HERC/IGEM Project

Yr 2: 6 month Progress Report

Project Title:	Sustaining the Competitiveness of the Food Industry in Southern Idaho: Integrated Water, Energy and Waste Management
Principal Investigator:	Dr. Karen Humes
Institution:	University of Idaho (lead) with subcontracts to Boise State University and Idaho State University
Grant Number:	IGEM19-001
Award Amount:	$700,000
Fiscal Period:	July 1, 2019 – June 30, 2020
Progress Report Submitted to SBOE:	January 1, 2020
Reporting Period:	July 1, 2019 – Dec 31, 2019

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1) Summary of project accomplishments for reporting period and Plans for remainder of Yr 2:

The accomplishments and plans for the four primary tasks identified in the original proposal are summarized here (Tasks A-D). A summary of accomplishments for the overall project management and coordinated stakeholder engagement activities are also summarized below, listed as Task E.

The team would like to stress that our partnerships with producers, processors, municipal treatment personnel and water management entities (private and public) are fundamental to all of our tasks and our project as a whole. Our Yr 2 activities have been influenced and enhanced by interactions with our Stakeholder Advisory Board (described in more detail under Task E below) and interactions with other stakeholders as well.

Task A) Recovery of energy, nutrients, water and bioproducts from waste streams: bench to place-based pilot projects

Team: Erik Coats (UI, environmental engineering/molecular biology; emphasis on resource recovery from waste streams); Armando McDonald (UI, biomass conversion and bioproducts); Kevin Feris (BSU, algae-based resource recovery and microbial ecology))

Team background and overall goals:

This team collaborated for 10+ years and has the required multidisciplinary experience to integrate biological, chemical, physical and thermal approaches to the recovery of energy, bioproducts and nutrients from multiple waste streams. The team is leveraging investments made by the INL, CAES, HERC, and the IGEM incubation fund. Over the last 10 years our efforts have resulted in multiple extramurally funded awards, student training opportunities, scientific publications and a pending patent. We have worked across bench and pilot scales. Recent support from SBOE HERC allowed us to build a pilot scale system to convert dairy waste to value added products (biogas, bio-plastic, algal biomass); previous HERC funding supported construction of two pilot systems at UI by Dr. Coats–one located at the Moscow WWTP, designed for municipal wastewater and one mobile system (24 ft. trailer) designed for dairy manure resource recovery. We are engaged in testing, validating, and extending these systems to evaluate opportunities to recover high-value products (bioplastics, algae, biofuels) from industrial/municipal wastewater while achieving treatment. Research is focused on further understanding/optimizing our integrated system to maximize utility across input streams and demonstrate "real-world" applicability. Research objectives will further technology interrogations and advance wastewater as an economic resource. Ultimately, research will advance solutions that can be applied in Idaho agricultural and food processing sectors; producing economic value from waste will enhance Idaho-based industries by diversifying product portfolios.

Accomplishments this reporting period:

The following provides detail of progress in the first half of Year 2, building from Year 1 successes, towards the aims described in the original proposal.

i. Bench scale: Assess and evaluate nutrient recovery, energy reduction, bioplastics production, and algal production strategies to inform pilot scale operations.

a) Assessment of optimal process sequences (biological, chemical, physical, thermal) to recover energy, bioproducts (biofuels; bioplastics) and nutrients from mixed waste.

- (Coats) Bench-scale bioreactor operations continue to be operated and evaluated. One current focus is analysis of process "success" vs. "failure." Stable operations of any resource recovery system at full scale demands intrinsic knowledge on what constitutes stable operation, and how unstable, or "failed," operations might be recovered. Investigations are being conducted using macro- and molecular-level methods.
- (Coats) Phosphorus recovery from wastewater is most sustainably and reliably achieved through a process known as enhanced biological phosphorus removal, EBPR. Bench-scale EBPR operations are ongoing, with a focus on ascertaining the effects of key process operational criteria on maximal P recovery. Building from past research efforts, current investigations are focused on two operational scenarios that integrate a new operational strategy. One operational scenario feeds all wastewater to the bioreactor at one time (beginning of the cycle), while the 2nd strategy feeds a more targeted, controlled wastewater (VFA-rich fermenter liquor) at the beginning of the cycle and then the raw wastewater stream at the end of the anaerobic period. The former operational strategy is identified as the A/O process, while the latter is known as the Westbank process. The central question relates to understanding the effect of adding VFAs outside of the anaerobic period. The new operational strategy employed involves oxidation-reduction (redox) control of the anaerobic period. Research suggests that "deep anaerobic" conditions can enhance and stabilize EBPR; we are utilizing real-time redox process control to further evaluate this operational strategy and its impact on operational "success" vs. "failure." Results will ultimately inform pilot (2020) and full scale operations.
- (Coats) Another current focus is on achieving stable nitritation in an activated sludge wastewater treatment system achieving carbon, ammonia-N, nitrite-N, nitrate-N, and phosphorus removal. Nitritation is a biological process whereby ammonia-N is oxidized only to nitrite. Process success will result in significant energy savings in wastewater treatment. Process success was realized at both bench and pilot scale in 2019; results are being reviewed to inform 2020 pilot operations.
- Complementing the nitritation research are efforts to understand and better characterize denitritation, with the aim to further optimize the EBPR process for energy efficient nutrient recovery. Nitrate is a contaminant of concern in drinking water, and often must be removed from wastewater prior to discharge to the water environment. A primary concern with conventional EBPR processes that integrate nitrite/nitrate reduction is the potential production of nitrous oxide, which is a very potent greenhouse gas (300X CO_2). Bacteria exhibit variable metabolic pathways to reduce nitrate vs. nitrite; some bacteria cannot reduce nitrate to nitrite, which requires a more complex microbial culture to successfully eliminate nitrate from the wastewater. Ongoing efforts by one of Coats' PhD students is centered on better understanding the metabolic capabilities of bacteria and how they reduce nitrate vs. nitrite.

- One of Coats' PhD students conducted intense evaluations of the dairy-based PHA pilot in Y1/Y2, with very successful results. Ongoing efforts are focused on finalizing and submitting a peer-reviewed journal manuscript that details the results from these investigations. The manuscript includes numerous team members, including McDonald's research team. Coupled with results from a graduating MS student (funded through other means), plans will be developed in the 2nd half of year 2 to i) execute new bench-scale investigations, and ii) develop plans for summer 2020 pilot scale operations.
- Algal cultivars continue to be used for routine experimental deployment. On-going experiments are focused on cultivation at both bench and pilot scales employing wastewaters from multiple sources (e.g. currently dairy and municipal provided by the Coats lab and the City of Boise) to maximize nutrient capture and algal biomass production. Bench scale experiments are identifying which strains produce optimal levels of biomass under various cultivation conditions. Current bench scale experiments are assessing the utility of municipal sourced struvite to cultivate high value algal biomass under controlled conditions, while simultaneously capturing struvite sourced nutrients (e.g. nitrogen (N) and phosphorus (P)). Specifically, we are testing three algal strains known to produce high concentrations of omega-3 fatty acids under the proper cultivation conditions (i.e. *Chlamydomonas reinhardtii*, *Nannochloropsis oculata*, and *Paeodactylum tricornutum*). These data suggest that certain modifications to the cultivation conditions are required to obtain significant levels of growth when using struvite as the primary nutrient source. These experiments not only direct future work for optimization of algal cultivation on municipal struvite, but are also potentially applicable to struvite produced from agricultural resource recovery systems. As we hone our understanding of what cultivation media factors and growth conditions are required to maximize growth and high value biomass production we will then scaled these experiments up to pilot scales to evaluate high-value algae production at these larger scales.

