Summary Information

A. Project Title: *Innovative Use of Bio-Mass in Wastewater Treatment*

B. Applicant Information: City of Kalispell
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Kalispell, MT 59901
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C. Funding Request: $500,000

D. Total Project Cost: $1,000,000

   a. Applicant In-Kind Match: $500,000

E. Project Period: February 2011 through February 2014

F. DUNS Number: 021996665

G. Estimate of potential greenhouse gas reductions and assumptions and emissions factors used in calculations:

   a. Estimate of potential greenhouse gas reductions:

Proposed 7000 gallon model anaerobic bioreactor will produce about 931 cubic feet of biogas (27.9 kg biogas) or about 78 % reduction in greenhouse GHGs using the AACT process. Methane weight per CF at 14.3 grams and CO2 weight per CF at 53.7 grams. Therefore a 60:40 ratio of Methane weighs (0.6 * 14.3 + 0.4 * 53.66) = 30 grams / CF . The process will target the 60:40 - methane to CO2 ratio for optimal combustion

This means a conventional water treatment plant produces between 22,000 * 30 grams = 660 KG of high performance biogas per day. The 5,000 sq ft facility will only be able to produce only a small fraction of this each day. A 1000 gallon digester can only deliver about 141.2 CF of biogas per day OR 30 * 141.2 = 4.236 kg. To grow 22 kg of algae a day requires at least 11 kg of carbon. Therefore the digester will need to be at least 5-6 times the proposed algal-cellulosic demo digester.

Molecular weight of CH4 = 16; Molecular weight of CO2 = 44; % weight C in CH4 = 12 / 16 = 0.75 ; % weight C in CO2 = 12 / 44 = 0.27 The combined carbon ratio in the 60:40 biogas is about 50%. To produce 1 kg of algae we need about 1 kg of biogas.

Algae growth rate limited 22 kg in our 5K sq ft GPH we need at least 22 kg of biogas or roughly 1000 CF of biogas per day or a bioreactor that can handle 7500 gallons per day.

   b. Assumptions and emissions factors used in calculations:

0.5 * 16 metric tons / X = % reduction for the small-scale demonstration unit (5000 sq ft);
0.5 * 73.5 metric tons / X = % reduction for the full-scale facility (between 4 and 5 times the size of the demo unit).

The assumptions and emission factors: The carbon sequestered by the system comes from the fixation of CO2 in the algal biomass. The percent reduction is calculated as 0.5 * weight of algal biomass produced / weight of GHG from sludge digestion. The Stoltze bench model showed production of approximately 16 metric tons of algae annually in a 5000 sq ft. Green Power House ™.

Narrative Proposal Work-Plan

1. Project Summary/Approach

Overall Project Approach

The City of Kalispell, Montana, requests funding for planning and demonstration of a novel, zero-to-negative greenhouse gas (GHG) wastewater treatment facility. Current land application of raw sewage from private septic systems in Flathead County, Montana, has an adverse impact on environmental quality to the entire watershed of our region. Completion of the planning and demonstration project proposed here is necessary precursor to construction of a full-scale sewage treatment facility that will, among other benefits: 1) Reduce GHG by an estimated 78% from current production; 2) eliminate the threat to public health and water quality created by the current practice of land spreading raw septage; 3) produce electricity, offsetting demand of the current plant; and 4) produce organic fertilizer from bio-solids.

This innovative project is the result of a new partnership between the City of Kalispell and Algae Aqua-Culture Technology, Inc. (AACT), a local startup company. The project is also supported by additional community entities including Flathead Valley Community College (FVCC).

The proposed project's innovation over existing biomass-to-algae processes is in its addition of components to the system that render the process closed-loop and in the computerized control system that optimizes the algal growth process for location-specific conditions. The process is GHG neutral-to-negative when all modes of GHG emission reductions and/or avoidance involved in the process are considered, as is detailed in the *GHG Reduction Potential* section of this proposal.

