1.0 Project Proposal Summary Sheet

Project Title: Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading – project continuation

Project Period: July 1 2012 – June 30 2016

Project Sponsor:
South Dakota State University
Water Resources Institute
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Project Funding:

Budget Category	Amount ($)
NPS Funding Requested	81,662
Match (cash/in-kind)	54,579
Other Federal Funds	0
Total Project Costs	**136,241**

Project type: Planning/Assessment

Project Location:
The outreach and education efforts and the implications of the demonstration project will be statewide. The location of the demonstration site used for the monitoring and forming the basis of the BMP development is indicated in the table below.

Project location	
Watershed	**Lower Big Sioux**
303(d) listed stream	**Yes**
HUCs (8 digit)	**10170203**
County(ies)	**Moody**
Coordinates of project location	**Lat:** 43° 56' 16"; **Long:** 96° 45' 16"

NPS Pollution Source Category:

NPS Pollution Source Categories to be Addressed (percent)			
Agriculture	100	Silviculture	0
AFOs	0	Hydrologic Modification	0
Urban Runoff	0	Construction	0
Resource Extraction	0	Other:	0

NPS Functional Category:

NPS Functional Category (percent)			
BMP Implementation	10	Technical Assistance	5
Information and Education	20	Planning	10
Watershed Assessment	0	Groundwater	10
Water Quality Monitoring	45	Other	0

NPS Pollutants to be Addressed

NPS Functional Category (check all that apply)			
Excess Nitrogen	X	Pesticides	
Excess Phosphorus	X	Oil and Grease	
Sedimentation	X	Temperature	
Pathogens/Bacteria	X	pH	
Metals		Other: Runoff Volume	X
Low dissolved oxygen		Other:	

Project Goals:

The project goals are:

1. Manage the demonstration site using common agricultural practices and monitor runoff quantity and quality,
2. Compare in-field placement of manure during winter spreading to determine which practice that minimizes the impact on water quality and develop BMPs,
3. Assess climatic risk factors using frequency of soil frost and rainfall events impacting runoff and water quality and monitor changes in soil nutrient levels.,
4. Monitor surface runoff and leaching of nitrogen to shallow groundwater from field storage of manure, and
5. Provide education on winter manure spreading BMPs to livestock producers, extension educators, crop advisers, land managers, water quality experts, state regulators, and other stakeholders.

Project Description:

Nutrient, sediment and bacteria loss at the watershed scale will be monitored using flumes at the outlets of each of three small watershed areas. The continuous record of discharge and water quality samples will be used to calculate loads of suspended sediments, nutrients, and *E. coli* loads from each watershed. We will compare different winter manure spreading practices to evaluate the risk of water quality degradation. The information gained will be used to develop management strategies and best management practices that more effectively reduce nutrient, sediment, and bacteria loading to surface water.

2.0 Statement of Need

This proposed demonstration project is a continuation of an ongoing project titled "Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading" funded by the DENR EPA 319 program for the period July 2010 – June 2013. As part of that project, a demonstration and monitoring site for collecting information about the water quality impacts of winter manure spreading has been established and equipped for surface runoff sampling. The site consists of three adjacent watersheds. Because of challenges relating to sampling under adverse weather conditions and dry conditions during the 2012 growing season we have been unable to collect enough information to substantiate the development of best management practices (BMPs) for winter manure spreading. We propose to continue the monitoring of the water quality impacts of winter manure spreading for an additional three years to obtain a better dataset for the BMP development. In addition, we propose to add the following activities: 1) Monitoring of nitrate movement from manure piles to shallow groundwater and 2) Characterization of runoff and erosion behavior in the watershed and in eastern South Dakota using computer modeling.

Project partners directly involved in the project by being represented on the project advisory board include:

- East Dakota Water Development District
- Moody County Conservation District
- South Dakota Cattle Feeders Council of the SD Cattlemen's Association
- South Dakota Department of Environment and Natural Resources (DENR)
- South Dakota Farm Bureau
- USDA Natural Resources Conservation Service (NRCS)

Project collaborators from South Dakota State University (SDSU) include

- Jeppe Kjaersgaard, South Dakota Water Resources Institute
- Dennis Todey, State Climatologist
- Ronald Gelderman, Soil Fertility Extension Specialist
- Larry Wagner, Extension Agronomy Field Specialist

2.1 Demonstrated Water Quality Need

Row crop and livestock production has been identified as two of the leading contributors of surface water impairment in South Dakota (SD DENR, 2012). The 2012 Integrated Report for Surface Water Quality (SD DENR, 2012) indicates that 65% of the approximately 6400 miles of streams assessed to determine the water quality status during the five-year reporting period does not support one or more of their designated uses. SD DENR (2012) further indicates that out of the 137 lakes assessed during the project period 34% did not meet their designated uses.

Fecal coliform bacteria, nutrients, and sediment have been identified as leading sources of water quality impairment (SD DENR, 2012). Fecal coliform bacteria and sediment impact the use of rivers and streams for boating, fishing, swimming, and other recreational uses while high Trophic State Indexes (TSIs) associated with excessive phosphorus loading limits beneficial uses of many lakes. Due to potential impacts on water quality the South Dakota DENR administers rules for land applications of manure through a permit process. The permitting utilizes the provisions established in the South Dakota USDA NRCS Nutrient Management Standard 590. The 590 standard is currently under review and preliminary information from this demonstration project has been included in the review process. The currently proposed 590 standard if adopted

may allow up to 10 percent of annual manure production to be spread in winter months with certain restrictions on placement.

Fecal contamination of water may arise from inefficient sewage treatment plants, leaking septic tanks, agricultural runoff, in-stream livestock access and wildlife. Pathogenic microorganisms introduced into surface water from feces can cause disease in humans and livestock thereby threatening the public health as well as the economic vigor of businesses that depend on water of sufficient quality. Instead of monitoring for the varied and often difficult-to-culture pathogenic microorganisms, detection of fecal pollution indicator microorganisms has been used as a tool for decades to help determine if water has received fecal contamination. Because the State of South Dakota is in the process of switching from using fecal coliforms to *E. coli* as the indicator organism, we will use *E. coli* as the indicator organism in this project.

Livestock production is a major component of the South Dakota economy. Because the importance of livestock production crosses watershed boundaries and affects both the rural and urban population, especially in heavily populated watersheds, the issue of manure management has been the subject of debate in recent years. At the center of this debate is the land application of manure and the possible impacts on the state's water resources as nonpoint source (NPS) discharges of pollutants can be significant, especially where high concentrations of livestock are present if manure is not managed properly.