  Separate cultivation experiments are planned for Fall 2019/Spring 2020 that will pursue mixed-culture approaches for the capture of nutrients from liquid wastewaters. Biomass from these experiments will subsequently provide algae biomass for HTL processing by the McDonald lab. Nutrients captured from the HTL processing of algal biomass will then be tested as inputs to a struvite production system (either via modeling or bench scale struvite production). Struvite produced in this way will then either be tested similar to the municipal struvite experiments described above or analyzed for mineral content to allow accurate estimate of the utility of the algae-capture nutrients purified by struvite production. Based on this suite of experiments we will determine the most appropriate mechanism for algal cultivation and nutrient source in our integrated system. Additional experiments in year 2 and 3 will continue testing of individual or consortia of algal strains previously selected based on their ability to grow in the selected wastewater streams and based on their growth rates, yields, and nutrient capture rates. As noted above these experiments will also be informed by the biomass characteristics and subsequent estimates of economic potential of algae cultivated in struvite that we are currently working towards acquiring. We expect to have some biomass characteristics data acquired during the second half of year 2. However, this effort will continue into year 3.

ii. Pilot scale assessments: Conduct pilot scale evaluations from mixed waste streams; implement/evaluate treatment resource recovery processes.

- Both Coats' pilot systems were made fully operational in Y1, with operations extended into Y2. Coats' research team was fully trained on systems operation.
- Completed hypothetical re-configuration of the Twin Falls wastewater treatment plant to integrate proximate waste streams and achieve resource recovery. Analyses were conducted using SUMO process modeling software by Dynamita. Results will inform Coats' 2020 scale model operations (dairy PHA system; municipal EBPR/nitritation system).
- Completed 2019 operations of Coats' pilot operations at the UI dairy (PHA pilot) and at the city of Moscow, Idaho (EBPR/nitritation pilot). Former efforts were intensively focused on collecting data to facilitate ultimate transition to a full scale system; ongoing data interrogation is informing and being integrated into a journal manuscript. Moreover, PHA pilot data greatly informed potential future scale-up to commercial operations, and the team is evaluating potential new funding opportunities to make the transition to commercialization. Latter efforts focused on preliminary assessment of integrated EBPR-nitritation, with an emphasis on integrating ammonia-based aeration control (ABAC) to enhance nitritation over nitrification. Successful nitritation was achieved for the entire month of August 2019 (early Y2); data evaluation is ongoing, with the aim to inform 2020 pilot operations.
- The initial pilot scale greenhouse systems have been constructed at the Boise State research greenhouse and are being tested for suitability for cultivation of multiple strains. New equipment required for initiation of the greenhouse scale experiments (i.e. a 20L flow through centrifuge) has been purchased and installed in the Boise State greenhouse. Installation and safety checking of the centrifuge has taken longer than expected and has affected the rate of optimization of operational conditions. However, we expect final installation and testing of the centrifuge to be completed by December 2019 and we will initiate greenhouse scale experiments soon thereafter. We expect the proposed greenhouse scale experiments for year 2 to still be completable, however the data collection and analysis may be delayed until the start of year 3. We will do our best to accelerate the rate of these experiments to facilitate our ability to inform decisions about which types of algal cultivation systems to couple with the AD/PHA aspects of our integrated system. Currently, laboratory scale experiments are being utilized to further refine which algal cultivars/species to employ in our greenhouse and pilot-scale tests. We will continue to operate the pilot scale algal cultivation systems through 2020 in collaboration with the Coats and McDonald labs at UI.

iii. Produce prototype products (bioplastic mulch film, biochar, biofuel) for evaluation.

- One PhD student has been working on extracting and isolating pure PHA bioplastic generated from eight trials on the pilot plant over 84 days of operation. Each batch of PHA was produced under slightly different operating conditions (see section ii). The eight batches of the purified PHA bioplastic are being characterized for their thermal and rheological properties in order to determine their suitability for producing bioplastic films.
- With the on-ramping of the greenhouse scale experiments in Fall 2019/Spring 2020 in the Feris lab we will begin to produce suitable quantities of algal biomass for use in HTL

experiments by the McDonald lab. Primary outputs of HTL processing of algal biomass will include biofuel (i.e. biooil), biochar, and aqueous phase nutrients. The aqueous phase will be recycled to the algal cultivation system to enhance algal biomass production.

iv. Partnerships with producers, processors and municipal treatment personnel are fundamental to all of these tasks. Team will build on existing relationships with Twin Falls wastewater treatment facility, Food Northwest, Chobani, Amalgamated Sugar, J.R. Simplot, Idaho Dairymen's Association, and Glanbia, and expand to new partners throughout this project

- We held our initial Stakeholder Advisory Group (SAG) meeting on May 3rd at the University of Idaho Water Center in Boise, Idaho. A primary component of the SAG feedback for the Task A team was to focus on demonstration of commercialize-able product production. We also had a deep conversation regarding the complexities of bringing new systems to market in complex regulatory environments. All of the stakeholders were strongly supportive of the proposed integrated goals of waste treatment and commodity production and pledged to help seek opportunities for the project team to introduce our proposed systems to key commercial partners and operators in the region.

Research plan adjustments in response to our Stakeholder Advisory Group (SAG): During year 1 of our project we had our first stakeholder advisory group (SAG) meeting in May 2019 and our second meeting Dec 2019. These meetings have been very valuable to help fine-tune the trajectory of some of our research tasks and for providing new opportunities to engage with a broader group of potential constituents in the agricultural industry. For example, based on feedback from our SAG the Feris lab adjusted the trajectory of our algal cultivation experiments to encompass studies that address the utility of struvite as a nutrient source for algal cultivation with the idea that these experiments have potential to more quickly develop a process that could become market ready. Additionally, our SAG engagement resulted in leadership from the Idaho Dairymen's Association inviting two members of our team (Feris, Coats) to the joint Idaho/Utah Dairymen's association meeting in Salt Lake City, UT in July 2019. This meeting provided an opportunity to further develop relationships with regional dairy producers and to introduce them to the potential outcomes of our project. Additionally, the Idaho Dairymen's Association networked Coats/Feris with Newtrient LLC (Steve Rowe, CEO). Newtrient is advancing an integrated set of technologies focused on achieving 'net zero' emissions from dairies. Discussions will continue with Newtrient to i) potentially ascertain how the PHA technology might be integrated, and ii) potentially collaborate on future commercialization funding.

One of our goals for year 2 of this project is to continue to build on these budding relationship with the hopes that they will blossom into partnerships for seeking pre-commercialization funding in year 3.

In addition, Dr. Feris will be taking a sabbatical leave during the second half of year 2 and will be dedicating a portion of his sabbatical time to the help forward the Task A team developments towards commercialization. Specific goals will include working to develop

relationships with the agricultural industry and local municipalities targeted towards future deployment of our pilot scale systems at potential partner locations in Idaho. Part of this work will include building upon the relationship building initiated during the July 2019 meeting.

Task B) Decision-support tools for industry and community leaders to quantify and visualize trade-offs among water, energy, land use and municipal growth

Team: Jae Ryu, UI, systems dynamics modeling, water resources; Karen Humes (UI, water/energy nexus, geospatial analysis

Overall Goals:

The goal of this task is to integrate energy components into an updated version of a pre-existing system dynamics model for water supply, use and flows in the region of the Eastern Snake Plain Aquifer. The model which will serve as a decision-support tool for stakeholders (including the food producers, food processors, irrigation districts, water and energy providers and municipal communities/citizens). The tool will quantify and provide users with visuals on the linkages between water, energy, land use and municipal growth, to be used for planning and decision-making by producers, water users, businesses, utilities, state agencies and communities.