The novel closed-loop biomass/algae process developed by AACT can use any type of biomass as input, and thus it may be utilized in wood mills, farms, food, coal and oil applications. In the application proposed here the system will be used to process septage in a carbon neutral manner, and reduce GHG emissions over conventional treatment by an estimated 78% reduction of GHG emissions from current production.

In addition to GHG reduction achieved by carbon-neutral treatment of septage, the AACT system also produces other beneficial carbon-neutral by-products that further reduce GHG emissions, and potentially render the system as a whole carbon-negative. These additional by-products include: 1) heat in excess of what is needed to run the system and can then be used to create steam for industrial processes, generate electricity, or heat greenhouses for food production; 2) high quality fertilizer, which when produced by conventional means requires high input of natural gas and consequent high levels of GHG emissions; and 3) biochar produced by employment of the system further reduces GHG by sequestering carbon.

The AACT system has been demonstrated to work using wood waste as input. AACT has collaborated with a local, private logging and lumber company to construct a small-scale demonstration facility that uses wood waste from the lumber operations as the biomass input for the process. Preliminary results show that AACT's system can use wood waste to achieve the

additional by-products listed above. The estimated reduction in GHG emissions for the lumberyard operations upon employment of full-scale AACT facility for processing wood waste is estimated to be a 78% reduction of GHG emissions from current production.

The City of Kalispell requests funds through this Climate Showcase Communities grant proposal for the following activities:

1) Construction of a small-scale demonstration unit of the AACT system which will be used to:
    a. Determine operating parameters for the input of septage (rather than wood waste) for the AACT process; and
    b. Demonstrate the feasibility and performance of the process applied to the treatment of septage as a necessary preliminary step to construction of a full-scale facility.

2) Planning to be executed by the City of Kalispell and Flathead County of the administrative and legal framework required for the post-demonstration-of feasibility construction of a full-scale sewage treatment system that employs AACT's innovative zero-to negative carbon sewage treatment process. Key tasks include:
    a. Drafting and approving collaborative agreement(s) between the City and County for the project;
    b. Drafting and approving changes in regulations allowing the application of new technology for septage treatment.

Specific actions for demonstration of the AACT technology applied to the treatment of septage that will be the responsibility of AACT are:

1) Specify and construct a bench-scale (1-to-40 scale) demonstration facility for the AACT system in cooperation with Flathead Valley Community College;
2) Use the bench-scale facility to customize the process for the input of septage (rather than wood waste); and
3) Provide the analytical data from the demonstration unit updating estimates provided here with experimentally determined numbers for outputs and reduction in GHG and co-benefits.

Specific actions that the City of Kalispell and Flathead County will undertake and be responsible for completing are:

1) Preparing interlocal agreement(s) providing the legal framework for collaboration on a full-scale septage treatment facility;
2) Update regulations to allow for the new method of septage treatment;
3) Citing of large-scale facility; and
4) Planning and design related to project construction and implementation.

Scope of Work

The proposed project addresses the following priority areas and generates quantifiable GHG reductions as stated in Section I.B, Scope of Work:

- Energy performance in municipal operations (wastewater utilities)
- Solid waste management

The proposed project also accomplishes the following components identified in Section I.B, Scope of Work:

1) Achieves ongoing GHG reductions
2) Builds capacity with local agencies to address GHG emissions
3) Builds and leverages partnerships across multiple stakeholder groups
4) Links climate change initiatives with environmental, economic and health co-benefits
5) Creates a model of success that is broadly replicable

This proposed project is linked to broader climate management through "complementary activities" that the City and our community partners have completed, are in process of or are planning including:

- City of Kalispell Brownfield Redevelopment Program: through an EPA Brownfield Community-wide Assessment grant (funded 2009) provides Phase I/Phase II Environmental Site Assessments on a voluntary basis to property owners interested in redevelopment.
- City of Kalispell energy efficiency facility upgrades to City Hall and the Public Safety Building including energy saving improvements to lighting, roofing and HVAC systems.
- Flathead Valley Community College (FVCC) is incorporating alternative energy studies into its curriculum and in 2008 purchased two solar cells to expose students to the technology as a part of the Associate of Applied Science (AAS) and Certificate of Applied Science Electrical Technician (ET) programs. In 2009, FVCC purchased a small wind generator to serve as a student laboratory while helping provide power to part of FVCC's trades building. Additionally, FVCC has established a formal transfer program with the University of Montana's Energy Technology and Biomass baccalaureate program focusing on exploration of alternative energy systems.
- Flathead County and Flathead Electric Co-op have partnered to utilize methane gas created by rotting garbage at the public landfill to put energy back on the grid diversifying energy sources to meet the area's growing need. This is the first such effort in Montana.
- Re-Powering the Flathead for a New Energy Economy has formed as a grassroots organization in the last year to support energy efficiency and the use of renewable energy resources in order to achieve greater regional energy independence and sustain a healthy economy and environment in the Flathead Valley for current and future generations.
- Stoltze Land and Lumber Company is partnering with Flathead Electric Co-op to explore using biomass for heating fuel as another energy diversification effort reducing the need to purchase energy from the Bonneville Power Administration's hydro-electric plants.

All of these complementary activities are separate from the efforts described here as the proposed project and are *not* part of the submitted project cost-match.

In addition, this project proposal includes activities that are within the statutory terms of EPA's financial assistance authority under the Climate Showcase Communities authorizing statute, Public Law 111-88, and will be used to support direct costs of planning and demonstration activities.

GHG Reduction Potential

This project specifically addresses the Environmental Protection Agency's (EPA) Strategic Plan Goal 1, "Clean Air and Global Climate Change—Protect and improve the air so it is healthy to breathe and risks to human health and the environment are reduced. Reduce greenhouse gas intensity by enhancing partnerships with businesses and other sectors."

The components of and the estimated amount of direct GHG reductions from the proposed project are shown in the table below. Note that the table includes an estimate of GHG reductions of both the small-scale demonstration facility proposed here and also of the full-scale facility, while not a funded portion of the project proposed, which is the ultimate goal of completing this project.

Capacity and Partnerships

The proposed project builds capacity within the City of Kalispell and Flathead County for reducing GHG by providing a source of revenue to be earmarked for further energy efficiency and clean energy projects to be undertaken by these units of local government. One specific source of revenue generated by this project is organic, weed-free fertilizer that is produced as a by-product of the AACT treatment process which can be sold through a retail partner.

A key partnership developed as part of the project proposed here is that between the City of Kalispell and Flathead County. Disposal of septage from private septic systems in the Flathead Valley is technically under the jurisdiction of the County, but because the practice of land spreading may soon not be a viable disposal method, the "County's" problem may impact the City. Specifically, the City may be called upon to treat the septage at its wastewater treatment facility, which does not have the capacity to take on this additional, concentrated waste. The pro-active collaboration between the two units of government will establish the precedent and framework to build relationships that may be used as a model for additional collaboration on importance energy efficiency and clean energy projects in the future.

Co-benefits

The most important co-benefit of the proposed project is the solving of the environmental water quality and public health threat posed by the current disposal of raw septage by land spreading. Additional co-benefits are the cultivation of a green-energy company in an economically depressed area. The Flathead Valley is economically depressed as evidenced by an unemployment rate of 11.7 in May 2010 (nearly 2 percentage points higher than the national rate) and the highest rate of residential foreclosures in the state of Montana. The City's long-

term vision for economic development is to create a hub of entrepreneurial ventures in green and emerging technologies and to provide good jobs in a growing market.

Replicability

Disposal of septage is a global problem. By demonstrating carbon-neutral sewage treatment through AACT's Green Power House Technology™ in this project, the technology may be deployed throughout the U.S. as a multi-pronged tool for reduction of GHG, including: turning septage treatment from an energy-using to a net energy-producing process, sequestering carbon, funding additional energy conservation programs through fertilizer sales, and providing electrical power.

