



1202 Musser Street  
Muscatine, IA 52761-1645  
(563) 263-2752  
Fax (563) 263-3720

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**WATER POLLUTION CONTROL**

**MEMORANDUM**

To: Gregg Mandsager, City Administrator

CC: Nancy Lueck, Finance Director  
Cinda Hilger, Administrative Secretary

From: Jon Koch, WPCP Director

Date: January 29, 2018

Re: ISU Biogas Production Study

**INTRODUCTION:** The Water Pollution Control Plant (WPCP) has partnered with Iowa State University (ISU) and CIRAS (Center for Industrial Research and Service) from the ISU Office of Economic Development to study the biogas production from several feedstocks available in the area. The proposed study is \$21,334.00 with half being paid by CIRAS and half being paid from the operations budget of the WPCP.

**BACKGROUND:** The new MARRVE (Muscatine Area Resource Recovery for Vehicles and Energy) project will be receiving waste food from multiple sources. While it is known that food waste will increase methane (biogas) production in digesters and generate more revenue, certain wastes are more compatible and beneficial than others. This study is proposed to identify the best feedstocks for the digesters and determine how much biogas production can be anticipated. The food waste composition fluctuates widely in terms of chemical compositions, pH, alkalinity, etc. This study will bench test these wastes to avoid failures in the digesters. The optimal blending ratio of food waste to regular municipal processes is unknown and needs to be studied case by case. This will allow for a more accurate cost benefit analysis for selling the gas in the next phase of the project and protect the digesters from upset.

**RECOMMENDATION/RATIONALE:** WPCP staff recommends approval of the Biogas Production Study proposal from ISU for \$21,334.00 with \$10,666.00 being paid by CIRAS and \$10,668 being paid by the WPCP.

**BACKGROUND:**

1. CIRAS Proposal

**"I remember Muscatine for its sunsets. I have never seen any  
on either side of the ocean that equaled them" — Mark Twain**

**Proposal Date:** January 18, 2018

**Project Title:** Food Waste Anaerobic Digestion in Muscatine Water Pollution Control Plant

**Proposal #:** P- 2018-021

**Proposal for:** Jon Koch  
Muscatine Water Pollution Control Plant  
1202 Musser Street  
Muscatine, IA 52761  
563.263.2752  
[jkoch@muscatineiowa.gov](mailto:jkoch@muscatineiowa.gov)

**CIRAS Contact**

**Brian Muff**  
Project Manager  
Economic Development Core Facility  
Suite 2300  
1805 Collaboration Place  
Iowa State University  
Ames, IA 50010  
Phone: 515.520.1033  
Fax: 515.598.7739  
[bmuff@iastate.edu](mailto:bmuff@iastate.edu)

**PROPOSAL****Background:**

Muscatine Water Pollution Control Plant (WPCP) is planning to receive the food wastes from several large food companies in the sounding area and co-mingle with the primary clarifier raw sludge and waste activated sludge (RAW/WAS) as feedstock for anaerobic digestion (AD). However, there are several uncertainties for the AD process when food wastes are used as feedstock. The food waste composition fluctuates widely in terms of TS/VS content, chemical compositions, pH and alkalinity, which result in a wide variation of biogas production potential. In general, an AD process occurs through two sequential stages. The first stage is acidogenesis, in which acidogen bacteria break down organic materials into volatile fatty acids (VFA). The second stage is methanogenesis, in which methanogen bacteria utilize the VFA to produce methane. A balanced acidogenesis and methanogenesis is crucial for a successful AD. Most food wastes, however, contain a large portion of "readily-digestible" organic matters (proteins, starch, lipid), which means that the acidogenesis may convert those organic matters into VFA too quickly to be utilized by the methanogen bacteria. As a result, the digestion materials will become too "acidic", which inhibits the methanogens and eventually causes digester crush. This imbalance between acidogenesis and methanogenesis is a common problem observed in food waste AD. Blending food waste with RAW/WAS can alleviate this problem, but the optimal blending ratio of food waste vs. RAW/WAS is unknown and needs to be studied case by case.

**Objective & Financial Impact:**

Based on a "Business Insider" report, a third of the planet's food goes to waste. Based on the percentage of the materials that go to the waste, food wastes can be categorized as follows: milk, yogurt and cheeses (17.1%); chicken, beef and pork (21.5%); lentils, green peas, chickpeas, and seeds that make oil (22.1%); cereal, bread, and rice (29.1%); tuna, salmon, shrimp, and other seafood (34.7%); fruits and vegetables (45.7%); and potatoes, beets, radishes, and carrots (46.2%) (<http://www.businessinsider.com/food-world-wastes-most-2016-10>).

Considering such diverse characteristics of food waste materials, it is not realistic to study AD of each single stream of the food waste. Also, the selection of the materials to be used in this project needs to accommodate the logistics and transport of the materials to Muscatine WPCP.