Having the option of spreading manure on frozen ground is an important management tool for livestock producers since winter spreading of manure reduces the quantity of winter storage needed, provides more flexibility for spreading on cropland and reduces soil compaction problems. While winter spreading of manure is often limited by recommendation, Srininvasan et al. (2006) reported that limitations on the spreading of manure during winter periods were determined largely from perceptions, not scientific data.

Several studies show lower runoff volumes and sediment loss from manured areas compared to non-manured or control areas (Young, 1974; Hensler et al.,1970; Young and Mutchler, 1976; McCaskey et al.,1971 c.f. Khaleel et al, 1980; Meals, 1991) although concentrations of dissolved P in runoff are often higher.

In a recent literature review, Srinivasan et al. (2006) lists several key research and management issues that need to be addressed. They are:

1. Characterization of the changes in the physical and chemical properties of manure under winter conditions as they affect nitrogen (N) and P release rates;
2. Development of strategies and methods that relate the findings of small-scale experiments to large-scale soil, landscape, and climate patterns;
3. Collection of sufficient data to establish the linkages among watershed-scale water quality, winter manure spreading practices, and winter conditions that affect hydrology and erosion processes;
4. Development of empirical model(s) of snowmelt and nutrient transport for use in evaluating current winter spreading practices and developing BMPs; and
5. Development of alternate methods of manure application.

Additional research to evaluate current winter spreading practices and develop best management practices (BMPs) that reduce the water quality impacts of spreading manure on frozen soil is needed. The proposed project is designed to fill some of the knowledge gaps that have been identified in understanding winter manure spreading and impacts on water quality, and to collect data under conditions common to the state. Based on the information gained, tools will be developed to assist livestock producers in making decisions about when and how to apply manure in an environmentally responsible manner.

2.2 Waterbody Information

The proposed project will have statewide implications, and thus, will involve multiple watersheds. The 14 major watersheds in South Dakota are shown in Figure 1. The location of the demonstration site is indicated in section 2.3.

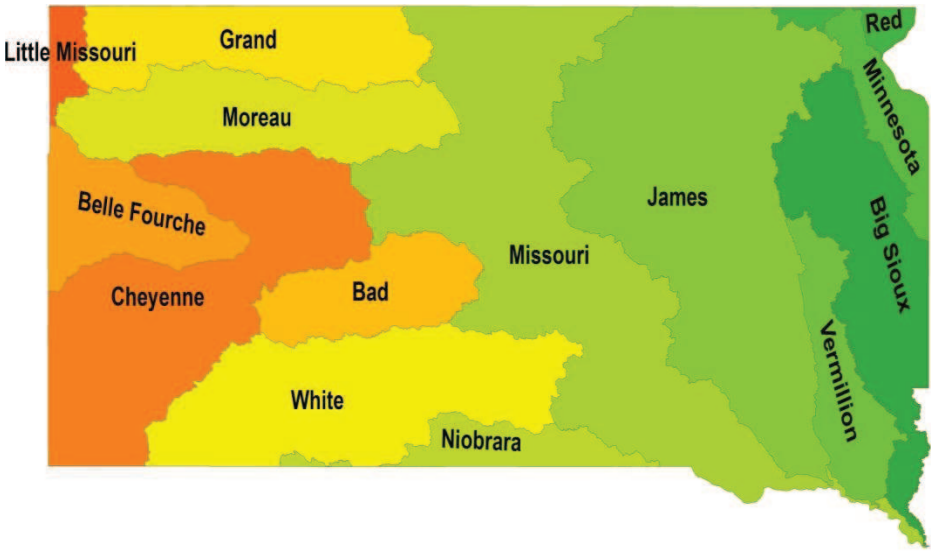

Figure 1. Major South Dakota watersheds. The Big Sioux River Watershed is located in the eastern part of the state.

2.3 Project Map

The location of the demonstration site is in Moody County approximately 8 miles southeast of Colman SD. A map of the project location is shown in Figure 2.

2.4 General Watershed Information

Surface runoff from the demonstration site drains into Bachelor Creek located about a half mile south of the site. Bachelor Creek drains into the Big Sioux River (BSR) about five miles east of the site. The BSR drains part of the *Coteau des Prairies*, a plateau rising above the prairie composed of thick glacial deposits. The glacial drift overlays bedrock and ranges in thickness from a few feet to nearly 200 feet and groundwater levels are typically shallow. The average annual precipitation at the field site is 23 inches, of which three-quarters typically falls during the growing season April through October. The average annual snowfall is 37 inches per year (SDSU Climate Office, 2012).

Figure 2. Location of the demonstration field site.

There are several communities located downstream of the demonstration site including Sioux Falls, the largest city in the state with a population of nearly 154,000. The BSR provides recreational values such as boating and swimming, ecosystem services supporting a large population of fish and wildlife, and public utility services.

3.0 Project Description

3.1 Project Outcomes

The overall objective for this demonstration project is to evaluate the environmental risk of field manure storage and spreading manure during winter conditions and develop BMPs for winter manure spreading that minimize impacts on water quality. The proposed project will assess the relationship that exists between timing and placement of winter spread manure and water quality of field runoff at the watershed scale. This project will provide soil scientists and resource managers with information from which to develop a better understanding of the risks associated with winter spreading practices and the factors governing nutrient and sediment exports from the fields. Based on the information gained, we will identify BMPs that effectively reduce nutrient and sediment loading to surface water resources and contributes to the eutrophication of lakes and streams in the state.

The objective will be attained by reaching the following five outcomes:

1. Manage the demonstration site using common agricultural practices and monitor runoff quantity and quality,
2. Compare in-field placement of manure during winter spreading to determine which practice that minimizes the impact on water quality and develop BMPs,
3. Assess climatic risk factors using frequency of soil frost and rainfall events impacting runoff and water quality and monitor changes in soil nutrient levels.,
4. Monitor surface runoff and leaching of nitrogen to shallow groundwater from field storage of manure, and
5. Provide education on winter manure spreading BMPs to livestock producers, extension educators, crop advisers, land managers, water quality experts, state regulators, and other stakeholders.

3.2 Outcomes, Targets, and Tasks

Outcome 1: Manage the demonstration site using common agricultural practices and monitor runoff quantity and quality.