Accomplishments this period:

- Improved the existing model of water supply/use to better incorporate the specific data needs and what options we can use for conservation scenarios given the existing data types.
- We developed a new graphical user interface based on the newly added Stella Architect modeling platform developed in Yr 1.
- Held a meeting with IDWR regarding their newest ESPAM model version and updated data needs.
- Began exploring management options to incorporate into the model, such as managed aquifer recharge (MAR) option which is the most active management option led by IDWR.
- Evaluated the feedback from IDWR and Surface Water User's Association at the stakeholder meetings in May 2019 and Dec 2019 and how the model could be more useful for stakeholders.
- Began analysis of energy use data associated with irrigation obtained from IDWR in Yr 1
- Further collaboration with experts from Idaho Power on energy use in irrigation in order to further analyze energy use data from across the
- Further evaluation of spatial patterns in energy use for irrigation in the ESPA and controlling factors in order to identify key variables to relate water and energy use in irrigation (i.e., crop type, irrigation system characteristics, water source, etc.)
- Readying the updated Stella Architect model on water use/supply to accept modifications relating water use to energy use.

Plans for remainder of Yr 2:

- Continue incorporating new features that are available in Stella Architect into the system dynamics model and user interface.

- Perform a quality analysis of the most recent data available from IDWR and complete the integration process to bring the model up to date.
- Continue coordinating with IDWR staff to incorporate the new data set from ESPAM version 2.2
- Continue updating management options (e.g., MAR) for stakeholders within Stella Architect modeling platforms to be more useful and help them explore their own management strategies.
- Develop system evaluation criteria associated with new data inputs and potential uses for the expanded and update model, such as system reliability, vulnerability, resilience, etc.
- Incorporate supply side scenarios to address the uncertainty of the water/energy nexus in the Eastern Snake Plain Aquifer (ESPA).
- Increase interaction with the water stakeholder groups to evaluate the ESPA modeling by adding several scenarios of interest from their perspectives, including climate variability and change.
- Offer a short course titled "System dynamics modeling and applications" for UI graduate student, local professionals, and interested groups. Note that this activity is also part of our workforce development tasks (described in Task D).
- Complete the analysis of energy use in irrigation and derive equations to be implemented in the systems dynamics model
- Complete first attempt at adding equations relating water and energy use into the Stella-based Systems Dynamics model of water use/supply.
- Submit draft of journal article describing the linkages between water and energy use in Idaho
- Continue to seek input from our Stakeholder Advisory Board and other water and energy providers, managers and community leaders on how to make the tool/model most useful to them.

Task C) Technical innovations/sensing systems to reduce water/energy/nutrient use in targeted production systems:

Primary team members: Donna Delparte, (ISU, drone and satellite-based sensing systems) and partners among growers and crop consultants.

Accomplishments this period:

Progress in the following task area has been made through the subcontract award to Idaho State University and included:

- **Goal 1 – Decision Support Systems**
    - Decision support online tool prototype for sustainable agriculture decisions making: https://avalanche.geology.isu.edu/i2i/osgood.html
    - This decision support tool was developed by working with stakeholders and our Advisory Board member (Brandon Vining, ProGro) to provide remote sensing data/tools to aid decision making that is relevant to business decision making and operations
    - Stakeholders are excited about the potential of the tool to improve ROI, reduce fertilizer inputs and improve precision farming techniques for sustainable agriculture

- **Goal 2 - Pilot projects to use drone-based, other field-based and satellite sensors to reduce water/nutrient/energy use in production of targeted crops**
    - Conducted remote sensing analysis to forecast yield for potato growers based on a growing season of high-resolution satellite imagery (submitted for publication in 2019 to *ASPRS Pecora Conference Proceedings* by Masters student)
    - Conducted thermal camera surveys of irrigated cropland using UAS in the 2019 growing season irrigation to assess efficiency and support water reduction efforts. Data collected and analysis in progress
    - Hyperspectral camera data collection during the 2019 growing season of potato crops to detect crop threats
    - PhD student conducted experiment to determine essential spectral signatures required to detect individual unhealthy plants in a growers field that leverages machine learning of hyperspectral imagery – thus offering the opportunity to reduce inputs for control and mitigation of disease.
    - Delparte launched a new Idaho based spin-off company (I2IGeo) to provide growers with technological innovations and decision support to assist their operations, leveraging the research outcomes from this grant.

Plans for next reporting period:

For the next reporting period, the team will focus on the continued development and testing of UAS platform and sensor combinations for data collection in the first half of the 2020 growing season, again in partnership with growers and crop consultants. Dr. Delparte will also continue to work actively toward commercialization of the most promising technologies from this research.

Task D) Engaging the present and future workforce in the adoption of new technologies

Team members for training (primary): Karen Humes, Erik Coats, Kevin Feris, and partners at CSI, UI Idaho Falls and professional organizations such as Food Northwest, *Primary team member for drone outreach activities:* Jae Ryu (Idaho Drone League (I-Drone), Founder).

Overall goals:

The overall goals in this task are two-fold: 1) to provide direct support to our stakeholders in the near-term by identifying workforce development needs that universities could plan and implement, together with partners at community colleges and professional organizations (resourced primarily in Yrs 2 and 3) and 2) contribute to longer-term workforce needs by holding outreach events designed to engage the future workforce in STEM activities that will serve the food industry in Idaho in the future, such as drone operations and the analysis of data from sensors onboard drones.

Accomplishments this period:

- Goal 1: Current/near-term workforce development needs
    - Engaged with a stakeholder (IDEQ) that approached us about workforce development needs and added a representative to our Stakeholder Advisory Board

- Discussion and initial planning for training sessions we could hold in coordination with the rural water treatment association meetings later in Yr 2 and in Yr 3.

- Goal 2:
  - Hosted a hands-on education program known as "Idaho Drone League(iDrone)" to promote STEM pipelines in the Treasure Valley and skills important to the Idaho food industry in the future.

Plans for latter half of Yr 2:

- Training session to be held in May 2019 in conjunction with the Rural Water Treatment association meetings
- Idaho Drone League event to be held in Twin Falls in June 2020. Event will include a table highlighting how drones can be used in food production (from Task C of this research)
- Continue to engage with our Stakeholder Advisory Board and professional organizations such as Food Northwest to identify and implement professional development needs in food, water, energy and waste and how the universities can catalyze and facilitate these.
- Continue to engage with other stakeholders such as the IDEQ on needs and opportunities in professional development on pollution control and management.

Task E) Project Management/Stakeholder Engagement

Background: An important element of our project management was to put together and meet regularly with an advisory board comprised of stakeholders in the food production and processing industries, water user groups and state agencies. In Year 1 we formed this advisory and had a very successful 1st meeting in person in Boise in early May 2019. As noted in the technical progress reports (earlier sections of this report), the board feedback influenced our research plans in Year 2, as planned. The board agreed to meet in it's entirety once/yr in person (Apr/May), once/yr via videoconference (Nov/Dec) and have specialized meetings between specific sub-groups of team and advisory board members in between.

Accomplishments this period:

- We held a 2nd meeting of our full Stakeholder Advisory Board (SAB) on Dec 17, 2019. As planned and discussed at our May meeting, the meeting was held by video, with 4-5 attendees in one conference room in The following SAB members attended and those listed with a (*) were invited and had hoped to attend but were not able to do so:
  - Jeff Bohlscheid, Senior Principal Scientist, J.R. Simplot Company
  - Shawn Moffitt, Regional Business Manager, Jacobs Engineering (contractor for City of Twin Falls and Chobani water treatment plants)
  - Bob Naerebout, Government Affairs and former Exec Director, Idaho Dairyman's Association and and Megan Satterwhite, Environmental Programs Director, IDA
  - Ben Nydegger, Biosolids Program Manager, City of Boise
  - Sean Vincent, Hydrology Section Manager, Idaho Dept of Water Resources

- Ben Jarvis, Pollution Prevention Projects Coordinator, Idaho Department of Environmental Quality
- Brian Olmstead*, President, Surface Water Appropriators and General Manager, Twin Falls Canal Company
- Brandon Vining*, ProGro Consulting

- The primary goal of this second meeting of our SAB was to update the SAB on our previous 6 months activities, particularly those things that had been prioritized or tweaked as a result of their feedback in May, and to gain more insight from them as to how we could make our research as useful to them as possible.
- PI Karen Humes and Co-I Erik Coats met individually with Ben Jarvis in Oct 2019 to discuss workforce training opportunities that could "piggyback" along with existing IDEQ events and/or professional meetings such as the Idaho Rural Water Association
- As described in some detail under our "Task A" Technical progress section above, two of our Co-Is (Coats and Feris) have done considerable outreach to the dairy industry in both Idaho and Utah, including presentations at the Utah Dairyman's Association in July 2019.
- We also established a cloud file storage space for our project (and shared it with the SAB) in which all presentations and notes from our SAB meetings are stored, along with our progress reports to the SBOE/HERC.
- In the way of other team management and organization among Co-Is at the multiple institutions, we have continued our monthly team meetings via videoconferencing.

