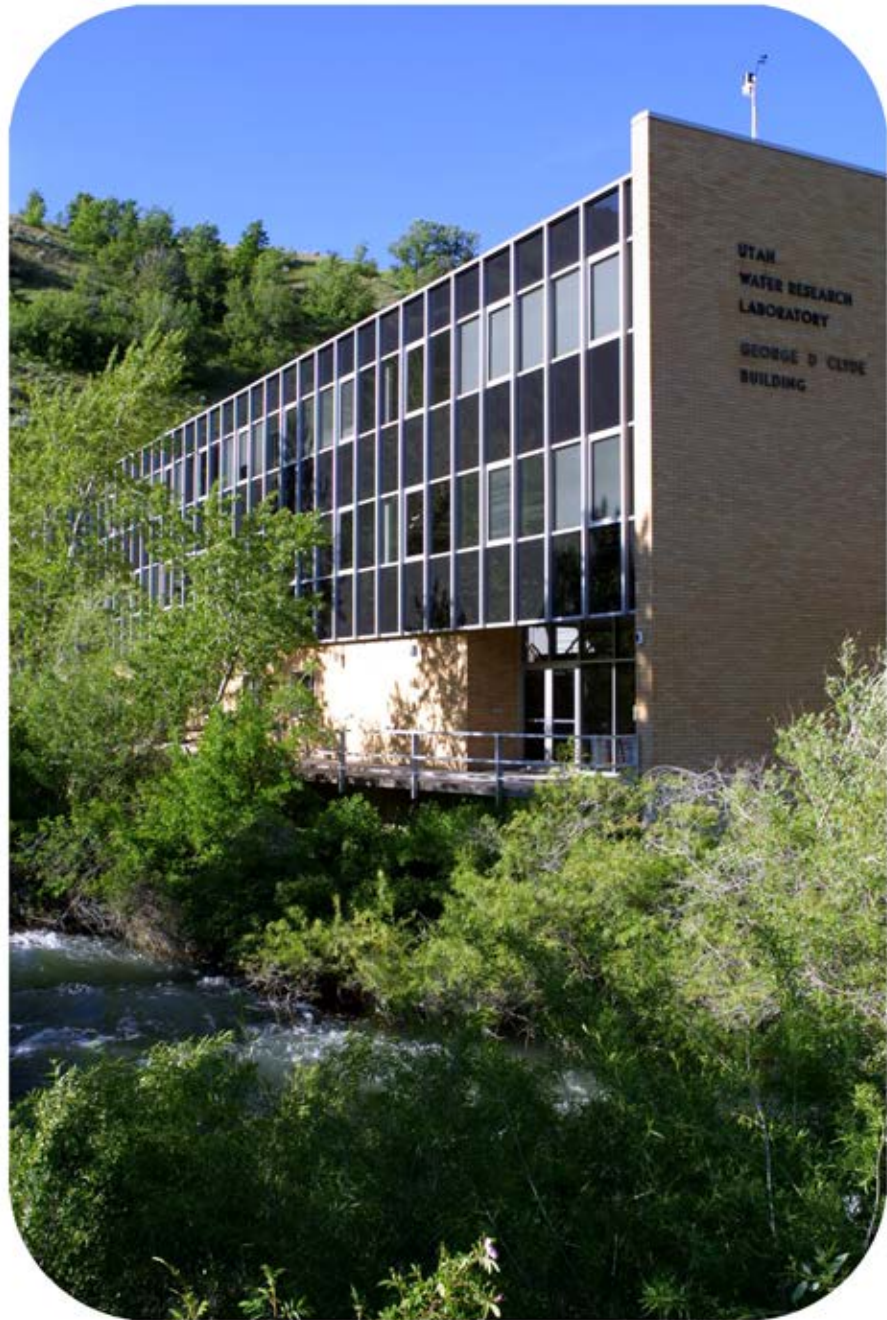




UTAH WATER RESEARCH LABORATORY

Logan, Utah



PROVIDING SOLUTIONS TO UTAH'S
WATER PROBLEMS
JULY 1, 2003 - JUNE 30, 2005



The Utah Water Research Laboratory works closely with state and federal agencies to address all kinds of water issues in Utah. The following comments received from some of our private and public collaborators exemplify the value of the work done by the UWRL in the State of Utah.

