Environment and Natural Resources Trust Fund
2010 Request for Proposals (RFP)

LCCMR ID: 050-B1

Project Title:

Septic System Greenhouse Gases: Measurement, Reduction and Energy

LCCMR 2010 Funding Priority:

B. Renewable Energy Related to Climate Change

Total Project Budget: $ $470,000

Proposed Project Time Period for the Funding Requested: 2 years, 2010 - 2012

Other Non-State Funds: $ $0

Summary:

Project will quantify greenhouse gases emissions from septic systems across Minnesota, develop a model to predict emissions and research methods to reduce emissions and use methane to generate renewable energy.

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Sponsoring Organization: U of MN

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Location:

Region: Statewide

County Name: Statewide

City / Township:

_____ Knowledge Base _____ Broad App. _____ Innovation

_____ Leverage _____ Outcomes

_____ Partnerships _____ Urgency _____ TOTAL

Septic System Greenhouse Gases: Measurement, Reduction and Energy

I. PROJECT STATEMENT

Methane (CH_4) is a substantial contributor to the greenhouse effect and emissions are increasing at about 0.6% per year. In 2008, the USEPA reported that up to 76% of all methane emissions from the wastewater sector are attributed to decentralized wastewater treatment systems (septic systems). This estimate was achieved through theoretical calculations with no field-verification of the data. Field-based data is clearly required to ensure an accurate greenhouse gas (GHG) estimation from septic systems. What is known about septic systems is their ability to naturally produce methane gases. Since there are over 600,000 septic systems treating wastewater across Minnesota, understanding the quantities and variability of methane production is important. This methane gas is both a potential harm as a GHG, but can also be a benefit as it is a source of renewable energy. This project will quantify the amount of GHG being generated by septic systems. It will also focus on the over 7,000 commercial properties utilizing septic systems for wastewater treatment where the opportunity for methane generation, collection and energy production may be more feasible. The goals of this project are to:

- Quantify the amount and variability of methane produced by septic systems.
- Develop simple tool/model to predict methane emissions.
- Research methods to reduce greenhouse gas emissions and use methane emissions to create renewable energy.

The project will achieve these goals by:

- Measuring the methane emissions from five dwellings with conventional systems, five properties with non-conventional systems and five commercial/resort properties all geographically spread across Minnesota,
- Developing an inventory tool to predict methane production from septic systems,
- Researching options available to reduce emissions from septic systems, and
- Researching options available to create renewable energy from methane production.

II. DESCRIPTION OF PROJECT RESULTS

Result 1: Data Collected on Greenhouse Gas Emissions from Septic Systems, **Budget:** $250,000. A field procedure will be developed to measure GHG emissions from septic systems from both point sources (plumbing stack, tank access risers, soil treatment inspection ports) and non-point sources (over septic tanks and soil treatment area). Data will be collected on temperature and the emissions of methane, nitrous oxide, carbon dioxide, total reduced sulfur, hydrogen sulfide and ammonia concentrations from 15 properties geographically spread across Minnesota. Data collection will occur in both the northern and southern part of Minnesota over the course of one year as methane production is directly impacted by temperature. Deliverables will include field procedure for collecting emission data from septic systems and a database of methane production from differing septic system types.

Result 2: Inventory Tool Developed and Tested to Predict Methane Emissions, **Budget:** $150,000. A model will be adapted and validated to predict methane emissions from various septic systems correlating system type with soil temperature, moisture and climatic information. A validated landfill methane oxidation and transport model which includes soil methane oxidation and transport accounting for climatic and soil variability will be the beginning for our septic system prediction model. The model will be validated by field testing on 15 septic systems geographically spread across Minnesota (Result 1).

Result 3: Summary of Options for Reduction of Methane Emissions from Septic Systems, **Budget:** $35,000. Investigate the variety and effectiveness of existing and potentially practical controls at reducing GHG emissions. The controls tested will depend on the observed emissions from

Result 1 and will likely include "bioreactors" or other simple alterations to increase the oxidation potential of methane prior to being emitted to the atmosphere.

