University-Utility Collaborative Partnerships

In Partnership With:

With Support From:

Contents

1 Introduction

1.1 Background

In a 2007 editorial in Water Environment Research, Krishna Pagilla succinctly summarized the benefits of university utility collaborations:

> *Applied research in water and wastewater conveyance and treatment is critical to address many short-term problems encountered by utilities and identify longer-term research needs and fundamental issues. Universities local to utilities have a great role to play in conducting such applied research and developing site-specific solutions to technical problems.* ***A university–utility collaboration is a win–win combination for both*** *and has synergistic benefits in terms of technical problem solving directly applicable to utility operations and training future professionals for the same utility.*[1]

The Leaders Innovation Forum for Technology (LIFT) program, jointly administered by the Water Environment Federation (WEF) and The Water Research Foundation (TWRF), has a focus area on encouraging university – utility partnerships (UUP). To communicate the best practices, challenges, and successes of university – utility collaboration, the LIFT team is working with influential stakeholders including:

- WEF Research & Innovation Committee
- Association of Environmental Engineering and Science Professors (AEESP)
- International Water Association (IWA) USA National Committee (USANC)
- IWA Canadian National Committee
- A research team working on a Grant Opportunities for Academic Liaison with Industry (GOALI) project funded by the National Science Foundation (NSF)

1.2 AEESP/IWA Meeting

USANC and AEESP hosted a one-day program on June 23, 2017 in Ann Arbor, MI following the AEESP Biennial Education and Research Conference, which took place June 20-22. The AEESP conference theme was "Advancing Healthy Communities through Environmental Engineering and Science." The theme of the one-day IWA program focused on the international research efforts by IWA members in building healthy communities around the world in the Water, Sanitation, and Hygiene (WASH) sector. The goal was to showcase WASH sector research and education work of academics from North America. As part of this one-day event, WEF and WE&RF led a workshop showcasing leading university-utility partnerships around the country and promoting such partnerships among other universities and utilities. Leaders from WEF, WE&RF, LIFT, universities and utilities defined successful methods and strategies to establish strong utility-university collaborative partnerships, which are detailed in this report.

1.3 Case Studies Identified

In preparation for the workshop, nine brief case studies on Utility-University partnerships were collected and presented later in this report. The collaborations demonstrate how partnerships

[1] Pagilla, Krishna. "University–Utility Collaborative Applied Research—A Win–Win Combination." Water Environment Research 79.6 (2007): 579-580.

can be formed around relevant issues in various regions, such as Peracetic acid (PAA) as a disinfectant (Midwest), aging infrastructure (Northeast), and water reuse (Southwest).

2 Success Factors

In general, partnerships are more difficult for utilities than for universities. This is often because of the fundamental nature of utilities, whose job is to protect public health on a daily basis. A failed project in academia is a lesson learned and opportunity for future research. A failure at a utility can lead to non-compliance, fines, public health and environmental consequences. Thus, utilities seem to be more interested in technical solutions than laying the groundwork for research. In addition, in some cases, professors and students do not fully understand the "on the ground" reality at a working, full-scale utility. Therefore, the partners in a successful university-utility collaboration need to be honest and realistic to match university capabilities and utility needs.

2.1 General Characteristics of Successful Partnerships

Some general themes were identified by the workshop participants to help manage expectations at both organizations.

Utilities should:

- Support local institutions to build research infrastructure locally, but not be confined to only working with local schools.
- Encourage timely publication and presentation of results in journals and conferences. Minimize the requirements for separate reports (that mostly nobody reads anyway), and allow the substitution of peer-reviewed journal articles for final reports.
- Be open to the investigation of unexpected outcomes or fundamental issues through longer-term research, especially for high-risk projects, where universities can handle when projects don't work out.
- Strengthen local institutions to leverage support in obtaining research projects from larger funding sources.
- Encourage researchers to conduct pilot- and full-scale research on site to generate results most applicable to the facility.
- Understand that a Professional Engineer (PE) is not always needed for a research project.
- Recognize the degree requirements of university graduate students in terms of research (including project schedules, timelines, etc).
- Offer to serve on graduate student advisory committees, subject to university rules and requirements.
- Have a specific liaison to the project that works with the student.
- Facilitate the partnership of a university with a consultant when a cost estimate or business case analysis is needed to go along with a research or pilot project.

Researchers (both professors and students) should:

- Understand that there may be competing interest types; for example, academic. research versus practical projects needed by a utility. Not every "cool" consulting project is going to be practical.

- Understand that when they are on utility property, it is "their space, their place" and utility critical operations take precedence.
- Establish long-term relationships with the utilities, if possible.
- Keep the utility informed of the work progress frequently and in a timely manner and keep the utility actively engaged in the research direction.
- Provide deliverables (both interim and final) that have significant value and use for the utility.
- Consider an initial project that is practical and immediately relevant. Start with projects that lead to quick wins.

2.2 Structure for Implementation

There are a myriad of alternatives in which utilities and universities can partner. Utilities, funded by ratepayers, often have funding available for applied research and development efforts in support of specific issues they face. In smaller utilities, there are more opportunities for in-kind support and less money. Some of the types of collaborations include:

- Faculty sabbatical at utility - The professor obtains direct industry exposure and provides valuable scientific and technical expertise to the utility.
- Short term student internships - Graduate and undergraduate students are relatively inexpensive and not a long-term commitment. Identifies potential future employees for the utility or other areas of the water sector, such as manufacturers. Challenges exist in balancing the hours needed to work at the utility if the student is in term and taking classes. Students can get enough experience to obtain operator licenses (depending on their role and how many hours worked), which is a benefit to the student that would give them an advantage with many employers (utilities, consultants, etc.).
- Research project at utility – Professor (or utility R&D team member, if the utility has the capacity) serves as Principal Investigator (PI) with student team performing pilot or demonstration work of technologies or processes at utility facility in conjunction with utility staff. Utilities are often challenged by the mechanics of a long-term project, including things like having to find living arrangements for students. This approach could also involve equipment manufacturers and the utility's consulting engineers in the collaboration.
- Research project at university – Utility provides data to researchers to perform data analysis or other paper studies to help utility solve a problem.
- Capstone Design data – As part of a capstone class at a university, a utility will provide data and constraints for the course participants to use. This approach can also be used to support the WEF Student Design Competition, as shown by the Florida Water Environment Association's efforts, which used the potential brewing of beer from water reuse as one of the team entries.
- Adjunct faculty – Utility professionals have been used as adjunct professors in both undergraduate and graduate coursework.
- Research or capstone advisors – Utility professionals advise an undergrad student team for senior design or capstone class. This can begin as an informal transaction. The approach can be expanded to graduate students. Utility staff would be engaged with multiple students, or teams, instead of just one student, and could provide the student teams real interaction with the utility.
- Advisory board members – Utilities can have representatives on academic departments' industry advisory boards. These boards can help keep the curriculum current, develop internship programs, and strengthen the link between academia and industry.

- Shared Lab facilities – If a utility has analytical needs but doesn't have the equipment, the local university might have the high end lab equipment to perform the testing. The reverse can also be true, the utility may have lab equipment that the university doesn't have.

2.3 Ideal characteristics of students

The characteristics most identified as being beneficial to in partnership with utilities were students who can:

- Ask questions and develop good rapport with their utility counterparts
- Consider an industry job in future career, so they are really interested in getting the experience
- Perform fundamental research, but also work on applied projects
- Strengthen relationships through volunteering
- Be a good listener and genuinely interested
- Communicate effectively, both verbally and in writing

3 Building Relationships

Building and maintaining relationships are perhaps the most important aspect of UUPs. UUPs are not project based, they are based on relationships and the projects follow. Practices and issues are grouped below into three phases: Initiating the first connection, developing the first engagement, and maintaining relationships.

3.1 Initiating the First Connection

There are a number of ways that universities and utilities can make the first contact:

- Universities can arrange to have classes tour treatment plants to develop good relationship with plant managers. Utilities are proud of the work they do and their facilities. They run tours routinely and don't see them as disruptive.
- Utilities can use the AEESP listserv to post their "needs" and put a request out for contacts in the academic community.
- Utilities can post research and technology needs in the "Needs Forum" on LIFT Link (http://liftlink.werf.org). Universities can see which utilities are following various needs and connect with them to assemble partnerships for projects and proposals.
- University professors can volunteer and participate in committees of 'applied' professional organizations such as WEF or AWWA in order to build academic-utility networks and collaboration opportunities. Academic involvement and participation in such organizations are essential not just for initiating relationships, but also for maintaining them.
- Universities can contact the staff or volunteer committee members at the local WEF member association or AWWA section to identify the progressive utilities in the region, and key contacts.
- Universities and Utilities can search the LIFT FAST Water National Test Bed Network and Directory to identify appropriate contacts at university and utility test beds (http://www.werf.org/lift). The Directory helps to connect researchers and innovators with test facilities appropriate for their needs.

- Encourage state professional organizations to highlight academics at the state-level conferences, creating opportunities for utilities and universities to network. The local organization could even host a "dating service" at a conference to match interests between utilities and universities.
- Universities can actively participate in state and local association activities, such as conferences.
- Utilities and universities can participate in interdisciplinary workshops either through organizations such as TWRF, National Science Foundation, U.S. Department of Energy, etc., or through information sharing groups established by other utilities and universities. For example, DC Water has done this on the topic of short cut Nitrogen removal via teleconferencing with key international academia and utilities to inform one another on progress and challenges related to the topic.

3.2 Creating the First Engagement

In order to get the first project off the ground, academics must make sure their proposed research is relevant to the utility. If a university approaches a utility with a technology, the technology should have strong potential to go into practice. If the university is coming to utility for funding, the utility needs to be invested on the topic and technology in order to commit. Methods to make those links include:

- Set up a lunch or other meeting to discuss the potential of project without commitment. The first step could be an information exchange to learn about each other's capabilities and needs/interests, as well as coordinating and coming to an agreement on common questions that benefit the utility and the university for future investigation.
- Researchers should review the utility's master plan, capital improvement plan, budget, and facilities to prepare for an interview with the utility. An hour-long interview with the utility should help a university figure out opportunities to address utility needs. The researcher could steer the interview, knowing the capabilities of the students. Key questions that should be asked include "what are your problems?" and "where do you want to save money?"
- Utilities generally prefer universities approaching them with a specific project and ask, so it is easier for utilities to say "yes" or "no." A one-page research proposal that includes a short literature review, proposed scope, timeline, and budget can be effective.
- Utilities can classify problems that need to go to consultants (mission critical, etc.) versus those that could go to university (feasibility studies, etc.).

3.3 Maintaining Relationships

Building the relationship helps to build the partnership. Longer term initiatives may work better as a wider collaboration. Recognize the scope that is inherent in how different groups work. For example, utilities know and understand the details of a particular situation they are facing (in-depth), while a consultant might know less detail but have many different angles from different clients (wide view). Multiple universities or academic departments can partner with a single utility. Some considerations for managing the long-term relationships include:

- Communicate the value of the project through quarterly report-outs, a final report or journal publications, and a student presentation about the project to top management.
- Overlap with new and long-standing faculty as well to semi inherit relationships or start to build relationships
- Create continuity in students on teams – having multiple students allows the senior student to help mentor the rising researchers.

- Show economic savings to utilities through applied projects; utility might not have time to investigate problems but know something is going on – doing basic research on which technologies perform the best.
- Researchers at utility labs need to ensure that they manage the lab needs so they aren't taking utility staff away from their regular duties to assist with research sampling and analysis. Working around staff schedules is important.
- Researchers can set up mutual learning benefits, such as leaving a piece of the lab work with the utility to help ensure buy-in and shared ownership of the research.
- Ensure utility and industry staff have advisory roles to help define and prioritize key research questions.
- Consider involvement in LIFT, WEF and AWWA committees.
- For larger efforts, engage with TWRF subscribers or submit proposals for Subscriber Priority Research, Tailored Collaborative Research (TCR), Unsolicited Research, or one of TWRF's other research programs.
- Include consultants in the work, if it is applicable.

4 Distance

Partnerships are often locally or regionally based, but there are interstate and international UUPs. Geographically related UUPs are convenient because students can work directly with or at the utility while taking classes. Furthermore, utilities and universities located nearby generally face the same issues with respect to climate and natural resources, which means project interests are often aligned. It is often easier to have meetings in person, especially when you are in the "getting to know the project" phase where lengthy discussions are needed. When working at a distance, the researchers and utilities tend to have one or two main contacts and miss out on the opportunity to collaborate more broadly with many different types of people in a shorter timeframe as is often the cases with local partnerships. Although co-location provides opportunities to strengthen critical interpersonal relationships, ready access to webinar tools makes it very easy to establish strong interpersonal relationships over distance in ways that can overcome some of the barriers noted.

For some public utilities, there are structural constraints to working with Universities outside their regions. These organizations may specifically prohibit working out of state, or might not encourage it if a local university is perceived as having adequate capabilities to do the intended research. This leads to the "perception of plenty" that might be a barrier if the research interests or expertise of the local universities don't match what the utility needs or vice versa. Another challenge in expanding collaboration is university loyalties – people tend to reach out to and collaborate more with their network of alumni, which can create a barrier to others, especially the smaller universities.