We will monitor three small watersheds located southeast of Colman, SD. The locations and outlines of the three watersheds are shown in Figure 3. The three watersheds are part of the same field and will be managed using the same agricultural practices. The three watersheds are in a corn – soybean rotation and have the same cropping and management history. Each watershed area contains a drainage area similar in area and slope. Monitoring infrastructure has already been established on a cooperator's property (Mike Schmidt). In the following, these watersheds will be referred to as the "Schmidt Watersheds". The South Dakota Water Resources Institute, Moody County Conservation District, East Dakota Water Development District, South Dakota Farm Bureau, Mike Schmidt, and the USGS 104b program contributed funds to establish the Schmidt Watersheds monitoring installations.

We will use a paired watershed design (Clausen and Spooner, 1993). The paired watershed design is effective for documenting a linkage between land treatment and water quality changes in small watersheds over a relatively short time period. For this project a cluster of 3 watersheds will consist of a control and two treatment watersheds. This study design eliminates the effects of inter-annual climatic variation on water quality. The recommended method of analysis for paired watershed designs is simple analysis of covariance (ANCOVA) on time aggregated data.

Manure will be applied at two of the three watersheds. On the south watershed, manure will applied to the one-half of the watershed located highest in the terrain. On the north watershed, manure will be applied to the one-half of the watershed located lowest in the terrain, Figure 3. ArcGIS software and GPS equipment will used to delineate the median (50%) contour line of each watershed. No manure will be applied to the third watershed (control). The sizes and treatments of the three watersheds are outlined in Table 1.

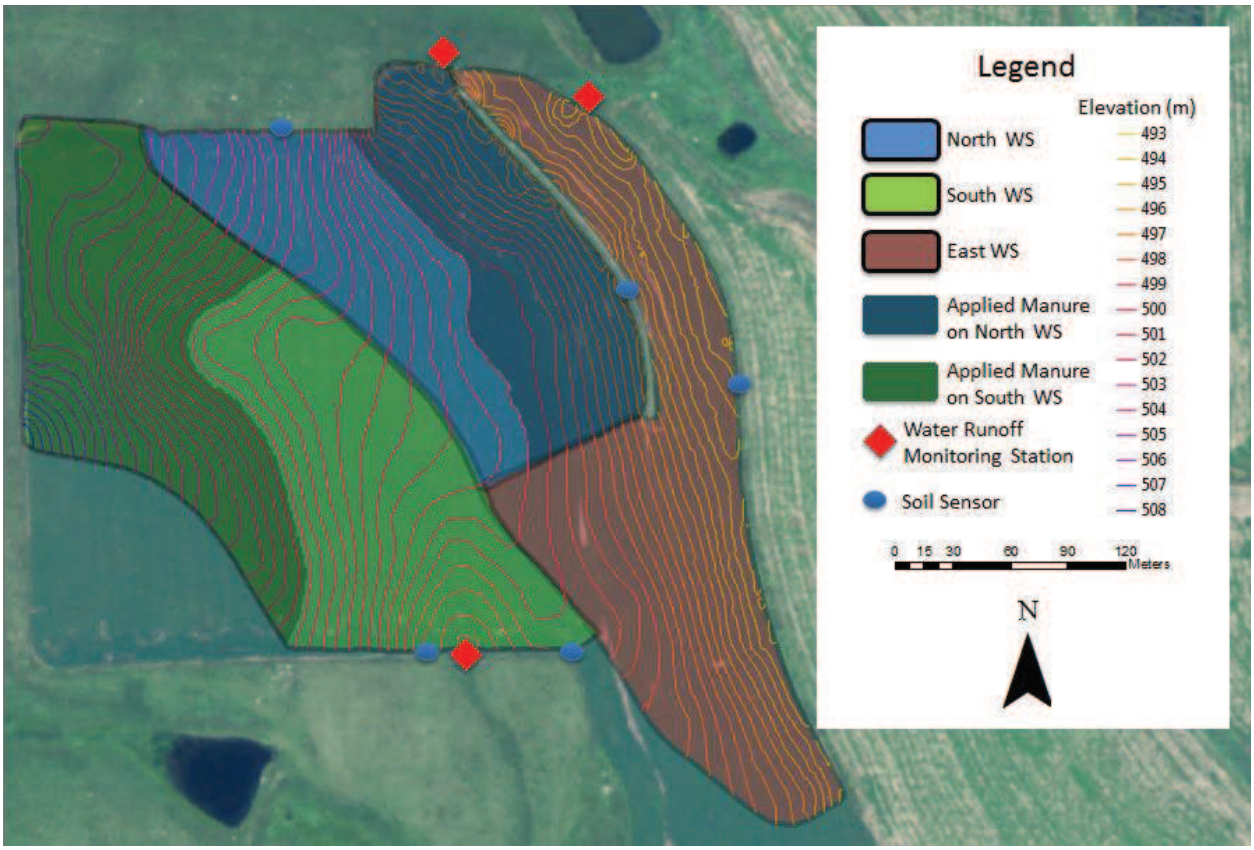

Figure 3. Outline of the three watersheds at the demonstration site. Darker colors within the north and south watersheds indicate areas where manure is being applied.

Table 1. Size and treatment of the three project watersheds.

Watershed	Size (acres)	Treatment
North	6.7	Manure applied on 50% lowest of the watershed
East	6.8	No manure, control
South	10.2	Manure applied on 50% highest of the watershed

We will maintain detailed records of farm activities, such as location and amount of manure spreading, fertilizer used, dates of field operations etc. in order to relate changes in water quality to changes in manure management practices. The south watershed will receive manure in the upper part of the watershed on a Wentworth-Egan complex (WeB) soil type and the north will receive manure in the lower part of the watershed on a Ethan-Egan complex (EtC) soil type. The east watershed will be used as a control (Figure 3).

One H-flume has been installed as a hydrologic control at the discharge location for each of the three watersheds. Each flume is connected to a stilling well equipped with a Stevens Type F stage recorder (Figure 4) to monitor water runoff volumes.

Figure 4. Flume and stage recorder at the outlet of the East watershed during wintertime.

An Isco automated sampler is installed at each flume to collect water samples for lab analysis. Samples will be collected for each half inch change in stage of the water exiting the field through the flume. We will select samples for analysis to describe the rising limb and the falling limb of the hydrograph. For each year of the proposed project, we assume we will have runoff from 6 runoff events caused by snowmelt and/or precipitation.

