD in central Nebraska and contains all or portions of Buffalo, Custer, Dawson, Frontier, Hall, Hamilton, Howard, Merrick, Nance, Platte, and Polk counties and covers approximately 2,136,304 acres. There are approximately 1,028,044 acres of irrigated crops in the CPNRD, of which, 936,554 acres are groundwater; 14,315 acres are surface water and 77,175 acres are co-mingled use (groundwater and surface water). The land use consists of 49 percent cropland, 39 percent rangeland/pasture, three percent wetlands, one percent forest, and the remaining eight percent is grouped as other land uses, including other minor cover, urban/residential development, streams and other water, and transportation (CPNRD, 2011).

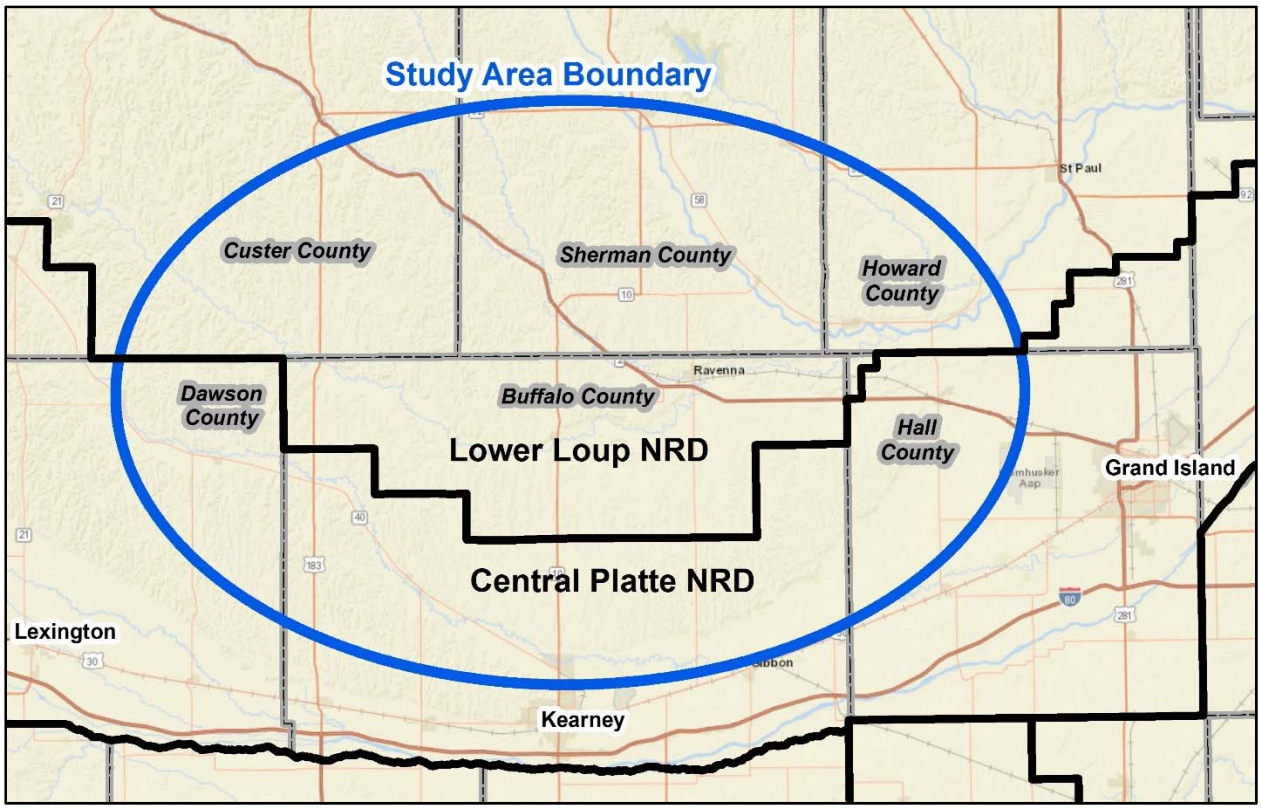
This study design outlines the field locations, data collection methods, data analysis, and study report.

1.1. Background and Purpose

The LLRND and CPNRD are charged with managing groundwater quantity and quality within their boundaries. The purpose of this project is to assist the NRDs in understanding the impacts on groundwater due to the implementation of cover crops. The Lower Loup Basin and Central Platte River Basin have diverse soil type and cropping practices that can affect both water quantity and water quality. The utilization of cover crops has been promoted as being a conservation practice, that when implemented, will improve water quality and soil health.

A Literature Review was conducted for this project. There is considerable research showing the impact of cover crops on crop yields and improvement to soil health, but there is limited information that quantifies the impact of cover crops on groundwater recharge (EA, 2017).

Figure 1. Study Area



The objective of this project is to develop and implement a scientifically defensible and practical study design that will increase the understanding of the general influence of cover crops on soil moisture, groundwater recharge, and movement of nitrate vertically through and below the root zone.

A better understanding of these impacts would assist the NRDs with the following:

- Make informed management decisions regarding promotion of cover crop management programs based on quantifiable results;
- Allow for adjustments of existing models to more accurately simulate the long-term impacts of the utilization of cover crops;
- Establish a baseline for impacts of common cover crop management practices to evaluate future changes in cover crop management practices.