While utilities should definitely support their local academic community, if they have the resources they should also pursue strategic collaborations that make sense based on the expertise needed by the university research team rather than just accepting the expertise available nearby. Utility research often benefits from advanced state-of-the-art analytical methods that are only available at a small number of universities and it is more productive to work directly with these experts. Furthermore, universities are increasingly encouraging students to gain practical experience away from campus and graduate student summer internships are becoming popular and accommodated by university enrollment rules. Finally, the strongest sustained U-U relationships require interpersonal chemistry between those involved; proximity does not guarantee those relationships will exist. A committed partnership between individuals

who have a strong mutual working relationship is going to be more sustained than a forced partnership between individuals who may be in close proximity but do not develop a functional working relationship.

Opening to others around the world can lead to alignment of needs. One is more likely to find matching interests when looking at a larger potential group. This concept is continually covered in the scientific press as well: Scientific American recently had a feature editorial discussing how partnering across borders means faster discovery.[2] The June 2017 workshop featured a number of professors who had partnerships with utilities in other countries, including Michigan-Ethiopia, North Carolina-Zambia, and Virginia-China.

Distance is relative. A one-hour drive may be as large a barrier as a several hour flight, depending on the nature of the research or working relationships. Working with utilities in developing countries can have a number of challenges, including:

- Utilities don't always know how to reach out to US universities.
- In blending high income country work with low income country work, there is a difficulty in figuring out what to offer the utilities. For example, ceramic water filters might be of interest in the developing country utility, but not in a developed country. There could be some skills that overlap, for example, with water reuse.
- Getting samples stabilized to take back to university OR set up at utility. Depending upon the sample, researchers may need to get CDC approval if shipping samples from overseas. Approval per project requires about 2 weeks to turn around after completion of an online form. Recent changes are moving to having them shipped via World Courier or DHL.
- Soil samples can be challenging to process and handle. For example, they require USDA approval, on-site approval and/or customs protocols. Some countries that are harder to ship from than others (e.g., India). Researchers need to lay out international protocols for how to ship to and from, and make this publicly available to anyone needing it.

5 Risk Management

The level of acceptable risk is different at the university than the utility - utilities are very conservative on risk. In order to manage expectations for UUPs, the three most important aspects of risk management in a UUP are finance, intellectual property (IP), and public outreach.

5.1 Finance

From a utility perspective, with public procurement laws, it can be a challenge to work with a university and meet procurement rules. One participant even made the comment that "procurement is the enemy of innovation." To develop a contract by sole sourcing (going into an agreement without a competitive bid) is difficult: approval can take several months, and sometimes the maximum threshold $10,000 or lower. Some utilities that have their own boards (not a city department who have to answer to an elected mayor) have more flexibility to fund research. Considerations for funding a UUP include:

- A contract offers more flexibility than a purchase order. An overall master agreement between the utility and a university (sample language is in Appendix A) means that the

[2] Science Without Walls (2017). Scientific American, 316(7), 7

utility can then sole source. The master agreement can often be amended for additional work. In the master agreement at Metropolitan Water Reclamation District of Greater Chicago, a project can be initiated either by the utility approaching the university with a problem and need to build expertise, or the university can approach the utility with a proposed technology.

- Another example of an effective contract is Grand Rapids' program with Grand Valley State University, where the utility pays the university to get graduate or undergraduate students to come and do projects working full time. The department manager defines the needs for the utility. This arrangement has to be done via a contract, as the utility cannot give a grant.
- Coordinating with a consulting engineer or other third-party partner (may be part of a team initiating, or being brought in to assist) can be a benefit, but may also need to be managed.
- Since utilities are used to dealing with consulting engineers and contractors, they expect proposals and projects like consulting engineers would provide (includes deliverables, fee structure, etc.), which can be different than academic grant proposals.
- The university can also have some flexibility to facilitate the financial agreement. If the research is performed at the utility (off campus), then a lower overhead rate may apply, increasing the amount of research that can be accomplished for the same money.
- Researchers can also seek support from higher level in the administration. For example, Virginia Tech lowered overhead for help in fostering a partnership with multiple utilities.
- Universities can also look at co-funding a project using discretionary funds from the academic department or college.
- Equipment can be purchased and owned by the utility in order to avoid additional indirect costs.
- Universities should try to match funds or look for external funding outside of the utility in order to accelerate collaboration.
- Procurement rules in some states may allow contracts with public universities without competition. In this case, only a scope and fees must be negotiated. The utility procurement policies may need to be updated to reflect the allowable operating space.

5.2 Intellectual Property

Historically, IP has been the domain of the universities, and utilities generally have not been interested. As the water sector moves towards a resource recovery paradigm and seeks sources for additional revenues, that model is changing. The example IP framework provided in the contract in Appendix A shows that if either partner exclusively develops some IP, then it is the property of the developing organization. Any IP developed on a joint effort would be shared equally by the parties. Any issues with a third party not part of the master agreement, such as a technology manufacturer, must be agreed to prior to their participation in the research program.

5.3 Public Outreach

Both researchers and utilities want to share the results of their research. Academics generally want to publish in peer reviewed journals and utility professionals want to be seen as leaders by presenting at industry conferences like WEFTEC. The master agreement should specify publishing requirements. In general, best practices for publicizing the research results are:

- Either partner can present or publish a technical paper, but must check with the partner for the opportunity to edit and comment.
- Each partner is required to ask for the right of first refusal for co-authorship.
- If the partner does not wish to participate, the other partner will be unnamed or sanitized in the publication or presentation. For example, "Utility A" instead of "Springfield Water Resource Recovery Facility."
- Data issues must be discussed at the beginning of the project. For example, if there is new analysis about emerging contaminants in solids, the partners need to come up with a common way to release information and everyone should agree to the same. Utilities don't want to hide the data, but also don't want data presented in a way that negatively portrays the utility in the public eye.

6 Opportunities for Future Engagement

With the expanded activity of UUPs over the past few years, the emergence of the LIFT program, and the energized engagement of the stakeholders that supported the June 2017 workshop, there are opportunities to continue the discussion and develop programs to support the developments and advancement of UUPs. To facilitate an understanding of the needs and cultures of the utility professionals and academics, suggestions for future efforts included:

- AEESP and WEF could do a workshop that explains the basics of partnering – fundamentals of what a utility and what an academic is looking for in a partnership, as well as facilitating the understanding of barriers and opportunities to partnering.
- Mixer for utilities and academics at WEF, AEESP and IWA events.
- "Speed dating" to compare interests and find partners at WEF, AEESP and IWA events.

In general, the workshop participants recommended continuing to demonstrate the value of attending professional meetings such as WEFTEC, and understand what each group sees as the values of attending. For example, participants discussed why utilities attend WEFTEC. Reasons included the following:

- Pride in work – showcasing the city or the utility.
- Being seen – important to show they are experts and on top of issues so their customers have trust in what they do. Being seen is as important to a utility as being published is to most academics.
- Having opportunities to share ideas and move them forward – less opportunities to do so within a single utility, but one can come to a professional meeting and have discussions with peers from other utilities.
- Continuing education – license requirements to keep up to date.
- Taking the pulse of the industry – getting out of their own bubble to see what other utilities are doing, what issues they may be facing soon, and how others have found different ways to handle the same challenges.

7 List of Workshop Participants

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8 Case Studies

The LIFT Program and the WEF Research & Innovation Committee gathered a number of case studies highlighting utility-university partnerships, which are described in the following sections.

8.1 Hampton Roads Sanitation District, VA & Various Universities

8.1.1 Partnership Overview

8.1.1.1 Utility Partner

Name of Utility:	HRSD
Location:	VA
Primary Contact for Information on Partnership Effort:	Charles Bott
Type (Water, Wastewater, etc.):	Wastewater
Size (Average flow and/or population served):	1.7 M pe

8.1.1.2 University Partner

Name of University:	Several

8.1.1.3 Summary of Partnership

The objective is stronger connections, engagement, and collaborations between utilities and universities for researching, developing, and testing innovative solutions to facility owner needs. Currently, many universities and utilities operate in a siloed manner when it comes to solving water challenges. Among those who do collaborate, universities and utilities only tend to work with those nearest to them, even if the most skilled research expertise on a topic or process technology for a given research activity are not co-located. Improved collaboration and engagement across a broader geographic space provides win-win scenarios for both sectors and advances new technology development and deployment. The following are categories that describe how HRSD collaborates with universities:

- Category 1: Utility funds research at universities through a contract with the university
  - Consider a policy to limit overhead. HRSD limit paid is 25%
  - University faculty member is often student's primary advisor
  - Students covered by normal assistantship
  - Students may be hosted to work at utility facility for some, all, or none of research work
  - Utility lead and professor work together to determine project scope
  - No final report required. Peer reviewed publications are sufficient for this purpose
  - Modeling is always encouraged, and in general using the same tools as used by the utility
  - Project timing must follow normal academic schedules
  - Ideally utility lead serves on student committee
  - Supply and equipment money can come from grant or direct purchase by utility
- Category 2: Similar to Category 1, but supplemental funding is obtained by successful grant from external entity: NSF, TWRF, etc
  - Utility works with professor to develop proposal for extramural funding

    - Utility cash or in kind funding is dedicated to the project
    - No extramural funding is typically directed to the utility
    - Objective is really to leverage utility funding to support research of interest to utility
    - Research is accomplished exactly as Category 1
- Category 3: Graduate students supported through Utility internship program and advised by utility lead and professor jointly or mostly by professor
    - Student funded by utility internship (~$30-40k/yr) + direct tuition payments to university on behalf of student
    - This category is limited in that there is no easy mechanism for professor summer salary/compensation
    - Supply and equipment money from direct purchase by utility
    - Students may be hosted to work at utility facility for some or all or none of research work
    - Student advised by utility lead and professor jointly or mostly by professor, depending on research work location
    - Utility lead and professor work together to determine project scope
    - No final report required. Peer reviewed publications/thesis/dissertation are sufficient for this purpose
    - Modeling is always encouraged, and in general using the same tool as used by the utility
    - Project timing must follow normal academic schedules
    - Ideally utility lead serves on student committee
    - Must allow students time for course work. MS coursework can often be done in two very packed semesters. Student salary and tuition should also be covered during this time.
- Category 4: Graduate students supported through Utility internship program and advised primarily by utility lead working in an adjunct appointment at university
    - Requires utility lead with PhD (generally) and who can submit an appropriate dossier for adjunct appointment
    - Student funded by utility internship (~$30-40k/yr) + direct tuition payments to university on behalf of student
    - Must allow students time for course work. MS coursework can often be done in two very packed semesters. Student salary and tuition should also be covered during this time.
    - Supply and equipment money from direct purchase by utility
    - Students typically hosted to work at utility facility for all of research work, located at university for full load course work semesters
    - Student advised primarily by utility lead, utility lead serves on student committee as chair or co-chair
    - Utility lead primarily determines project scope, BUT the project must allow time and scope to conduct research work that is appropriate for MS thesis or PhD dissertation
    - No final report required. Peer reviewed publications/thesis/dissertation are sufficient for this purpose
    - Modeling is always encouraged, and in general using the same tool as used by the utility
    - Project timing must follow normal academic schedules and allow course work semesters

Research work conducted by students at utility facilities have some special requirements:

- Provide travel support as needed, utility vehicle
- Provide safety training
- Provide uniform and safety PPE
- Provide computer/laptop
- Provide mentoring by more senior graduate students
- Provide a clear overview for utility staff about student's role and responsibilities and expectations of utility staff for project support

8.1.1.4 Outcomes & Goals for Utility:

- New solutions and insights to utility problems;
- Low-cost technical problem solving;
- Identification of new talent for staffing and/or contracting;
- Proactive and progressive approach for problem solving;
- De-risking of innovative technologies (e.g., through research and piloting) for faster adoption and cost-savings;
- Engagement of operations and administrative staff in current research activities.
- Education of graduate students, HRSD generally chooses support of PhD and MS students over postdocs.
- Innovation, developing and testing new technologies
- Opening new areas of research
- Partnership with universities, idea generation, collaboration
- Cost-effective

8.1.1.5 Outcomes & Goals for University:

- Improved understanding of end user R&D needs;
- Access to utilities that employ technologies or practices that best suit research studies so that more comprehensive field studies can be undertaken;
- Better outcomes and higher likelihood of solutions being adopted and implemented by industry;
- Real world training and experience for students, and increased employment potential post-graduation;
- Synergies with practitioners in developing new technologies and processes;
- Additional patent opportunities;
- Closer relationship with practice
- Funding
- Opportunities for support of MS students

8.2 Metropolitan St. Louis Sewer District & Washington University in St. Louis

8.2.1 Partnership Overview

8.2.1.1 Utility Partner

Name of Utility:	Metropolitan St. Louis Sewer District (MSD)
Location:	St. Louis, MO
Primary Contact for Information on Partnership Effort:	Angela Martin (amartin@stlmsd.com) Cooperative, independent studies
Type (Water, Wastewater, etc.):	Wastewater collection and treatment
Size (Average flow and/or population served):	7 treatment facilities with an average wastewater flow of 350 mgd serve a population of approximately 1.3 million

8.2.1.2 University Partner

Name of University:	Washington University in St. Louis
Location:	St. Louis, MO
Primary Contact for Information on Partnership Effort:	Ray Ehrhard Master of Engineering students address problem areas of interest to the District
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	Research institution, 4 year + graduate studies
Size (Number of students at University or Department):	Approximately 14,400 total students at university, 6,440 are undergraduate

8.2.1.3 Summary of Partnership

MSD worked with four Master of Engineering students in an independent studies course to gain practical knowledge and hands-on experience with real problems and engineering challenges. The topics assigned are current and long term areas of interest to MSD: Corrosion control in large force mains, digester optimization for energy recovery, struvite control and iron fouling of UV disinfection tubes, and non-incineration/landfill options for sludge disposal. MSD provided background information and operating data.