<u>Plans for next reporting period:</u>

- Hold our spring SAB meeting in Apil or May 2019
- Continue to build on existing relationships with Twin Falls wastewater treatment facility, Food Northwest, Chobani, Amalgamated Sugar, J.R. Simplot, Idaho Dairymen's Association, and Glanbia, and expand to new partners throughout this project
- Continue to hold monthly team meetings to monitor progress and facilitate coordination of all project tasks and stakeholder engagement activities. In coming months these meetings will focus on student presentations of research.

2. Summary of budget expenditures thus far for Yr 1 (July 1, 2019 – June 30, 2020)

A detailed expenditure is provided in Section 6 below, but the table below summarizes the spending in the major budget categories, relative to the budgeted amounts in the original proposal. The expenditure report was run on Dec 18, 2019 and due to delays in invoicing from our partner institutions (primarily) and lag in payroll at the UI, the total expenditure amount now showing ($204,675.21), which translates to a "burn rate" of 29.2% thus far for Yr 2) is considerably less than the actual expenditures at this time. Additionally, our personnel time (both faculty and students) burns at its fastest rate in May/June as many of our faculty and students prepare for and implement field-based research in those months.

Yr 2: IGEM19-001 (Humes) Sustaining the Food Industry in Idaho: Food-Energy-Water-Waste

	Original Budgeted	Expensed 12/18/19		
Salaries:	182481	67732		
Fringe:	25045	8951		
Irregular Help	40000	28946		
Travel:	30000	9830		
OE:	55566	35300		
Participant Support*:				
<$5K Capital:	5500	2522		
>$5K non-capital:	15000	0		
Turstee/Benefits:	58973	23455		
Subawards/contract:	287435	27941		
Total award:	700000	204675	29.2%	Burn rate 12/18/19

*$13,066 budgeted in this category in original proposal will still be expended as indicated in the original budget justification (expenses for team and meetings and professional development events), but was shifted to OE upon budget set-up, per UI OSP advice about appropriate categories for these expenditures.

3. Demonstration of economic development/impact

- Patents, copyrights, Plant Variety Protection Certificates received or pending

Co-I Dr. Donna Delparte has formed a private company in Idaho and is working to develop a commercialization pathway for her research on this grant related to the use of satellite and drone technology to assist growers in the application of nutrients, herbicides, pesticides and water.

- Private sector engagement

Because every aspect of our work involves considerable private sector engagement, we have noted those engagements in each of our five tasks described in Section 1, particularly under *Task E: Project Management/Stakeholder Engagement.*

- Jobs created

Several of the university staff and all of student research assistantship positions described in the next section were newly created in Year 1 of this grant.

4. Numbers of faculty and student participation

In the first half of Yr 2, the numbers of faculty, students and other researchers participating are as follows:

Faculty:	6	(4 UI, 1 BSU, 1 ISU)
Graduate Students:	9	(6 UI, 3 ISU)
Undergrad Students:	4	(3 UI; 1 BSU)
Research Scientists:	4	(1 UI, 1 ISU, 2 BSU, all partially supported by this grant)

More details on staffing, by Task:

Task A: Recovery of energy, nutrients, water and bioproducts from waste streams

Coats staffing: 2 PhD students in Environmental Engineering; 1 MS student in Environmental Engineering; 2 undergraduate students in Environmental Engineering; 1 undergraduate student in Environmental Science; 1 research scientist. 3 women, 4 men.

McDonald staffing: 1 PhD student in Environmental Science. 1 woman.

Feris staffing: Current staffing includes 2 research technicians and 1 undergraduate research assistant (Spring and Summer 2019) (3 male, all from underrepresented groups in STEM). One of the current lab members (Mr. Alex Torres) is transitioning to the MS graduate program in the Biological Sciences with a Spring 2020 start date. His thesis project will focus on expanding the utility of nutrients and other resources recovered from wastewater for the cultivation of high-value algal biomass. The research technicians and undergraduate students will participate in experimental development, data collection, and data analysis. Additional undergraduate students (1 or 2) will be targeted for recruitment in the second half of year 2 to assist with laboratory and greenhouse scale experiments.

Task B: Quantifying Water/Energy Linkages

- 2 PhD students (1 in Geography, 1 in Water Resources)

Task C:

- 1 PhD students in Geosciences
- 2 summer Masters students in Geoscience
- 1 research/programming technician

5. Description of future plans for project continuation or expansion

- PI Karen Humes is a Co-Lead on the newly formed CAES Focus Area group in the Energy-Water Nexus arena. Being a CAES Focus Area lead provides some access to CAES resources, including program development funds, to build a team of CAES researchers in pursuit of establishing CAES as a global leader in research, education, and innovation related to the energy-water nexus. Team members of this project are looking forward to leveraging our current work to pursue future opportunities. The coupling of food, water and energy is exceptionally strong in southern Idaho, from both a national and international standpoint, making a compelling case for other funding sources. Our integrated approach to water, energy and waste is also unique among teams studying the food-energy-water nexus. She and Co-I Erik Coats organized and attended a workshop at CAES in Idaho Falls on Nov 25, 2019 and are now involved in developing proposals.

- Team members are also actively writing grants to other agencies for related work, such as the NSF, USDA and NASA. This includes a current effort led by PI Karen Humes and involving Co-I

Erik Coats (and 6 other UI faculty) for a graduate student training grant to NSF related to water quality and public health, with emphasis on Idaho (proposal due date Feb 6, 2020). This effort includes also stakeholder partners such as IDWR, IDEQ, and the City of Boise Dept of Public Works.

6. Expenditure reports

The expenditure reports (detailed first, then a summary by category) details the expenditures at the University of Idaho, including the amounts for paid invoices from our two contracting institutions (Idaho State University and Boise State University). Please note that that this report was run on Dec 18, 2019 and due to delays in invoicing from our partner institutions and lag in payroll at the UI, the total expenditure amount now showing ($204,675.21), which translates to a "burn rate" of 29.2% thus far for Yr 2) is less than the actual expenditures at this time. Additionally, our personnel time (both faculty and students) burns at a faster rate in May/June as many of our faculty and students prepare for and implement field-based research in those months.