1.2. Overview of Data Collection Activities

The following provides an overview of data collection activities:

- The study period for field data collection will be three years.
- A total of four (4) fields will be included in the study. Each field will be approximately half cover crop and half without cover crop.
- Each field will consist of eight (8) sites for data collection. Four (4) sites will be in the cover crop area and four (4) sites will be in the area without cover crop.
- Data from other sources will be gathered during the study period.
- The study is structured to easily expand to additional fields, if additional funding becomes available.

Field data collection consists of two primary elements: continuous soil monitoring and soil sample collection. Continuous soil monitoring includes the following components:

- Moisture sensors at multiple depths
- Soil surface temperature sensors
- Rainfall measurement
- Remote data acquisition and transmission
- Initial installation of equipment
- Maintenance and temporary removal of equipment
- Final removal of equipment.

Soil sample collection includes the following components:

- Collection of multiple soil samples to a total depth of 15 feet
- Sample collection and laboratory analysis for nitrate in soils
- Sample collection and laboratory analysis for soil moisture content
- Coordination with NRCS for supplemental data collection in the field (such as soil health).

2. FIELD SELECTION

The process for selection of the four fields to be included in the study will be important for success of the study. The entire selection process will be closely coordinated with the LLNRD and CPNRD and will include consultation with the local NRCS office. Maintaining favorable relationships with landowners of the selected fields will be imperative throughout the duration of the study as the landowners will need to be cooperative partners in the project. The LLNRD, CPNRD, and the local NRCS office will identify potential producers with suitable fields who are willing to participate in this study.

The following are key factors for selection of fields:

- The fields need to be located within the study area boundary and to the extent possible clustered close together to maximize field work efficiency.
- The fields need to be representative of the type of cover cropping system that the Districts are most interested in and that is typical throughout the study area.
- The fields need to be representative of soil types in the region. GIS will be used to summarize soil types by land use.
- The landowner of the field needs to be willing to participate in the study and willing to commit to the full three-year duration of the study. The landowner/operator needs to have control of the site for the duration of the study and the authority to sign an agreement (see Appendix A).
- The landowner needs to be able to manage the cover crop and regular crops, as needed for the study. It will be beneficial if the landowner has previous experience managing cover crops in the vicinity.
- The study will include both dryland and irrigated fields. Ideally, two fields will be irrigated and two fields will be dryland. Pivot corners may be considered if suitable dryland fields are difficult to find.
- The target size for fields is approximately 120 to 160 acres.

It is recognized that there are a significant number of potential variables in cover crop management. Additional considerations will be made on field selection to minimize the number of variables, focus the study, and provide useful results. Field selection will consider the cropping and tillage system, the number of years the field has been in the current tillage and cropping system, soils, slope, type of irrigation system, suitability of the field for the data collection equipment, and accessibility.

A matrix will be used to rank the suitability of the field for the project to ensure that the best fields are selected for the project (see Appendix B).

Once selected, the final field locations will be included in Appendix C.

3. SOIL MOISTURE VIA MOISTURE SENSORS

3.1. Equipment

The data collection equipment for this project will be purchased by EA on behalf of the LLNRD and CPNRD, and the NRDs will be the owner of this equipment. EA will be responsible for replacement of equipment that is damaged due to negligence by an EA employee. The NRDs will be responsible for replacement of equipment that is damaged due to acts of nature, vandalism, or other causes.

3.2. Selection of Sample Sites Within the Selected Field

Sites for the installation of sampling equipment will be selected by:

- Reviewing the field to ensure that the cover cropped sites and non-cover cropped sites have similar soils, slope and exposure.
- Have reasonable access to install and maintain the equipment.
- Receive a cell phone signal so the cellular gateway will function.

The site selected within the field will be reviewed with the respective NRD and the local NRCS office to gather any field specific information that would have an impact on the suitability of the site for data collection.