“Work at Hill through the UCWRR/UWRL has also supported Hill AFB’s activities to reduce risk of off-site migration of solvent contaminated plumes through laboratory and field studies of enhancements to natural degradation of solvents taking place in the aquifers below Hill, and in quantifying the role that trees play in controlling groundwater and contaminant movement off-base, and the hazards posed to the off-base population of TCE uptake and concentration in fruit trees and vegetables that overlay Hill’s off-base plumes. This work has enhanced the understanding of contaminant fate and transport in the subsurface around Hill AFB, and has allowed Hill Environmental Management staff to more effectively invest limited remediation resources for the effective reduction of risk to the surrounding public. In so doing, the UCWRR/UWRL has provided an invaluable service to the citizens of Utah who might be at risk from exposure to TCE contamination.”

...Joel Workman, Co-Chair, Restoration Advisory Board, Hill Air Force Base, Utah

“The UCWRR/UWRL has assisted our organization in the evaluation and design of a constructed wetland system for the polishing of our lagoon wastewater to meet increasingly stringent water quality standards for nutrients and metals in an energy efficient and environmentally friendly way. The findings generated from the UCWRR/UWRL study resulted in the implementation of a 280 Ac constructed wetland system for the City of Logan that has met or exceeded its performance goals since becoming operational in 2003, representing a savings of more than \$5 million over a mechanic treatment system that would have otherwise had to have been installed in its place.”

...Issa Hamud, Environmental Director, City of Logan, Utah

“The latest project was the development and implementation of a complex water quality computer model for our river basin. This model not only has great statistical capabilities for handling our huge database of historical data, but it also has strong predictive capabilities to assist us in determining the affects of water quality events within the watershed, whether it is a train derailment into the river, a landslide event, or simply of interest. It is and will continue to be a great asset to our District.”

...Tage J. Flint, General Manager/CEO, Weber Basin Water Conservancy District, Layton, Utah

“As a participant in the Virgin River Resource Management and Recovery Program, the District has worked closely with UWRL in fish recovery, water management, stream monitoring, hydrologic modeling, and habitat assessment. The academic expertise of UWRL has been invaluable when dealing with local and regional water issues.”

... Ronald W. Thompson, General Manager, Washington County Water Conservancy District, St. George, Utah

UTAH WATER RESEARCH LABORATORY

PROVIDING SOLUTIONS TO UTAH'S WATER PROBLEMS

RESEARCH AND TESTING
EDUCATION SUPPORT
OUTREACH

July 1, 2003 - June 30, 2005



Dr. Mac McKee - Director
Dr. Thomas B. Hardy - Associate Director

**UTAH STATE UNIVERSITY
COLLEGE OF ENGINEERING
LOGAN, UTAH 84322-8200
<http://www.engineering.usu.edu/uwrl>**

Foreword

The Utah Water Research Laboratory (UWRL) is a stand-alone facility located at Utah State University (USU) on the Logan River, Logan, Utah. The UWRL operates within an academic environment and collaborates with government and private sectors to address technical and societal aspects of water-related issues, including quality, quantity, distribution, and conjunctive use. This is accomplished through providing more than 100,000 square feet of state-of-the-art laboratory, computer, and office space. The research, education, and outreach efforts of the UWRL are currently funded at an annual rate of approximately \$9 million with money obtained from the state and grants and contracts from federal and private sources. The accomplishments of associated faculty, students, staff, and collaborators are reported here in an effort to communicate to audiences external to USU, including clients, financial supporters, future potential supporters, alumni, and the public. The information presented illustrates the role of the UWRL in advancing and integrating water resources, hydraulics, and environmental engineering to improve the decision-making processes that will affect stewardship of water in local, regional, national, and global contexts. This report presents the UWRL program, including research, testing, education support, and outreach activities for the period from July 1, 2003 through June 30, 2005.

