Background

Three trends underlie the needs and opportunities for a new certificate and professional master’s program in CU-Boulder’s Civil Engineering Program: (1) changing professional and educational demands, (2) increasing need for civil engineers to meet future demand for leaders in the profession and society, and (3) retirement of a significant fraction of the civil engineering professional workforce over the next decade. These trends will especially affect local, state, and federal agencies that employ nearly 40% of civil engineers (Grigg, 2000).

In one area in particular, water, the need for engineers who are prepared to lead public agencies that manage the nation’s water supply and environmental services, is especially acute. Effective water resource management is essential for the nation’s economic growth, environmental protection, and community development, and civil engineering is the principal field for training the technicians and managers operating, planning, and modifying water delivery, allocation, storage, and treatment systems. Challenges to utilities and government agencies include decaying water and wastewater infrastructure, assessing the risk of emerging contaminants and associated impacts on treatment costs, water supply limitations exacerbated by climate change and population growth, and links between energy and water – impacting both energy consumption and production. Moreover, these issues must be addressed over the next several decades in the face of a declining workforce due to retirements and potentially fewer US graduates in engineering.

The US Census Bureau and the USEPA through its Community Water System Survey estimate there are approximately 25,000 publicly owned water supply systems and
approximately 20,000 wastewater collection and centralized treatment systems. A water and wastewater workforce of nearly 300,000 people, which is almost as large as that of the electric power industry maintains these systems. These numbers may underestimate the number of water and sewerage systems and workers, since many small utilities may not have been counted (Grigg, 2009). The Association of Metropolitan Sewerage Agencies (AMSA, 2002) estimated that 17-23% of the water/wastewater utility workforce was administrative employees. The US Bureau of Labor Statistics data indicate that only 5% of the water and wastewater utility workforce are managers (USBLS, 2009). However, water utility managers are responsible for decisions that determine society’s capacity to provide safe water supplies and wastewater treatment. The Water Research Foundation of the American Water Works Association (AWWA) found that over one-third of utility managers, executives, and supervisors will retire by 2012 (Olstein et al., 2005). A State of the Industry Report sponsored by AWWA (Runge and Mann, 2008) reported that work force needs are one of the top five issues cited by water suppliers.

Education of engineers will determine a large share of the capacity of the US and indeed other countries to meet technical, sustainability and workforce challenges in civil engineering. In Educating the Engineer of 2020, the National Academy of Engineers (NAE), recommended that the traditional Bachelors of Science (BS) degree curriculum would not be sufficient for educating future engineers (NAE, 2005). Partly in response to the NAE report, in 2007 the American Society of Civil Engineers (ASCE) approved a Policy Statement, PS 465, which stated the need to base civil engineering professional licensure on attainment of a body of knowledge which would require education beyond the level of the traditional BS degree and require the Masters of Science (MS) level or equivalent (ASCE, 2009). The education requirements envisioned in PS 465 have been developed into a new set of guidelines for civil engineering education, the Body of Knowledge, version II (BOK II). Significant changes embodied in BOKII include the addition of sustainability, risk and uncertainty, contemporary issues, and project management to technical outcomes of civil engineering education; knowledge about public policy, globalization, leadership and professional attitudes are significant new non-technical outcomes for engineering degree programs; finally, advanced knowledge of civil engineering technology will require master’s degree-level education for professional licensure (ASCE, 2008).

1. Statement of Purpose

The purpose of the certificate is to address the emerging trends in the water profession and take advantage of the private sector and academia expertise of the Civil, Environmental and Architectural Engineering (CEAE) and the School of Public Affairs (SPA). The certificate courses focus on leadership, communication and utility financial
management in the water profession. Students who complete the certificate will have understanding of the tools and skills necessary for the future of the water profession.

2. Statement of Need

The need for senior management and leadership professionals to replace retiring engineering managers in water supply and wastewater can also be met effectively by encouraging practicing civil engineers to return to school to enhance their opportunities for career advancement. The educational needs of this group may not be met by traditional MS programs in civil engineering, which typically consist of advanced study in science and engineering topics. On the other hand, graduate degree programs in professional management (master’s in business administration) are business-oriented and rarely offer targeted curriculum for engineers who will be managing public agencies responsible for large-scale civil infrastructure. The only training programs available to fill the gap between graduate study in water engineering and in management are primarily short courses or workshops without certificates or degrees.