The AACT technology employed in the proposed project can be replicated in virtually any location throughout the country. Any location with sufficient sources of biomass, solar energy and water are prime site locations. And, the Green Power House ™ (GPG) system can be scaled to the site. A small system can be adapted to a rural agricultural community or a large scale system sited to utilize waste from a logging/lumber operation, sugar beet mill, petroleum refinery or coal fired facility. Even in the northern climate of Montana there is enough solar energy available to build a 5,000 sq ft or larger GPH system according to information from the National Renewable Energy Laboratory website www.energyatlas.org listing of solar insulation (a measure of incoming BTU load/square foot of surface area).

AACT systems use off-the-shelf components such that all components within the GPH are standard and readily available. No exotic materials are used. The photo bioreactors (PBR) are ground-level ponds with clear covers. Anaerobic bioreactors (ABR) are steel tanks. PBRs and ABRs are connected by plastic and transfer pumps. Measuring instruments and the AACT intelligent agent-based controls complete the system.

2. Environmental Results—Outcomes, Outputs and Performance Measures

Greenhouse Gas Reduction

Direct GHG reduction	**Input metric to calculate GHG reduction for small/large-scale facility**	**GHG reduction calculation method**	**Est. GHG reduction small-scale facility**	**Est. GHG reduction large-scale facility**
Carbon-neutral processing of septage	9350 gallons/week of septage for small-scale facility and 187,000 gallons/week of septage for large-scale facility	GHG Reduction estimated equal to tons of sewage treated by carbon neutral AACT process multiplied by average GHG released by conventional sewage treatment 78% est. reduction	Mitigates 78%; 4 metric tons/year of carbon	Mitigates 78% of 40 metric tons/year of carbon
Carbon-neutral generation of electricity from biogas	Kw hours: Small System—12,165 Kw Large System—1,216 Kw	GHG Reduction estimated equal to kw hours generated by carbon-neutral AACT process multiplied by average GHG produced by coal-/natural gas fired power plant. Both are typical electrical generation processes.	GHGs generated by carbon-neutral conversion of septage gas to electricity are recycled and consumed by process. Unlike traditional generation, carbon-neutral system recycles CO2 as process input and sequesters it in produced fertilizers	GHGs generated by the carbon-neutral conversion of septage gasses to electricity by process. Unlike traditional generation, carbon-neutral system recycles CO2 as process input and sequesters it in produced fertilizers.
Carbon-neutral processing of solids from City of Kalispell wastewater treatment plant	116 tons of solid waste diverted from the landfill from small-scale facility/large scale facility diverts 1160 tons per year from landfill	Reduction in GHG equal to tons of solid waste diverted multiplied by average GHG associated with solid waste per ton disposed of in landfill		

Carbon sequestered in biochar produced	56.7 metric tons/year of biochar produced by small-scale facility/large-scale facility	56.7 metric tons/year of carbon sequestered per ton biomass processed multiplied by GHG reduction per ton of carbon		

Co-benefits

Below is a table showing the additional, significant indirect GHG reductions that are achieved indirectly from employment of the AACT process to treating septage and solids.

Indirect GHG reduction	**Input metric to calculate GHG reduction for small-scale facility/ large-scale facility**	**Method employed to estimate GHG reduction**	**Est. GHG reduction for small-scale demonstration facility**	**Est. GHG reduction for large-scale facility**
Carbon-neutral production of fertilizer	Tons fertilizer produced by small-scale: 121.4 metric tons/year. Large-scale facility: 1214 metric tons/year. The process consumes GHGs produced by process	Tons fertilizer produced * GHG associated with conventional fertilizer production (cubic feet natural gas/ton anhydrous ammonia): 37.5 cubic feet natural gas /ton anhydrous ammonia	Offset for Small-scale: 121.4*37500=4,552,500 cubic feet of natural gas are NOT consumed	Offset for Large-scale: 1214*37500= 45,520,000 cubic feet of natural gas are NOT consumed
Local food production	$6/sq ft of production @ 3 cycles of production per year. Small-scale: 2040 sq ft*6$/sq ft=$12,240/year. Large-scale: 10X, or $122,240/year.	Small system: 3735 lbs CO2 per truck load GHG avoided by trucking in area non-local produce (50 mile radius). Large system: 37,350 lbs CO2 per truck load GHG avoided by trucking into area of non-local produce (500 mile radius)	Small system CO2 savings: 3,696.75 lbs	Large system CO2 savings: 36,967.55 lbs