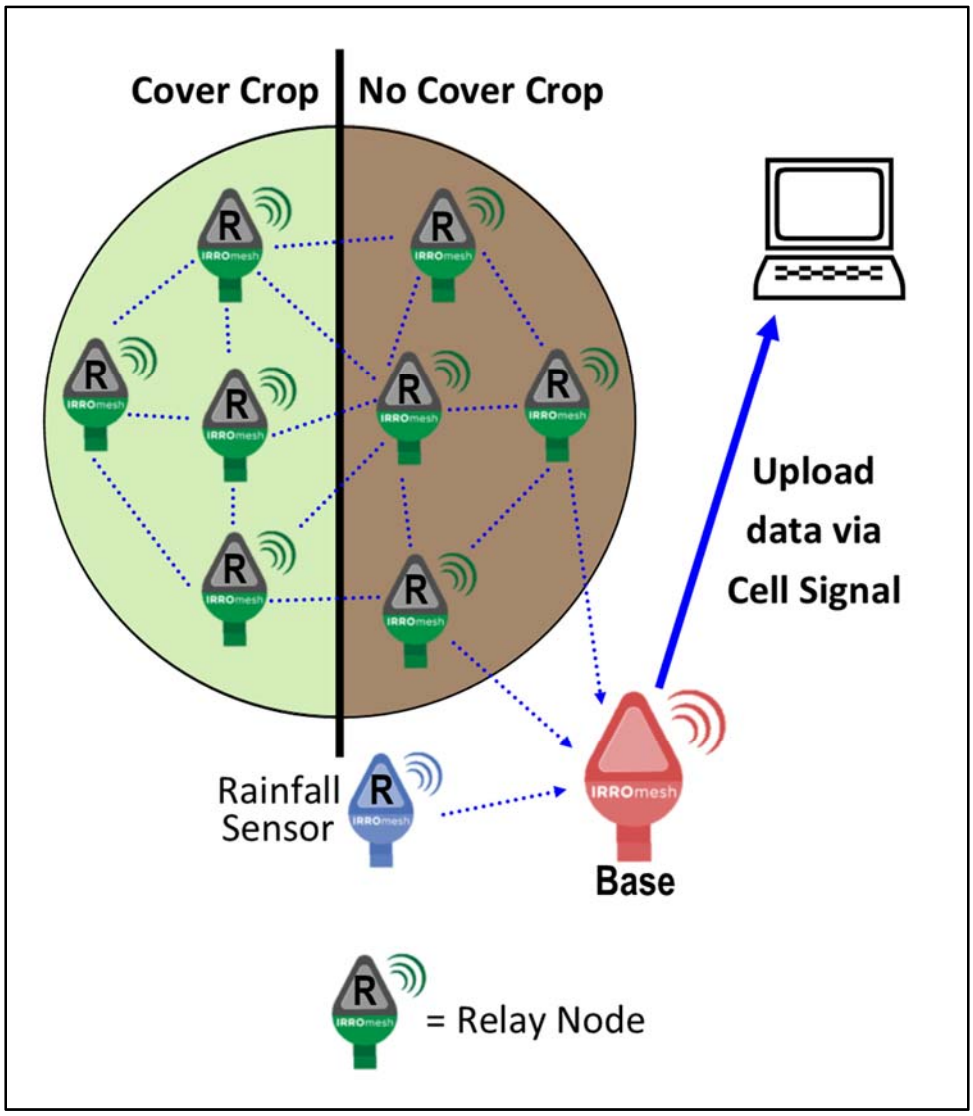
Four fields will be selected within the study area. Monitoring equipment will be installed at 8 sites within each field as shown in Figure 2 (page 6)

Considerations will be made to ensure the installation of the data collection equipment will fit into the producers' cropping operations and that it is installed to allow it to be removed or placed out of the way to accommodate the producers' planting and harvesting operations.

The data collected with be analyzed to compare the impact of cover crops versus no cover crops on soil moisture content, soil moisture movement through the soil profile, and soil surface temperature.

The typical layout shown in Figure 2 (page 6) represents the ideal situation, which may need to be modified depending on the availability of fields and the willingness of producers to participate in the study.

Figure 2. Typical Layout for Monitoring Equipment



3.3. Equipment Set Up

Paired monitoring sites utilizing Watermark Sensors will be installed within the selected fields to track soil moisture levels through the entire year. Soil surface temperatures will be tracked at the selected sites within each field via an Irromesh wireless system that will record three Watermark Sensors and one temperature sensor per field location. The Irromesh system will transmit the field data to a base station located near the field. A rainfall sensor will be located near the base station and connected to and additional relay node. The base will upload the collected data to a website where the data is stored and available to be retrieved. Data collection will continue for the duration of the study.

Table 1. Equipment Details

Mfg./Part No.	Component	Quantity	Sites	Total
Irrometer 975NR	Relay Node	9	4	36
Irrometer 975B	Base	1	4	4
Irrometer 975G-BP	Cellular Gateway	1	4	4
Irrometer 200-SS-15	Watermark Sensor @ 3 per node	24	4	96
Irrometer 900RG	Rain Sensor	1	4	4
Irrometer 200TS	Temperature Sensor	8	4	32

In addition to this list provided in Table 1, a subscription service will be required for each Cellular Gateway, and other miscellaneous items will be required for the final field installation.

3.4. Methods and Procedures

Paired monitoring sites utilizing Watermark Sensors will be installed within selected fields to track soil moisture levels through the entire year.

The sensors will be installed at 18, 72, and 84 inches deep. The sensors installed at 72 inches and 84 inches will track movement of soil moisture between the root zone and the vadose zone. The soil temperature sensor will be installed at a depth of 1-2 inches below ground surface. The rainfall sensor will be placed outside the field, beside the base stations, in an open area.

The sensors will be installed to minimize the impact on the producer during planning and harvesting situations and minimize the time involved in setting up and taking down the above ground components.