The most recent need for educational needs became apparent from the activities of the Water Environmental Federation (WEF) and the American Water Works Association (AWWA), and a PMP workshop held in Boulder at the University of Colorado. Both WEF and AWWA, with 45,000 members, are sponsoring the Water Leadership Institute (WLI). It will have 30 professionals participating in a non-credit, 9-month workshop, meeting monthly over the internet, including only two face-to-face meetings. The curriculum will include leadership, communications, and sustainability. The need for the WLI comes for the recognized lack of leadership and communication skills in the water profession.

In October 2011, the CEAE department held a program workshop at the University of Colorado Boulder. The purpose was to identify the specific needs for a new certificate and MS program. The attendees were CEOs, general managers, president’s and senior managers of several water, wastewater utilities and consulting firms. The attendees were: Cathy Gerali, General Manager, Metro Wastewater Reclamation District of Denver; Brian Good, Deputy Director, Denver Water Department; Jeff Theerman, Executive Director, Metro St. Louis Sewer District; Jerry Johnson, CEO, Washington Suburban Sanitary Commission and Elisa Speranza, CEO, CH2MHiIl O&M Business Group. In addition to technical subjects, the curriculum workshop recommendations for a new program must include: leadership; communications; governance; and financials. These professionals will serve as an external program advisory committee.
Currently, there are no MS-level graduate programs that offer integrated study of management and advanced technical issues in a formal program to meet the combination of engineering and leadership challenges described previously. A new program is proposed that will center on the environmental and water resources engineering areas of the profession. The unique aspect of the program is incorporation of advanced study in public affairs to prepare students for careers in consulting firms, public water and wastewater utilities and other government agencies focused on management of water and environmental resources.

The Water Engineering and Management (WE&M) program is made possible by integrating programs in the CEAE and SPA. New curriculum will incorporate professional-level case studies from public utilities and water agencies, and related classes in the area of planning and decision support.

New students will be recruited from the pool of professional engineers interested in career advancement by learning about management, planning and policy issues of public agencies, public and private employers (government agencies, consulting firms whose clients are public agencies) seeking training in finance, leadership, and communications for engineer employees to fill managerial positions, and new engineering graduates interested in starting a career in engineering management focused on public sector activities in the water and environmental services industry.

Managing Public Utilities: Current Issues & Future Challenges, CVEN 5834, is a new core engineering course in the WE&M program and was offered for the first time in 2012 Maymester. Eighteen students had attended. Comments and FAQ results from the students clearly showed that the course was very successful. Also, the course instructors included members of the program Advisory Committee, the CU-Boulder CEAE Department, and the UC Denver School of Public Affairs.

The WE&M will not adversely impact other programs or student recruiting. Also, there are no programs like this in Colorado and other states in the U.S. It will bring in new students, many of whom are employed by utilities, consulting firms, and government agencies, in and out of the State of Colorado, who envision an engineering career with a focus on management and leadership in public agencies. The participation of distance learning through the Center for Advanced Engineering and Technology Education (CAETE) will play a key role in the enrollment growth. CAETE is an enterprise partnership of the CU-Boulder Division of Continuing Education and College of Engineering and Applied Science.

Program recruiting will utilize contacts with professional societies that have strong utility representation such as the WEF, AWWA, National Clean Water Agencies (NACWA),
Association of Municipal Water Agencies (AMWA), Water Environment Research Foundation (WERF) and Water Research Foundation (WRF). The interests of this new group of students will be addressed with a combination of existing, modified or new courses offered in the Department of Civil, Environmental and Architectural Engineering at CU-Boulder and the School of Public Affairs at UC Denver, as described below.

3. Statement of Congruence with Campus Goals.

The certificate is consistent and congruent with the role and mission of CEAE and SPA. Likewise, the targeted students for the certificate are those young professionals are historically served by the CEAE and SPA.

The certificate is congruent with the role and mission of the College of Engineering and Applied Science’s core values, particularly in the areas of integrated and professional learning and supporting the following graduate outcomes:

- Desire and skills for life-long learning and personal and professional development.
- Technical excellence and knowledge in modern engineering, mathematics, and science.
- Ability to contribute effectively as individuals and in multidisciplinary teams.