Result 4: Summary of Options for Renewable Energy Production form Septic Systems, **Budget:** $35,000. Investigate the variety and the effectiveness of existing and potentially applicable methods of generating energy from the methane produced in septic systems. Again, this is highly dependent on the field measurements (Result 1). For the selected larger commercial systems, options will be evaluated to ascertain the feasibility of utilizing the quantity of generated methane as a renewable energy source. Potential options include methods to enhance methane generation efficiencies and the use of a micro-turbine for electricity generation.

Deliverable	Completion Date
1. Result 1 - Data Collected on Greenhouse Gas Emissions	July 1, 2011
2. Result 2 - Inventory Tool Developed to Predict Methane Emissions	July 1, 2012
3. Result 3 - Summary of Options for Reduction of Methane Emissions	July 1, 2012
3. Result 4 - Summary of Options for Renewable Energy Production	July 1, 2012

III. PROJECT STRATEGY

A. Project Team/Partners

A multidisciplinary partnership provides the needed skills to evaluate methane energy production and GHG emissions from septic systems. This proposal combines the expertise of two programs at the University of Minnesota (UMN) and the USDA:

- Sara Heger Christopherson in the UMN, Onsite Sewage Treatment Program (OSTP) provides the knowledge of septic system componentry, operation and site selection. Ms. Christopherson provides project management as Co-PI and technical expertise. Dan Wheeler, a research fellow in Soils, Water, and Climate, who is also part of the OSTP, provides technical expertise related to soil based treatment systems.
- Chuck Clanton, a full professor with Bioproducts and Biosystems Engineering (BBE) Air Quality program, imparts strong leadership on the biochemistry of methane production and air sampling and analysis and provides project management as Co-PI. The UMN Air Quality team offers additional expertise and support in development of the field testing protocol.
- Kurt Spokas, a research soil scientist with USDA-Agricultural Research Service, offers expertise in field measurement of methane and the use of an inventory tool utilizing soil temperature, moisture and climate information to model methane emissions.

B. Timeline Requirements

Due to the temperature variation across Minnesota and our seasonality, a minimum of one year is needed for collection of GHG emission data and summarization from the field test sites. During this time the model developed for landfills will be adapted for septic systems. Field site data will then be used to calibrate the model and verify the effectiveness. While the field data is being collected and model developed and tested, investigation of emission control techniques and energy production will be gathered and summarized.

C. Long-Term Strategy

Depending on the results of this study, additional research is likely needed to further optimize energy production from septic systems.