8.2.1.4 Outcomes & Goals for Utility:

MSD gets a report of the students findings and evaluations on topics that are of interest to the utility.

8.2.1.5 Outcomes & Goals for University:

Students are able to conduct applicable inquiry for their independent study credit and study a working wastewater collection and treatment system. Site visits were conducted. Various software was introduced.

8.2.2 Structure of Partnership

8.2.2.1 Discussion of Contractual Relationship and Mechanisms for Funding

Informal arrangement with group discussion sessions.

8.2.2.2 Entities Participating at Utility

Planning engineers.

8.2.2.3 Entities Participating at University (departments, levels of students, etc.):

Graduate advisor and graduate students.

8.2.3 Lessons Learned

8.2.3.1 Successes

Developed a problem statement and offered practical resolution options.

8.2.3.2 Challenges

Additional time was needed to fully develop and test solutions.

8.3 Northern Nevada Regional Utilities Team & University of Nevada, Reno

8.3.1 Partnership Overview

8.3.1.1 Utility Partner

Name of Utility:	Northern Nevada Regional Utilities Team
Location:	Reno, Nevada
Primary Contact for Information on Partnership Effort:	Lydia Peri – Washoe County (775) 954-4626 LPeri@washoecounty.us
Type (Water, Wastewater, etc.):	Water and Wastewater
Size (Average flow and/or population served):	Population: 440,000 Total flow from 5 WRFs: 31.3 mgd

8.3.1.2 University Partner

Name of University:	University of Nevada, Reno
Location:	Reno, Nevada
Primary Contact for Information on Partnership Effort:	Krishna Pagilla, PhD, PE, BCEE Professor and ENVE Program Director Department of Civil and Environmental Engineering (775) 682-7918 pagilla@unr.edu
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	4 year + graduate studies
Size (Number of students at University or Department):	Total students: 21,353 (university) / 470 (department)

8.3.1.3 Summary of Partnership

The Northern Nevada Regional Utilities Team (Regional Team) consisting primarily of six public agencies is jointly implementing a feasibility study to determine if indirect potable reuse (IPR) can be developed into a viable water management strategy for the region. The Regional Team presently envisions conducting IPR field-scale demonstrations utilizing reclaimed water from two of the region's water reclamation facilities. Two field-scale projects will be developed to evaluate the suitability for groundwater augmentation utilizing infiltration basins and aquifer storage and recovery (ASR). The Regional Team has engaged the University of Nevada, Reno (UNR) to develop the technological justification for selecting the advanced treatment, IPR strategy plan for integrated water management in the region, field scale demonstration project design basis and testing plan, assist in acquiring the necessary equipment, assist during the installation of the demonstration project, startup of the plant, optimization of the components, monitoring and testing of the operating, process control, and performance parameters during

steady state operations, data analysis, and report preparation. The project schedule for UNR tasks will extend over a period of 4 years.

8.3.1.4 Outcomes & Goals for Utility:

The overall goal of the project is to develop two field scale demonstration projects for indirect potable reuse of reclaimed water for implementation at regional facilities in Reno, Nevada. Each demonstration project is envisioned to operate 9-12 months. The specific outcome and goals for the Regional Team that will be performed by UNR are as follows:

1. Develop IPR strategies for groundwater augmentation utilizing both infiltration basins and direct injection wells.
2. Develop the plans for scale and sequence of technical components for the field scale demonstration project.
3. Develop operational testing plans including day-to-day operation, monitoring, analytical testing, data analysis and modeling, and risk management for implementation.
4. Operate and collect data, conduct data analysis, and prepare full scale implementation needs of the groundwater replenishment system.
5. Develop legitimacy and independent information for public acceptance of IPR as a water management strategy.

8.3.1.5 Outcomes & Goals for University:

The university is engaged in multiple water reclamation and reuse projects through the support and collaboration of the Regional Team. In addition, the Regional Team has created a Water Innovation Campus at UNR to pursue water innovation that meets regional needs and demonstrates national leadership by UNR. In addition to the above described project, UNR has been able to engage with the Regional Team in multiple ways for mutually beneficial collaborative partnerships. The outcomes from these partnerships include capacity building for conducting water reclamation and reuse work at UNR, increasing the number of PhD students enrolled in the environmental engineering program, and leveraging Regional Team provided resources for winning nationally competitive projects. UNR has just been awarded a USDA project on assessing human health impacts from the use of reclaimed water for agriculture. This is an outcome of the collaboration and facilities offered by the Regional Team members to UNR. The goals of the university from this partnership with the Regional Team include:

1. Development of research and technical capacity to win and undertake nationally competitive projects.
2. Conduct research and development to address regional water needs of the community.
3. Educate the workforce needed for local and regional needs in the water sector.
4. Develop knowledge and discover new systems and practices by solving real world problems, leading to innovation and entrepreneurship in the water sector.

8.3.2 Structure of Partnership

8.3.2.1 Discussion of Contractual Relationship and Mechanisms for Funding (informal, grant, contract, work study, advisory board, etc.):

The Regional Team developed a project plan which included engaging UNR for the demonstration of water technologies for IPR. Consequently, the Regional Team members who serve on the Northern Nevada Water Planning Commission (NNWPC) provided a report seeking engagement of UNR for the project. On August 3, 2016, the NNWPC accepted this report and approved the UNR proposal for the 4-year project entitled “Advanced Water Treatment Technologies Demonstration” and budget, not to exceed $155,699 for fiscal year 2016-2017 and

a total of $676,475 from the Regional Water Management Fund, and executed an interlocal agreement with UNR for that purpose. The funding provides for the support of students, travel, PI, and indirect costs. The actual materials, equipment, and operation costs are provided by the Regional Team directly for the project.

8.3.2.2 Entities Participating at Utility (engineering, operations, lab, etc.):

- Northern Nevada Water Planning Commission – UNR contract, contribution to regional plan
- City of Reno – Aquifer storage and recovery through direct injection demonstration project
- City of Sparks – Water rights and possible effluent uses outside of the region
- Truckee Meadows Water Authority – Project rationale and hydrologic investigations
- Truckee Meadows Water Reclamation Facility – Alternative effluent uses for nutrient discharge mitigation
- Washoe County – Soil aquifer treatment utilizing infiltration basins demonstration project

8.3.2.3 Entities Participating at University (departments, levels of students, etc.):

- Department of Civil and Environmental Engineering
    - 3 PhD Students (0.5 FTE)
    - One MS Student (0.5 FTE)
    - One BS Student (Intern)
    - a Lab Manager (0.1 FTE)
    - Principal Investigator, Dr. Krishna Pagilla (0.08FTE)

8.3.3 Lessons Learned

8.3.3.1 Successes:

The Utility-University partnership between the Regional Team and UNR has already proven to have numerous successes for long term planning for Northern Nevada region. The project brings credible and independent information from the university and helps build public trust. This regional effort allows agencies to collaborate with a leader in the community of research while building into the engineering capacity of the local student body by funding 3 PhD students. UNR has also hosted a workshop for the local agencies and internationally known experts for the purpose of developing enhanced State of Nevada reclaimed water regulations. The collaboration has been a great success and the future of the regional IPR demonstration project is very bright.

8.3.3.2 Challenges:

Throughout the current duration of the project, there have been few challenges. Local agencies and the university have been very supportive of the partnership; however, there is a major focus on maintaining a consistent group value since there are multiple entities involved. Adequate funding can also pose a challenge, but the Regional Team was able to come together and agree upon suitable contributions.

8.4 Rocky Mountain Water Environment Association

8.4.1 Partnership Overview

8.4.1.1 Utility Partner

Name of Utility:	Various Utilities in Colorado / Participants in IWT committee, etc.
Location:	Colorado
Primary Contact for Information on Partnership Effort:	Tanja Rauch-Williams, IWT Co-chair and U2 Program Initiator trauch-williams@carollo.com, 720-670-0479
Type (Water, Wastewater, etc.):	
Size (Average flow and/or population served):	NA

8.4.1.2 University Partner

Name of University:	Colorado State University (CSU), University of Colorado (CU) Boulder, Colorado School of Mines
Location:	Colorado
Primary Contact for Information on Partnership Effort:	University Liaisons: Sybil Sharelle, CSU Mark Hernandez, CU Boulder Junko Munakata-Marr, CSM
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	Undergraduate / Graduate
Size (Number of students at University or Department):	

8.4.1.3 Summary of Partnership

The Innovative Wastewater Technology (IWT) Committee under the Rocky Mountain Water Environment Association (RMWEA) and since 2016 a LIFT Affiliate has since 2015 initiated several programs to help foster stronger collaborations between utilities and universities and to encourage bilateral off-campus education for students and operating staff of Water Resource Recovery Facilities.

1. Utility-University (U2) Intership/ Workforce Development Program

- Active encouragement for utilities to hire students from three local universities in Colorado for temporary interships, pilot evaluations, data management, or process optimization projects.
- IWT offers administrative, and logistical support - advertisement among students, experience exchange with successful hiring program, HR set up, payment structure, etc. among facilities.
- This program is supported by Professors at all three universities (CSM, CU Boulder, CSU) serving as program liaisons.
- IWT offers support with adequate definition of responsibilities and evaluation of value of experience for students and plant staff.

2. Involvement of University Liaisons in IWT Committee meetings and Committee initiatives (seminars, workshops, etc.)

- Active involvement of universities and utilities in the committee work has widened the perspective brought to the discussion of various initiatives, and allows on a continuous basis exchange of ideas, interaction between utility members and universities, and alignment of needs and solutions.

3. Direct Communication Platform

- The IWT committee has launched in 2016/2017 a direct communication platform ("IWT Classified") that allows anybody (students, professors, WRRF staff, consultants, etc.) to login and post specific needs to interested parties who will be notified through email of new postings. This program can be used to post internship opportunities for students or needs for specific literature review topics which can be integrated into existing graduate classes at the universities for which students need to develop research papers for credit.
- This platform aims overcoming one challenge identified under the program that more direct communication between universities and utilities is needed to not make IWT a bottleneck.

8.4.1.4 Outcomes & Goals for Utility:

- see successes below

8.4.1.5 Outcomes & Goals for University:

- see successes below
- Students gain practical, hands-on experience
- Off-campus work
- Applied research involvement for department faculty
- Networking & broader local research collaborations
- Partnership may be regarded as attractive program addition for new students

8.4.2 Structure of Partnership

8.4.2.1 Discussion of Contractual Relationship and Mechanisms for Funding (informal, grant, contract, work study, advisory board, etc.):

Innovative Wastewater Technology (IWT) Committee under the Rocky Mountain Water Environment Association (RMWEA)

8.4.2.2 Entities Participating at Utility (engineering, operations, lab, etc.):

Operations group, management, process specialists, HR department

8.4.2.3 Entities Participating at University (departments, levels of students, etc.):

Students, supervisors

8.4.3 Lessons Learned

8.4.3.1 Successes:

<u>Workforce development program</u>

- Started to strengthen links between local universities and wastewater utilities and STEM Education programs at universities and utilities
- Increased networking organization facilitating
    - Academic and special study support for Colorado utilities / students can bring IT and data management skills that are beneficial to utilities
    - Practical industry experience for graduate and undergraduate students

- Brought younger workforce with new ideas to utilities
- Students have taken on special study needs that plant staff has limited resources for (know-how and time)
- Provided academic support for process or control optimization opportunities
- Fits into innovation needs to do more with less
- Engaged students not only in the lab but also in the industry - practical learning
- Long-term project-bound internships have led to student hiring by utilities after graduation in some instances

8.4.3.2 Challenges:

Workforce Development program

- Utilities do not have support / mentoring / or payment structure in place to hire students
  - This challenge is addressed with a planned workshop for 2017 in Colorado to exchange information among utilities on (internal) funding mechanisms for innovation and research.
- Students are needed but location may be remote
- Students are not immediately available, upfront planning and coordination is required
- Competition for good students (university research and internships)

General program challenges that IWT makes partners aware off:

- Not having a specific organization and expectations in place on utility and university side to co-mentor students
- Disappointment on utility side with results students were able to deliver
- Not enough preparation, limits of what parties can do.
- Coordination with course work, matching personalities deserves consideration
- Have enough work planned out for internships to productively cover 20 hours a week etc.
- Paper type exercise not as useful, ppt, spreadsheets, presentations, hands-on better for both utilities and students.