Based on this requirement, we will use the database of the companies in Muscatine sounding area within 100 miles radius (See the attached data base) and the Iowa Waste Exchange website (<https://programs.iowadnr.gov/iwe/searchmaterials.aspx>), as well as recommendations from Muscatine WPCP to select a total of 10 companies and their waste materials to work with.



The City of Muscatine is seeking to begin a new program of organic solid waste collection to produce renewable natural gas, reduce landfilling and generate new revenue streams. Financial impacts have been estimated at \$500,000 in tipping fees and potential \$1.2 million in gas sales/renewable energy credit sales (RINs).

**Statement of Work to be performed by ISU:**

This project will include two stages. In Stage One, ISU researchers will use “artificial” food waste by blending different sources of food to mimic the food waste materials. The blending ratio of these “artificial” waste materials will be at an approximate ratio of the food waste mixture commonly found in the food companies. The biogas production performance of these “artificial” food waste materials will be evaluated. In Stage Two, the “real” food waste materials collected from the food companies will be used to validate the results obtained in Stage One.

**Stage One:** The project investigators will use multiple CSTR (continuous-stir-tank-reactor) at ISU research facility to mimic the circular digesters in Muscatine WPCP. The working volume of the CSTR is 10-L. The CSTR will be operated at a one-a-day feeding/discharging mode with a hydraulic retention time (HRT) of 15 days. For each type of food waste (ketchup sauces, fruit and vegetable waste, and FOG), the material will be blended with the RAW/WAS at three ratios 1:1; 1:2 and 2:1 (w/w). Therefore, there will be a total 9 sets of experiments. For each set of experiment, the reactor will be operated to reach steady state, at which the following parameters will be analyzed: daily biogas production, methane content, COD/ammonia/total nitrogen of influent and effluents. Once these performance parameters are obtained, the researchers will then mix all the three types materials and blende with RAW/WAS to re-perform AD, the mixing ratio of the three types of food waste materials will be determined based on the individual materials AD performance results. In this stage, the RAW/WAS will be taken from Ames WPCP for convenience reasons.

**Stage Two:** ISU will use the “real” food wastes collected from Muscatine WPCP to perform the AD. The HRT will still be 15 days. The ratio of these food wastes to RAW/WAS will depend on the Stage One results, i.e., the ratio resulting in the best biogas production will be used in this stage. The AD performance will be evaluated using the same parameters determined in Stage one. In this stage, the RAW/WAS will be taken from Muscatine WPCP.

**Time Period for Performing Services:**

The project is anticipated to be four-month period, including three-month experiment work, and one month of data summary and reporting.

**COMPANY Responsibilities:**

The City of Muscatine will be responsible for delivering all samples to ISU for this project.

COMPANY will assist ISU in the development of a success story based on testimonial, case study and impact results of project to help illustrate and explain educational programs and the impact of Iowa State University and CIRAS in publications such as economic development annual reports, as well as CIRAS News.

Upon completion of the project, the COMPANY will complete a satisfaction and preliminary impact evaluation, and some months later (up to 18), a final impact evaluation will be completed.

**Description of Results to be provided by ISU:**

At the end of the project, CIRAS/ISU will submit a comprehensive report to City of Muscatine. The report will include (1) the rationale why specific food waste materials were chosen, (2) the total biogas production potential and the methane content of the biogas when these food waste materials are digested, and (3) the perspective of using those materials for the City to use in their AD process.

**Project Fee:**

<b>Project Price</b>	<b>\$21,334</b>
<b>CIRAS Funding</b>	<b>\$10,666</b>



<b>Final Price</b>	<b>\$10,668</b>
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If the COMPANY is not fully satisfied with the project, CIRAS will refund any amount paid to date and cancel outstanding invoices.

ISU shall issue an invoice or invoices to COMPANY, and COMPANY shall pay such invoices within thirty days of receipt. Checks should be made payable to Iowa State University of Science and Technology. COMPANY shall submit the payments to ISU at the following address:

Iowa State University  
 CIRAS ATTN: Accounts Receivable  
 Economic Development Core Facility  
 1805 Collaboration Place, Suite 2300  
 Ames, Iowa 50010

This proposal is valid as written for 30 days from the Proposal Date.

The products and services outlined in this proposal are subject to the terms and conditions provided in the CIRAS Terms of Service (<https://goo.gl/WJT71A>). Company must acknowledge these online prior to CIRAS executing the contract.

**Accepted by:**

To accept this proposal, sign and date below and deliver it to: Brian Muff by hard copy, fax, or emailing a scanned copy. If a hard copy or fax is sent, please also email a notification when the document is sent.

\_\_\_\_\_  
 Authorized Client Representative

Date: \_\_\_\_\_

Name: \_\_\_\_\_

Title: \_\_\_\_\_

\_\_\_\_\_  
 Mike O'Donnell, MEP Program Director, CIRAS

Date: \_\_\_\_\_