In the past two years, the Utah Water Research Laboratory and Utah State University have experienced a number of changes with regard to water research and education. The UWRL has participated in these changes to better integrate water education and research at USU and, as a result, bring greater opportunities to faculty, staff, and students in addressing Utah's water problems. The UWRL now has faculty with joint appointments in both the Civil and Environmental Engineering and the Biological and Irrigation Engineering Departments. In the past year, the UWRL has expanded its policy of investment of available Utah Mineral Lease Funds (MLF) in applied research on water and environmental problems in the State of Utah. MLF resources are now available on a selected basis to faculty and students throughout the College of Engineering. This program to diversify and expand the research capabilities supported by the UWRL will be continued in the years to come. In a time when funds from traditional federal sources to support water resources research are declining, the faculty and administration of the UWRL are aggressively pursuing alternative sources of external funding. As examples, UWRL personnel are teamed with faculty from various departments across campus in a strategic effort to develop international research funding opportunities, and the UWRL administration is working closely with the water research centers of several western states to acquire financial support for applied research on water problems that will be driven by anticipated future energy development in the region. In building and strengthening these local and regional partnerships—which include other departments and colleges at USU, local, state, and federal water resources agencies and stakeholders, and international funding and research groups—the UWRL will continue to play a role of leadership in the area of water resources research in the 21st Century.

This report is organized to illustrate the UWRL approach to conducting both fundamental and applied research and testing that supports higher education at the B.S., M.S., Ph.D., and post-doctoral levels. To accomplish this mission, the UWRL forms collaborations with private and government organizations that support UWRL participation through competitive financial awards, in-kind services, personnel exchange, contracts, etc. Typically, a team of faculty members directs and coordinates a project with the sponsoring collaborator. Student involvement takes the forms of graduate student research projects, senior design projects, and laboratory testing, with the majority of involvement at the graduate level. Products of research and testing projects typically include theses, dissertations, professional publications, technologies, patents, posters, presentations at professional meetings, and special reports formatted for clients.

If you are interested in obtaining more information or in sponsoring research or testing, please contact Dr. Mac McKee at Mac.McKee@usu.edu or one of our staff listed in the Current Personnel section of this report. Additional information can also be found at the UWRL web address:

<http://www.engineering.usu.edu/uwrl>

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I. Introduction

The UWRL is uniquely positioned to form collaborations with USU departments, other academic institutions and water centers, government, and private sector organizations involved in addressing water issues. The strong and consistent support of the State of Utah illustrates the importance of water and the creation of knowledge to manage water in Utah and the surrounding western states. The scope of projects ranges from multimillion dollar partnerships related to soil and groundwater remediation with national impacts, to small scale projects related to outreach to a specific city or county public sector audience. The UWRL mission, the strategy used to accomplish the mission, and a summary of accomplishments follows.

Mission Statement

The mission of the Utah Water Research Laboratory includes the following activities that are related to stewardship of water quantity and quality:

- Facilitate research that supports education and teaching within a university environment.
- Conduct research that is directed at solving multimedia water-related problems of state, national, and international scopes.
- Cooperate with academic departments and other academic research units in generating, transmitting, applying, and preserving knowledge in ways that are consistent with the land grant university mission of Utah State University.
- Conduct research that provides for a technically informed water-related policy that can be used to ensure and improve human health and environmental assets in Utah, the United States, and globally.
- Facilitate research, testing, and design activities that involve training university students to provide services to audiences that are external to the university.
- Provide research-based training on water-related subjects to governmental and private organizations and to the general public.

The UWRL Mission Statement is based on the philosophy that activities related to water science and engineering be organized to integrate research, testing, and design components with university and public education. The context for water includes multimedia aspects that incorporate atmosphere and surface and subsurface earth components, and that address environmental as well as public health issues.