Below are issues identified by Partners and solutions found to address them:

Universities	Possible Solutions
Student availability; competing interests of faculty to use students	Student screening can be implemented – Human Resources at the Utility can require an application and selection process for students
Funding Support	Scholarships for students Allocate funds from utilities Explore opportunities for financial support from outside organizations
Mentoring students on-site	Set clear expectations and provide mentoring oversight

Utilities	Possible Solutions
Adequate time for mentoring students	One dedicated supervisor, with other engineers working with student on project
Initial expectations are not fulfilled	Meet early on with professors and faculty to have the same expectations and not pull students in different directions
Data sharing and publications	Early definition of expectations
Early resistance due to lack of experience with program	Initial education on success programs, support from planning group

8.5 Brookings Municipal Utilities and City of Sioux Falls, South Dakota

8.5.1 Partnership Overview

8.5.1.1 Utility Partners

Name of Utility:	Brookings Municipal Utilities
Location:	Brookings, South Dakota
Primary Contact for Information on Partnership Effort:	Eric Witt (ewitt@swiftel-bmu.com)
Type (Water, Wastewater, etc.):	Wastewater
Size (Average flow and/or population served):	730 million gallons/year or approximately 2.0 mgd

Name of Utility:	City of Sioux Falls
Location:	City of Sioux Falls, South Dakota
Primary Contact for Information on Partnership Effort:	Mark Perry (mperry@siouxfalls.org)
Type (Water, Wastewater, etc.):	Wastewater
Size (Average flow and/or population served):	15 mgd

8.5.1.2 University Partner

Name of University:	South Dakota State University
Location:	Brookings, South Dakota
Primary Contact for Information on Partnership Effort:	Chris Schmit (Christopher.schmit@sdstate.edu)
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	Undergraduate, Graduate, and Ph.D. programs
Size (Number of students at University or Department):	Approximately 12,600 students

8.5.1.3 Summary of Partnership:

Brookings Municipal Utility & SDSU - For the past thirty years the Brookings Municipal Utility and SDSU have been under yearly contracts to help operate the waste water treatment facility for the City of Brookings. Our students (both graduate and undergraduate) operate the plant in the evenings and overnight hours. We are there every day of the year and have three shifts on weekends and

holidays. We also do the permit compliance laboratory testing for the plant using graduate students.

Sioux Falls & SDSU - An ongoing relationship has been established with the City of Sioux Falls WWTF. This relationship has resulted in several research projects to help the City better operate their plant and to make decisions regarding upgrades and renovations. Some of these projects have occurred on the site of the WWTF and others have occurred in the laboratory at the University. These projects include work done on nutrient removal, operation of activated sludge systems, anaerobic digestion of fats, oils, and greases, and effluent filtration.

8.5.1.4 Outcomes & Goals for Utility:

Brookings Municipal Utility: The utility is able to capitalize on skilled workers to help operate the plant without the cost of full time employees. Additionally, the utility is providing an educational benefit to the University in terms of training and potentially providing future employees in the wastewater profession.

Sioux Falls: Research projects have resulted in improved operation of the facility and aided in the design of new systems within the facility. These improvements have also resulted in financial savings. The goals for these projects is to help to educate students as well as to benefit the facility both operationally and financially.

8.5.1.5 Outcomes & Goals for University:

Brookings Municipal Utility: The goal of the partnership is to provide assistantships to our graduate program and also to provide experience to our undergraduate and graduate students. These experiences have greatly enhanced the marketability of our students primarily to consultants. Some students leave the experience as a licensed wastewater operator.

Sioux Falls: The goal of this partnership is to provide research topics and funding to graduate students so that they are able to complete the M.S. degree. The secondary goal is to help the Sioux Falls Wastewater Treatment Facility improve their plant both operationally and financially.

8.5.2 Structure of Partnership

8.5.2.1 Discussion of Contractual Relationship and Mechanisms for Funding

- Brookings Municipal Utility: Yearly Contracts; The graduate students are under assistantship and the undergraduate students get paid hourly.
- Sioux Falls: Contracts are generally done as sponsored service agreements where the City agrees to pay a portion of the cost in generally two payments with the second payment pending completion of enumerated deliverables.

8.5.2.2 Entities Participating at Utility (engineering, operations, lab, etc.):

- Brookings Municipal Utility: Operations, Laboratory
- Sioux Falls: Wastewater superintendent and operations supervisor

8.5.2.3 Entities Participating at University (departments, levels of students, etc.):

- For Brookings Municipal Utility: Graduates and Undergraduates and principal investigator
- Sioux Falls: Graduate student and principal investigator

8.5.3 Lessons Learned

8.5.3.1 Successes:

- Brookings Municipal Utility: There are a whole host of lessons that we have learned in this endeavor regarding contacts, negotiating indirect costs, and managing this type of grant. There have been several other research projects that have spun off of this grant related to the Brookings WWTF. It really is a win-win-win since students, the utility, employers, and the University all benefit from this arrangement.
- Sioux Falls: Lessons learned include how to take an engineering project and accomplish those goals while providing the student with enough "research" to get a thesis paper. How to structure contracts, payments, and deliverables. How to manage students that are working 50 miles from the University on a daily basis.

8.5.3.2 Challenges:

- Brookings Municipal Utility: One big challenge in this partnership is the turnover that occurs among the students. This requires constant training and flexibility to meet the needs of both the utility and the students. Communication between the utility and the university has also been challenging since the utility operators may observe behavior that needs correction, but that is sometimes not relayed back to the university supervisors to take the corrective action.
- Sioux Falls: The primary challenge with this partnership is forming a project that benefits the WWTF while still providing enough depth for the student to complete a masters's thesis. Many of the projects are fixed on a specific outcome and don't have enough "basic science" to allow a student to complete a thesis. It is important to work the scope of the project out with the WWTF prior to initiating the research so both parties are on the same page. In the end, both parties will have to be flexible so their goals can be accomplished.

8.6 Ft. Collins Utilities & Colorado State University

8.6.1 Partnership Overview

8.6.1.1 Utility Partner

Name of Utility:	Fort Collins Utilities
Location:	Fort Collins, CO
Primary Contact for Information on Partnership Effort:	Link Mueller (wastewater), John Haukaas (water), Basil Hamdan (stormwater)
Type (Water, Wastewater, etc.):	Water, Wastewater and Stormwater
Size (Average flow and/or population served):	130,000 people

8.6.1.2 University Partner

Name of University:	Colorado State University
Location:	Fort Collins, CO
Primary Contact for Information on Partnership Effort:	Sybil Sharvelle
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	Research Institution
Size (Number of students at University or Department):	33,000 students at CSU

8.6.1.3 Summary of Partnership

CSU has collaborated with the Fort Collins Utilities (FCU) on several projects related to water supply, wastewater and stormwater. In the area of water supply, CSU collaborated on a project with FCU to evaluate alternatives for separate supply of potable demand to meet indoor demand. This project involved a participatory process with multiple FCU departments to develop a hybrid triple bottom line multi-criteria decision analysis tool delivered to FCU. Alternatives of both centralized and decentralized water supply were included. CSU has collaborated with FCU on wastewater projects to evaluate the potential to use the Drake Wastewater Reclamation Facility (DWRF) to accept and process local food waste via anaerobic digestion and analyze nutrient removal at DWRF. Outputs from these wastewater related projects were guidance for decision making and plant operations. In the area of stormwater, CSU has collaborated on several projects to monitor stormwater systems and provide guidance on installation of new and innovative stormwater technologies.

8.6.1.4 Outcomes & Goals for Utility:

FCU has utilized CSU resources to support early feasibility studies in areas where their own staff would not have the time to conduct literature reviews and evaluate alternatives. Through FCU-CSU partnerships, FCU has been provided with guidance on several new management strategies including separate supply of potable water, installation of innovative stormwater technologies and use of DWRF for anaerobic digestion of municipally collected food waste. Work conducted by CSU has enabled FCU to make more informed decisions regarding these new management strategies.

8.6.1.5 Outcomes & Goals for University:

The partnership between FCU and CSU has enabled CSU to provide students with practical research projects that prepare them for professional careers. These projects have provided students with opportunities to work closely with FCU staff in teams that build their technical and communication skills. Some of the projects have resulted in manuscripts published in the peer reviewed literature. The FCU-CSU collaborator projects have provided invaluable opportunities for students to engage in meaningful research projects while building their technical knowledge and professional skills.

8.6.2 Structure of Partnership

8.6.2.1 Discussion of Contractual Relationship and Mechanisms for Funding

Many of the project collaborations between CSU and FCU have been through contracts with funding. Some projects have funded students as interns to support research efforts. In these cases, the students were employed by FCU and CSU faculty contributed in-kind time to support the projects.

8.6.2.2 Entities Participating at Utility (engineering, operations, lab, etc.):

Engineering and Management in each water supply, wastewater and stormwater departments.

8.6.2.3 Entities Participating at University (departments, levels of students, etc.):

Department of Civil and Environmental Engineering, Faculty, MS and PhD students

8.6.3 Lessons Learned

8.6.3.1 Successes:

Tools and guidance have been presented to FCU that have guided more informed decisions on water management.

Through our project on separate supply of water, our project team engaged many departments from both FCU and the City of Fort Collins (e.g. Parks and Recreation, Customer Relations, Transportation Planning, Urban Renewal, Transportation Planning among others). This connected the utility and city staff in an engaged way through a participatory process to develop solutions, thus breaking down institutional barriers for working across municipal departments.

8.6.3.2 Challenges:

In our project on separate supply of water, we realized we needed to engage various departments of the utility and staff earlier in the project development process. They were brought into the decision making too late in the process.

Communication is important. FCU staff are busy and constant communication is needed to ensure deliverables are met on time. These issues were resolved via monthly reporting and setting recurring meetings for project participants to participate in.

8.7 Virginia Tech & Various Utilities

8.7.1 Partnership Overview

8.7.1.1 Utility Partner

Name of Utility:	Western Virginia Water Authority
Location:	Roanoke, VA
Primary Contact for Information on Partnership Effort:	Scott Shirley
Type (Water, Wastewater, etc.):	Wastewater
Size (Average flow and/or population served):	37 MGD

Name of Utility:	Alexandria Renew Enterprises
Location:	Alexandria, VA
Primary Contact for Information on Partnership Effort:	Charlie Logue
Type (Water, Wastewater, etc.):	Wastewater
Size (Average flow and/or population served):	38 MGD

Name of Utility:	Washington Suburban Sanitary Commission
Location:	Laurel, MD
Primary Contact for Information on Partnership Effort:	Caroline Nguyen
Type (Water, Wastewater, etc.):	Wastewater
Size (Average flow and/or population served):	259 MGD

Name of Utility:	Hampton Roads Sanitation District
Location:	Hampton Roads, VA
Primary Contact for Information on Partnership Effort:	Charles Bott
Type (Water, Wastewater, etc.):	Wastewater
Size (Average flow and/or population served):	249 MGD

8.7.1.2 University Partner

Name of University:	Virginia Tech
Location:	Blacksburg & Manassas, VA
Primary Contact for Information on Partnership Effort:	Zhen (Jason) He
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	Research Institution
Size (Number of students at University or Department):	545 undergraduates, 328 graduate students in the Civil and Environmental Engineering department

8.7.1.3 Summary of Partnership

We expect to conduct applied research in wastewater treatment, such as anammox, biofiltration and resource recovery.

8.7.1.4 Outcomes & Goals for Utility:

- Use research to solve problems encountered during operation;
- Attract talent for potential employment;
- Participate in cutting-edge research and promote the profile of the utilities;

8.7.1.5 Outcomes & Goals for University:

- Obtain the financial support and opportunities for applied research and publications;
- Train graduate students and prepare them for further employment;

8.7.2 Structure of Partnership

8.7.2.1 Discussion of Contractual Relationship and Mechanisms for Funding

We have established an industry affiliate program at Virginia Tech, through which the members will pay membership fee and select the research projects. This program is called "Virginia Tech Center for Applied Water Research and Innovation (VT-CAWRI)". The center has officially started in fall 2017 and will hold an annual research symposium open to both center members and non-members.

8.7.2.2 Entities Participating at Utility (engineering, operations, lab, etc.):

We plan to build a facility at WVWA for pilot studies. We can also take advantages of pilot facilities at HRSD for applied research.

8.7.2.3 Entities Participating at University (departments, levels of students, etc.):

The center is open to all the faculty members at Virginia Tech.

8.8 MWRD Chicago & Iowa State University

8.8.1 Partnership Overview

8.8.1.1 Utility Partner

Name of Utility:	MWRD Chicago
Location:	Chicago, IL
Primary Contact for Information on Partnership Effort:	Tom Kunetz KunetzT@mwrd.org
Type (Water, Wastewater, etc.):	Wastewater
Size (Average flow and/or population served):	1,200 MGD, 5.5 million people served

8.8.1.2 University Partner

Name of University:	Iowa State University
Location:	Ames, IA
Primary Contact for Information on Partnership Effort:	Dr. Zhiyou Wen
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	4 yr Plus graduate university
Size (Number of students at University or Department):	36,000

8.8.1.3 Summary of Partnership

Collaborative effort between ISU and MWRD to mature a pilot-stage technology developed by Dr. Wen, called "Revolving Algae Biofilm Reactor (RAB)" into a full-scale, practical means for MWRD to remove and recover phosphorus from wastewater effluent in a sustainable manner. Four pilot units were designed by ISU, fabricated under contract to ISU, and installed at a research greenhouse on the MWRD's O'Brien Water Reclamation Plant site by ISU and MWRD forces. MWRD research staff perform daily operations, maintenance, and collect, analyze, and record samples. ISU provides advice and expertise. Phase 1, a year-long study to optimize the process, has been completed. Results from Phase 1 were used to develop Phase 2, a second year-long study, which will evaluate, optimize, and enhance the performance of a second generation RAB unit.