The potential funding for additional green energy and energy efficiency projects is estimated as follows:

Est. tons of septage input:	**Est. tons of fertilizer generated:**	**Retail value per ton of fertilizer**	**Revenue generated through fertilizer sales**
Small system: 30,465 Large system: 304,650	Small system: 1295 Large system: 129,500	$125/ton wholesale	Small system: $161,875 Large system: $1,618,750

Expected quantitative and qualitative outcomes specific to GHG reductions and co-benefits were detailed in the charts earlier in this proposal. Below are descriptions of the performance measures and plans to be employed to measure, track and document progress toward achieving outputs and outcomes.

Outcome/Output related to co-benefit	**Performance Measure**	**Plan for tracking and measuring progress**	**Form of reporting on progress**
Environmental and public health benefit of avoidance of disposal of raw septage through land spreading	Experimental verification of adequate capacity and performance in septage treatment by the AACT process	Perform trials of capacity for septage treatment and quality of treatment for experimental verification of the ability of the process to process the amount of raw septage generated by the county and produce benign outputs	Environmental and public health benefit of avoidance of disposal of raw septage through land spreading
Financing for additional energy conservation and green energy projects through profit generated from fertilizer sales	Experimental measurement of quality and quantity of fertilizer produced by AACT treatment system	AACT staff conduct experiments	AACT staff prepare reports
Entrepreneurship in the area of green technologies and jobs fostered	Success in the demonstration facility opening up additional markets for AACT startup company	PR generated by the project and interest and inquiries generated by the project from other municipalities or local units of government	Reporting by AACT staff on the benefits of the project on company growth and increase in jobs

Demonstration facility engages local community college (FVCC) in economic development and job training for green jobs	Number of FVCC students participating in the demonstration facility in the areas of process engineering, software/control system development, or chemical analysis	FVCC maintains records of use of the demonstration facility for educational and vocational training	FVCC liaison prepares report on educational and vocational uses of the demonstration facility

3. Past Performance—Programmatic Capability and Reporting on Environmental Results

Completion of and Reporting Compliance with Assistance Agreements

Assistance Agreements				
Project	**Date Awarded**	**Amount Awarded**	**Grant**	• **Reporting requirements met?** • **Acceptable final technical reports?**
Public Safety Building Energy Efficiency Retrofit	June 2010	$103,300	Montana DEQ, Energy Efficiency Block Grant	• All reporting requirements met to date. • No final technical reports completed to date.
Public Safety Building Energy Efficiency Retrofit	Sept 2009	$96,700	US DOE, Energy Efficiency Block Grant	• All reporting requirements met to date. • No final technical reports completed to date.
Core Revitalization Project	October 2009	$400,000	US EPA Brownfield Community-Wide Assess. Grant	• All reporting requirements met to date. • No final technical reports completed to date.
Woodland Park Pond Remediation	June 2009	$20,000	MT Dept of Natural Resources and Conservation Renewable Resource Grant	• All reporting requirements completed. • Final technical reports completed as required.
Wastewater Treatment Plant Preliminary Engineering Report	2002	$20,000	MT CDBG Planning Grant	• All reporting requirements completed. • Final technical reports completed as required.