Strategy

The strategy utilized by the Utah Water Research Laboratory to accomplish the mission stated above involves a commitment to support the following activities:

- Facilitate state-of-the-art research and testing that encompasses multimedia water-related issues addressing state, national, and international challenges.
- Provide research-based academic experiences in water-related topics for undergraduate and graduate university students to enhance their theoretical and practical skills.
- Provide financial assistance for graduate students to facilitate recruitment of excellent students in academic departments.
- Provide an academic environment where water-related problems are addressed through the process of obtaining academic degrees.
- Partner with public and private agencies in the pursuit of addressing important problems that can also be used to help train students.
- Provide outreach services for local, state, national, and international agencies, and for citizens desiring information on water-related issues.
- Provide facilities and services for physical model studies and for hydraulic structures related to design, analysis, and field testing.
- Cooperate with the Departments of Civil and Environmental Engineering and Biological and Irrigation Engineering, and other academic departments at USU to recruit and retain faculty.
- Work collaborately as engineers with water-related scientists from other colleges and departments to address local, state, national, and international water problems.

Accomplishments

Accomplishments of the UWRL can be measured in part through its research products, the academic training to which it has contributed, and the outreach programs it supports. Its research products include research projects, dollars brought into USU for support of research and educational opportunities, and publications generated by its faculty to convey the benefits of research to potential users (see Section VII for listings of projects awarded, and Section VIII for publications).

The UWRL provides financial support to graduate students and research opportunities to undergraduate students as they work toward completion of their education. Fellowship awards amounts vary, with the average at approximately \$14,000 per year for M.S. students and \$17,000 for Ph.D. students. Senior students in Civil and Environmental Engineering often provide technical services to private industry and local and state government agencies as a part of their required senior design project.

In addition to refereed journal publications, projects supported through the UWRL provide outreach information in the form of short courses, field training, newsletters, brochures, and videos.

The following table provides a numerical summary of the accomplishments of the UWRL for 2004 and 2005 in the areas of research, academic training facilitated, and outreach:

Activity	2004	2005
Research Products		
Number of Projects Awarded	47	60
Dollar Value (\$ Millions)	2.3	2.6
Publications (Refereed)	26	16
Academic Training Facilitated		
Number of Graduate Research Fellowships Awarded	71	59
Number of Undergraduate Students Supported	58	71
Senior Design Projects (Number of Students)	4	6
Outreach Products		
Short Courses and Field Training	18	18
Newsletters, Brochures, Videos	5	6



Benefits to the State of Utah

Research conducted by the UWRL benefits the citizens of the State of Utah in numerous ways. Current projects at the UWRL are found in every county of the state. Examples of current, past, and expected future benefits provided by the UWRL include:

- The UWRL has worked for the past three years with the Utah Department of Environmental Quality (UDEQ), Drinking Water Division, to address national regulations and requirements regarding Source Water Protection Plans in Utah. The assistance includes the development of new tools and methods for source water assessment of the risk of contamination of surface water supplies in Utah. This is especially important under drought conditions that have been recently experienced in Utah. A source water protection assessment tool (SWPAT) is under development for the Ogden River Watershed as a technology transfer product of this research.
- On-site wastewater treatment training and technology transfer for State of Utah personnel in the Utah Department of Environmental Quality and local health departments continued in this reporting period. Undergraduate and graduate students participate through projects that involve hands-on, real-world activities. Utah health department staff and other Utah On-Site Wastewater Treatment professionals were trained in site characterization, treatment, and monitoring on-site systems and source water protection aspects of on-site systems. Additional information can be found at the UWRL web site: <http://www.engineering.usu.edu/uwrl/training>. UWRL faculty and staff taught on-site wastewater treatment workshops throughout the State of Utah over the past 24 months to local health department personnel and contractors that included: (1) Soil Evaluation and Percolation Testing, (2) Design, Inspection, and Maintenance of Conventional Systems, and (3) Design, Inspection, and Maintenance of Alternative Systems.
- UWRL faculty are currently assisting UDEQ personnel in the evaluation of state needs regarding Total Maximum Daily Loads (TMDLs) for Utah's lakes, rivers, and streams, and the impacts of proposed land use changes on water quality. Personnel from the UWRL have provided direct technical assistance in this reporting period for the preparation of TMDLs in several Utah locations.
- Results of our laboratory investigations continue to provide cost-saving methods for improving the performance and safety of dams and of dam spillways in Utah, and can be expected to play an important role in future dam safety rehabilitation in the state. In addition, UWRL faculty and staff continue to develop procedures that consider risks associated with the performance of dams.