8.8.1.4 Outcomes & Goals for Utility:

The goal is the development of a viable, robust technology to reduce phosphorus limits in plant effluent to below 1.0 mg/l, using biofilm algae biomass as the recovery method. A second goal is to identify a market for, and create a marketable product of, the harvested algae, as a revenue stream for the MWRD.

8.8.1.5 Outcomes & Goals for University:

The ultimate goal is to commercialize the RAB technology. The research projects will help to optimize the process to maximize nutrient uptake, maximize algal biomass production, while minimizing the system footprint requirement. Use analytical data collected by the MWRD to help support promotion of the viability of the technology for commercial sale.

8.8.2 Structure of Partnership

8.8.2.1 Discussion of Contractual Relationship and Mechanisms for Funding

- Formal contract between MWRD and ISU.
- MWRD is funding the research, paying for equipment purchase and ISU expertise.

8.8.2.2 Entities Participating at Utility (engineering, operations, lab, etc.):

- Assistant Director of Engineering (PM)
- Senior research scientist
- Research technician
- Laboratory staff
- Trades for maintenance of equipment, equipment installation, and installation of ancillary infrastructure.

8.8.2.3 Entities Participating at University (departments, levels of students, etc.):

- Professor, Department of Agriculture (PI)
- Post-doc

8.8.3 Lessons Learned

8.8.3.1 Successes:

First generation RAB unit successfully demonstrated the viability of the technology. Various process changes were evaluated. The data was collected and analyzed, and used to design the second generation RAB unit. The second generation RAB unit will be deployed in 2017.

8.8.3.2 Challenges:

Finding ways to further intensify the performance of the RAB-- including shrinking the overall footprint requirement-- without significantly impacting energy usage, cost, or complexity.

Understanding how seasonal variations in light and temperature will affect the mix of species of algae that grows, and if this will have an impact on the marketability of the harvested algae biomass.

8.9 Great Lakes Water Authority & Wayne State University

8.9.1 Partnership Overview

8.9.1.1 Utility Partner

Name of Utility:	Great Lakes Water Authority
Location:	Southeast Michigan
Primary Contact for Information on Partnership Effort:	Wendy Barrott: Manager Research & Innovation wendy.barrott@glwater.org 313-999-3952
Type (Water, Wastewater, etc.):	Water and Wastewater Utility
Size (Average flow and/or population served):	Serving 4 Million drinking water customers and 2 Million wastewater

8.9.1.2 University Partner

Name of University:	Wayne State University
Location:	Detroit, Michigan
Primary Contact for Information on Partnership Effort:	Dr. Carol J. Miller (ab1421@wayne.edu) Professor and Director of Healthy Urban Waters
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	4 year + graduate
Size (Number of students at University or Department):	27,000 at University

8.9.1.3 Summary of Partnership

Great Lakes Water Authority (GLWA), established during the settlement of the City of Detroit bankruptcy, developed a brand house to lead the organization during all strategic and business planning activities. One of the three pillars of the brand house is “High quality through innovation” which sets an expectation to lead innovation and enhanced treatment processes, act as a technology incubator, and foster collaborations with local universities to develop leading edge technology and research. To begin to fulfill the vision of the brand house, GLWA is building on an existing relationship with Wayne State University. The existing Memorandum of Understanding was extended last year and the parties continue to collaborate on leading edge research around contaminates of emerging concern (CECs), including endocrine disrupting compounds (EDCs), pesticides, antibiotics and personal care products and a data platform for Huron to Erie source water monitoring communication. The current research in CECs involves analysis of selected EDCs from inlet through the treatment process to determine the fate of the selected EDCs across the treatment train, evaluating the removal efficiency at each process under various conditions and evaluation of biological effects on Danio rerio (zebrafish) and Daphnia pulex (waterflea), including direct evaluation of effects on zebrafish from exposure to the EDCs present in the water intake.

The research is conducted at Wayne State University laboratories and GLWA's Water Works Park Pilot Plant. The water treatment facility is a 240 MGD rated treatment capacity using coagulation, flocculation, sedimentation and granular media filtration treatment processes with state of the art ozonation unit with post chlorination. The pilot plant is an exact replica of the main plant including use of water taken from the same intake pipes.

The data platform for the Huron to Erie Source Real-Time Drinking Water Protection Network, hosted at WSU, now has near real-time data for each of the participating water intakes along the Huron to Erie Corridor, including GLWA intakes. The data platform allows analysis that portrays the spatial and temporal changes of source water quality. Discussions have begun with the Ohio monitoring system to combine data platform for a Huron to Erie and beyond data network.

8.9.1.4 Outcomes & Goals for Utility:

Great Lakes Water Authority's overarching goal for this partnership is to obtain actionable information from research which allows GLWA to provide better, more reliable, cost effective treatment and distribution protocols. GLWA's goal for the CEC research is to support the basic research which contributes to the understanding of the presence, impacts and possible treatment options for these contaminants that arise from human impacts the ramifications of which are only beginning to be pieced together. For the monitoring project, GLWA hopes that region-wide support is generated for real-time source water monitoring with the ultimate establishment of a funding mechanism to fully support ongoing operations, maintenance and enhancements.

8.9.1.5 Outcomes & Goals for University:

Wayne State's goals for the partnership are to: (1) contribute new applied knowledge and technical resources both for utility operators and society at large, and (2) train the next generation of water utility practitioners in sustainable, healthy, innovative, and environmentally-sound operations. The immediate goals of the projects underway are 1) determine the removal efficiencies of CECs across the treatment train, 2) explore changes in the treatment protocols that could lead to improved removal efficiencies 3) determine the occurrence and effects EDCs in Detroit water bodies. The immediate goals of the Huron to Erie real-time drinking water monitoring effort is to demonstrate performance of the data platform, which takes real time monitoring data from 14 water treatment plant intakes and compiles it into useful, actionable information and evaluate the viability of real-time source water early warning for volatile Organic Compounds (VOC).

8.9.2 Structure of Partnership

8.9.2.1 Discussion of Contractual Relationship and Mechanisms for Funding

To date, the relationship has evolved around a Memorandum of Understanding and participation of the Utility in the Healthy Urban Waters Advisory Board. The Healthy Urban Waters program is funded by the Erb Family Foundation. This funding has also allowed students to be employed as interns and staff to physically perform the research at the GLWA's Water Works Park pilot plant.

8.9.2.2 Entities Participating at Utility (engineering, operations, lab, etc.):

GLWA areas currently involved include GLWA Water Works Park personnel, Public Relations and the newly formed Research & Innovation Group.

8.9.2.3 Entities Participating at University (departments, levels of students, etc.):

The following WSU Departments are involved: Civil and Environmental Engineering, Pharmaceutical Sciences, Industrial and Systems Engineering, Medicine (Physiology), and Biology.

8.9.3 Lessons Learned

8.9.3.1 Successes:

1. Demonstration of a platform to collect and compile data from multiple sources.
2. Preliminary indication of the effects of EDCs present in source water on the hatch rate, survival and abnormalities in zebrafish.
3. Development of protocols to measure specific EDCs across the pilot plant treatment train.

8.9.3.2 Challenges:

1. Continuation of funding to support Healthy Urban Waters or a successor program.
2. Regional commitment to support ongoing real-time monitoring of source water.
3. Connecting findings to public messaging that is accurate and engaging.

8.10 Hillsborough County Public Utilities and University of South Florida

8.10.1 Partnership Overview

8.10.1.1 Utility Partner

Name of Utility:	Hillsborough County Public Utilities
Location:	Tampa, Florida
Primary Contact for Information on Partnership Effort:	Luke A. Mulford, Ph.D., P.E. Senior Professional Engineer
Type (Water, Wastewater, etc.):	Water, Wastewater and Reclaimed Water
Size (Average flow and/or population served):	Potable Water 56 MGD average, Population Served ~ 598,000.

8.10.1.2 University Partner

Name of University:	University of South Florida
Location:	Tampa FL
Primary Contact for Information on Partnership Effort:	Sarina J. Ergas, Professor, Department of Civil & Environmental Engineering, sergas@usf.edu
Type (Research Institution, 4 year + graduate studies, 4 year only, etc):	Research 1 university, 4 year + master's + PhD
Size (Number of students at University or Department):	>50,700 students in the USF system, > 5,000 undergraduates and > 1,200 graduate students in the college of engineering

8.10.1.3 Summary of Partnership:

USF and Hillsborough County's Public Utilities Department have collaborated on a large number of projects. These have included: 1) capstone design projects for student design teams in both Civil Engineering and Chemical Engineering; 2) Hillsborough County funded projects on wastewater process modeling and optimization, sidestream nutrient impacts on mainstream processes; 3) collaboration on research funded by state and federal agencies such as the USEPA, NSF and the Hinkely Center for Solid and Hazardous Waste Management; 4) internships and full-time employment opportunities for undergraduate and graduate students; 5) class tours of wastewater and solid waste management facilities; 6) co-authorship of publications; 7) utility staff who serve as advisors and committee members to our students. Hillsborough County and USF are part of the

WEF/Water Research Foundation LIFT network. Hillsborough County and USF jointly operate a pilot facility at the County's Northwest Regional Water Reclamation Facility.

8.10.1.4 Outcomes & Goals for Utility:

1) Expert services from University faculty and students for in depth systems analysis using advanced analytical technics and robust QA/QC to optimize chemical and biological processes.
2) Access to engineering faculty and students on multi-disciplines teams to develop and calibrate advanced models with user friendly interface for plant operations staff to proactively simulate process changes.
3) Access to additional advanced resources for bench and pilot studies to identify and support future processes to achieve sustainability in energy, nutrients and water resource recovery.
4) Promote research in advanced technology in conjunction with educating students of all ages and the public on current and future resource recovery facilities. This is promoted by conducting tours of pilot and full scale facilities and allowing the university students to lead tours to educate elementary and high school students. The goal is succession planning by educating students of all ages to future careers in utility and environmental fields.

8.10.1.5 Outcomes & Goals for University:

The following is a listing of some of USF's goals:

1) Teaching - provide real-world, hands-on opportunities for our undergraduate and graduate students to learn about wastewater treatment, solid waste management, environmental regulations and related topics. This is accomplished through teacher and student tours of Hillsborough County's facilities, capstone engineering design projects, and internships and full-time employment opportunities for undergraduate and graduate students. In addition, USF student teams have used Hillsborough County wastewater projects in the FWEA and WEF student design competition.

2) Research - collaborate on research that both benefits the County and contributes to current knowledge of wastewater treatment, solid waste management and related topics. This is accomplished through Hillsborough County funded projects, support from the County for externally funded research by providing sites for research, data, samples, technical support, etc. Research is also facilitated by Hillsborough County staff serving on graduate thesis and dissertation committees and co-authoring publications with USF students and faculty.

3) Service - USF has an active student chapter of the Florida Water Environment Association (FWEA). Hillsborough County has actively participated in USF FWEA events and activities. The Water Resources/Environmental Engineering Capstone design class is considered a USF Service Learning class.

8.10.2 Structure of Partnership

8.10.2.1 Discussion of Contractual Relationship and Mechanisms for Funding:

The County has a "Research and Technical Assistance" Interlocal Agreement with USF to provide technical assistance in the form of research and development studies. The agreement is for 3-years and may be renewed for an additional two (2) 3-year terms. A blanket purchase order is established from which work orders can be issued. There is a limit of $200,000 per work order and

an annual funding limit of $500,000. Work orders can be fixed fee or hourly rates with reimbursable expenses.

8.10.2.2 Entities Participating at Utility:

A senior professional engineer within the Technical Services Division manages the contract and projects directly funded by the Department. The engineer develops scope, schedule and budget, coordinates and documents activities. However, a main focus and intent is to support the operational divisions so projects are developed with respect for their needs and priorities and require their active participation at plant and field sites. Engineering Planning, Regulatory, and Laboratory Services groups all provide technical expertise and data required by the researchers to conduct the systems evaluations. Other County departments such as Public Works use the contract for storm water, wetlands, and ponds surveys,

8.10.2.3 Entities Participating at University:

Department of Civil & Environmental Engineering - undergraduate and graduate students

Department of Chemical & Biomedical Engineering - undergraduate and graduate students

8.10.3 Lessons Learned

8.10.3.1 Successes:

- Regular class and student group tours of Hillsborough County's facilities.
- Large number of capstone design projects, master's theses and PhD dissertations derived from projects done with the County.
- USF team wins at FWEA and WEFTEC student design competition based on Hillsborough County projects.
- Hillsborough County and USF are part of WEF/The Water Research Foundation's Leaders Innovation Forum for Technology (LIFT). We jointly operate a pilot facility at the County's Northwest Regional Water Reclamation Facility.
- The County has provided support for projects funded by the NSF, USEPA and Hinkely Center for Solid and Hazardous Waste Management. Support has varied from providing advice or samples for laboratory research to providing space and technical support for pilot and full-scale studies carried out at County facilities.
- Publications in professional journals, conference posters and presentations and peer reviewed journals based on projects done with the County.
- County has funded more than $300,000 of research which has assisted them in improving their wastewater and solid waste operations.