Organizational Plan to Achieve Project Objectives--Timeline

Year 1:

Step 1: a) Develop/execute partnership agreement between City and County
Step 2: a) Identify site at FVCC for locating small-scale facility
b) Construct small-scale facility
c) Conduct small-scale testing
d) Develop testing needs for materials from septage sources
Step 3: a) State level regulatory changes on septage disposal
Step 4: a) Develop County enforcement regulations
b) Implement County enforcement regulations
Step 5: a) Determine intergovernmental roles and responsibilities, including: Siting facility, ownership, operational responsibility, financing
Step 6: a) Determine outcomes and feasibility

Year 2:

Step 1: a) Issue Request for Proposals for facility design
Step 2: a) Financing process/documents
Step 3: a) Licensing, permitting, partnership agreements
Step 4: a) Large-scale facility construction

Year 3:

Continuation of Year 2, Step 4 through facility completion and commencement of operations.

The chart below indicates phasing of project activities for each year by month starting in February 2011.

Year One	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**
Step 1, a	x	x	x																					
Step 2, a	x	x	x	x	x																			
Step 2, b					x	x	x	x	x															
Step 2, c					x	x	x	x	x	x	x	x												
Step 2, d	x	x	x	x	x	x	x	x	x															
Step 3, a	x	x	x	x	x	x	x	x																
Step 4, a	x	x	x	x	x	x	x	x	x	x	x	x												
Step 4, b												x	x	x	x	x	x	x	x	x	x	x	x	x
Step 5, a						x	x	x	x	x	x	x	x	x	x									
Step 6, a												x	x	x	x									
Year Two																								
Step 1, a													x	x	x	x	x	x						
Step 2, a															x	x	x	x	x	x				
Step 3, a														x	x	x	x	x	x	x	x	x	x	x
Step 4, a																								x

Staff Qualifications

The project is broken into two components: Planning (led by City of Kalispell City Manager, Jane Howington) and Demonstration (led by the AACT Vice President of Engineering, John Murdock and CEO Michael Smith). See resumes attached.

4. Detailed Budget Narrative

Narrative
Attached to this document is SF424A, pages 1 and 2; Budget Information—Non-Construction Programs.

The proposed project is divided into three years per the funding period and according to required tasks. Year one funds will be dedicated to confirming the operational model. Year two proposes the transition from project demonstration to full scale operations. The final year, year three, is commencement of operations.

Year one expenses are highest because of start-up costs for the initial modeling (private side component) to demonstrate the commercialization of the research.

Calculations for construction, equipment and supplies in Year One are based on the construction of a 5,000 square foot, small-scale facility that will complete the demonstration portion of the project.

Grant Program Function or Activity

1. Demonstration and Testing: the majority of AACT participation will occur throughout this function as their innovative process is refined for the application to septage.
2. Partner Agreements: this function will develop the regulatory modifications necessary for successful implementation. Interlocal agreements will also be delineated in this phase.
3. Facility Siting: Planning, engineering and design of full-scale operation facility.
4. Business Model: Development of financial pro-forma (sources and uses of funds) and operational roles and responsibilities.

Object Class Categories
Personnel costs include City, County and AACT staff throughout the three year grant period. Fringe benefits are calculated between 20% and 25% of Personnel costs depending on the organization.

Travel is budgeted to cover annual Climate Showcase Communities training and is estimated based on registration, flight, hotel, and per diem costs that would be the case in 2010 where the event is held in Washington, D.C., since future training locations are yet to be determined.

Equipment is calculated as above and is required in the first year.

Supplies, much like equipment, are most needed in the first year of the project to enable the demonstration. Examples of which include: a fuel cell, generator, digestors.

Contractual costs are associated with the development of interlocal agreements between units of local government as well as technical assistance in modifying the regulatory requirements that govern septage disposal. This category also includes the Project Manager's services.

Other cost constitutes the value of land located on Flathead Valley Community College campus donated for the purpose of siting the small-scale demonstration facility.

The proposed budget is for a total project cost of $1,155,000 excluding the value of the Year Three construction to be financed by the applicant and partners. The total project request to EPA Climate Showcase Communities is $500,000 and is leveraged by the applicant and partners through in-kind matching contributions of $333,070 in Year One and another $322,000 in Year Two.