This certificate would directly support the objectives of the University of Colorado Boulder’s Flagship 2030 initiatives. In particular, it includes: (1) foster the continued growth of enrollment in CEAE and SPA; (2) further develop our current model of transcending traditional academic boundaries by promoting interdisciplinary education; (3) serve the needs of the global water profession; and (4) reinforce our leadership among worldwide graduate water profession programs.

4. Statement of Resources.

The Department of Civil, Environmental and Architectural Engineering (CEAE) at the University of Colorado Boulder is well-positioned to initiate and sustain the WE&M Certificate. Institutional resources include:

- Fourteen environmental and water engineering faculty whose research and graduate teaching are in areas strongly coupled to public utilities and water agencies, including water, wastewater and water reuse assessment and treatment, solid and hazardous waste management, sustainable development, water resources planning and decision support.
- Existing courses in the Civil Systems program covering management science tools such as life cycle assessment, risk management, and systems analysis.
- A significant record of cooperative research with Colorado public utilities and water agencies in the cities of Boulder, Longmont, Aurora, Louisville, Ft. Collins,
Parker, and Denver (the Denver Water Board and the Metro Wastewater Reclamation), as well as the Front Range Drinking Water Consortium, and the Colorado Department of Public Health and Environment.

- The Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) is a research and training enterprise whose focus is development of regional water resources planning tools, including software, for river basin management. Agencies sponsoring research and development at CADSWES include the US Bureau of Reclamation, the Tennessee Valley Authority, and the US Army Corps of Engineers.
- A robust MS degree program, with approximately 40 students currently enrolled in the environmental and water resources engineering areas and over 20 graduate courses in analysis, design and planning for water and environmental systems.
- IT and communications resources to assist with recruiting and advising applicants and new students.

The School of Public Affairs (SPA) at the University of Colorado Denver has 33 faculty and offers both a Master’s degree in Public Administration (MPA) and a Ph.D. in Public Affairs. The MPA program includes a track in Environmental Policy, Management & Law. The Boulder and Denver Campuses are within a 40-minute commute by bus, which will allow WE&T students to take classes at SPA and meet with faculty. To accommodate distance-education students, and in particular professionals who wish to arrange their studies around their work schedules, certificate courses will be available online. CU-Boulder distance offerings will be facilitated by the Center for Advanced Engineering and Technology Education (CAETE). UC Denver distance offerings will be through the CU Online program.

Because of the participation of distance-learning students, the administrative and financial model of the proposed certificate will engage CAETE, which is a partnership of the Division of Continuing Education and the College of Engineering and Applied Science formed in 2003 to manage other professional graduate programs (e.g., Telecommunications, Engineering Management, various electrical-engineering certificates) with distance components. As such, the finances will be handled as an auxiliary enterprise and not through the general fund. An approximate budget for the 2013 pilot year is shown below, assuming 20 students enrolled (50% on-campus, 50% distance). Expenses include a part-time director (who will also teach the core courses), a part-time staff member, payment to the participating departments for elective courses, and the various overheads for campus (GAIR), CAETE, and Continuing Education.
Revenue
10 online students x 4 courses x $2316 per course = $92,640
7 resident students x $6363 tuition = $44,541
3 nonresident students x $14,301 tuition = $42,903
Total revenue: $180,084

Expenses
Program Director Salary + Benefits (67% time): $84,249
Staff Support Salary + Benefits (25% time): $15,000
Operating Expenses (advertising, office, travel): $10,000
Student Aid: $10,000
GAIR (5.5% of above expenditures): $6,559
Payment to CEAE ($600 per student x 20 students, one course): $12,000
Payment to SPA ($600 per student x 20 students, one course): $12,000
CAETE Overhead (25% of revenue): $36,017
Continuing Education Overhead (5% of revenue): $9,004
Total Expenses: $194,829

Note that the pilot program is projected to operate at a small loss, even with 20 students. Continuing Education, Civil Engineering, and the College of Engineering and Applied Science agree to split in three equal parts any shortfall in the program the first year(s). Then, as the program grows and becomes profitable, any profits will be used to (1) pay back these three units and (2) build up a reserve of $50K for the program. Any additional profits will be split by these three units in equal parts.

5. Description of Curriculum.

The certificate in water engineering and management will consist of four courses.