8.10.3.2 Challenges:

- Some lack of continuity as students graduate and grant funded research ends.
- So far, we have not partnered on The Water Research Foundation funded research.
- Although we are now part of LIFT and have pilot facilities available, we have only been contacted by a couple of vendors to test their technologies. USF does not have dedicated technicians that can carry out short-term projects and costs have been a barrier to closing the deal with these vendors.
- Some mismatch between faculty research interests and Hillsborough County facilities. For example, Hillsborough County does not currently anaerobically digest their sludge so faculty normally collaborate with other utilities on these projects.
- Difficulty implementing USF student internships and full-time positions thorough Hillsborough County Human Resources Policies.

9 Appendix A: Sample Contract Language

The following text for a sample contract between a utility and a university has been provided by Metropolitan Water Reclamation District of Greater Chicago.

MASTER AGREEMENT

This Master Agreement ("Agreement"), effective as of the last date of signature by a party below, is between the [Name of Utility] ("UTILITY"), and [Name of university] ("UNIVERSITY"), and sets forth the terms and conditions upon which UNIVERSITY will conduct research projects funded by UTILITY.

No commitment is made by UTILITY to contract and pay for research or other services, or for UNIVERSITY to conduct research or provide other services, by the execution of this Agreement alone. Commitments for research projects and other services are made by the issuance of Research Project Specifications (in the form of **Exhibit A**). The UTILITY shall not be liable to UNIVERSITY for research funds to be expended until such has been authorized, approved and/or allocated by the [Name of governing body of Utility].

1. SERVICES: RESEARCH PROJECT SPECIFICATION (RPS)

1.1. **Services:** This Agreement is applicable to UTILITY's procurement of research and other services from UNIVERSITY in, but not limited to, the following areas: [List research areas].

1.2. **Order of Precedence:** In the event of any conflict in terms, the following order of precedence shall govern:

(1) the terms of this Agreement,

(2) the RPS which has been prepared for the particular project.

2. REPORTS

The Principal Investigator identified in the RPS will be available by telephone or to meet in person at UNIVERSITY and the UTILITY's offices to discuss the progress and results, as well as ongoing plans, or changes therein, of a Research Project. Individual reporting requirements shall be set forth in each RPS.

3. REPRESENTATION

UNIVERSITY agrees to provide services to UTILITY in accordance with the terms of this Agreement and the RPS. UNIVERSITY further agrees to develop and provide the deliverables identified in the RPS (the "Deliverables") at the times indicated.

4. RIGHTS IN DATA

All original data and records of this work created and developed by UNIVERSITY shall be the property of UNIVERSITY. Copies of such data will be made available to UTILITY upon request in both hardcopy and electronic form, in their original application form (e.g. Word, Excel, PowerPoint, GPS-X, etc.) All data and records supplied by the UTILITY shall remain the property of the UTILITY.

5. CONFIDENTIAL INFORMATION

5.1. During the course of this project, it may be necessary for the parties to exchange confidential and proprietary information. Subject to Section 5.1.2, "Confidential Information" means all information of a party, including, without limitation, technical information, business information, sales information, customer and potential customer lists and identities, product sales plans, license and sublicense agreements, inventions, invention disclosures and descriptions of inventions, developments, discoveries, know-how, methods, techniques, formulae, data, processes, and other proprietary ideas, whether or not protectable under patent, trademark, copyright, or other legal principles, that the other party obtains or receives after the date of this Agreement, whether furnished in any form, including but not limited to written, verbal, visual, electronic or in any other media or manner and pursuant to the purpose that the disclosing party intends to remain secret from third parties on the grounds that its disclosure would either cause the disclosing party competitive harm or waive a privilege granted by law. All information meeting the foregoing definition which will be provided for purposes of each Project Specification, whether provided in tangible form, by electronic media, by visual display or orally, shall be considered to be Confidential Information for purposes of this Agreement, provided that (i) in the case of information provided in tangible form, by electronic media or by visual display, it is marked with, or accompanied by, the legend "CONFIDENTIAL", and (ii) in the case of information disclosed orally, such disclosure is identified as confidential when revealed and summarized in a writing so marked, referencing the date and type of information disclosed,

delivered to the other party within thirty (30) days of such disclosure. All information disclosed orally which is identified as confidential when revealed shall be treated as Confidential Information pending timely delivery of the writing referred to in clause (ii) above.

5.2 The term "Confidential Information" shall exclude any information or other material that:

(i) was in the public domain on the Effective Date or subsequently enters the public domain through no fault of the receiving party; (ii) the receiving party can demonstrate was independently developed by the receiving party; (iii) was communicated rightfully to the receiving party by an unrelated third party that was free of any obligation of confidentiality and without restriction as to use; or (iv) the receiving party can demonstrate that it was in its possession free of any obligation of confidentiality and without restriction as to use prior to receipt from the disclosing party. The parties agree that the receiving party shall bear the burden of proof of demonstrating that any information or material included within the Confidential Information of the disclosing party falls under one of the foregoing exceptions.

5.3 If a receiving party at any time is required pursuant to judicial order or other compulsion of law to disclose Confidential Information, the receiving party agrees to promptly provide prior written notice of any such requirement to the disclosing party so that the disclosing party may seek an appropriate protective order or other remedy. The receiving party may disclose only that portion of the Confidential Information that the receiving party is legally compelled or is otherwise required by law to disclose and the receiving party shall continue to treat such disclosed portion as Confidential Information of the disclosing party.

[5.4 Both Parties are public bodies and as such are subject to release of information under the XXXXX Freedom of Information Act. Both Parties understand the confidentiality provisions herein are to be used to protect actual information which, if released to the general public, could damage the competitive nature of the disclosing party's business, and are not to be extended to each and every piece of information that is transmitted.]

6. INTELLECTUAL PROPERTY

[If no patentable inventions are anticipated, select below….]

6.1 Inventions

Patentable inventions and copyrightable software are not anticipated under this Agreement. In the event that a patentable invention and/or copyrightable software is first created in the performance of any project sponsored hereunder, ownership of and license rights in any such resulting intellectual property shall be determined in accordance with applicable U.S. law and UNIVERSITY policy, and with both parties acting in good faith. No license or other right is granted under this Agreement by either party, either directly or by implication, estoppel or otherwise, under any intellectual property rights of that party.

[Otherwise, select following…]

6.1 Inventions. "Inventions" means those potentially patentable discoveries, including pending patent applications and issued patents, first conceived and actually reduced to practice in performance of the work for this project. The UNIVERSITY shall own all Inventions first conceived and actually reduced to practice solely by UNIVERSITY employees ("UNIVERSITY Inventions"). UTILITY shall own all Inventions otherwise first conceived and actually reduced to practice solely by UTILITY employees ("UTILITY Inventions"). The parties shall jointly own all Inventions first conceived and actually reduced to practice by both UNIVERSITY and UTILITY employees ("Joint Inventions").

6.2 Patents

6.2.1 Patent Filing. At UTILITY's request and expense, UNIVERSITY will file patent applications in the United States and in foreign countries for UNIVERSITY or Joint Inventions. For Joint Inventions, UTILITY may, with UNIVERSITY approval, control the patent application filing, prosecution and maintenance. UTILITY will make any filing request to UNIVERSITY in writing and within 60 days of UNIVERSITY's notice of Invention disclosure. UNIVERSITY will keep UTILITY promptly informed regarding the status of any patent application filed at UTILITY's request and will give UTILITY reasonable opportunity to comment. If UTILITY elects not to have UNIVERSITY file a patent application on a Joint Invention or UNIVERSITY Invention, then UNIVERSITY may, at its discretion and at its expense, file a patent application on such Joint Invention or UNIVERSITY Invention in the United States and in foreign countries.

6.2.2 Foreign Filing Election. UTILITY will notify UNIVERSITY of any foreign countries in which UTILITY desires a license at least 60 days prior to the respective foreign filing due date.

6.2.3 Costs. If UTILITY requests UNIVERSITY to file a patent application on UTILITY's behalf, UTILITY will pay UNIVERSITY, within 30 days of invoice date, all documented out-of-pocket costs incurred by UNIVERSITY to secure any resulting patents for UTILITY.

6.2.4 Licensing. In consideration of UTILITY's support of this project, UNIVERSITY grants to UTILITY a non-exclusive, non-transferable, irrevocable, perpetual, royalty-free license to practice each UNIVERSITY Invention for non-commercial purposes. No license will be provided to UNIVERSITY for UTILITY Inventions.

6.3 Background Intellectual Property. Except as provided in this Section 1.5, nothing in this Agreement grants to either Party any rights or interest in the other Party's Background Intellectual Property. "Background Intellectual Property" means (a) all works of authorship created outside the scope of this Agreement and (b) potentially patentable discoveries, including pending patent applications and issued patents, conceived or first reduced to practice outside the scope of this Agreement. Any Background Intellectual Property that is reasonably anticipated by the Principal Investigator to be required to perform the Research, the Principal Investigator will specify in an Exhibit B to this Agreement. In the event UNIVERSITY owns Background Intellectual Property and becomes aware that such Background Intellectual Property is required to practice an Invention, UNIVERSITY, to the extent that is legally able to do so, shall grant, and does hereby grant, a non-exclusive royalty-free license to such Background Intellectual Property to enable UTILITY to practice the Invention.

6.4 CREATE Act. The parties agree that this Agreement constitutes a "joint research agreement" as that term is defined by the Cooperative Research and Technology Enhancement Act of 2004, pre-America Invents Act ("AIA") 35 U.S.C. § 103(c) and/or AIA USC 102(c) and 100(h). In the event of any Inventions, the parties will reasonably cooperate in invoking the CREATE Act and its companion regulations to overcome an obviousness or novelty rejection of a patent application.

6.5 Copyrights and Software

6.5.1 Ownership. Title to all original works of authorship created in performance of this project and in which copyright may be claimed ("Copyrightable Works") shall vest initially in the author, subject to the policies of the party that employs the author. Any joint work, as that term is defined by the U.S. Copyright Act of 1976, 17 U.S.C. § 101, as amended, shall be jointly owned, but co-owners shall have no duty of accounting for any profits.

6.5.2 Internal Use License. UNIVERSITY grants to UTILITY a non-exclusive, irrevocable, perpetual, royalty-free license to use, reproduce, prepare derivative works, display, distribute and perform all UNIVERSITY -owned Copyrightable Works (including any computer software and its documentation and/or databases first developed and delivered) for UTILITY's non-commercial

purposes to the extent necessary to practice any Invention licensed by UNIVERSITY under this Agreement, provided that UTILITY shall not have the right to market or sublicense the Copyrightable Works or distribute copies or derivative works to third parties unless such rights are provided for in a separate distribution or licensing agreement.

7. PUBLICATIONS

UNIVERSITY and its researchers shall have the right to publish or otherwise disclose the results of the work performed at UNIVERSITY, subject to the following conditions:

A. A copy of the proposed complete manuscript for publication or presentation materials for other public disclosure shall be submitted to UTILITY at least forty-five (45) days prior to any submission for publication or public disclosure.

B. If UTILITY determines that potentially patentable subject matter, or UTILITY's proprietary information is disclosed in any such manuscript of presentation materials, UTILITY will notify UNIVERSITY in writing within thirty (30) days of receipt of the manuscript or presentation materials. Should UTILITY fail to respond within said thirty (30) day period, the author(s) may proceed with publication of public disclosure.

C. Upon notification that potentially patentable subject matter or UTILITY's proprietary information is contained in any manuscript or presentation materials, then:

(1) UNIVERSITY agrees to delay enabling public disclosure of such patentable subject matter for a period not to exceed six (6) months from the date of receipt of the manuscript or presentation materials by UTILITY in order to file for statutory protection, or

(2) Author(s) shall have the option of deleting such subject matter or otherwise modifying the manuscript or presentation material to avoid disclosure of potentially patentable subject matter or UTILITY's proprietary information, and proceeding with publication or public presentation without delay.

The Parties shall not use the name of the other (except in an acknowledgement of sponsorship of this Agreement) in publications, advertising, or for any other commercial purpose without the prior written approval of UNIVERSITY or the UTILITY. The Parties shall not state or imply in any publication,

advertisement, or other medium that any product or service bearing any of the parties' names or trademarks, and manufactured, sold, or distributed by either party, has been tested, approved, or endorsed by the other Party.

8. LIMITATION OF LIABILITY

NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY AMOUNTS REPRESENTING LOSS OF PROFIT, LOSS OF BUSINESS, OR OTHER INDIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES OF THE OTHER PARTY OR ANY THIRD PARTY IN CONNECTION WITH, OR ARISING OUT OF, OR RELATED TO THIS AGREEMENT, REGARDLESS OF THE THEORY OF LIABILITY, WHETHER FOR BREACH OF THIS AGREEMENT, INCLUDING BREACH OF WARRANTY, OR IN TORT (INCLUDING NEGLIGENCE), EVEN IF THE PARTY MAY HAVE BEEN PREVIOUSLY ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

9. TERM AND TERMINATION

9.1. **Term and Termination of Agreement**. This Agreement is effective as of the last date signed and shall end on [Date], unless earlier terminated as provided herein, with or without cause. Either party may terminate this Agreement without cause by giving the other party at least sixty (60) days prior written notice of the date of such termination. Either party may terminate this Agreement for cause, upon written notice specifying the date of such termination, if the other party fails to cure a material breach of any provision of this Agreement within thirty (30) days after receipt of written notice thereof. Notwithstanding the foregoing, the terms and provisions of this Agreement shall govern all RPSs issued by UTILITY and accepted by UNIVERSITY prior to the expiration or termination of this Agreement, provided such RPSs are not terminated in accordance with Section 9.2.