Detailed Expense Report:

University of Idaho

Itemized Expenditures by Grant Code

From 30-JUN-2019 To 18-DEC-2019

Grant: SG3587 - 18-Dec-2019 01:51 PM

Salaries

E4106 Staff	8707.22
E4108 Summer Salary	8802.00
E4109 IA/GA Salary	50186.00
E4175 Overtime - Covered by FLSA	36.28

	$ 67731.50

Temporary/Irregular Help

E4135 Temporary Student	28945.78

	$ 28945.78

Fringe Benefits

E4280 Faculty CFR Benefit Expense	2719.82
E4281 Staff CFR Benefit Expense	3541.10
E4282 Student CFR Fringe Expense	2690.49

	$ 8951.41

Travel

E5360 Personal Vehicle - In-State

20-SEP-19	I2095733	Ryu, Jae H.	5.00
18-OCT-19	I2101059	Humes, Karen S..	48.09
10-DEC-19	ZT913239	Parking 11112019	10.00
13-DEC-19	I2110710	Ryu, Jae H.	147.69

E5365 Personal Vehicle - Out-of-State

07-AUG-19	I2087973	Coats, Erik Robert.	42.28
22-OCT-19	I2101614	Coats, Erik Robert.	96.82
22-OCT-19	I2101614	Coats, Erik Robert.	55.00

E5367 Rental Vehicles - In-State

12-AUG-19	ZT407009	Car Rental Fuel 07202019	60.55
12-AUG-19	ZT407009	Car Rental Fuel 07242019	44.04
12-AUG-19	ZT407009	Car Rental Fuel 07292019	26.72
12-AUG-19	ZT407009	Car Rental Fuel 07302019	37.88
12-AUG-19	I2088874	Ryu, Jae H.	520.99
20-SEP-19	ZT534237	Car Rental Fuel 08102019	27.36
20-SEP-19	ZT534237	Car Rental Fuel 08102019	60.55
20-SEP-19	ZT534237	Car Rental Fuel 08132019	63.74
20-SEP-19	ZT534237	Car Rental Fuel 08142019	27.90

20-SEP-19	ZT534294	Car Rental 09032019	230.06
20-SEP-19	ZT534294	Car Rental Fuel 08302019	64.79
20-SEP-19	ZT534294	Car Rental Fuel 08312019	29.63
20-SEP-19	ZT534294	Car Rental Fuel 09022019	16.02
20-SEP-19	I2095733	Ryu, Jae H.	604.78
20-SEP-19	I2095733	Ryu, Jae H.	53.87
18-OCT-19	I2101059	Humes, Karen S..	181.16
18-OCT-19	I2101059	Humes, Karen S..	2.02
10-DEC-19	I2109969	Humes, Karen S..	252.00
E5380 Airfare - In-State			
18-OCT-19	I2101059	Humes, Karen S..	58.30
18-OCT-19	I2101059	Humes, Karen S..	284.50
10-DEC-19	ZT913239	Airfare 11112019	521.51
E5381 Airfare - Out-of-State			
23-JUL-19	I2085705	Coats, Erik Robert.	478.20
23-JUL-19	I2085707	Coats, Erik Robert.	1280.00
08-OCT-19	I2098846	Ryu, Jae H.	125.00
18-DEC-19	I2111627	Ryu, Jae H.	213.10
E5391 Ground Transportation - In-State			
18-OCT-19	I2101059	Humes, Karen S..	38.00
E5392 Ground Transportation-Out-of-State			
07-AUG-19	I2087973	Coats, Erik Robert.	17.72
22-OCT-19	I2101614	Coats, Erik Robert.	278.80
18-DEC-19	ZT905632	RyuJa 905632 Uber Jae traveled to S	13.95
18-DEC-19	ZT905632	RyuJa 905632 Uber Jae traveled to S	15.26
E5396 Lodging & Per Diem ? In State			
20-SEP-19	I2095776	Ryu, Jae H.	23.00
20-SEP-19	I2095776	Ryu, Jae H.	49.00

20-SEP-19	I2095776	Ryu, Jae H.	49.00
18-OCT-19	I2101059	Humes, Karen S..	26.00
18-OCT-19	I2101059	Humes, Karen S..	42.00
18-OCT-19	I2101059	Humes, Karen S..	42.00
18-OCT-19	I2101059	Humes, Karen S..	33.00
18-OCT-19	I2101059	Humes, Karen S..	30.00
18-OCT-19	I2101059	Humes, Karen S..	164.02
18-OCT-19	I2101059	Humes, Karen S..	433.07
10-DEC-19	I2109969	Humes, Karen S..	26.00
10-DEC-19	I2109969	Humes, Karen S..	49.00
10-DEC-19	ZT913239	Hotel - Lodging 11132019	185.00
10-DEC-19	ZT913239	Hotel - Lodging 11142019	178.71
13-DEC-19	I2110710	Ryu, Jae H.	49.00

E5397 Lodging & Per Diem ? Out of State

22-JUL-19	F0168715	GRT226540-CIVIL&ENV ENGINEERIN	-1526.56
23-JUL-19	I2085705	Coats, Erik Robert.	147.96
24-JUL-19	ZT335285	Hotel - Lodging 07032019	2289.84
07-AUG-19	I2087973	Coats, Erik Robert.	43.00
07-AUG-19	I2087973	Coats, Erik Robert.	56.00
08-OCT-19	ZT599870	Hotel - Lodging 08142019	76.61
08-OCT-19	I2098846	Ryu, Jae H.	37.05
08-OCT-19	I2098846	Ryu, Jae H.	50.00
08-OCT-19	I2098846	Ryu, Jae H.	38.00
22-OCT-19	I2101614	Coats, Erik Robert.	76.00
22-OCT-19	I2101614	Coats, Erik Robert.	76.00
22-OCT-19	I2101614	Coats, Erik Robert.	76.00
22-OCT-19	I2101614	Coats, Erik Robert.	76.00
22-OCT-19	I2101614	Coats, Erik Robert.	76.00

18-DEC-19	I2111627	Ryu, Jae H.	568.54
18-DEC-19	I2111627	Ryu, Jae H.	56.00
18-DEC-19	I2111627	Ryu, Jae H.	56.00
18-DEC-19	I2111627	Ryu, Jae H.	56.00
18-DEC-19	I2111627	Ryu, Jae H.	56.00
18-DEC-19	I2111627	Ryu, Jae H.	33.00

$ 9829.52

Operating Expenses

E5049 Journal Publication Costs

25-SEP-19	ZT574740	Professional Services 09042019	25.00

E5070 Conference/Registration Fees

24-JUL-19	ZT335285	Conference Registration 07012019	615.00
24-JUL-19	ZT335285	Conference Registration 07092019	-570.00
24-JUL-19	ZT335285	Conference Registration 07092019	725.00
24-JUL-19	ZT335285	Conference Registration 07092019	570.00
26-SEP-19	ZT568130	Memberships / Subscriptions / Regis	180.00
01-NOV-19	ZT748634	Memberships / Subscriptions / Regis	-725.00
18-DEC-19	I2111627	Ryu, Jae H.	630.00

E5307 Analytical Services

02-OCT-19	J1252563	MJ/GRC 1811977_Forney	860.00
16-DEC-19	J1260582	bf ASL Invoice EOCT19-003	46.00

E5320 Software/Applications - Individual

27-AUG-19	ZT406541	Supplies 07272019	129.00

E5330 Software/Applications - College/Dep

24-JUL-19	I2086054	Ryu, Jae H.	799.00
14-AUG-19	ZT401299	Supplies 07032019	19.15

14-AUG-19	ZT401299	Supplies 07172019	15.99
12-SEP-19	ZT511342	Supplies 08032019	19.99
12-SEP-19	ZT514946	Supplies 08272019	129.00

E5410 Office and Administrative Supplies

04-DEC-19	ZT859061	Supplies 11122019	88.34

E5430 Consumable Water

08-AUG-19	I2088020	Culligan Water Conditioning	29.95

E5465 Gasoline

14-AUG-19	ZT401299	University Vehicle Expenses 0701201	42.34
14-AUG-19	ZT401299	University Vehicle Expenses 0715201	40.31

E5560 Technology - Supplies

09-AUG-19	I2088550	Ryu, Jae H.	476.96
04-SEP-19	ZT498840	Supplies 08122019	62.99
30-OCT-19	ZT730095	Supplies 10152019	33.99

E5710 Tools

14-AUG-19	ZT401299	Supplies 07042019	107.25
14-AUG-19	ZT401299	Supplies 07112019	38.03