Project Budget

IV. TOTAL PROJECT REQUEST BUDGET (*2* years)

BUDGET ITEM	AMOUNT
Personnel:	
Project Co- PI: Sara Christopherson (75% time, 69.6% is salary, 30.4% is fringe). Lead tasks: Project oversight, septic system technical expertise, responsiblity for all reports, factsheets and assureance of dissemation of materials.	$ 108,000
Project C0- PI: Chuck Clanton (10% time, 69.6% is salary, 30.4% is fringe). Lead tasks: project oversite and air quality monitoring expertise.	$ 26,000
Dan Wheeler (20% time, 69.6% is salary, 30.4% is fringe). Lead tasks: Oversight of field sampling protocal and modeling relating to soil treatment systems.	$ 34,000
Research Asssitant at 50% time to assist in site identification, preliminary data collection, literature review (67.3% salary, 32.7% fringe).	$ 50,000
Undergraduate Student to assist with field mearsurements (full time during summer, part time during school year, 95% salary, 5% fringe)	$ 20,000
Two Graduate Students: One in SWC, second in BBE. Graduate student in soils will take lead on evaluation of emissions and modeling from relating to the soil treatment systems. Graduate student in BBE will focus on process of GHG formation, dilution modeling, controls and options for energy production (57% salary, 43% fringe).	$ 130,000
Administrative Support staff for administration of grant and editing of documents.	$ 10,000
Equipment, Tools, Supplies:	
Materials for modifications of existing sytems to allow for in-situ sampling.	$ 1,500
Sample analysis for grab samples during preminarly field work. Instrument rental, Tedlar air quality sampling bags, analysis at $25/sample with a total of 100 samples.	$ 2,500
Air sampling equipment and instruments for analysis. Use/rental of portable trailer with existing equipment for 12 months at $4,000 per month.	$ 48,000
Travel: All in-state travel: 1) Travel to each of the 15 field sites a minimum of 10 times with an average distance of 300 miles round trip per site, and 2) travel to presentations of materials (6 events 300 miles per event).	$ 25,000
Other: Honorarium to the property owner for allowing site acces, his/her time and incidentals used on site. 15 sites at $1000 per site.	$ 15,000
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$ 470,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period: Kurt Spokas's salary is covered by USDA and with an effort level of 10%.	$22,000	*Secured*
In-kind Services During Project Period: Provided by Tim Haeg with Watab, Inc. donating his time as a Designer, Installer and Service Provider of up to 200 hours to assist in site identification and modifcations for sampling. Mark Wieser with Wieser Concrete is donate up to 200 hours of time and expertise as a professional engineer who is an expert in septic tank design to assist in identifying the key issues around tank compartments, venting and obtaining representative gas samples. $50 per hour was asssumed in determining in-kind contribution. Letters of support are available upon request. The 15 field sites will also allow free access to their systems for evaluation. With 10 visits to each site and 1 hour of time per visit estimtes at $50/hour this equates to $7500.	$20,000	Secured

Project Manager Qualifications

Since 1998, Sara Heger Christopherson has been a state specialist Extension Engineer and Instructor at the University of Minnesota in the Water Resource Center. She has a BS in Biosystems and Agricultural Engineering, a MS in Water Resource Science and is working on PhD in Water Resource Science all from the University of Minnesota. During the last five years she has served as the PI on several grant projects:

- USEPA CIDWT National Installer Training materials, 2007 – 2009
- MPCA UMN professional manual project, 2005-2009
- WERF wastewater monitoring project, 2007-2008
- UMN Large septic tank evaluation, 2005 - 2008
- Infiltrator chamber/rock trench field study, 2005 - 2008

In addition, Ms. Christopherson as been played a key role in several other large research projects:

- 319 Milkhouse Wastewater Treatment Research and Demonstration Project, 2001-2007
- LCMR Alternative Septic System Project, 1995-2002

Ms. Christopherson is a national expert on septic systems. Her duties in Minnesota include:

- Providing technical assistance to county employees, designers, installers, inspectors and maintainers of onsite systems,
- Present at many local, state and national conferences regarding onsite sewage treatment,
- Develop, explain and present septic outreach workshops for onsite wastewater professionals in Minnesota (over 1,500 attendees each year).
- Troubleshooting potential and existing onsite systems offering expert options to designers and county officials.
- Coordinate educational activities and serve on the board of both the Minnesota Onsite Wastewater Association and the National Onsite Wastewater Association.

Related Publications

1. Janni, K.A., S.H. Christopherson and D.R. Schmidt. 2009. Milk house wastewater flows and characteristics for small dairy operations. Applied Engineering in Agric. (Accepted).
2. Christopherson, S.H., D.R. Schmidt and K.A. Janni. Aerobic and media filter treatment systems for milk house wastewater on small dairy operations. Applied Engineering in Agriculture (Draft).
2. Christopherson, S., D. Wheeler, J. Wittwer, and T. Haeg. 2008. Field comparison of rock-filled and chambered trench systems. J. Hydrologic Engineering. 13:671-680.
3. Christopherson, S. and D. Gustafson. 2006. Preliminary Evaluation of Cluster Septic Tank Performance. In Proceedings of the 2006 National Onsite Wastewater Recycling Association (NOWRA) Conference, Denver, CO.
4. Christopherson, S. and J. Anderson. 2004. Twenty Years of Successful Onsite Wastewater Management – The Otter Tail, Minnesota Water Management District. In