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- In FY 2003 through FY 2007, the UWRL has been requested to assist the State of Utah to develop a plan and methods of management to minimize sediment release from dams during drawdown events. The UWRL has received U.S. EPA funding to assist the state in this effort.
 - UWRL faculty serve on state and local advisory panels as part of our outreach and service activities, including the Utah Drinking Water Board (Dr. Laurie McNeill), Utah Water Quality Board (Dr. Ronald C. Sims), the Utah Solid and Hazardous Waste Control Board (Dr. William J. Doucette), Lake Powell Technical Advisory Committee (Dr. Darwin L. Sorensen), Salt Lake County Solid Waste Management Council (Dr. R. Ryan Dupont), and the Utah On-Site Wastewater Association (UOWA) (Dr. Ronald C. Sims, Ms. Judith L. Sims, and Dr. Darwin L. Sorensen).
 - Real-time management of irrigation systems in the Sevier River Basin is being implemented using computer models to increase the efficiency of basin-wide water management. This is especially useful when the total quantity of water decreases as in the recent drought conditions in Utah.
 - Computer models for managing the quality of streamflows and improving the operational efficiency of Weber Basin water treatment plants continue to be developed and are expected to be transferable to other river systems in Utah.
 - UWRL faculty are currently involved in improving drinking water treatment and plant performance in Utah with regard to coagulation and arsenic removal processes. We are also working closely with the Utah Water Quality Alliance through Dr. Laurie S. McNeill.
 - Monitoring of fish populations within the Sevier River drainage is a cooperative project with the State of Utah Division of Wildlife Resources and the Sevier River Bridge Canal Company to guide decisions about long-term water allocation and enhancement of native fish in the Sevier River Basin. Similar assistance is being provided for the Virgin River Basin.
 - The UWRL obtained land from USU and worked with the Utah health departments and UDEQ to establish the Utah On-Site Wastewater Treatment Physical Demonstration Facility in FY 2001, and the site became operational in FY 2002. In 2002, 2003, 2004, and 2005 the site was used extensively for training provided to a variety of participants from all around the state. Financial support for the facility was provided by the U.S. EPA and private industry.

-
- The use of vegetation for reclaiming mining areas is being investigated through the development of phytoremediation techniques at the UWRL to assist Utah and other intermountain areas with metal-contaminated soil and ground water.
 - UWRL faculty continued to provide technical support to the Virgin River Resource Management and Recovery Program in FY 2004 and FY 2005. The program considers actions that will promote protection of species and meet water allocation needs. UWRL faculty have participated in this important program for nearly two decades.
 - UWRL personnel provided research support on a more realistic approach to assessing the impacts of altered flow regimes on drifting feeding fish species (i.e., trout). This will provide resource managers with a tool to make better decisions on protecting Utah fisheries resources.

Future Directions

Water Problems in the Future: The relative scarcity of water is growing due to population and economic growth, pollution, and diversification of the types of demands that humans place on the available water resource (e.g., water quality maintenance, endangered species protection). With increasing scarcity comes a greater need to more intensively manage the resource and a widening interest on the part of an ever more diverse set of stakeholders to have a seat at the water resources decision-making table. These things—a need for more intensive management and a diversifying decision-making public—require that we be able to generate and deliver better information about the current and future states—both quantity and quality—of our water resources.

In spite of an increasing need for better, more decision-relevant information about our water resources systems, investments in traditional water resources data collection (e.g., point stream flows, snow pack, soil moisture, water quality, etc.) is declining at the federal and state levels, making it more difficult each year to meet this information need. However, investments in new data collection methods are increasing—such as satellite imagery of land cover, snow cover, ocean surface temperatures, etc.; radar estimation of precipitation, aircraft and satellite imagery for estimation of evapotranspiration—that might be used to back-fill the decline in the availability of traditional data.