Water sample bottles will be collected from the automatic samplers as soon as possible following runoff events. Water samples will be stored in polyethylene or polycarbonate bottles at 4°C and transported immediately to the water analysis laboratory. Each sample will be analyzed for nitrate nitrogen (NO_3-N), ammonia-nitrogen (NH_3-N), total Kjeldahl nitrogen (TKN), total phosphorus (TP), total dissolved phosphorus (TDP), total suspended solids (TSS) and *E. coli*. *E. coli* bacteria samples will be collected by grab sample using sterilized sample bottles. Sample analysis will be completed using established procedures (AWWA, 2005).

Game cameras will be used for continuous photographic monitoring of each flume to characterize runoff characteristics during times where project staff is unable to do *in-situ* monitoring.

Task 1: Manage the watersheds and monitor runoff volumes and nutrient, sediment and *E. coli* export from the three watersheds.

Product 1:	Manage the watersheds using normal agricultural practices and monitor the runoff volumes.		
Cost:	319 Funds:	$0	Labor costs are included in the overall budget
	Non-Federal Match:	$10,500	
	Total Product Cost	$10,500	

Product 2:	Collect water samples and analyze runoff for nutrient, sediment, and *E. coli* export from the three watersheds		
Cost:	319 Funds:	$900	Labor costs are included in the overall budget
	Non-Federal Match:	$18,000	
	Total Product Cost	$18,900	

The non-federal match for product 2 is used to cover expenses related to laboratory analysis of water samples.

Outcome 2: Compare in-field placement of manure during winter spreading to determine which practice that minimizes the impact on water quality and develop BMPs.

BMPs are used to reduce environmental risks to an acceptable level. The results of the watershed runoff data coupled with precipitation, temperature and frozen soil data will be used to assess the risks to water quality from the manure management practices under study. The data will be used to provide guidance to producers and policy makers on the impact of their decisions.

Task 2: Quantify water quality impacts from winter manure spreading.

Product 3:	Quantify risks and develop BMPs for winter manure spreading
Cost:	Labor costs are included in the overall budget

Product 4:	Set up and run appropriate model to simulate runoff and sediment transport in the watersheds
Cost:	Labor costs are included in the overall budget

Outcome 3: Assess climatic risk factors using frequency of soil frost and rainfall events impacting runoff and water quality and monitor changes in soil nutrient levels.

Little work has focused on analyzing weather data to determine the occurrence of conditions that may be detrimental to water quality from manure spreading on frozen ground. All economic development, whether agricultural, municipal or industrial, is carried out with the understanding of risks and implementation of policies and rules to minimize risks, especially with regard to

human health and safety. The South Dakota State Climatologist is assessing trends and changes in temperature and precipitation over the region as well as introducing soil moisture measurements to the state. We will utilize historical soil temperature and precipitation data to establish average and ranges of the time of soil freeze-up and the risk of occurrence of rainfall events during seasons. Analysis of historical data for changes/trends in rainfall rates and freezing time of soils will occur with historical data sets. These datasets are necessary to determine what length of time to expect frozen soils in South Dakota and assess the risk of having rainfall or snow melt to produce run-off on frozen soils.

To supplement the runoff data, additional weather and soil data are collected on-site. Each watershed is monitored for soil moisture and soil temperature recorders at three levels 5 cm (2 in.), 20 cm (8 in.) and 50 cm (20 in.). These depths are chosen to measure a near-surface value and a depth value for temperature and moisture.

Several important pieces of information will be gathered from temperature and moisture data, 1) is the soil frozen and 2) to what depth? What are the near-surface and deeper soil moisture conditions in the watershed? The soil moisture and temperature data will be used to establish relationships between snowmelt and rainfall rate and run-off amounts in the watershed. The amount of snowfall and precipitation will help determine the risk of runoff from the test area. Rainfall rates and total rainfall will be determined using standard CoCoRaHS rain gauges and tipping bucket rain gauges at each watershed. The climatological data will used to establish a link between the watershed scale water quality, manure spreading practices, winter weather conditions and climatic factors that affect runoff.

The soil chemical and physical properties of the three watersheds will be determined, 1) an intensive grid sampling scheme (0.5 acre/sample) will be used to map Olsen P distribution at the 0-2 inch interval, and 2) Olsen P and total nitrogen will be analyzed on the 0-6 inch interval. A composite soil sample will be obtained for each watershed by combining equal amounts of soil from the discreet samples. This will be used to establish the average soil P and N value of each watershed. A total of 1 composite sample at two depths and for 3 watersheds will be collected for each of three years for a total number of soil samples = 18 in three years.

Task 3: Mine historical meteorological information and merge it with weather information collected during the project in a database. Build database of soil nutrient levels.

Product 5:	Build a database of historical meteorological information by mining historical weather data sets. Add current meteorological information and soil temperature and moisture data.
Cost:	Labor costs are included in the overall budget

Product 6:	Collect information about soil temperature and soil moisture and collect soil samples for analysis.		
Cost:	319 Funds:	$0	Labor costs are included in the overall budget
	Non-Federal Match:	$2,400	
	Total Product Cost	$2,400	

Task 4: Meteorological data analysis.

Product 7:	Complete a climate risk assessment of critical meteorological factors impacting the runoff potential of excess surface water.
Cost:	Labor costs are included in the overall budget

Outcome 4: Monitor surface runoff and leaching of nitrogen to shallow groundwater from field storage of manure.

Storing manure in a field for later application reduces the number of times the manure is handled and may help utilize spreading equipment more efficiently. To assess the risk of nitrate leaching to shallow groundwater we have installed three wells to a depth between 20 and 30 feet on the headland of a field adjacent to the demonstrations site. The wells are located down a gradient thereby allowing us to estimate the hydraulic conductivity of the saturated subsoil layers. We will monitor the ground water level and collect water samples from the wells every two weeks. In addition, we will collect samples of surface water runoff using an automated sampler.

Task 5: Establish a manure pile and collect surface water and groundwater samples for nitrogen analysis.

Product 8:	Monitor surface runoff and leaching of nitrogen to shallow ground water from field storage of manure.		
Cost:	319 Funds:	$0	Labor costs are included in the overall budget
	Non-Federal Match:	$2,100	
	Total Product Cost	$2,100	

Outcome 5: Provide education on winter manure spreading BMPs to livestock producers, extension educators, crop advisers, land managers, water quality experts, state regulators, and other stakeholders.

We will maintain a project website where all information relating to the project will be shared. SDSU Extension, NRCS and South Dakota DENR are important partners relating to the outreach efforts of this project. The Extension Soil Fertility Specialist will disseminate study findings to

livestock producers through fertility meetings and manure management training for permitted feedlot operators in South Dakota.

