



Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-228

Proposal Title: Solar Co-Benefits: Reducing Nitrates, Enhancing Habitat, Sequestering Carbon

Project Manager Information

Name: David Mulla

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

Office Telephone: (612) 625-6721

Email: mulla003@umn.edu

Project Basic Information

Project Summary: This project will quantify the co-benefits of drinking water protection, carbon sequestration, renewable energy production, and rural economic revitalization associated with perennial vegetation at ground solar PV sites on DWSMAs.

Funds Requested: \$344,000

Proposed Project Completion: 2023-06-30

LCCMR Funding Category: Foundational Natural Resource Data and Information (A)

Project Location

What is the best scale for describing where your work will take place?

Region(s): Central, SW, SE,

What is the best scale to describe the area impacted by your work?

Region(s): Central, SE, SW,

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Drinking water supply management areas (DWSMAs) cover 135,282 ac of Minnesota. Groundwater in DWSMAs is often impaired as a result of high nitrate-N concentrations, resulting in large costs to rural communities. DWSMAs surround a wellhead protection area (WPA) responsible for supplying drinking water to a rural community. A high vulnerability for nitrate-N pollution occurs on 34,555 ac of DWSMAs. Minnesota's ground solar photovoltaic energy facilities currently produce 1 GW of energy and are installed on about 10,000 ac of land. A majority of these are planted with perennial vegetation (e.g. pollinator habitat) between and underneath solar panels. There is increasing interest in siting ground solar photovoltaic facilities with habitat friendly pollinator plantings on DWSMAs to provide the co-benefits of renewable energy and drinking water source protection. We plan to collect data for stormwater runoff, nitrate leaching, carbon sequestration and economic impacts at three solar PV sites located on vulnerable DWSMAs with well established perennial vegetation. These results will be compared against a baseline condition of a corn-soybean rotation. The project will use these data to quantify the potential benefits of scaling up implementation of ground solar PV with pollinator habitat for protection of Minnesota DWSMAs.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

This project will quantify the co-benefits of drinking water protection, carbon sequestration, renewable energy production, and rural economic revitalization associated with pollinator habitat at ground solar PV sites located on vulnerable DWSMAs. State entities have been aiming to convert sensitive lands to perennial plantings for the sake of nitrate mitigation. Adding solar to these projects, or being able to target sensitive lands for solar deployment, may create multi-layered wins for energy, land use, and clean water. This research will begin to build the scientific foundation for creating community drinking water co-benefits for the rapidly expanding solar energy market. This project addresses multiple co-benefits: Water - providing a market based mechanism for mitigating agricultural nitrate contamination; Carbon – sequestering carbon and reducing greenhouse gas emission; Economy - producing stable rural income; Energy – producing renewable energy and reducing reliance on non-renewable fuels.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Specific outcomes include protection of vulnerable drinking water, reductions in greenhouse gas emission through carbon sequestration, reduced barriers to implementation of ground solar PV facilities with perennial vegetation, including pollinator habitat on DWSMAs, and quantification of how many acres of these facilities need to be established on DWSMAs to achieve significant improvement in drinking water quality.

Activities and Milestones

Activity 1: Quantify Improvement in Carbon Sequestration and Drinking Water Quality for Groundwater in DWSMAs with Solar PV Pollinator Habitat

Activity Budget: \$211,845

Activity Description:

Activity 1 will provide data to quantify improvements in carbon sequestration and reductions in stormwater runoff, infiltration and nitrate leaching from ground based solar installations with pollinator habitat relative to the baseline for a corn-soybean rotation. Ground-mounted solar installations with pollinator habitat will be monitored for carbon sequestration, runoff, soil moisture, nitrate leaching and water table depth to identify impacts based on type of collector (fixed tilt or sun tracking), type of ground cover (e.g. pollinator habitat), and site characteristics (soil and slope). Results will be used with long-term climatic data to quantify impacts on carbon sequestration and drinking water quality of pollinator habitat at ground solar sites relative to a corn-soybean rotation. Simple tools will be developed to quantify impacts of pollinator habitat at ground solar PV sites on drinking water quality and carbon sequestration.