Research is needed to develop the data that are now becoming available from emerging remote sensing sources into useful information for all temporal and geographical scales of water resources management. Further, the products of this research must be of practical use to the water resources managers who are now losing access to traditional data sources; they must also be of use to a wider range of stakeholders who have heterogeneous technical backgrounds and skill levels, but who are now demanding a role in water resources decision-making.

The faculty, staff, and resources of the UWRL, in coordination with water scientists across campus, are well suited to respond to these new research needs and emerging water resources problems.

Strengthening Ties Across Campus: Recent years have brought significant changes to water research and education at USU. Reorganization of the Departments of Biological and Irrigation Engineering and Civil and Environmental Engineering has created opportunities for the UWRL to work more closely with the faculty of both departments. The integration of the UWRL into both departments has expanded the areas of water resources

research that can be addressed at USU and has strengthened the ability to address large-scale and complex land/water systems that include irrigation components. The faculty and staff of the UWRL are working closely with the Biological and Irrigation Department to identify and pursue research opportunities of common interest, especially in the area of international water problems and research. In addition, the changing nature of water resources problems in the state, the nation, and around the world, coupled with advances in modern technology, have prompted researchers at the UWRL to seek collaboration with faculty from other departments within the College, especially with the Departments of Electrical and Computer Engineering and Mechanical and Aerospace Engineering. The USU "Water Initiative" has provided a forum for water researchers from across campus to come together and begin to address common curriculum problems and identify opportunities for collaborative, interdisciplinary research on water issues. In coordination with the USU Research Foundation (USURF), researchers at the UWRL work with the Water Dynamics Laboratory (WDL), a component of the USURF, to market the products of water research in the private sector. The faculty and staff at the UWRL have welcomed the opportunity to participate in the broadening of research and educational efforts in the water sector and look forward to establishing the strong, interdisciplinary partnerships that will be needed to address the newly emerging water resources research problems that confront Utah, the nation, and the world.

Strengthening Partnerships for the Future: The water problems of the future are complex and their solution will require the development and application of new sets of tools. Water managers at all levels of government will require education and training in order to grapple with these new problems and take advantage of the new tools that will be required to deal with them. The UWRL is well positioned to provide the basic and applied research capabilities that will be needed to support water managers and stakeholder groups at local, state, national, and international levels. The faculty and staff at the UWRL are committed to strengthening our ties with resources management agencies at all levels, to listening to them and their stakeholders as they articulate their concerns about water management problems, and working with them to find ways to solve those problems. The UWRL will provide facilities and financial support to university students to become water resource engineers and specialists and, through research-based training in new water challenges, will provide the future leaders of water management in Utah, the United States, and the world.