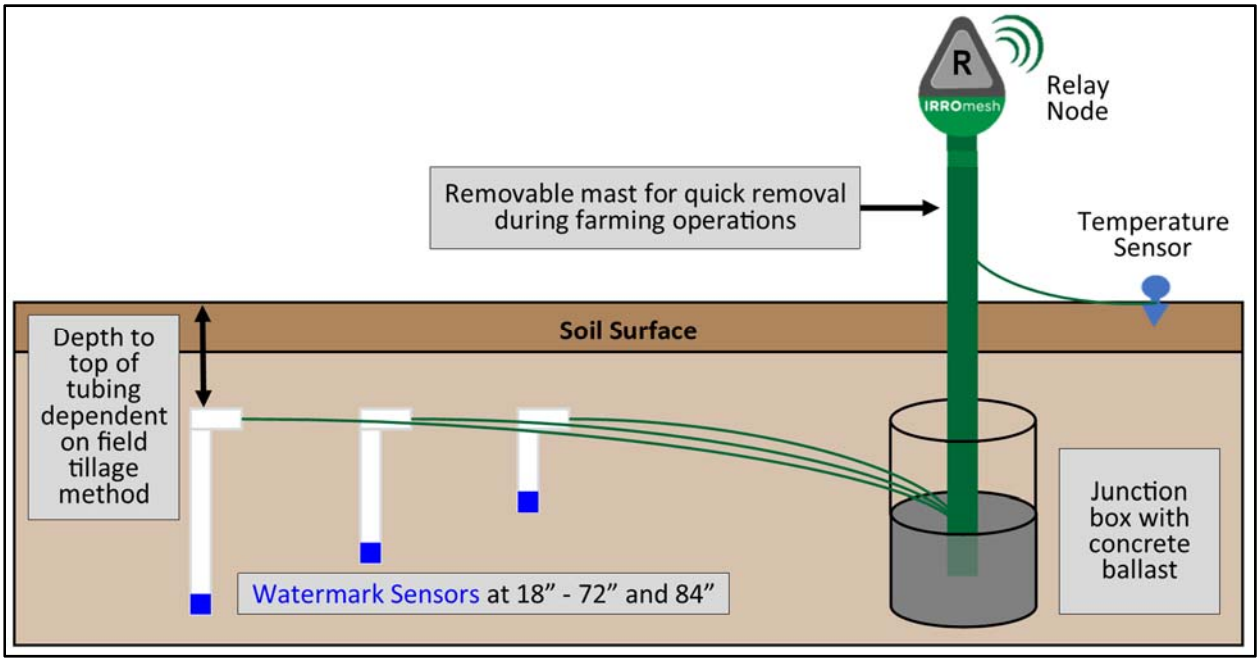
The watermark sensors and the wiring will be permanently installed for the term of the study and will be installed entirely below the soil surface (Figure 3, page 8). The wires from the sensor will be routed through conduit to a junction box (plastic 5-gallon bucket) and the wiring then routed up through a removeable mast to the relay node. The relay node will transmit the data to the base and be sent via wireless signal to a server where the data can be retrieved remotely.

The mast will be the only above ground component and can be removed for farming operations. The relay node must be above the crop canopy so it can transmit, by line of sight, to another

relay node or the base. The relay node must be below the lowest points below center pivot support members. The height of the removeable mast will be adjustable to accommodate different types of crops. When the mast is removed for farming operations, the soil temperature sensor will also be removed because it is installed at a shallow depth, near the soil surface.

Soil moisture and soil surface temperatures will be tracked at the selected sites within each field via an Irromesh wireless system that will record three Watermark Sensors and one temperature sensor per field location. The Irromesh system will transmit the field data to a base station located near the field. The base will upload the collected data to a website where the data is stored and available to be retrieved weekly. The data collection will continue for the duration of the study.

Figure 3. Monitoring Equipment Installation Details



Soil moisture percentage, soil surface temperature, and rainfall will be recorded for each site so soil moisture conditions can be compared for cropping systems with and without cover crops.

Local weather station data will also be reviewed and compared to the on-site rainfall sensor results. Sites within a field will be located to minimize likelihood of saturated field conditions due to ponding, high water table, or flooding.

3.5. Data Collection and Distribution

The data will be collected and distributed as follows:

- Data will be accessed, downloaded, and organized weekly via the Irromesh website.
- The data will be reviewed for completeness to ensure all sensors are working.
- Nonfunctioning equipment will be identified. The NRD will be notified and repair or replacement will be scheduled.

- Data will be shared with landowners/operators at the completion of the study. If data sharing is essential for landowners to agree to participation, the NRDs will handle weekly data sharing with landowners.

3.6. Coordination with the LLNRD, CPNRD, and Other Partners

EA will maintain a close working relationship with the LLNRD, CPNRD, and the local NRCS field offices to ensure that the project proceeds smoothly. The following actions will be needed for this to occur:

- The NRD will obtain a signed agreement with the landowner/operator to grant EA access to their property for the purposes of installing, maintaining, inspecting, or moving the installed data collection instruments.
- EA will notify the NRD and the landowner/operator in advance when they plan to access the field sites.
- The landowner/operator will notify EA one week in advance of the need to have the equipment removed for farming operations. This will allow a reasonable time to remove the equipment and not interfere with farming operations.
- The landowner/operator will notify EA a week in advance of activities on the field that may impact the data collection equipment (i.e. harvest, planting, or producer is going to graze crop residues, so the equipment would need to be protected from livestock).

4. SOIL SAMPLE COLLECTION AND ANALYSIS

EA will collect soil samples at each site where a soil moisture sensor is installed to provide information related to the impact of cover crops on soil moisture and nitrate movement below the root zone.

4.1. Soil Sample Locations and Depths

Soil samples will be collected at each site to a depth of 15 feet during fall to measure soil moisture and soil nitrate levels. Each sample will be analyzed to measure the soil moisture content and nitrate levels in 3 ft intervals (0-3 ft, 3-6 ft, 6-9 ft, 9-12 ft, and 12-15 ft).

Soil sampling will be conducted during the fall/winter, following harvest.

4.2. Utility Clearance

Utility clearances will be conducted prior to any drilling or subsurface work by EA. Utility locations will be confirmed by locating manholes, poles, vaults, and other related structures. Two to ten business days prior to drilling and sampling activities, the One-Call System and appropriate utility companies will be contacted to locate buried utilities. Information collected during the utility surveys will be documented.

4.3. Equipment

Shallow soil samples will be collected utilizing a truck-mounted Giddings direct push rig and a nominal 1.5 in ID sample tube. Shallow soil samples will be collected from the root zone (0-3 and 3-6 ft) and three samples from the shallow vadose zone (6-9, 9-12, and 12-15).