E5724 Research Supplies

18-JUL-19	ZT303097	Supplies 07032019	1613.10
18-JUL-19	ZT303097	Supplies 07052019	11.94
18-JUL-19	ZT303097	Supplies 07062019	98.17
18-JUL-19	ZT303097	Supplies 07072019	11.74
18-JUL-19	ZT303097	Supplies 07092019	396.00
18-JUL-19	ZT303097	Supplies 07092019	18.00
18-JUL-19	ZT303097	Supplies 07102019	166.30
18-JUL-19	ZT303097	Supplies 07112019	91.62
23-JUL-19	I2085701	Ryu, Jae H.	271.08
02-AUG-19	ZT335026	Supplies 07032019	420.44

02-AUG-19	ZT335026	Supplies 07102019	69.54
02-AUG-19	ZT335026	Supplies 07102019	1704.66
02-AUG-19	ZT335026	Supplies 07122019	75.80
02-AUG-19	ZT335026	Supplies 07132019	52.28
02-AUG-19	ZT335026	Supplies 07162019	30.26
02-AUG-19	ZT335026	Supplies 07162019	169.80
02-AUG-19	ZT335026	Supplies 07172019	13.75
02-AUG-19	ZT335026	Supplies 07222019	29.98
02-AUG-19	ZT335026	Supplies 07242019	320.62
02-AUG-19	ZT335026	Supplies 07242019	327.90
02-AUG-19	ZT335026	Supplies 07252019	701.46
07-AUG-19	ZT381455	Agriculture and Medical Supplies 07	18.08
14-AUG-19	ZT401299	Supplies 06262019	5.99
14-AUG-19	ZT401299	Supplies 06272019	94.80
14-AUG-19	ZT401299	Supplies 07022019	92.91
14-AUG-19	ZT401299	Supplies 07022019	9.24
14-AUG-19	ZT401299	Supplies 07082019	39.94
14-AUG-19	ZT401299	Supplies 07112019	189.74
14-AUG-19	ZT401299	Supplies 07142019	217.28
14-AUG-19	ZT401299	Supplies 07192019	156.86
15-AUG-19	ZT402367	Supplies 07192019	61.57
15-AUG-19	ZT402367	Supplies 07272019	69.54
15-AUG-19	ZT402367	Supplies 07272019	48.02
15-AUG-19	ZT402367	Supplies 08012019	53.10
15-AUG-19	ZT402367	Supplies 08012019	185.84
15-AUG-19	ZT402367	Supplies 08022019	-53.10
15-AUG-19	ZT402367	Supplies 08052019	28.45
15-AUG-19	ZT402367	Supplies 08062019	13.94

15-AUG-19	ZT402367	Supplies 08072019	32.44
15-AUG-19	ZT402367	Supplies 08082019	250.82
15-AUG-19	ZT402367	Supplies 08082019	334.67
15-AUG-19	ZT402367	Supplies 08082019	13.98
27-AUG-19	ZT406541	Supplies 07292019	28.93
27-AUG-19	ZT406541	Supplies 07292019	7.41
04-SEP-19	ZT498840	Agriculture and Medical Supplies 08	36.10
04-SEP-19	ZT498840	Supplies 08072019	9.65
12-SEP-19	ZT511342	Supplies 08032019	217.94
12-SEP-19	ZT511342	Supplies 08032019	4.55
12-SEP-19	ZT511342	Supplies 08052019	5.29
12-SEP-19	ZT470567	Supplies 08102019	113.20
12-SEP-19	ZT470567	Supplies 08132019	197.90
12-SEP-19	ZT470567	Supplies 08132019	79.82
12-SEP-19	ZT470567	Supplies 08142019	54.04
12-SEP-19	ZT470567	Supplies 08142019	65.08
12-SEP-19	ZT470567	Supplies 08152019	149.99
12-SEP-19	ZT470567	Supplies 08162019	32.26
12-SEP-19	ZT470567	Supplies 08172019	1046.30
12-SEP-19	ZT470567	Supplies 08182019	1700.00
12-SEP-19	ZT470567	Supplies 08182019	82.51
12-SEP-19	ZT470567	Supplies 08212019	55.97
12-SEP-19	ZT470567	Supplies 08212019	38.35
12-SEP-19	ZT470567	Supplies 08222019	216.16
12-SEP-19	ZT470567	Supplies 08272019	188.66
12-SEP-19	ZT514946	Supplies 08202019	89.90
12-SEP-19	ZT514946	Supplies 08222019	229.00
12-SEP-19	ZT514946	Supplies 08262019	241.38

18-SEP-19	ZT536932	Supplies 09032019	487.72
18-SEP-19	ZT536932	Supplies 09042019	182.70
18-SEP-19	ZT536932	Supplies 09052019	456.23
25-SEP-19	ZT574740	Supplies 09032019	88.77
25-SEP-19	ZT574740	Supplies 09082019	81.80
25-SEP-19	ZT574740	Supplies 09092019	62.95
25-SEP-19	ZT574740	Supplies 09102019	51.94
25-SEP-19	ZT574740	Supplies 09102019	28.39
25-SEP-19	ZT574740	Supplies 09102019	49.69
25-SEP-19	ZT574740	Supplies 09112019	211.89
25-SEP-19	ZT574740	Supplies 09132019	102.25
01-OCT-19	I2097494	Ryu, Jae H.	3120.00
07-OCT-19	I2098295	Culligan Water Conditioning	29.95
07-OCT-19	ZT582328	Supplies 09092019	4.50
07-OCT-19	ZT582328	Supplies 09092019	28.26
07-OCT-19	ZT582328	Supplies 09092019	75.00
07-OCT-19	ZT582328	Supplies 09092019	1.42
07-OCT-19	ZT582328	Supplies 09112019	166.30
07-OCT-19	ZT582328	Supplies 09122019	157.46
07-OCT-19	ZT582328	Supplies 09132019	81.64
07-OCT-19	ZT582328	Supplies 09132019	21.60
07-OCT-19	ZT582328	Supplies 09132019	66.68
07-OCT-19	ZT582328	Supplies 09202019	173.07
07-OCT-19	ZT582328	Supplies 09212019	75.80
09-OCT-19	ZT631422	Supplies 09212019	3244.50
09-OCT-19	ZT631422	Supplies 09242019	283.86
09-OCT-19	ZT631422	Supplies 09272019	2154.25
09-OCT-19	ZT631422	Supplies 09272019	-3244.50

09-OCT-19	ZT631422	Supplies 10012019	17.40
09-OCT-19	ZT631422	Supplies 10022019	396.00
25-OCT-19	ZT638339	Agriculture and Medical Supplies 09	18.50
25-OCT-19	ZT638339	Supplies 09192019	56.82
25-OCT-19	ZT638339	Supplies 09232019	7.40
25-OCT-19	ZT638339	Supplies 09232019	4.79
01-NOV-19	ZT748634	Supplies 10082019	446.27
01-NOV-19	ZT748634	Supplies 10182019	377.25
01-NOV-19	ZT748634	Supplies 10222019	266.80
06-NOV-19	I2103978	Culligan Water Conditioning	29.95
18-NOV-19	ZT811408	Supplies 10282019	70.56
18-NOV-19	ZT811408	Supplies 10292019	41.98
18-NOV-19	ZT811408	Supplies 10302019	147.50
18-NOV-19	ZT811408	Supplies 11012019	187.34
04-DEC-19	ZT900954	Supplies 11042019	8.99
04-DEC-19	ZT900954	Supplies 11072019	6.63
04-DEC-19	ZT900954	Supplies 11132019	461.22
04-DEC-19	ZT900954	Supplies 11152019	1096.36
04-DEC-19	ZT900954	Supplies 11152019	137.09
04-DEC-19	ZT900954	Supplies 11162019	91.62
06-DEC-19	I2109475	Culligan Water Conditioning	29.95
09-DEC-19	J1260116	KRE-H; Phys Mchn shp wrk A McDonald	87.79
11-DEC-19	ZT907694	Supplies 11032019	77.15
11-DEC-19	ZT907694	Supplies 11112019	178.17
18-DEC-19	ZT030436	McDonald A purchased o-rings and co	12.88
18-DEC-19	ZT030436	McDonald, A purchased research supp	40.32
18-DEC-19	ZT852583	McDonald A purchased lab supplies.	24.92
18-DEC-19	ZT852583	McDonald A purchased lab supplies:	6.78