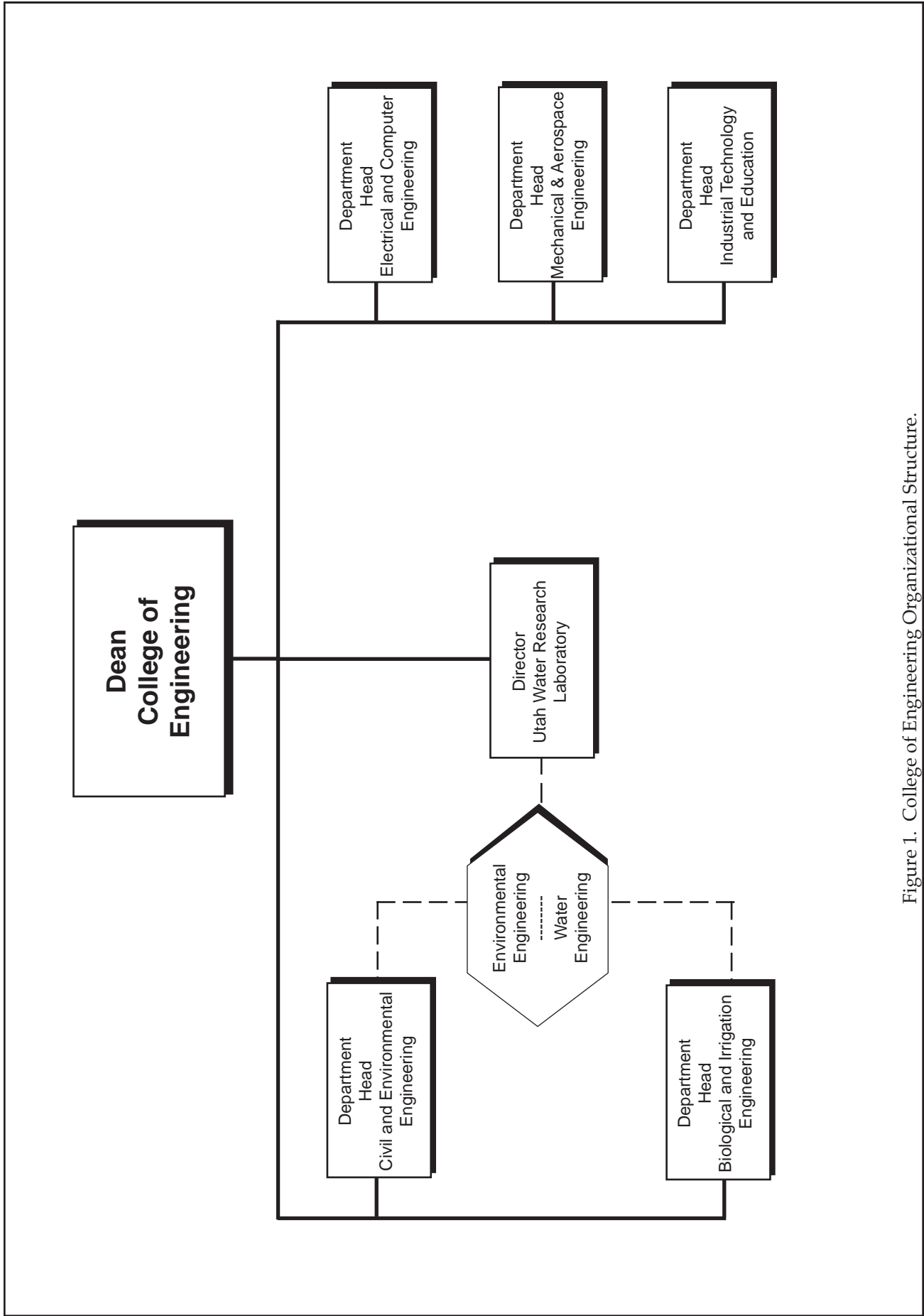


Figure 1. College of Engineering Organizational Structure.

II. Background

In the early 1950's, Utah State University (USU) faculty and administrators began planning for an integrated facility for interdisciplinary water resources research. In 1959, the Utah State Legislature authorized the establishment of the Utah Water Research Laboratory (UWRL). Funding for the original structure was provided by the Utah Legislature, with supplemental funding from the National Science Foundation (NSF) and the National Institutes of Health. The building was dedicated in 1965, and faculty from a wide range of academic departments began using the facility. By 1975, the research program had outgrown the facility. The Environmental Quality Laboratory was housed in makeshift construction in the back of the Hydraulics Laboratory, and office space was scarce. Additional funding was obtained from the Utah State Legislature, and, in 1980, the present UWRL building was completed.

UWRL's first director was Dr. Vaughn E. Hansen (1964 to 1966). He was replaced by Dr. Jay M. Bagley who served until 1976. Dr. L. Douglas James was director from 1976 to 1991. Dr. David S. Bowles, after serving as Acting Director, was appointed Director in 1992 and stepped down in 1996. Dr. Ronald C. Sims served as UWRL Director from 1996 to 2003. Dr. Mac McKee is our current director.

The UWRL also houses the Utah Center for Water Resources Research (UCWRR), the second largest of 54 U.S. centers. The Center administers the U.S. Geological Survey 104 funding program, performs coordinating roles for water research in Utah, and represents the State of Utah at regional and national levels.

Today, multidisciplinary faculty work together in Environmental Engineering, Groundwater, Fluid Mechanics and Hydraulics, Hydrology, Natural Systems Engineering, Water Education, and Water Resources Management to support the mission of the UWRL.