4.4. Methods and Procedures

Soil samples will be collected at each site to a depth of 15 ft during fall to measure soil moisture and soil nitrate levels.

The soil samples will be conducted as follows:

- Sampling will be conducted using EA's small, truck-mounted rig with a two-person crew. The crew will consist of one EA staff member and one NRD staff member.
- Shallow soil samples will be collected from the root zone (0-3 and 3-6 ft) and three samples from the shallow vadose zone (6-9, 9-12, and 12-15). Two split spoon samples (3 ft) of soil will be composited for one shallow soil sample.
- Each sample will be analyzed to measure the soil moisture content and nitrate.
- During only the first sampling event, each sample will also be analyzed for soil texture.
- Sampling will be conducted at each of the eight selected sites within each of the four selected fields, with five sample intervals at each sample location. This results in a total of 160 soil samples to be submitted to the laboratory for analysis, plus Quality Assurance/Quality Control (QA/QC) samples.

- The composite soil samples will be homogenized by thoroughly mixing retrieved soil from each sampling interval in a large rubber container. The composite sample will be comprised of several sub-samples randomly collected from the rubber container.
- Each composite sample will be place into two separate containers. One container will be a regular soil bag for nitrate and soil texture analysis. The second container will be a zip lock bag to be used for soil moisture analysis. Once collected, samples will be placed in coolers and keep out of direct sunlight to avoid condensation.
- An example field sheet for shallow boring locations is found in Appendix D. Data specific to each location will be recorded on field sheets. Three photos will be taken at each site: one at eye level standing at the base node and looking at the relay nodes, one at eye level standing at the relay nodes and looking at the base node, and one from 10 feet north of the base, looking directly down at the site to document cover crop conditions.
- Sample location coordinates will be documented by EA using a sub-meter GPS following the first sampling event. Surface elevation will not be recorded.
- QA/QC procedures will include duplicate samples at a rate of one QA/QC sample per 20 samples collected (5%). Duplicate soil samples will be given a discrete number within the composite depth the duplicate was taken.

4.5. Sample Handling Procedures

The soil sample bag will be labeled with the following information:

- Client: LLNRD
- Field Number
- Site Number
- Sample ID: will consist of the of the SS + Field Number + Site number + Sample depth range (i.e. 3 for 0-3 ft, and 15 for 12-15 ft)
- Sampler's Name
- Date
- Sample Time

All soil samples will be stored in a cooler during active field sampling. Ambient air temperatures during sampling (late fall, winter) will be sufficient for cooling preservation of all samples. Samples shall be kept out of direct sunlight for extended periods to avoid condensation in in the sampling containers

A Chain-of-Custody (CoC) will be completed by EA during active soil sampling and will be current with the samples at all times.

Soil samples will be delivered to Ward Laboratories, Inc. on a weekly basis. Soil samples will be shipped to:

Ward Laboratories
4007 Cherry Avenue
Kearney, NE 68848
800-887-0788

4.6. Analytical Procedure

Samples will be analyzed using the following laboratory techniques:

- Nitrate: Method 4500-NO_3 from Standard Methods of Water and Wastewater
- Soil Moisture: Method 21-2.2.2 from Soil Society Science of America (SSSA)
- Soil Texture: Method 15-5 from SSSA

4.7. Coordination with the LLNRD, CPNRD, and Other Partners

Coordination activities will be the same as previously described under Section 3.6.

5. DATA FROM OTHER SOURCES

Data from other sources will be used to aid in the selection of fields and sites and to help interpret results.

5.1. Collection and Utilization of Existing Data

The collection of existing data will include, but will not be limited to:

- LIDAR – LLNRD and CPNRD or USDA Geospatial Gateway
- Soils information – USDA Geospatial Gateway and Web Soil Survey
- Topographic maps –USDA Geospatial Gateway
- Land use maps – LLNRD, CPNRD, NASS
- Rainfall maps – High Plain Climate Center
- Pan evaporation maps – High Plains Climate Center
- Weather Station data – High Plains Climate Center

6. REPORTING

Reports will be provided to the LLNRD and the CPNRD to track the progress of the project.

6.1. Annual Data Summary Reports

A brief field summary report will be prepared to document methods and compile results. The field summary report will only include a limited evaluation of measurements and sampling results to address the quality of the data, data gaps, and make recommendations for any revisions or adjustments in the methods and procedures for data collection during the next year.

A separate field summary report will be prepared for each year of data collection. A full analysis of the data will be completed and documented in the study report.

6.2. Study Report

The study report will contain the following information:

- Introduction
- Materials and Methods
- Results
- Discussion
- Conclusions

7. STUDY SCHEDULE

The following is a summary of the tentative schedule for the entire study:

- Study Design and Grants
  - Complete Literature Review — August 2017
  - Draft Study Plan — August 2017
  - Submit Grant Application for NET — September 2017
  - Notification of funding from NET — January 2018
  - Identify and Select Fields — March 2018
  - Finalize Agreements with Landowners — April 2018
  - Final Study Plan — May 2018
- Grant Year 1 (July 1 – June 30)
  - Purchase Monitoring Equipment — August 2018
  - Install Monitoring Equipment — October 2018
  - Collect Initial Soil Samples — November 2018
  - Move Equipment for Planting — April 2019
- Grant Year 2
  - Move Equipment for Harvest — October 2019
  - Collect Soil Samples/Reinstall Equipment — November 2019
  - Annual Data Summary Report — January 2020
  - Move Equipment for Planting — April 2020
- Grant Year 3
  - Move Equipment for Harvest — October 2020
  - Collect Soil Samples/Reinstall Equipment — November 2020
  - Annual Data Summary Report — January 2021
  - Move Equipment for Planting — April 2021
- Grant Year 4
  - Remove Equipment for Harvest (Not Reinstalled) — October 2021
  - Collect Soil Samples — November 2021
  - Annual Data Summary Report — January 2022
  - Submit Draft Study Report — May 2022
  - Submit Final Study Report — June 2022

If the Nebraska Environmental Trust does not award an extension for the fourth grant year, the study schedule will be shortened to three years.