The information gained from this project will also be used in a more formal educational format. SDSU Extension/NRCS/SD DENR offer approximately three or four manure management seminars or short courses each year. These seminars are part of the Environmental Training Program for CAFOs that are required by SD DENR for permitting purposes. The results of the winter manure spreading studies will be used during the training to raise awareness of livestock and crop producers of BMPs for land application of manure to reduce non-point source loading to water resources of South Dakota.

The project will also be used to educate undergraduate students at SDSU as part of the course Agricultural Waste Management (AST 463). The project will provide needed knowledge that can be incorporated into the learning outcomes of the course.

Early in the project these educational brochures, fact sheets and handouts will be used to explain information about winter manure spreading gathered from the literature. As the project progresses the field results will be used to update educational tools which will be distributed to livestock producers, extension educators, and various environmental stakeholders. Information in these educational tools will explain the benefits of using BMPs during winter manure applications and to identify times of year when risk of contaminating water resources is greatest. An iGrow article will be produced at the end of the project. Approximately 500 total copies of brochures and handouts will be produced. Materials will be distributed by manure management seminars/training sessions and other events.

Task 6: Information transfer and outreach.

Product 9:	Maintain the project website and post results, reports, presentations and other pertinent information.
Cost:	Labor costs are included in the overall budget

Product 10:	Develop educational brochures, fact sheets and handouts.		
Cost:	319 Funds:	$600	Labor costs are included in the overall budget
	Non-Federal Match:	$0	
	Total Product Cost	$600	

Product 11:	Organize or contribute to nine meetings, crop clinics or CAFO training workshops to disseminate information generated during the project.
Cost:	Labor costs are included in the overall budget

Task 7: Project reporting.

Product 12:	Prepare semi-annual reports for the SD DENR describing project progress and results.
Cost:	Labor costs are included in the overall budget

Product 13:	Prepare annual reports for the SD DENR describing project progress and results.
Cost:	Labor costs are included in the overall budget

Product 14:	Prepare a project completion report for the SD DENR describing project results and impact.
Cost:	Labor costs are included in the overall budget

3.3 Milestone Table
The milestone table is included as Appendix A.

3.4 Project Management and Tracking
The primary faculty and staff that will be part of this project have extensive experience with project management and technical expertise in agriculture and water quality issues. An advisory board has been established to help guide the direction of the project and interpret the results. Therefore, the project sponsors are well qualified to management this demonstration project.

3.5 Permits
The project sponsor will secure all necessary permits including 401, 404, and storm water construction permits prior to implementation of any grant fund activity that may fall under applicable federal, state, or local laws. The sponsor will comply with cultural resource and threatened and endangered species clearance requirements. Cultural resource clearances will be conducted using guidance provided by DENR Practices with potential to affect listed threatened and endangered species in the area will follow procedures provided through USFWS.

4.0 Coordination Plan
4.1 Cooperating Organizations
South Dakota State University
The SDSU staff members assembled for the project has a history of serving the agricultural community through research and extension. The project team has access to the SDSU Agricultural and Biosystems Engineering shop and/or the SDSU physical plant shop for construction of the runoff gauging equipment. The project team has access to an irrigation and hydrology laboratory which is located in the Agricultural Engineering building. All equipment necessary to build and maintain the stilling wells and flumes is available.

The office of the SD state climatologist is located on the SDSU campus and has access to current as well as historic climatological data necessary to estimate weather related risks associated with manure applications. Both the Water Resources Institute and State Climatologist maintain websites to distribute information to the public.

The SDSU Extension is vital to the success of the proposed project. The SDSU Soil Extension Specialist will devote part of his time to dissemination of the results generated by the research. Much of the information gained from the project will be used to educate area livestock producers, crop advisors, land managers, Extension Educators, undergraduate animal science students, and the general public. Results will be disseminated primarily through educational seminars/short courses, workshops, and formal instruction. The state climatologist will work on educational aspects related to climate.

Moody County Conservation District
The Moody County Conservation District will be a partner with SDSU to develop winter manure management BMPs. The Moody Conservation District will also contribute a representative to the project advisory board. A letter of support is enclosed in Appendix B.

East Dakota Water Development District
The East Dakota Water Development District (EDWDD) will be a partner with SDSU to develop winter manure management BMPs by contributing $9,000 over a three-year period to provide part of the laboratory costs associated with water analysis. The EDWDD will also contribute a representative to the project advisory board. A letter of commitment is enclosed in Appendix B.

The Cattle Feeders Council
The Cattle Feeders Council has pledged support for the project and will contribute matching funds for equipment rental, diesel fuel costs, manure purchase and other direct project costs and provide a representative for the project advisory board. A letter of commitment is enclosed in Appendix B.

The South Dakota Farm Bureau
The South Dakota Farm Bureau has pledged support for the project and will contribute matching funds for soil and water sample analysis and provide a representative for the project advisory board. A letter of commitment is enclosed in Appendix B.

USDA Natural Resources Conservation Service
The Natural Resources Conservation Service (NRCS) provides leadership in partnership with other agencies and organizations to help individuals conserve, maintain, and improve our natural resources and environment. The NRCS will use the results of this project when providing technical assistance to livestock producers and in the development of 590 standards.

South Dakota Department of Environment and Natural Resources:
The South Dakota DENR is tasked with developing requirements for nutrient management for South Dakota as mandated by the EPA. Information gained about nutrient and bacteria loss in

runoff at the watershed scale will be useful in developing reasonable requirements that protect the water quality of South Dakota's streams and lakes without placing undue hardships on livestock producers.

4.2 Local Support for the Project

Stakeholder involvement will be important throughout this project. The project advisory board will be used to plan the research and education portion of the project. The cooperation of individual livestock producers is also vital for the success of the research phase of this project since they have offered the use of cropland watersheds for on-farm evaluation of manure management BMPs. Stakeholders will be involved in the research on water quality impacts of various manure management. Cooperating livestock producers will also provide field history information concerning manure spreading and general field management. A letter of commitment form Michael Schmidt is enclosed in Appendix B.

Project Advisory Board

To involve stakeholders in the project an advisory has been established. The board consists of cooperating landowners as well as representatives from state-wide producer groups that have an interest in manure management and the issue of winter spreading of manure. This ad hoc group will be used as an interface between University personnel and Agency staff at the State and Federal level. This group will also be included in the information transfer activities of this project. As information is transferred to this group it will be passed on to individual producers through each organization's newsletters and meetings.