9.2. **Termination of RPS**: Notwithstanding anything to the contrary herein, the UTILITY may terminate, with or without cause, all or any portion of the services under any RPS by giving at least thirty (30) days' prior written notice to UNIVERSITY, which notice shall state the portion of the services to be terminated and the effective date of such termination. UTILITY may terminate all or any portion of the services under any RPS for cause, upon written notice specifying the date of such termination, if UNIVERSITY fails to cure a material breach of any provision of this Agreement within thirty (30) days after receipt of written notice thereof. In the event UTILITY terminates all or any portion of a RPS, except for UNIVERSITY's breach of such RPS or this Agreement with respect to such RPS, UTILITY shall pay UNIVERSITY compensation pursuant to the RPS for the actual costs and non-cancelable obligations incurred by UNIVERSITY for all services

completed as of the effective date of termination, and UNIVERSITY shall transfer to the UTILITY copies of all work done to date in hardcopy and electronic format, and return immediately any records or material on loan from the UTILITY.

10. GENERAL

10.1. **Equipment and Travel**: Title to equipment and all other items purchased with funds provided by UTILITY shall be titled to and remain with UNIVERSITY. No equipment shall be purchased without the written approval of the UTILITY. No travel shall be made by UNIVERSITY personnel for which a charge will be made to the project without the advanced written approval of the UTILITY.

10.2. **Indirect Cost Rate**: The indirect cost rate applicable to these projects is XXXXX percent (XXX%). The indirect cost rate is applicable to all direct costs, except the cost of equipment, capital expenditures, rental costs of off-site facilities, student tuition remission, scholarships and fellowships, and subcontracts in excess of $25,000. [The full UNIVERSITY policy concerning indirect cost rates is attached herewith as Exhibit B. *(if applicable*)]

10.3. **Audit**: UNIVERSITY grants to UTILITY reasonable access to all pertinent ledgers, payroll data, books, records, receipts, vouchers and other documents for audit purposes. UNIVERSITY must segregate such documents and records in such a manner as to facilitate a complete audit of such documents and records and agrees that such audit may be used as a basis for settlement of any charges. UTILITY or its agents shall have the right upon reasonable notice to audit such documents and records during UNIVERSITY's normal business hours. Such documents and records shall be retained for three (3) years after the expiration of the Agreement.

10.4. **Force Majeure**: Any delay or failure of either party to perform its obligations hereunder shall be excused if, and to the extent that it is caused by an event or occurrence beyond the reasonable control of the party and without its fault or negligence, such as, by way of example and not by way of limitation, acts of God, actions by any governmental authority (whether valid or invalid), fires, floods, windstorms, explosions, riots, natural disasters, wars, sabotage, labor problems (including lockouts, strikes and slowdowns), inability to obtain power, material, labor, equipment or transportation, or court injunction or order.

10.5. **Government Compliance**: UTILITY and UNIVERSITY agree to comply with all federal, state and local laws, executive orders, rules, regulations and ordinances which may be applicable to such party's performance of its obligations under this Agreement.

10.6. **No Implied Waiver**: The failure of either party at any time to require performance of any provision of this Agreement shall in no way affect the right to require such performance at any time thereafter, nor shall the waiver of either party of a breach of any provision constitute a waiver of any succeeding breach of the same or any other provision.

10.7. **Non-Assignment**: Neither party may assign or delegate its obligations under this Agreement without the other party's prior written consent.

10.8. **Relationship of Parties**: UNIVERSITY and UTILITY are independent contracting parties and nothing in this Agreement shall make either party the agent or legal representative of the other for any purpose whatsoever, nor does it grant either party any authority to assume or to create any obligation on behalf of or in the name of the other.

10.9. **Severability**: If any term of this Agreement is invalid or unenforceable under any statute, regulation, ordinance, executive order or other rule of law, such term shall be deemed reformed or deleted, but only to the extent necessary to comply with such statute, regulation, ordinance, order or rule, and the remaining provisions of this Agreement shall remain in full force and effect.

10.10 **Entire Agreement**: This Agreement together with the attachments, exhibits, or supplements, specifically referenced in this writing, constitutes the final and entire agreement between UNIVERSITY and UTILITY with respect to the matter contained herein and supersedes all prior or contemporaneous oral or written representations, statements, understandings and agreements regarding such subject matter. Any modification, alteration or amendment to this Agreement must be in writing and signed by authorized representatives of each party hereto.

11.0 INSURANCE REQUIREMENTS

[List insurance requirements].

12.0 REFERENCE DOCUMENTS

1. Exhibit A: Research Project Specification form
2. Exhibit B: Indirect Cost Rate Policy [If required]
3. Exhibit C: Memorandum of Delegation of Contract Authority [If required]

(Signatory page follows)

MASTER AGREEMENT SIGNATORY PAGE

IN WITNESS WHEREOF, the parties hereto have executed this Agreement, to be effective as of the date of the last party to sign below.

If the Agreement is executed by other than the President and Secretary, a corporate resolution

must be attached in duplicate authorizing execution by the designated parties.

[Name of University]

By: _____ _____

Name

Title Date

Attest:

_____ _____

Name Date

Title

[Name of Utility]

By

_____ _____

Executive Director Date

Attest: _____ _____

Title Date

EXHIBIT A

RESEARCH PROJECT SPECIFICATION

Principal Investigator _____

Project Number _____

[The Research Project Specification includes the following information and will be agreed to by the UTILITY and UNIVERSITY, according to the terms and conditions of the Master Agreement.]

1. Research Project Title:

2. Principal Investigator(s):

   [Identify the UNIVERSITY employees who will direct work]

3. Attach a Statement of Work:

   [A description of the work to be performed by each party]

4. Duration of Project:

   [A schedule for the performance of the research/service described in the Statement of Work]

5. Specified Deliverable Items:

   A. Reports (per Article 2 of the Master Agreement)

   B. [Identify any creations (e.g., devices, samples, data, software {source and/or compiled code}, etc.) if any that will be created from this work and (i) that will be delivered to UTILITY and/or (ii) that shall not be delivered to UTILITY, and (iii) the final disposition of such property (e.g., and what license rights (if any) are granted by UNIVERSITY to UTILITY).]

6. Equipment (if any):

[Identify any equipment provided by UTILITY to UNIVERSITY or purchased by UNIVERSITY with UTILITY funding.]

7. Proposed UTILITY visiting scientists (if any) and duration of visit:

[Identify any UTILITY employee who will perform work at UNIVERSITY on the Research Project, briefly describe the collaboration, and specify the duration of the visit.]

8. Budget:

[Attach an itemized Budget, which includes a payment schedule and states that payments

shall be made by specified dates.]

9. Authorization:

Commitments between UTILITY and UNIVERSITY are made only by this signed Research Project Specification. UNIVERSITY shall not commence work, and UTILITY shall not be liable for any work performed or materials developed or purchased by UNIVERSITY, prior to the execution of such Research Project Specification subject to the UTILITY [governing body] authorization. A Signatory page is attached to execute this project.

Exhibit A

RESEARCH PROJECT SPECIFICATION SIGNATORY PAGE

IN WITNESS WHEREOF, the parties hereto have executed this Agreement, to be effective as of the date of the last party to sign below.

[Name of University]

By: _____ _____

Name

Title Date

Attest:

_____ _____

Name Date

Title

[Name of Utility]

By

_____ _____

Executive Director Date

Attest: _____ _____

Title Date

10 Appendix B: Supporting Materials from 2017 Workshop

10.1 University–Utility Collaborative Applied Research—A Win–Win Combination (Editorial from Water Environment Research)

Reprinted from: Water Environment Research 79.6 (2007): 579-580.

Applied research in water and wastewater conveyance and treatment is critical to address many short-term problems encountered by utilities and identify longer-term research needs and fundamental issues. Universities local to utilities have a great role to play in conducting such applied research and developing site-specific solutions to technical problems. A university–utility collaboration is a win–win combination for both and has synergistic benefits in terms of technical problem solving directly applicable to utility operations and training future professionals for the same utility. Although we have many outstanding challenges and needs, the traditional sources of support such as federal agencies have limited research funds for drinking water and wastewater related applied research because of the shift in their focus to emerging areas such as nanotechnology, energy, and molecular sciences. For example, our water resources are still not ''fishable and swimmable'' across the country, we still discharge most treated wastewater effluent to receiving waters instead of reusing it, more than 90% of wastewater treatment plants do not control nitrogen and phosphorus pollution of receiving waters, we still use coliforms as indicators of water quality with respect to pathogens, and we still land apply or landfill most of the biosolids generated at wastewater treatment plants. There are many more technical challenges and, consequently, many applied research opportunities. Hence, it makes a strong case for academic researchers to look closer to local water and wastewater utilities and vice versa for conducting the needed research. Utilities will greatly benefit by having the needed research conducted on site or nearby at the university with the highest quality and immediate application and applicability. This university–utility model is scalable to both large and small utilities and for both short and long-term research involving practitioners, researchers, and students.

There should be a clear understanding of expectations and deliverables and goals by the researchers and the utility. Some ground rules for a mutually beneficial and productive relationship between the two entities include the following:

Researchers should

- Not claim that they can do everything and do the work cheaper but better;
- Establish long-term relationships with the utilities, if possible;
- Keep the utility informed of the work progress frequently and in a timely manner and keep the utility actively engaged in the research direction;
- Provide short-term deliverables that have significant value and use for the utility; and
- Provide expected deliverables on time.

Utilities should

- Support local institutions to build research infrastructure locally;
- Remember that the students who work on the projects are the future workforce;
- Allow timely publication and presentation of results in journals and conferences;

- Not ‘‘over control’’ the project direction;
- Encourage investigation of unexpected outcomes or fundamental issues through longer-term research;
- Strengthen local institutions to leverage support in obtaining research projects from larger funding sources; and
- Encourage researchers to conduct pilot- and full-scale research on site to generate results most applicable to the facility.

Once we begin expanding this university–utility research collaboration model to more universities and utilities, more can be done with less, better and sooner.

Krishna Pagilla, Ph.D., P.E., Professor,
Department of Civil, Architectural, and Environmental Engineering,
Illinois Institute of Technology, Chicago, Illinois (***Currently at the University of Nevada, Reno***)
Editor, Water Environment Research

10.2 Questions for Discussion at 2017 Workshop

Working Across Distances

- Distance could be anything that is off the campus or off the utility property. Typically, it is easier to work within a state than out of state, especially in smaller states.
- It is important to identify the types of problems that can be solved with a project done at a distance vs. those that really need to be locally focused.

Building relationships and teams

- What recommendations do we have for “newbies”?
- What do we recommend for university faculty who want to get into a relationship with a utility?
- What do we recommend for utilities who want to get into a relationship with a university?
- What are the ideal characteristics of students who are well suited to being part of a university-utility project?

The nuts and bolts

- How can the utility set up an acceptable contractual structure that works within their normal procurement practice?
- There may be different expectations between utilities and universities about publications and intellectual property (IP). How can this be managed in a way that avoids conflicts and encourages dissemination of innovative ideas that come out of the partnership?
- What are alternative student degree and education models that can fit within a university-utility relationship?
- What are barriers, and what examples exist for addressing barriers?

10.3 Presentations from 2017 Workshop

Presentation 1: Overview of LIFT and UUP Efforts (Fidan Karimova, TWRF)

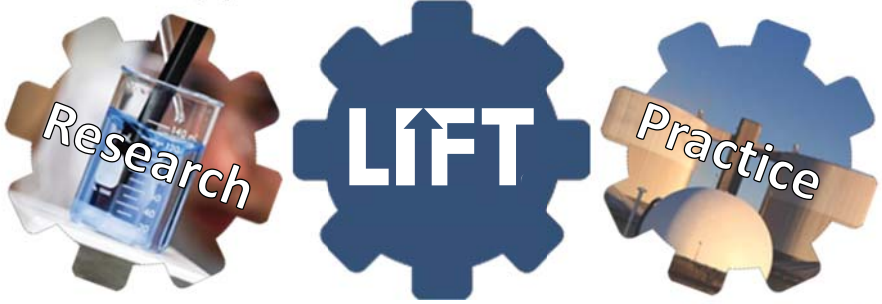
Presentation 2: UUP Case Studies (Morgan Brown, WEF)

University-Utility Partnerships

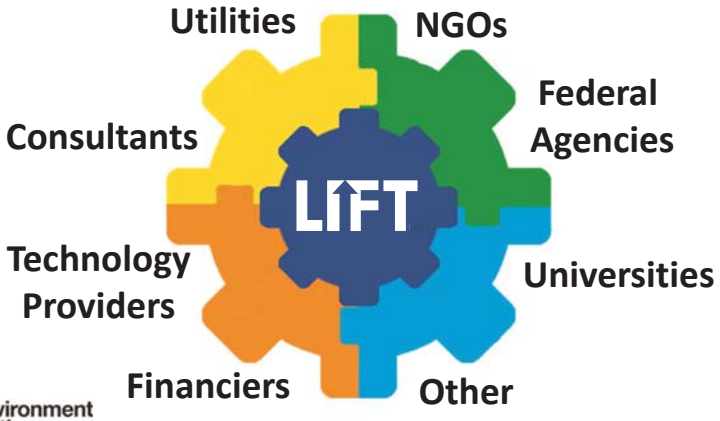
Dr. Barry Liner, WEF
Fidan Karimova, WE&RF