8. REFERENCES

EA Engineering, Science & Technology, Inc. (EA). 2017. *Technical Memorandum Literature Review: Impact of Cover Crops on Soil Moisture and Nitrates for Lower Loup NRD and Central Platte NRD.* August 2017.

Central Platte Natural Resources District (CPNRD). 2011. *CPNRD Master Plan 2011-2021.* March 2011.

Lower Loup Natural Resources District (LLNRD). 2012. *LLNRD Master Plan 2012-2022.* 2012.

Appendix A

Landowner Agreement Forms

LANDOWNER ACCESS & PROJECT AGREEMENT

The Lower Loup Natural Resources District (LLNRD) and the Central Platte Natural Resources District (CPNRD) has contracted EA Engineering, Science, and Technology, Inc., PBC (EA) to research the effects of cover crop management practices within various soil types within the Lower Loup Basin and Central Platte River Basin. The project objective is to design and implement a study to evaluate the effects of cover crops on both water quantity and water quality. The study will evaluate the influence of cover crops, under selected cover crop management practices, on soil moisture, groundwater recharge, and nitrate leaching.

The purpose of this landowner access and project agreement is to allow the LLNRD, CPNRD, and EA to install, maintain, inspect, and move data collection instruments related to the cover crop impact study, as well as collect soil and groundwater samples as needed. The property owner listed below agrees to participate in the study and allow access to the study area for a little more than three years, beginning in _____ (*Month, Year*) and concluding in _____ (*Month, Year*).

The undersigned property representative consents to allow the LLNRD, CPNRD, and EA access to the following property to perform cover crop impact study activities. The property owner will not be held liable for any work or related activities performed as part of the field work/ project activities.

The LLNRD, CPNRD, or EA will give notice to the property owner at least one (1) week in advance of the start of field activities. The property owner will notify the LLNRD or CPNRD at least one (1) week in advance of the start date of farming activities (such as planting, harvest, etc.) that could impact the instruments.

Landowner's Name: _____

Legal Description of Field:

Section _____

Township _____ **Range** _____

County _____

Signature of Landowner or Agent _____

Mailing Address _____

_____

Telephone No. _____ **Date** _____

Return To: EA Engineering, Science, and Technology, Inc., PBC
221 Sun Valley Blvd, Suite D
Lincoln, NE 68528
FAX (402) 476-7825
Office Phone Number (402) 476-3766

Appendix B

Field Selection Matrix

Impact of Cover Crops on Soil Moisture and Nitrates
Field Selection Matrix

Field Selection Matrix	Landowner willing to participate / has control of the site for the next 3 years	Years of Experience Managing Cover Crops	Years in Continuous No-till	Years in No Till	Irrigation Type	Irrigation Source	Tillage Type	Crop Rotation	Predominant Soil Type	Number of nearby fields (less than 5 miles)	Cover Crop Management							
											Cover Crop Type	How is cover crop planted	When is cover crop planted	How is cover crop terminated	When is cover crop terminated	Is cover crop grazed	Is cover crop hayed	Is residue removed from field
Example																		
Field A																		
Field B																		
Field C																		
Field D																		
Field E																		

Critical Factor for Study Participation

Appendix C

Field Location Maps

Appendix will be populated when field selection is made at the onset of the project.

Appendix D

Field Forms

Appendix will be populated when field selection is made at the onset of the project.

LOWER LOUP
NATURAL RESOURCES DISTRICT

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

July 24, 2018

Director Gordon W. Fassett, PE
Nebraska Department of Natural Resources
301 Centennial Mall South, 4th Floor
PO Box 94676
Lincoln, NE 68509-4676

RE: Water Sustainability Fund Application for Cover Crop Impact Study

Dear Director Fassett and Members of the Natural Resources Commission,

This letter is to document our support and financial commitment for the development of the Cover Crop Impact Study. As a project partner, the Lower Loup Natural Resources Districts is submitting this Water Sustainability Fund Grant Application to develop a Cover Crop Impact Study.

A declining groundwater trend has been identified in the southern portion of the District. To effectivity manage groundwater for long term sustainability, the NRD needs to have a more in-depth understanding of the impacts that best management practices have on water supplies. This proposed study would utilize soil moisture sensors at multiple depths of a period of 3 years to determine water availability impacts on fields with cover crops versus those without.

As General Manager for the Lower Loup Natural Resources District, I am authorized to commitment financial resources in support of this application. The Lower Loup Natural Resources District will commit $83,500 in both local financial support and in-kind services for the proposal. These dollars, combined with the commitment from the Central Platte NRD, will provide a total cost-share of $167,000 for the proposal (41%).

We urge the Nebraska Natural Resources Commission to recognize the importance and need for support and funding.