4.3 Duplicate Effort

This proposed project is designed to develop improved manure management strategies and improved technical assistance to livestock producers for manure management. It is further designed to complement rather than duplicate previous efforts such as the USGS funded project titled "Evaluation of manure application risk on frozen soils". The project will also compliment SDSU Extension programs, the Animal Nutrient Management Team, and the NRCS. This project will coordinate existing assistance to maximize efficient partnerships and to improve manure management in South Dakota. Information will be transferred to user groups and assistance providers through existing successful programs whenever possible.

4.4 Assumption of Responsibilities of Other Entities

To the knowledge of the project sponsor the proposed work does not fall under the responsibilities of other entities.

5.0 Evaluation and Monitoring Plan

Collection and analysis of all project data will be accomplished in accordance with the South Dakota Non-point Source Program Quality Assurance Project Plan and the project specific procedures outlined in the remainder of section 5 of this proposal.

5.1 Monitoring Strategy
The monitoring was described in section 3.2.

5.2 Sampling and Analysis Plan
The current protocols for field sampling and laboratory analysis follows the DENR standard operating procedures. The project sponsor will provide additional written information upon request.

5.3 Quality Assurance Project Plan
Evaluation of success in reaching the project goal will be accomplished by monitoring project activities to measure:

1. progress toward meeting established tasks,
2. progress toward evaluating the environmental risk of spreading manure in the winter months using studies at the watershed scale, and
3. contribution to and use of the data in the development of improved manure management BMPs and their adoption by the SD DENR and the NRCS.

For outcomes one, two and four, documentation of the project activities related to soil moisture and temperature monitoring and water quality monitoring will be used to evaluate success (i.e. number of soil samples collected and analyzed or number of runoff plots tested or runoff samples collected at discharge locations). Project monitoring will be completed by a team of staff from the SDSU State Climate Office, Plant Science Department, and Water Resources Institute.

The data collected will be stored and managed by the project staff under the direction of the Project Coordinator. Collection and analysis of data will be accomplished in accordance with the South Dakota Nonpoint Source Program Quality Assurance Project Plan. Water quality data related to runoff plots will be entered into the WRI database and made available to the DENR and any other agency requesting the data. Soil test results will be kept in the SDSU Soil Testing Lab database. For outcome three, information and maps produced will be provided including a record of all climate risk maps developed during the project. For outcome five, a record of all educational materials produced and events held will be kept including requests for materials.

Semi-annual reports will include current activities and an evaluation relative to project milestones as well as cumulative progress toward reaching the project goal. The reports will contain a financial summary showing match, income and expenses. A final report will be completed at the end of this project

The ultimate indicator of success of this project will be determined by the validity of the data produced and its use as the basis for improved manure management BMPs and how well the BMPs are adopted by livestock producers. Project success will be realized if the acquired data is used to revise current manure application guidelines established by the SD DENR and NRCS

under the 590 standard. Another indicator of success will be publication of these manure management BMPs in peer reviewed scientific journals.

5.4 Data Collection, Management and Analysis

Data collection is described in section 3.2. After collection, the water samples will be placed in a cooler box and immediately transported to the South Dakota Agricultural Laboratory in Brookings, or other laboratory, for analysis.

5.5 Models

We will utilize one or more computer simulation models to mimic the impacts of winter manure spreading on soil and water quality under different climatic and management scenarios. Historic climate data and data generated as part of the project will be used for model initialization and testing. We will utilize an appropriate existing model such as WEPP (Flanagan at al., 2012), SWAT (Srinivasan et al., 1998; Gassman et al., 2007) or DAISY (Abrahamsen and Hansen, 2000).

5.6 Operation and Maintenance

The operation and maintenance relative to the development of BMPs are described in section 3.2.

6.0 Information and Education

6.1 Information and Education Activities

Information and education activities are described in section 3.2.

7.0 Budget and Budget Justification

Budget and budget justification are provided in appendix C.

8.0 Literature

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Appendix A

Appendix A

Milestone Table

Project Name: Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading - Project Continuation

Date: July 1 2013 - June 30 2016

Task	Group	Quantity	2013		2014				2015				2016	
			07-09	10-12	01-03	04-06	07-09	10-12	01-03	04-06	07-09	10-12	01-03	04-06
Outcome 1: Water monitoring														
Task 1: Water sampling														
Product 1: Runoff volume	1,4	21 events	3		6				6				3	
Product 2: Water quality	1,4	108 samples	18		36				36				18	
Outcome 2: Develop BMPs														
Task 2: Compare water quality impacts														
Product 3: Quantify risk of winter spreading	1,2,3,4	3 watersheds										3		
Product 4: Computer simulation	1,4	3 watersheds							3					
Outcome 3: Climate risk factor														
Task 3: Databases														
Product 5: Database of meteorol. information	1,4	1 database	1											
Product 6: Soil data	1,4	144 samples		48				48				48		
Task 4: Meteorological data analysis														
Product 7: Climate risk assessment	1,2,3,4	1 assessment								1				
Outcome 4: Manure storage														
Task 5: Ground water impacts														
Product 8: Ground water samples and analysis	1,4	135 samples	24		45				45				21	
Objective 5: Outreach and reporting														
Task 6: Information transfer														
Product 9: Website	1	1 website	1											
Product 10: Handouts, factsheets, brochures	1,2,3,4	500 copies									500			
Product 11: Meetings, CAFO training	1,2,3,4	9 events	1		3				3				2	
Task 7: Reports														
Product 12: Semi-annual reports	1,4	3 reports				1				1				1
Product 13: Annual Reports	1,4	3 reports		1				1				1		
Product 14: Final Report	1,4	1 report												1

Groups

1. Project coordinator and SDSU project staff
2. Federal: NRCS
3. State: DENR
4. Local: Agricultural groups, analytical services, EDWDD, conservation districts

Appendix B

Moody County Conservation District

202 East Third Avenue
Flandreau, SD 57028-1902

(605) 997-2949 Ext. 3
Fax (605)997-5132

September 26, 2012

Jeppe Kjaersgaard
Water Resources Institute, SDSU
Box 2120
Brookings, SD 57007

To whom it may concern,

The Moody County Conservation District supports the proposed continuation of the demonstration project *Developing Best Management Practices to Minimize the Water Quality Impacts of Winter Manure Spreading*.

We feel this research is needed to identify the most suitable sites for application of manure on frozen or snow covered ground that will minimize the potential of the bacteria entering a public water source. The NRCS 590 Standard does allow the spreading of manure on frozen or snow covered ground under emergency conditions. This research will help to identify which sites will be most suited for these emergency applications.