Activity Milestones:

Description	Completion Date
Annual summaries of monitoring data for carbon sequestration and water quality	2022-12-31
Model based estimates of water quality and carbon sequestration benefits of pollinator habitat in DWSMAs relative to corn-soybean	2023-03-31

Activity 2: Reduce Barriers to Implementation of Ground Solar PV with Pollinator Habitat in DWSMAs through Community Engagement

Activity Budget: \$83,519

Activity Description:

We will engage citizens, farmers, local government officials, the MN Rural Water Association, MN Depts of Health/Agriculture and solar PV developers in a series of focus groups to identify barriers to implementation in DWSMAs of ground solar PV with pollinator habitat. Results will include environmental and economic impacts of drinking water quality, runoff, and pollinator habitat, as well as impacts on home prices, revenue streams, and jobs. We will disseminate project results and train local and state government, solar developers, and the general public about how to maximize the environmental and economic benefits of ground solar installations. Deliverables will include written and web-based reports and in-person dissemination to local and state government officials, decision-makers, habitat and agriculture sector stakeholders, and other interested parties. Deliverables will also include annotated and synthesized feedback and insights generated by community members to identify priority areas for implementation on vulnerable DWSMAs of solar PV projects with pollinator habitat.

Activity Milestones:

Description	Completion Date
Summarize focus group results in written and web-based reports	2022-03-31
Identify priority areas for implementation of solar pollinator plantings through public engagement	2023-03-31

Activity 3: Quantify Economic and Ecological Benefits of Pollinator Habitat at Ground Solar PV Installations located on DWSMAs

Activity Budget: \$48,636

Activity Description:

Results from Activities 1 and 2 will be used to estimate the economic and ecological benefits of planting pollinator habitat at ground solar PV installations located on DWSMAs. We will calibrate the Integrated Valuation of Economic Services and Tradeoffs (InVEST) model using these results along with datalayers for climate, topography, and soils. A spatial analysis will be conducted to investigate potential solar PV siting criteria and potential site locations that provide ground water protection. The calibrated InVEST model will then be used to evaluate cumulative economic and environmental impacts of pollinator habitat at solar PV installations located on DWSMAs above and beyond those studied experimentally in Activities 1 and 2, including sites that are currently being considered for new solar PV installations on DWSMAs at Perham, Adrian and the Lincoln-Pipestone area. The model will be used to identify how increasing the acres of solar PV with pollinator habitat in MN will impact drinking water quality, runoff, carbon sequestration and pollinator services in vulnerable DWSMAs.

Activity Milestones:

Description	Completion Date
Calibrate InVEST model at three experimental solar PV sites with pollinator habitat	2022-03-31
Map vulnerable DWSMAs with suitable site characteristics for solar PV with pollinator habitat	2022-12-31
Estimate economic and environmental benefits of solar PV pollinator habitat plantings on vulnerable DWSMAs	2023-03-31

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Brian Ross	Great Plains Institute	Community engagement and identification of barriers to installation of ground solar photovoltaic with pollinator habitat	Yes
Eric Lonsdorf	University of Minnesota, Institute on Environment	Quantify ecosystem and economic benefits of pollinator habitat	Yes
Jessica Gutknecht	University of Minnesota, Dept. Soil, Water & Climate	Carbon sequestration impacts of pollinator habitat.	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

After project completion, results and recommendations arising from the project will be implemented by communities in wellhead protection areas working with commercial ground solar photovoltaic producers who plant perennial vegetation or habitat friendly pollinators. Vulnerable DWSMAs suitable for installation of ground solar PV with pollinator habitat will be identified using project results. Simple tools will be developed that allow communities, local and state agencies and ground solar PV producers to estimate the ecosystem benefits of their projects. Additional work to quantify ecosystem benefits will be funded by DOE.

Project Manager and Organization Qualifications

Project Manager Name: David Mulla

Job Title: Professor

Provide description of the project manager's qualifications to manage the proposed project.