18-DEC-19	ZT852583	McDonald A purchased lab supplies:	13.60
18-DEC-19	ZT852583	McDonald Armando purhcased CHECK IN	254.41
18-DEC-19	ZT852583	McDonald purchased instrument pans	230.00
18-DEC-19	ZT987942	Charge for aluminum dish fluted 144	101.50
18-DEC-19	ZT987942	Charge for high pressure and specia	54.60
18-DEC-19	ZT987942	Charge for new digital ORP sensor,	1123.63

E5741 Med Lab & Tech Supplies

08-JUL-19	U0132495	Chemstores/Alfaro	16.51
10-JUL-19	U0132527	Chemstores/Guho	3.04
10-JUL-19	U0132530	Chemstores/Guho	8.65
24-JUL-19	U0132644	Chemstores/Abbasi	8.18
25-JUL-19	U0132646	Chemstores/Abbasi	30.02
25-JUL-19	U0132647	Chemstores/Abbasi	21.53
26-JUL-19	U0132658	Chemstores/Abbasi	134.58
26-JUL-19	U0132659	Chemstores/Dikshyapokhrel	61.69
07-AUG-19	U0132748	Chemstores/Alfaro	72.00
08-AUG-19	U0132758	Chemstores/McDonald	10.89
13-AUG-19	U0132773	Chemstores/Abbasi	9.91
14-AUG-19	U0132781	Chemstores/Pokhrel	8.18
23-AUG-19	U0132870	Chemstores/Abbasi	214.26
26-AUG-19	U0132881	Chemstores/Pokhrel	9.91
26-AUG-19	U0132882	Chemstores/Pohkrel	29.72
27-AUG-19	U0132894	Chemstores/Abbasi	39.63
29-AUG-19	U0132924	Chemstores/Abbissa	80.97
29-AUG-19	U0132925	Chemstores/Abbisa	61.47
29-AUG-19	U0132926	Chemstores/ReturnU132924	-61.70
03-SEP-19	U0132965	Chemstores/Pokhrel	61.47
04-SEP-19	ZT498840	Agriculture and Medical Supplies 08	30.04

04-SEP-19	ZT498840	Agriculture and Medical Supplies 08	9.90
04-SEP-19	ZT498840	Agriculture and Medical Supplies 08	213.00
04-SEP-19	ZT498840	Agriculture and Medical Supplies 08	43.99
04-SEP-19	ZT498840	Agriculture and Medical Supplies 08	47.17
06-SEP-19	U0133005	Chemstores/Abbasi	91.48
11-SEP-19	U0133072	Chemstores/Abbasi	34.02
13-SEP-19	U0133135	Chemstores/McDonald	23.13
17-SEP-19	U0133169	Chemstores/Abbasi	87.88
17-SEP-19	U0133186	Chemstores/Abbasi	44.84
19-SEP-19	U0133228	Chemstores/Abbasi	72.56
23-SEP-19	U0133262	Chemstores/Guho	9.91
24-SEP-19	U0133284	Chemstores/Guho	25.56
25-SEP-19	U0133296	Chemstores/Abbasi	38.16
02-OCT-19	U0133354	Chemstores/Brower	43.50
03-OCT-19	U0133365	Chemstores/Pokhrel	72.35
22-OCT-19	U0133570	Chemstores/Pokhrell	23.33
25-OCT-19	ZT638339	Agriculture and Medical Supplies 09	105.69
25-OCT-19	ZT638339	Agriculture and Medical Supplies 09	21.98
25-OCT-19	ZT638339	Agriculture and Medical Supplies 09	178.08
25-OCT-19	ZT638339	Agriculture and Medical Supplies 09	299.99
25-OCT-19	ZT638339	Agriculture and Medical Supplies 09	17.65
25-OCT-19	ZT638339	Agriculture and Medical Supplies 09	226.85
04-NOV-19	U0133705	Chemstores/Abbasi	23.73
21-NOV-19	U0133885	Chemstores/Pokhrel	30.00

E5747 Safety Supplies

25-SEP-19	ZT574740	Supplies 09022019	21.18

E5910 Rent - Machinery & Equip

28-AUG-19	I2091615	Culligan Water Conditioning	29.95

E5940 Other Rentals and Leases

20-AUG-19	I2090470	Boise State University	337.50

E5992 Promotion

02-DEC-19	J1259868	Bkstr;TABLECLOTH CALS	188.00

$ 35299.85

Subawards

ES001 Subaward 1 Expenses

28-OCT-19	I2102349	Boise State University	27940.93

$ 27940.93

Small Equipment (<$5K)

E7830 <5K Computer Equipment Other

16-JUL-19	I2084671	Ryu, Jae H.	1324.98

E7995 <5K Communication Equipment

06-NOV-19	I2104173	Ryu, Jae H.	1196.74

$ 2521.72

Tuition Remission and Training

E7140 Tuition and Fees - Grad Assistants

16-AUG-19	J1251999	G1GB for 171-55579	786.00
16-AUG-19	J1251999	SHI1 for 171-55579	951.00
16-AUG-19	J1251999	T1GB for 171-55579	4152.00
21-AUG-19	J1252645	G1GB for V00665494	786.00
21-AUG-19	J1252645	GP01 for V00665494	48.50

21-AUG-19	J1252645	SHI1 for V00665494	951.00
21-AUG-19	J1252645	T1GB for V00665494	4152.00
21-AUG-19	J1252645	VVSF for V00665494	100.00
22-AUG-19	J1252827	G1GD for 142-24168	786.00
22-AUG-19	J1252827	SHI1 for 142-24168	951.00
22-AUG-19	J1252827	T1GD for 142-24168	4152.00
03-SEP-19	J1253572	G1GA for 941-68901	596.00
03-SEP-19	J1253572	G1GB for 051-04535	786.00
03-SEP-19	J1253572	T1GB for 051-04535	4152.00
22-OCT-19	J1257016	AN01 for 051-04535	105.00

		$ 23454.50	

Total Expenses $ 204675.21

Expenditures Summarized by Category:

University of Idaho

Itemized Expenditures by Grant Code

From 30-JUN-2019 To 18-DEC-2019

Grant: SG3587 - 18-Dec-2019 01:51 PM

Salaries

E4106 Staff	8707.22
E4108 Summer Salary	8802.00
E4109 IA/GA Salary	50186.00
E4175 Overtime - Covered by FLSA	36.28

	$ 67731.50

Temporary/Irregular Help

E4135 Temporary Student	28945.78

	$ 28945.78

Fringe Benefits

E4280 Faculty CFR Benefit Expense	2719.82
E4281 Staff CFR Benefit Expense	3541.10
E4282 Student CFR Fringe Expense	2690.49

	$ 8951.41

Travel

E5360 Personal Vehicle - In-State	210.78
E5365 Personal Vehicle - Out-of-State	194.10
E5367 Rental Vehicles - In-State	2304.06
E5380 Airfare - In-State	864.31
E5381 Airfare - Out-of-State	2096.30
E5391 Ground Transportation - In-State	38.00
E5392 Ground Transportation-Out-of-State	325.73
E5396 Lodging & Per Diem ? In State	1378.80
E5397 Lodging & Per Diem ? Out of State	2417.44