Sincerely,

Russell Callan
General Manager
Lower Loup Natural Resources District

CPNRD
CENTRAL PLATTE
NATURAL RESOURCES DISTRICT

215 Kaufman Ave Grand Island NE 68803
T: (308) 385-6282 F: (308) 385-6285
www.cpnrd.org

July 19, 2018

Director Gordon W. Fassett, PE
Nebraska Department of Natural Resources
301 Centennial Mall South, 4th Floor
PO Box 94676
Lincoln, NE 68509-4676

RE: Water Sustainability Fund Application for Cover Crop Impact Study

Dear Director Fassett and Members of the Natural Resources Commission,

This letter is to document our support and financial commitment for the development of the Cover Crop Impact Study. As a project partner, the Lower Loup Natural Resources Districts is submitting this Water Sustainability Fund Grant Application to develop a Cover Crop Impact Study.

A declining groundwater trend has been identified in the southern portion of the Lower Loup Natural Resources District, and extends south into the northern portion of the Central Platte Natural Resources District. To effectivity manage groundwater for long term sustainability, the NRD's need to have a more in-depth understanding of the impacts that best management practices have on water supplies. This proposed study would utilize soil moisture sensors at multiple depths of a period of 3 years to determine water availability impacts on fields with cover crops versus those without.

As General Manager for the Central Platte Natural Resources District, I am authorized to commit financial resources in support of this application. The Central Platte Natural Resources District will commit $83,500 in both local financial support and in-kind services for the proposal. These dollars, combined with the commitment from the Lower Loup Natural Resources District, will provide a total cost-share of $167,000 for the proposal (41%).

We urge the Nebraska Natural Resources Commission to recognize the importance and need for support and funding.

Sincerely,

Lyndon Vogt
General Manager
Central Platte Natural Resources District

United States Department Of Agriculture

USDA NRCS
Natural Resources Conservation Service
Nebraska State Office
Federal Building, Room 152
100 Centennial Mall North
Lincoln, NE 68508-3866
(402) 437-5300 http://www.ne.nrcs.usda.gov

April 6, 2018

Tylr Naprstek
Lower Loup Natural Resources
District 2650 Airport Drive
Ord, NE 68862-3221

Dear Tylr,

The Natural Resources Conservation Service (NRCS) is looking forward to working cooperatively as a project partner with the Lower Loup and Central Platte Natural Resources Districts (NRD) on the proposed Impact of Cover Crops Impact Study. The NRCS supports the concepts and goals of increasing understanding of the impact of cover crops on soil moisture, recharge and nitrate leaching.

The NRCS will provide support for the project in assisting with the screening process in the selection of four fields that will be used in the study. The NRCS will serve as a technical advisor throughout the study and will attend the progress meeting conducted each year to review the data and provide guidance for evaluation. In addition, the NRCS will also conduct pre-and post-soil health assessments of the selected fields and provide the information to the respective Natural Resources District. The soils health assessment results can be used by the NRDs in conjunction with the data collected during the study and be included in the final report.

If you should have any questions, please free to contact James Huntwork, Assistant State Conservationist for Field Operations Central, at 308-392-3514.

Sincerely,

CRAIG DERICKSON
State Conservationist

cc: Dan Bigbee, EA Engineering, Science and Technology, INC., PBC

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
1614 N 28th Street
PO Box 243
Ord, NE 68862

http://www.ne.nrcs.usda.gov

Tylr Naprstek
Assistant Manager
Lower Loup Natural Resources District
2650 Airport Drive
Ord, NE 68862-3221

RE: Cover Crops Impact Study
Lower Loup and Central Platte Natural Resources Districts
Letter of Partnership Collaboration

Dear Tylr,

The Ord Natural Resources Conservation Service (NRCS) Office is looking forward to working cooperatively as a project partner with the Lower Loup and Central Platte Natural Resources Districts (NRD) on the proposed Impact of Cover Crops Impact Study.

The Ord NRCS Field Staff routinely works on projects with the Lower Loup NRD and will provide support for the project by assisting with the screening process in the selection of four fields that will be used in the study. We will also serve as a technical advisor throughout the study and will attend the progress meeting conducted each year to review the data and provide guidance for evaluation. In our regular assistance we will coordinate gathering pre-and post soil health assessments of the selected fields and provide the information to the respective Natural Resources District. The soils health assessment results can be used by the NRDs in conjunction with the data collected during the study and be included in the final report.

Sincerely,

Bryce Bauer
NRCS District Conservationist

Cc: Dan Bigbee, EA Engineering, Science and Technology, Inc., PBC

Klein Sales And Service
12929 N Blvd.
Osceola, NE 68651
402-366-9098
jk9098@gmail.com
www.kleinsales.com

July 20, 2018

Dan Bigbee,
EA Engineering
221 Sun Valley Blvd Suite D
Lincoln, NE 68528

We have been discussing the use of soil moisture sensors in this study. I am a dealer for Irrometer and their WaterMark Sensors.

I will provide the moisture sensing equipment for this study at the discounted prices and will provide a trip to the field to assist in installation set up if needed, and assistance by phone and participate in any or all field day or demonstrations of this moisture sensing equipment that informs the public about the results of the study.

I am eager to help to show producers how soil moisture sensors can help manage their irrigation systems to save water and financially save as well.