Dr. Mulla and his coauthors (including 50 MS and PhD students) have produced over 200 publications, and have received nearly \$27 million in extramural funding for research. Dr. Mulla has experience in modeling erosion, runoff, leaching, drainage and losses of phosphorus, nitrogen, and pesticides to surface and ground waters. He studied pollution of Minnesota rivers, lakes, and groundwater, and effectiveness of BMPs for each resource. In 1998 he was appointed to the White House Task Force on Hypoxia in the Gulf of Mexico. In 1999 he led a study for the Minnesota State Environmental Quality Board on the impacts of animal agriculture on water quality. In 2004 he collaborated on a statewide study to quantify phosphorus loads exported to surface waters from point and nonpoint sources. He led a paired watershed study on the effectiveness of BMPs. In 2007 he led a study for the LCCMR to develop a long-range conservation plan for biofuel production and environmental protection in Minnesota. In 2010 he led a study for the MN state legislature on nitrogen sources to surface waters, which was the foundation of Minnesota's Nutrient Reduction Strategy. In 2011 he was appointed to a National Academy of Sciences committee on numerical nutrient criteria (water quality standards) for Florida. In 2013 he was appointed to a National Academy of Sciences committee on Mississippi River water quality. In 2019 he coauthored a publication summarizing effectiveness of agricultural BMPs for reducing N and P losses from agricultural land in the Red River of the North Basin.

Organization: U of MN - College of Food, Agriculture and Natural Resource Sciences

Organization Description:

The mission of the University of Minnesota (UofM) mission includes Research and Discovery, Teaching and Learning, and Outreach and Public Service. Grand challenges in the College of Food, Agriculture and Natural Resource Sciences (CFANS) include food security, agricultural productivity, invasive species and biodiversity, pest and disease dynamics, climate change and renewable energy, water resources protection, and educating future leaders in applied science and technology. CFANS includes the Water Resources Center, which provides leadership in freshwater management through cutting-edge research, educational opportunities for students and professionals, and community outreach. CFANS also includes the Department of Soil, Water and Climate, whose mission is to advance our understanding of Earth system processes and the interaction among land, atmosphere, and water. Through research, teaching, and extension we seek to improve and protect the quality of soil, air, and water resources in natural and managed ecosystems; enhance agricultural and forest productivity and sustainability; predict and mitigate impacts of environmental and climate change on ecosystems and society; and provide science based knowledge for improved decision making and a better informed citizenry. CFANS partners with the Institute on Environment, whose Global Water Initiative is helping ensure a safe, sufficient supply of water worldwide by promoting water sustainability.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Researcher 5		Measure and model infiltration and nitrate leaching			36.5%	1		\$72,443
Grad Research Assistant		Measure carbon sequestration and soil fertility			86.6%	1		\$101,270
Education Program Specialist 1		Provide program support for community engagement and outreach			36.5%	0.5		\$38,369
Researcher 3		Ecosystem services modeling			31.8%	0.2		\$11,676
							Sub Total	\$223,758
Contracts and Services								
Great Plains Institute (nonprofit organization)	Sub award	The Great Plains Institute will lead Community Engagement in Activity 2 and provide spatial analysis and economic research relating to solar PV siting criteria and potential site locations that provide ground water protection, and an analysis of the extent to which potential PV sites would provide opportunities for community co-benefits.				-		\$79,110
							Sub Total	\$79,110
Equipment, Tools, and Supplies								
	Equipment	Supplies in year 1 include costs for expendable soil moisture sensors [12 at each of three sites @\$225 each (36 x \$225 = \$8100)], expendable suction lysimeters [6 at each of three sites @\$100 each (18 x \$100 = \$1800)], and expendable dataloggers [3 at each of three sites @650 each (9 x \$650 = \$5850). Also included are weather stations at each of three sites [@\$650 each (3 x \$650 = \$1950)], and batteries to power dataloggers and weather stations [@\$100/battery (12 x \$100 = \$1200)]. Replacement	These are for measurement of soil moisture, infiltration, nitrate leaching and climatic conditions at study sites.					\$21,550