	$ 9829.52

Operating Expenses

E5049 Journal Publication Costs	25.00
E5070 Conference/Registration Fees	1425.00
E5307 Analytical Services	906.00
E5320 Software/Applications - Individual	129.00
E5330 Software/Applications - College/Dep	983.13
E5410 Office and Administrative Supplies	88.34
E5430 Consumable Water	29.95
E5465 Gasoline	82.65
E5560 Technology - Supplies	573.94
E5710 Tools	145.28
E5724 Research Supplies	27699.23
E5741 Med Lab & Tech Supplies	2635.70
E5747 Safety Supplies	21.18
E5910 Rent - Machinery & Equip	29.95
E5940 Other Rentals and Leases	337.50

E5992 Promotion	188.00

	$ 35299.85

Subawards

ES001 Subaward 1 Expenses	27940.93

	$ 27940.93

Small Equipment (<$5K)

E7830 <5K Computer Equipment Other	1324.98
E7995 <5K Communication Equipment	1196.74

	$ 2521.72

Tuition Remission and Training

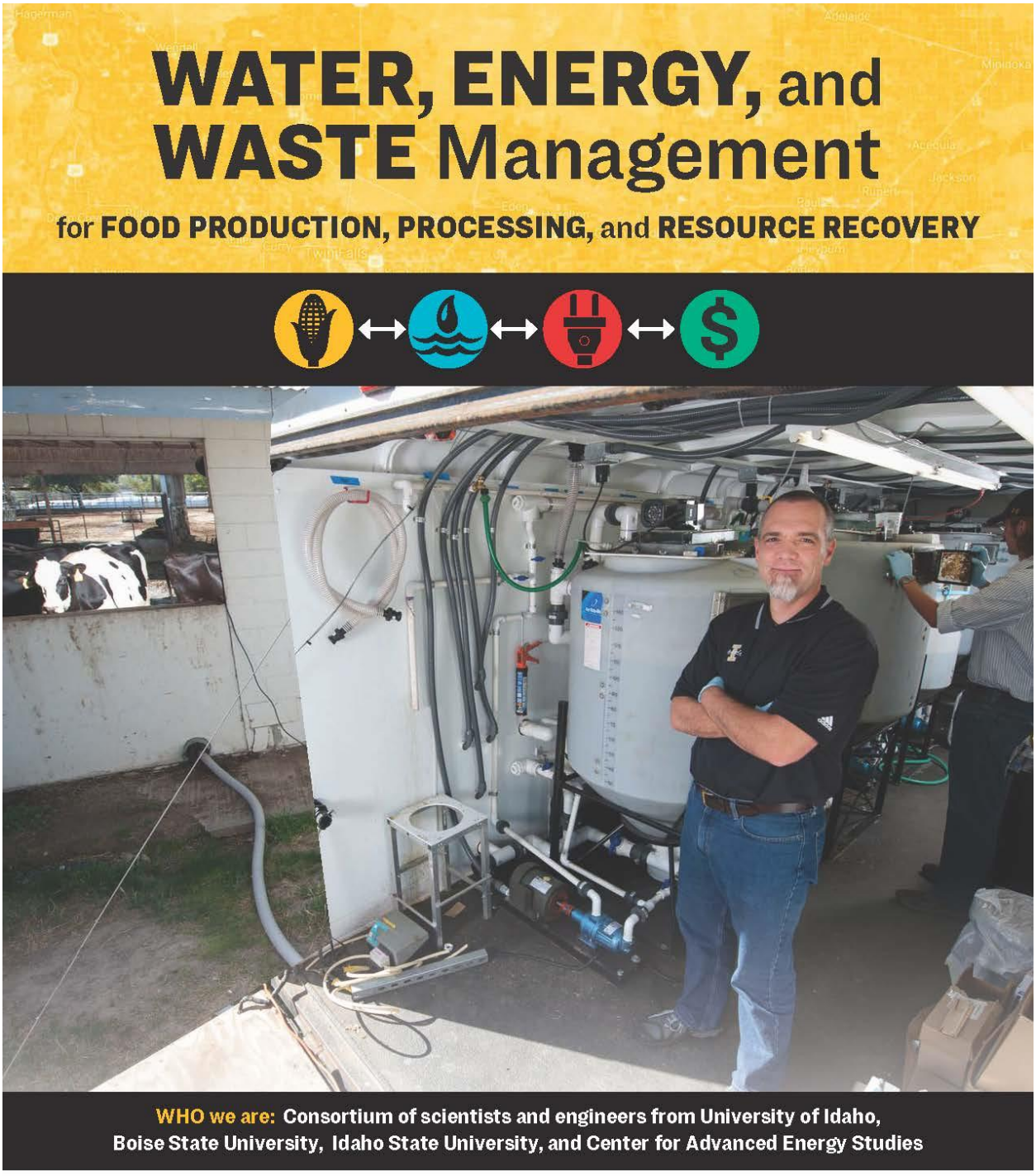
E7140 Tuition and Fees - Grad Assistants	23454.50

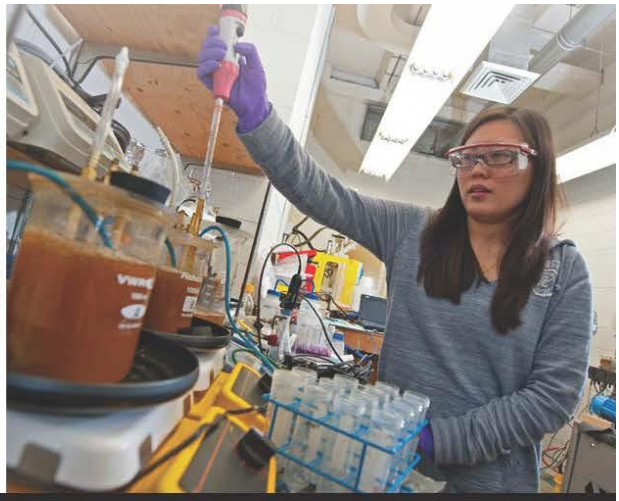
	$ 23454.50

Total Expenses	$ 204675.21

7. Commercialization revenue - None to report at this time, however, Dr. Delparte (ISU) is actively working on the development of commercialization pathways from the research being done under Task C and Dr. Feris will be working in the latter half of Yr 2 to explore commercialization pathways for aspects of the research being done under Task A.

Appendix A: Project Brochure Prepared for Stakeholder Engagement





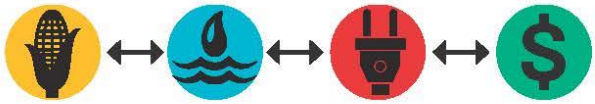
WHY ARE WE ASKING YOU TO

ENGAGE WITH US?

- You are among the leaders in Idaho food production, processing, and associated services such as water and waste treatment
- To gain your perspective and input on issues, challenges, and pathways for your industry
- To better understand both single-user solutions and longer-term visions for applied research on regional solutions, including efficiencies to be gained through collaboration.
- To learn about workforce preparedness gaps and how we can help fill them

WHAT we are:

- Team conducting applied research funded by Idaho State Board of Education
- Research activities focused on creative solutions in water, energy, and waste management that enhance economic and environmental bottom line for Idaho agro-industry and rural communities.



TEAM EXPERTISE -

FOR DAIRIES AND FOOD PROCESSING:

- Wastewater treatment: operations,energy efficiency, nutrient recovery, and water recycling
- Minimizing management of waste products or any other outputs parasitic to the economic bottom line
- Assisting stakeholders to diversify economic portfolio via resource recovery and retrieval of other value-added products

TEAM EXPERTISE -

FOR CROP PRODUCTION:

- Tools for utilizing satellite and drone data for optimal application of nutrients and water

TEAM EXPERTISE -

FOR ALL STAKEHOLDERS, INCLUDING STATE AND COUNTY/MUNICIPAL PLANNING:

- Quantifying the interconnection of water, energy, and waste streams in southeastern Idaho region
- Useful for planning and identifying synergies/ partnerships among stakeholders in the future

For more information, please contact Project Director Karen Humes, *khumes@uidaho.edu* or 208-885-6506.