Thank you,

Jason Klein

Jason Klein

The Nebraska Environmental Trust

preserving NATURAL NEBRASKA™ for future generations

Pete Ricketts, Governor
Mark A. Brohman, Executive Director

February 9, 2018

Tylr Naprstek
Lower Loup Natural Resources District
2620 Airport Drive
P.O. Box 210
Ord, NE 68862-

RE: **18-110- Cover Crop Impact Study**

Dear Tylr,

The Board of the Nebraska Environmental Trust met on Tuesday, February 6, and received a preliminary set of recommendations for funding in the 2018 grants cycle from the Grants Committee.

The Trust received more than $42 million in funding requests, nearly 2.5 times the available funds. The board was faced with very difficult decisions, choosing among many excellent proposals. Even though your project was found eligible, we regret that your application was not among those recommended for funding in 2018.

Scores are identified in the Rating Results Sheet. The enclosed Rating Results Sheet indicates "optional" points for geographic location. These points are an optional tool for the board to utilize as necessary to ensure a more equal distribution of Trust funds across the state. This year projects located in or partially in District 6 received up to 20 points. All others received zero points for geographic location. The Rating Results Sheet also indicates "optional" points for Feature Program Bonus Points. Thirty-five (35) extra bonus points may be awarded to projects that meet **all** of the extra criteria outlined in the application package, which encourages large-scale collaborative projects with significant environmental impact.

The board is accepting written public comment on these recommendations through Wednesday April 4, 2018. Persons wishing to comment may do so by writing to our office, or may appear in person at a public hearing to be held at 1:30 p.m., on Thursday, April 5, 2018 at the Nebraska Environmental Trust Office, 700 South 16th Street, Lincoln, Nebraska. Following the public hearing the board will vote to award grants. The final approved funding list will be available on our web site after the April 5, 2018 Board meeting.

Thank you for your participation and interest in the Nebraska Environmental Trust Fund. The next application deadline is September 4, 2018 for awards to be made in the spring of 2019. Please feel free to contact us if we can provide further information, materials or assistance.

Sincerely,

Mark A. Brohman
Executive Director

MAB/mt

2018 Rating Results

Application # 18-110
Sponsor Name: Lower Loup Natural Resources District
Project Name: Cover Crop Impact Study

Ratings Statement	Points Available	Average Rating
Advances Trust Priorities	25	**10.83**
Sound Planning and Design	25	**11.67**
Direct Measurable Environmental Benefits	20	**9.33**
Cost-Effective	20	**9.33**
Duration of Benefits	15	**8.00**
Matching (non-state) resources (monetary & in-kind)	15	**5.00**
Prevents Contamination/Degradation of Resources	15	**8.00**
Many people or communities served	15	**7.50**
General public benefit	10	**4.67**
Public/Private Partnerships	10	**5.33**
Economic Impact	10	**5.00**
Evaluation Plan	10	**5.67**
Unique Need	5	**2.67**
Public Health	5	**2.83**
Innovation	5	**3.17**
Replication Potential	5	**2.67**
Individual or Local Initiative	5	**2.83**
Sub-Total		**104.50**
Feature Program Bonus Points (35 available)		
Geographic Distribution (20 points available in District 6)		15
	Grand Total	**119.5**

Recommendation: Committee recommends not funding this application this year due to placement on the rank order list and availability of funds.

Mark A. Brohman

Signed: _____

Mark A. Brohman for Rod Christen, Grants Committee Chair

United States Department Of Agriculture

USDA NRCS

Natural Resources Conservation Service
Nebraska State Office
Federal Building, Room 152
100 Centennial Mall North
Lincoln, NE 68508-3866
(402) 437-5300

http://www.ne.nrcs.usda.gov

RECEIVED JUN 18 2018

June 15, 2018

Tylr Naprstek, Assistant General Manager
Lower Loup Natural Resources District
2620 Airport Drive
Ord, NE 68862-1002

SUBJECT: Funding Opportunity USDA-NRCS-Multi-State-Central-CCG-001, Conservation Collaboration Grants or Agreements Fiscal Year (FY) 2018

Mr. Naprstek:

Thank you for your interest in the above referenced funding opportunity advertised by the Natural Resources Conservation Service (NRCS) in Nebraska. We received several excellent applications for the available funding, but unfortunately your application was not selected for funding.

NRCS Nebraska received nine proposal submissions for this opportunity, with a total federal funding request that exceeded $2.2 million. We were very pleased with the large quantity of proposal submissions and for all the excellent potential partnership opportunities from which to select. Our initial announcement of fund availability indicated there was a total of $1 million available for the awards in Nebraska. However, due to some unforeseen limitations in certain program funds, we were not able to make awards up to the $1 million total through the Conservation Collaboration Grant or Agreement process.

We think there is considerable merit in the strategy proposed in your application to evaluate the impact of cover crops, and therefore we would like to work with you to address this need through our regular Environmental Quality Incentive Program (EQIP) in fiscal year 2019. Possibly we could work together to target producers in certain areas to promote this conservation activity and encourage them to sign up under the EQIP. This would of course be subject to the availability of program funds and the status of the Farm Bill funding. Brad Soncksen, Assistant State Conservationist for Programs, will be your contact for further discussions on this strategy in fiscal year 2019.

Again, I appreciate your organization's interest in this natural resource need and we look forward to your participation in future collaborative conservation projects with NRCS.

Sincerely,

CRAIG DERICKSON
State Conservationist

Cc: Brad Soncksen, Assistant State Conservationist – Programs, Lincoln State Office
James Huntwork, Assistant State Conservationist – Central Area, Grand Island Field Office
Bryce Bauer, District Conservationist, Ord Field Office