We also know that livestock producers with open feedlots have to periodically clean the feeding aprons off during the winter months. Instead of stockpiling this material in the feedlot and letting it melt and run off in the spring, we feel it will be better utilized if it is applied to an approved open field where it will be less concentrated and have a better chance of being absorbed by the crop residue and the top soil.

The research site has been equipped with the needed structures and equipment to properly monitor and sample the runoff waters. Now, all that is needed is the ability to conduct the research long enough to establish a scientifically sound and reliable database to ensure minimal runoff of the nutrients from the manure when applied to frozen or snow covered ground.

If you have questions about this letter, please feel free to contact me by phone at (605) 428-3090 or email at majeresj@hotmail.com.

Sincerely,

Jack Majeres, Chairman
Moody County Conservation District Board of Supervisors

East Dakota Water Development District
132B Airport Avenue
Brookings, SD 57006

605-688-6741 605-688-6744 Fax

MEMORANDUM

TO: Pete Jahrus, SD DENR 319 Coordinator

FROM: Jay Gilbertson, Manager

DATE: September 21, 2012

TOPIC: EDWDD Support for "Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading (Project Continuation)"

On September 20, 2012, the Board of Directors of the East Dakota Water Development District (District) agreed to provide cost-share assistance to the Water Resources Institute (WRI) at South Dakota State University for their proposal entitled, "**Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading (Project Continuation)**." Specifically, the District has agreed to provide $3,000 per year for each of the three (3) years of the project, for a total of $9,000.

The Board has previously supported the initial phases of this effort by the WRI to assess the impact of winter application of manure. While the Board understands that wintertime application of manure is a practice that is, and should be, largely discouraged due to water quality concerns, it also recognizes that this is a common practice none the less. In the absence of strict and explicit prohibitions, this practice is likely to continue, particularly for smaller animal feeding operations.

The Board believes that the current WRI project will help identify those manure management practices that would minimize the possible adverse impacts of wintertime spreading. There are clearly some factors (timing and rates of application, presence and/or depth of snow pack, temperature) that will affect the amount of nutrient- and bacteria-laden runoff, and avoiding these conditions may reduce the impact on area water resources. Until such time as this problematic practice can be avoided all together, the Board believes that this project may help develop viable management practices to minimize environmental risks.

South Dakota Cattlemen's Association

www.sdcattlemen.org

September 24 2012

Jeppe Kjaersgaard
Water Resources Institute, SDSU
Box 2120
Brookings, SD 57007

To whom it may concern,

It is a pleasure for me to provide this letter of collaboration for the proposed continuation of the demonstration project *Developing Best Management Practices to Minimize the Water Quality Impacts of Winter Manure Spreading*. The Cattle Feeders Council (CFC) under the South Dakota Cattlemen's Association enthusiastically supports the proposed work as it will provide much needed review of current management practices and help to identify practices relating to winter manure application that are acceptable and also identify other practices that may not be acceptable.

For example, a livestock producer that utilizes the Natural Resources Conservation Services (NRCS) Environmental Quality Incentives Program (EQIP) to cost share waste containment facilities is required to comply with Conservation Practice Standard 590 (590). 590 do not allow livestock producers to land apply manure on frozen and/or snow covered ground except in emergency situations. In South Dakota a producer can encounter snow as early as late October, the frost may not go out of the ground until April and when it does the fields are likely much too soft to land apply manure without creating rutting and compaction problems. During the growing season a significant portion of the cropland is planted to full season crops that may not be harvested until the ground is again frozen. The restrictions of 590 are excessive for the northern plains states of the United States and may create complex logistical manure handling problems that are complicated by unpredictable weather patterns. NRCS does allow states to propose modifications of the conservation practice standards but such proposed modifications usually need to be validated by sound monitoring before they are approved at the national level. This proposed project would attempt to identify the types of field situations, crop residue, tillage (if need be), terraces, slope, etc. that would have a runoff risk at a reduced level that would be acceptable to permit the land application of manure to frozen and/or snow covered ground. The project will generate much needed information to support natural resources management, protect water quality and agricultural production.

The CFC has been intimately involved in the project so far. The CFC will provide up $3000 per year or $9000 total as cash match for the project and an additional $2000 per year in in-kind contributions. The cash match is intended to help cover equipment rental, diesel fuel costs, manure purchase and similar.

Thank you for proposing this important work. If you have questions about this letter, please feel free to contact me at abnagel@gwtc.net or 605.369.2617.

Regards

Bryan Nagel

Bryan Nagel, Chair
SDCA Cattle Feeder Council

215 E. Prospect, Pierre, SD 57501 Phone: (605) 945-2333 Fax: (605) 224-0224

SOUTH DAKOTA FARM BUREAU®

September 25, 2012

Jeppe Kjaersgaard
Water Resources Institute, SDSU
Box 2120
Brookings, SD 57007

To Whom It May Concern,

South Dakota Farm Bureau (SDFB) is a voluntary farm organization with a membership of over 12,000 member families. The organizations policies clearly support enhancement of water quality, and improving the management of agriculture operations in an economical way.

It is a pleasure for me to provide this letter of collaboration for the proposed continuation of the demonstration project *Developing Best Management Practices to Minimize the Water Quality Impacts of Winter Manure Spreading*. South Dakota Farm Bureau enthusiastically supports the proposed work as it will provide much needed review of current management practices and help identify practices relating to winter manure application that are acceptable and also identify other practices that may not be acceptable.

For example, a livestock producer that utilizes the Natural Resources Conservation Services (NRCS) Environmental Quality Incentives Program (EQIP) to cost share waste containment facilities is required to comply with Conservation Practice Standard 590 (590). 590 do not allow livestock producers to land apply manure on frozen and/or snow covered ground except in emergency situations. In South Dakota a producer can encounter snow as early as late October, the frost may not go out of the ground until April and when it does the fields are likely much too soft to land apply manure without creating rutting and compaction problems. During the growing season a significant portion of the cropland is planted to full season crops that may not be harvested until the ground is again frozen. The restrictions of 590 are excessive for the northern plains states of the United States and may create complex logistical manure handling problems that are complicated by unpredictable weather patterns. NRCS does allow states to propose modifications of the conservation practice standards but such proposed modifications usually need to be validated by sound monitoring before they are approved at the national level. This proposed project would attempt to identify the types of field situations, crop residue, tillage (if need be), terraces, slope, etc. that would have a runoff risk at a reduced level that would be acceptable to permit the land application of manure to frozen and/or snow covered ground. The project will generate much needed information to support natural resources management, protect water quality and agricultural production.