		moisture sensors (6), lysimeters (5), and dataloggers (2) in year 2 are estimated to cost \$2,650.						
	Tools and Supplies	Analysis of soil samples each year include 3 sites and 12 samples/site for soil texture analysis @ \$20 per sample = \$720/yr total \$1440; for background fertility analysis (P, K, pH, CEC, OM) @ \$14 per sample = \$504/yr total \$1008; for background soil nitrate analysis @ \$5 per sample = \$180/yr total \$360; and for total soil C and N @ \$18 per sample = \$648/yr total \$1296. Analysis of soil leachate samples for nitrate at 3 sites, with 6 sampling locations/site and 20 samples/yr @\$9/sample would cost \$3,239/yr total of \$6,478.	Analytical costs for soil and water samples.					\$10,582
							Sub Total	\$32,132
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Thirty site trips by car	Collect data from solar photovoltaic sites with perennial vegetation on vulnerable drinking water areas and travel to related community engagement events					\$9,000
							Sub Total	\$9,000
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								

							Sub Total	-
Other Expenses								
							Sub Total	-
							Grand Total	\$344,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	-
Non-State				
			Non State Sub Total	-
			Funds Total	-

Attachments

Required Attachments

Visual Component

File: [3a2f74ae-acc.pdf](#)

Alternate Text for Visual Component

Minnesota Drinking Water Source Management Areas (DWSMAs) with Opportunity for Solar Photovoltaic Installations with Perennial Vegetation that provide Drinking Water Quality Improvement and other Co-Benefits

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include research?

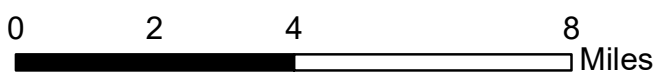
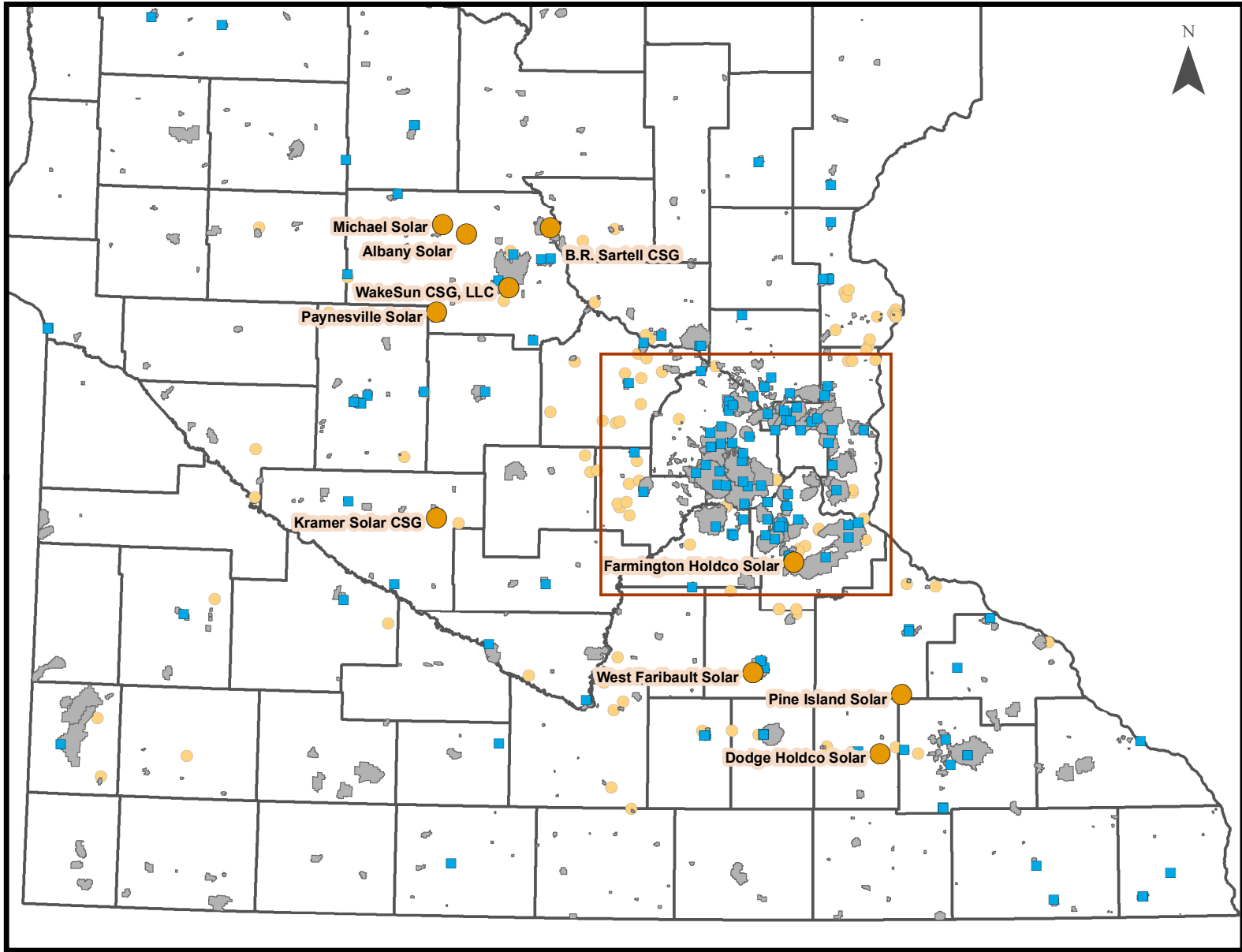
Yes