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<tr>
<th>Courses</th>
<th>Number</th>
<th>Units</th>
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<tr>
<td>Certificate Core Courses</td>
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<tr>
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<td>3</td>
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<tr>
<td>Total</td>
<td>4</td>
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CERTIFICATE CORE COURSES
CVEN 5834 (DL) Maymester - Managing Public Utilities
CVEV 5834 (DL) Water Profession: Leadership and Communication
and/or
New fall course 2013 (DL) Water Profession Financial/Management
CIVIL ENGINEERING ELECTIVES
CVEN 5147 Civil Engineering Systems
CVEN 5454 Quantitative Methods
CVEN 5834 Decision Support for Water Systems

PUBLIC AFFAIRS ELECTIVES
PAD 5631(OL) Seminar in Environmental Politics & Policy
PAD 5633 Seminar in Natural Resources and Environmental Law

(DL) CU-Boulder Distance Learning Course/(OL) CU Denver On-Line course

Distance-learning students may receive the certificate via on-line courses by taking all three core courses plus PAD 5631. In the future, it is anticipated that these courses will become part of a water engineering and management track within the existing Master’s in Civil Engineering for degree-seeking students.

6. List of Faculty

There are four primary faculty who will lead the certificate program (all members of the Graduate Faculty):

Richard Kuchenrither, Adjunct Professor (to be Scholar-in-Residence), CEAE
Tanya Heikkila, Associate Professor, SPA
JoAnn Silverstein, Professor, CEAE
R. Scott Summers, Professor CEAE

In total, the CEAE Department has 14 environmental and engineering faculty and the School of Public Affairs has 33 faculty. These additional faculty may participate in the program by offering elective courses.

7. Description of Program Administration

The program Director is Dr. Richard Kuchenrither, who is an Adjunct Professor in CEAE and former Senior Vice President of Black & Veatch Engineering. He will be appointed as a Scholar-in-Residence.

The Director’s responsibilities include working with faculty to develop curriculum and coordinate course offerings, consulting with a network of engineering and utility leaders who will provide advice on program content, assisting with course materials such as case-study information, and seeking internship and project opportunities for students. He will work with each student to create a certificate course plan that meets the student’s
background, experience and goals. The Director will manage the budget in coordination with the CEAE Department Chair, the Dean of the College of Engineering and Applied Science, and the Director of CAETE, and lead program recruiting and communication activities.

The Director will work with the primary faculty listed above to advise students in the certificate program and monitor their progress. The scope of these activities includes reviewing enrollment applications, determining acceptance or rejection in consultation with the CEAE graduate committee, working with the program director to develop individual course curriculum, and integrating existing courses into the WE&M program. The graduate advisor will track progress on the requirement completion and will issue the certificates, to be signed by the Director.

An External Advisory Committee (EAC) will play an important role in the WE & M program. The committee is comprised of leaders in the water and environmental services industry, including water and wastewater utilities, engineering consulting, planning and regulatory agencies. Currently this group includes Cathy Gerali, General Manager, Metro Wastewater Reclamation District Denver; Brian Good, Deputy Director, Denver Water Department; Jeff Theerman, Executive Director, Metro St. Louis Sewer District; Jerry Johnson, CEO, Washington Suburban Sanitary Commission; and Elisa Speranza, CEO, CH2M Hill O&M Business Group. EAC members will serve for fixed terms as advisors and contributors to the program. The primary faculty group listed above and the EAC members will review the program and curricular requirements annually.

8. Requirements

Admission criteria for certificate/MS students and non-degree students:
   a. B.S. degree in engineering or related field
   b. Minimum 3.0 undergraduate GPA
   c. M.S. degree students will meet all criteria of the CEAE Department and the Graduate School

Completion Criteria
   a. Successful completion of CVEN 5834, CVEN 5834 and/or CVEN New Fall Course, PAD 5631 or PAD5633, and CVEN 5147 or CVEN 5454 or CVEN 5834
   b. Cumulative GPA in the four courses of 3.0 or better
9. Endorsements

Keith Molenaar, Chair
Department of Civil, Environmental and Architectural Engineering

Robert Davis, Dean
College of Engineering and Applied Science

Diane Sieber, Associate Dean
Education

Mario Vidalon, Director
Center for Advanced Engineering and Technology Education

Anne Heinz, Dean
Division of Continuing Education

John Stevenson, Dean
Graduate School
REFERENCES