LIFT's Mission

LIFT is a WEF/WE&RF initiative to encourage and support innovation in water



Engaging the Water Community



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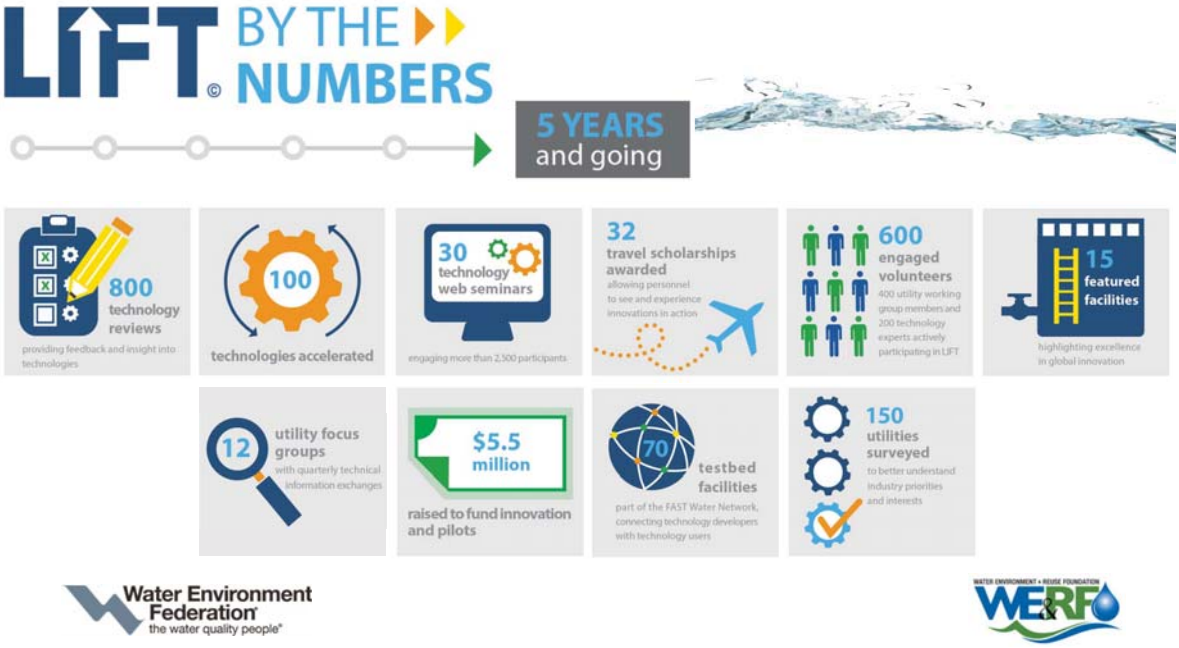

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LIFT Steering Committee

Dr. Charles Bott (Chair)
HRSD

Jim McQuarrie (Vice-Chair)
MWRD (Denver)

Dr. John Barber
Eastman Chemical

Tom Kunetz
MWRDGC (Chicago)

Dr. Nancy Love
University of Michigan

Dr. Sudhir Murthy
DC Water

Jeff Peeters
GE Power and Water

Dr. Art Umble
MWH

Dr. Mark LeChevalier (Liaison)
American Water

Jeff Lape (Liaison)
U.S. EPA

LIFT 101

Utility Peer Network

Technology Scans

LIFT Link

FAST Water Network

Technology Survey

SEE IT

University-Utility Partnership

Hubs, Partners, and Affiliates

Technology Scans Process

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WERF

LIFT
Leaders Innovation Forum for Technology

105 Technologies
97 Companies

Utility Technology Focus Groups

1	Biological Nutrient Removal	7	Green Infrastructure
2	P-Recovery	8	Small Facilities
3	Digestion Enhancements	9	Odor Control
4	Biosolids to Energy	10	Disinfection
5	Energy from Wastewater	11	Water Reuse
6	Collection Systems	12	Intelligent Water Systems

New in 2017

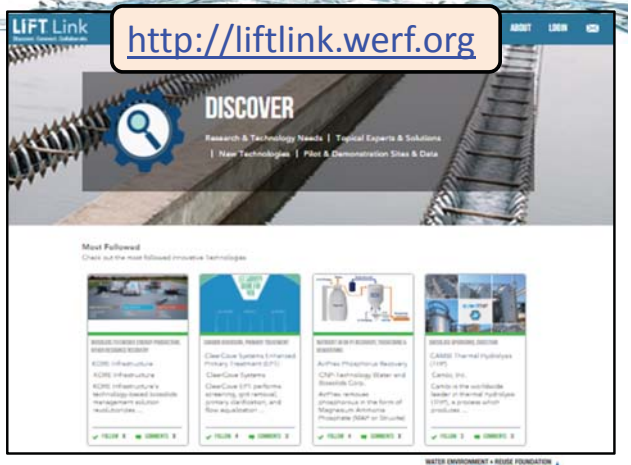
LIFTLink

Discover

Collaborate

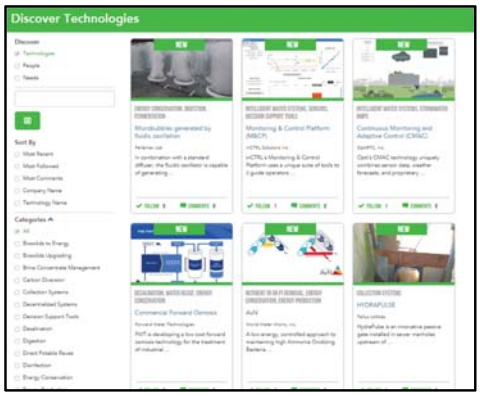
Connect

http://liftlink.werf.org

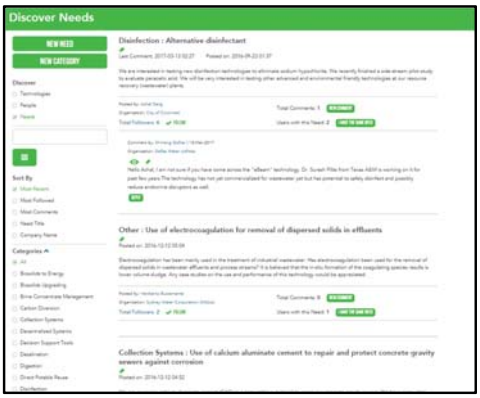


Discover Innovation

Discover Technologies



Discover Needs



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WATER ENVIRONMENT + REUSE FOUNDATION WE&RF

National Test Bed Network: FAST Water

- Steering Committee

www.werf.org/fastwaternetwork

NSF

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

UNITED STATES · ENVIRONMENTAL PROTECTION AGENCY

WATER ENVIRONMENT + REUSE FOUNDATION WE&RF

- Planning Partners

Argonne NATIONAL LABORATORY

Lawrence Livermore National Laboratory

NIST National Institute of Standards and Technology U.S. Department of Commerce

USDA

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Identifying Test Bed Facilities

- **Level 1**: A university or research lab that can assist with bench-scale work but is not dedicated to piloting new technologies
- **Level 2**: A water resource recovery facility that is interested in innovation and willing to host a project, but does not have a dedicated test facility
- **Level 3**: A water resource recovery facility or research lab with a dedicated physical space available for piloting innovative water technology
- **Level 4**: A staffed facility dedicated solely to R&D/piloting of new technologies

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FAST Water Directory

- **Level 1**
- **Level 2**
- **Level 3**
- **Level 4**

70 Facilities

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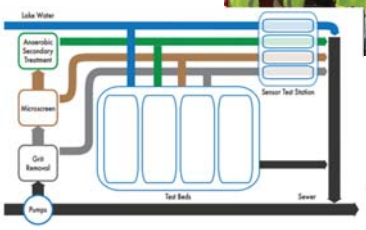
www.werf.org/testbeddirectory

WERF

Codiga Resource Recovery Center

- Level 4 Facility
- Stanford University in Palo Alto, CA
- Testing Emefcy's MABR Technology for FAST
- Sustainable resource recovery technologies that generate revenue by recovering freshwater from wastewater, fertilizer from nutrient-rich waste streams and energy and valuable biomaterials from waste organic matter
  - 4 test bays each 8'x18' for trailer- or skid-mounted pilot units
  - Ports for bench-scale tests
  - Connections for in-line sensors
  - 4 grades of water



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WE&RF University Subscription

- Access to a portfolio of high-quality research
- Complimentary electronic copies of all research
- Opportunity to participate in research projects.
- A 4-to-1 return-on-investment with every $1 invested generating $4 in matching funds and in-kind contributions
- Average annual investment of $5 million in new research, leveraged to produce more than $20 million in value

WE&RF University Subscription Benefits Sheet

SUPPORTING RESEARCH AND TECHNOLOGY TRANSFER

FOR CONTINUED UNIVERSITY INNOVATION

Universities are the starting ground for research advancement and technology creation. It is vital that as drivers of innovation, universities have access to the latest research, resources, and industry representatives to help inform and advance their work and drive important products and investigation results for the industry.

The Water Environment & Reuse Foundation (WE&RF) works closely with universities and other partners in order to produce quality, scientifically defensible research. Through WE&RF the universities could get access to research funding, access to research reports, and access to a network of leading researchers and practitioners for partnering on projects and proposals.

WE&RF also encourages university innovation through the Leaders Innovation Forum for Technology (LIFT) program. LIFT is a multi-pronged initiative led by WE&RF and Water Environment Federation (WEF) to help introduce new water technology to the field quickly and efficiently. University technology innovators can submit technologies to the Technology Scan application process, as well as take advantage of WE&RF's vast industry network to test inventions. They can also benefit from LIFT Link, which is an online platform that serves as a highway of interaction among academics, municipal and industrial water, wastewater, and stormwater agencies, technology providers, consultants, investors, federal agencies, NGOs, and others for advancing innovation.

The wastewater and stormwater industry spends a fraction of what other industries traditionally spend on research and development. WE&RF is the only organization in the United States that focuses specifically on producing the peer-reviewed science necessary to face the challenges that will define the future of water quality. As a WE&RF subscriber, you will play a key role in addressing these challenges and have access to many other benefits.

WE&RF's research portfolio encompasses all of today's critical water quality issues:

- Compounds of Emerging Concern
- Intelligent Water Systems
- Watershed Management and Water Quality
- Stormwater and Green Infrastructure
- Climate Impacts on Water Quantity and Quality
- Energy from Wastewater
- Nutrient Removal and Recovery
- Water Reuse
- Decentralized Systems

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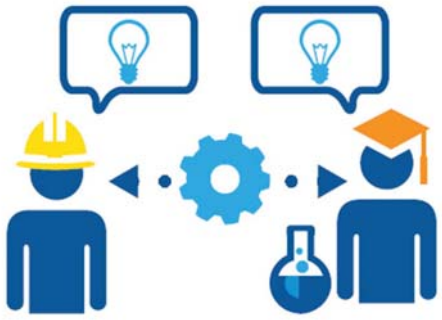
University and Utility Partnerships

- Program to Better Connect Universities and Utilities
- Embed Students at Utilities
- Targeted RDD&D
- Workforce Training
- Guidance document



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Common Benefits for Universities

- Research opportunities and funding
- Real world training for students
- Identification of problems for research
- Access to facilities
- Partnership may attract potential new students

Common Benefits for Utilities

- Students for research
- Seek out future talent
- New solutions & insights to problems
- Can be cost effective

Water Environment Federation

University of Nevada, Reno & Northern Nevada Regional Utilities Team

- 4 year regional IPR demonstration project
- Interlocal agreement
- Successes: public trust
- Challenges: working with multiple entities & adequate funding

Northern Nevada Water Planning Commission

Truckee Meadows Water Reclamation Facility

Water Environment Federation

South Dakota State University

Brookings Municipal Utility

- Plant operation
- Yearly contracts
- Successes: creation of new projects & lower costs
- Challenges: training & communication

City of Sioux Falls

- Operation enhancement
- Sponsored service agreements
- Successes: cost savings
- Challenges: amount of research for students

Colorado State University & Fort Collins Utilities

- Projects on water supply, wastewater, & stormwater
- Contracts & internships
- Successes: working across municipal departments
- Challenges: engagement early in process & communication

Hampton Roads Sanitation District & Several Universities

- Variety of partnership structures, including contractual and internships
- Successes: engagement across broader geographic space
- Considerations: travel support, training, mentorship

HRSD
Cleaning wastewater every day for a better Bay.

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Virginia Tech Center for Applied Water Research and Innovation

- Involves Western Virginia Water Authority, Alexandria Renew Enterprises, & Hampton Roads Sanitation District
- Industrial-funded projects through membership fees
- Begins Summer 2017

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MWRD Greater Chicago & Iowa State University

- Revolving Algae Biofilm Reactor (RAB) technology
- Contractual Agreement
- Successes: Demonstrated viability of technology
- Challenges: Intensify RAB Performance & Marketability of algae biomass

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Rocky Mountain WEA's Innovative Wastewater Technology Committee Programs

- Utility-University (U2) Internship/Workforce Development Program
- University Liaisons for IWT Committee
- Direct Communication Platform

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THANK YOU!
mbrown@wef.org