Does the organization have a fiscal agent for this project?

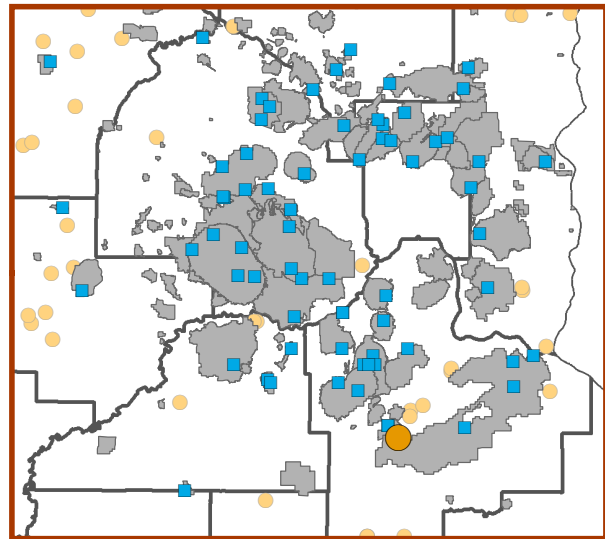
Yes, Sponsored Projects Administration

Minnesota DWSMAs with Opportunity for Solar and Drinking Water Quality Co-Benefits

Figure depicts (in a dark grey), the drinking water supply management areas (DWSMAs) across the state of Minnesota that contain either an existing solar installation (of at least 1MW) or an electric substation. These DWSMAs that already contain an existing solar installation (shown as orange circles) are good potential locations for a pilot site to study the opportunity for improving water quality through perennial vegetation or pollinator habitat. The DWSMAs with an electric substation (shown as blue square) showcase the breadth of opportunity associated with scaling the solar + drinking water quality co-benefits model across the state.



- Solar Installations located within a DWSMA boundary
- Electric Substations located within a DWSMA boundary
- Solar Installations
- DWSMA



Map created on 21 April 2020 by Great Plains Institute staff
 Data from Aaron Hanson at the Institute on the Environment (IonE) MN Solar Sites, the MN Board of Water and Soil Resources (BWSR) DWSMA Location Data, and Homeland Infrastructure Foundation-Level Data for substation locations.