SDFB has been intimately involved in the project so far. SDFB will provide up $3000 per year or $9000 total as cash match for the project. The cash match is intended to be used for the cost of testing and analysis of runoff, soil testing, etc..

Thank you proposing this important work. If you have questions about this letter, please feel free to contact me at wsmith@sdfbf.org or 605-201-4262.

Regards

Wayne H. Smith

Wayne Smith, Executive Director,SDFB

September 24, 2012

To whom it may concern

I am a rural landowner and own the quarter section of ground that currently is being used as part of the project: Developing BMPs to minimize the water quality impacts of winter manure spreading. I am willing to continue to offer this field site to conduct the evaluation of the effectiveness and safety of applying manure on frozen ground. I addition, I am willing help with the execution of the project and share records of field management and operations and to include my crop consultant in the all phases of the project as needed.

Michael L. Schmidt

47640 242nd Street

Dell Rapids, SD 57022

Appendix C

Appendix C
Budget

Project Name: Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading - Project Continuation
Date: July 1 2013 - June 30 2016

Item	Year 1	Year 2	Year 3	Total	319-EPA	State	Local		
	2013-2014	2014-2015	2015-2016			SDSU	EDWDD	SD FB	CFC
Project coordinator, incl benefits	$ 9,880	$ 10,192	$ 10,512	$ 30,584	$ 13,593	$ 16,991			
Graduate assistant, incl benefits		$ 18,804	$ 19,369	$ 38,173	$ 38,173				
Undergraduate assistant, incl benefits	$ 1,020	$ 1,051	$ 1,082	$ 3,153	$ 3,153				
Travel, 2000 miles @ $0.5/mile	$ 1,000	$ 1,000	$ 1,000	$ 3,000	$ 3,000				
Tuition remission		$ 3,000	$ 3,200	$ 6,200	$ 6,200				
Product costs (most of the costs are included in personnel and travel)									
Product 1: Field Mgmt. and Runoff volume	$3,500	$3,500	$3,500	$10,500					$10,500
Product 2: Water quality	$6,500	$6,200	$6,200	$18,900	$900		$9,000	$9,000	
Product 3: Quantify risk of winter spreading									
Product 4: Computer simulation									
Product 5: Database of meteorol. information									
Product 6: Soil data	$800	$800	$800	$2,400					$2,400
Product 7: Climate risk assessment									
Product 8: Ground water samples and analysis	$700	$700	$700	$2,100					$2,100
Product 9: Website									
Product 10: Handouts, factsheets, brochures		$300	$300	$600	$600				
Product 11: Meetings, CAFO training									
Product 12: Semi-annual reports									
Product 13: Annual Reports									
Product 14: Final Report									
Indirect costs (27%)	$3,348	$8,518	$8,765	$20,631	$16,043	$4,588			
Total	$ 26,748	$ 54,065	$ 55,428	$ 136,241	$ 81,662	$ 21,579	$ 9,000	$ 9,000	$ 15,000
Match						$ 21,579	$ 9,000	$ 9,000	$ 15,000

Match percentage: 40.1%

Budget Justification

Personnel Support for Project Staff

Project coordinator

$3,527, $3,635 and $3,744 for project years 1, 2 and 3 are requested for salary for project coordinator Kjaersgaard. Benefits are an additional 15% of the salary request plus $6,335 health and life insurance prorated to 5 % time. The funds will cover project coordination and oversight, managing project staff, oversee modeling efforts, managing the project advisory board, oversee installations and maintenance of monitoring equipment, day-to-day collaborations with project participants and outreach efforts.

Other Personnel

Support for a project assistant in the form of a graduate assistant is requested for project years 2 and 3 at $18,436 for project year 2 and $18,989 for project year 3 with benefits corresponding to 2% of the salary. The project assistant will lead the computer modeling efforts and assist with monitoring equipment maintenance, participate in advisory board meetings, maintain collaborations with project partners and assist with the project outreach efforts.

Support for 100 hours of undergraduate student labor at $10/hour plus 2% benefits are requested for each of the three project years. The roundtrip travel time to the field site including driving time and field work is expected to average 4 hours with 25 trips per year. The student will assist with maintaining and updating monitoring equipment and collect and interpret monitoring information.

Support of $3,494 in benefits is requested. The Project Coordinator benefits are figured at 15% plus Health Insurance of $6,652 pro rated to percent time. Benefits for other Personnel are at 2%.

All salaries are budgeted with a 3% increase per year for project years 2 and 3. Health and life insurance are budgeted to increase 5% per year.

Travel

$1,000 is requested for travel each project year at 2000 miles per project year at $0.5 per mile. This includes travel to monitoring sites, meetings with project stakeholders and outreach activities. State motor poll cars and pickups will be used for the travelling.

Other Direct Costs

Supplies

A total of $500 per project year is requested to cover supplies including charts and filters, and supplies for monitoring equipment maintenance and updates.

Tuition Remission

The student tuition remission rates at South Dakota State University are $3,000 and $3,200 for academic years 2014 and 2015.

Indirect Costs

As specified in the SD Board of Regents (SD BOR) Policy Manual 5:2:3 indirect costs are real and defensible costs of conducting sponsored activities. As per guidelines in the SD BOR Policy Manual 5:2:4 indirect costs for state agencies are calculated using 60% the federally negotiated indirect cost rate of 45%, or 27% of the project direct costs. The SDSU Cognizant Agency is DHHS, Helen Fung, phone 415-0437-7820.

Matching Funds

Cash Match

A total of $27,000 in cash match is provided.

The South Dakota Farm Bureau will provide $3,000 per year or $9,000 total in cash to support the project and half of the expense of the water sample analysis costs. East Dakota Water Development District will provide a total of $9,000 in cash to cover half of the water sample analysis costs. The Cattle Feeders Council will provide $3,000 per project year or $9,000 total to cover equipment rental, diesel fuel costs, manure purchase and other direct project costs.

In-Kind Match

Project coordinator Kjaersgaard will provide in-kind match corresponding to 6.25% of his annual non-federal salary. Benefits are an additional 15% of the salary request plus $6,652 health and life insurance prorated to 6 percent time and indirect costs at 27%. The Cattle Feeders Council will provide $2,000 in in-kind match for the project for each project year.