The UWRL is one of six units comprising the College of Engineering, under the leadership of Dean H. Scott Hinton with the other five units organized as academic departments (see Figure 1). Faculty are organized within the UWRL into the Water Engineering Division and the Environmental Engineering Division. The Water Engineering Division is affiliated with the Department of Civil and Environmental Engineering (CEE), and the Environmental Division is affiliated with both the CEE Department and the Department of Biological and Irrigation Engineering (BIE). The UWRL Director works closely with the Heads of the CEE and BIE Departments and the Division Heads to coordinate academic coursework and UWRL programs. Faculty members within the two divisions typically have joint appointments at the UWRL in either CEE or BIE, and students also work in both units. This coordination allows for a larger and more diverse educational environment for undergraduate and graduate students. The collaboration of the UWRL and the academic departments within the College of Engineering facilitates an integration of coursework, faculty skills, and hands-on research, testing, and training in water engineering and science that is unique in the United States.

The UWRL also collaborates with other academic and research units at USU and at other universities in Utah as well as outside of Utah. Examples of projects and partnerships that illustrate these types of collaboration are provided on the UWRL web address: <http://www.engineering.usu.edu/uwrl>.

Administration, Structure, and Function



Dr. Mac McKee

Administration

The administration and organization of the UWRL are shown in Figure 2. Dr. Mac McKee is the UWRL Director. He is assisted by Dr. Thomas B. Hardy, Associate Director. The research program at the UWRL is coordinated primarily with the academic programs in the CEE and BIE Departments, as described previously. Dr. R. Ryan Dupont is Environmental Engineering Head (Figure 3), and Dr. Jagath Kaluarachchi is Water Engineering Head (Figure 4). Our International Program involves collaboration with developing and developed nations, and involves faculty and students in both the Environmental Engineering and the Water Engineering Divisions. Support areas include: Administrative Services and Infrastructure, supervised by Ms. Jan Urroz; Publications and Information Dissemination, coordinated by Ms. Ivonne Harris; and the Business Office, supervised by Ms. Tamara Peterson. In addition, the Environmental Quality Laboratory is managed by Ms. Joan McLean, and the Hydraulics Laboratory is managed by Dr. Blake Tullis.

Water-related Centers at the UWRL add depth and enhance the overall UWRL program. These include: Environmental Management Research Group (EMRG) co-directed by UWRL research engineers Ms. Bethany Neilson and Mr. Jeffery Horsburgh; Institute for Dam Safety Risk Management (IDSRM) headed by Dr. David S. Bowles; Institute for Natural Systems Engineering (INSE) headed by Mr. Craig Addley; the International Irrigation Center (IIC), managed by Dr. Humberto Yap-Salinas; the International Office for Water and Science Education (IOWSE) managed by Mr. Geoffrey G. Smith; the Utah Center for Water Resources Research (UCWRR) headed by Dr. Mac McKee; the Utah On-Site Wastewater Treatment Training Program coordinated by Ms. Judith L. Sims; and the Water Dynamics Laboratory (WDL) managed by Dr. Richard Peralta.



Dr. Thomas B. Hardy

Expertise originating within the two UWRL Divisions and eight centers in the areas of water resources, hydraulics, and environmental quality are integrated for addressing current challenges with regard to ecological engineering, water and environmental stewardship, and risk management. Subprograms within the Environmental Engineering Division that link environmental quality with current challenges are described in Figure 5. Subprograms within the Water Engineering Division that link water resources and hydraulics with current challenges are described in Figure 6. Specific research and testing projects are directed at addressing water-related needs that are supported by a mix of institutions, clients, and UWRL staff through cooperative and collaborative efforts. Specific projects identified in Section VII demonstrate that the applications include local, state, regional, and global scales. UWRL physical facilities and staff technical capabilities provide strong leveraging of all projects. In addition, the organization and management of all research and testing projects at the UWRL serve to support the academic programs at undergraduate and graduate levels. The following sections of this report provide more details about the UWRL divisions and its affiliated centers.

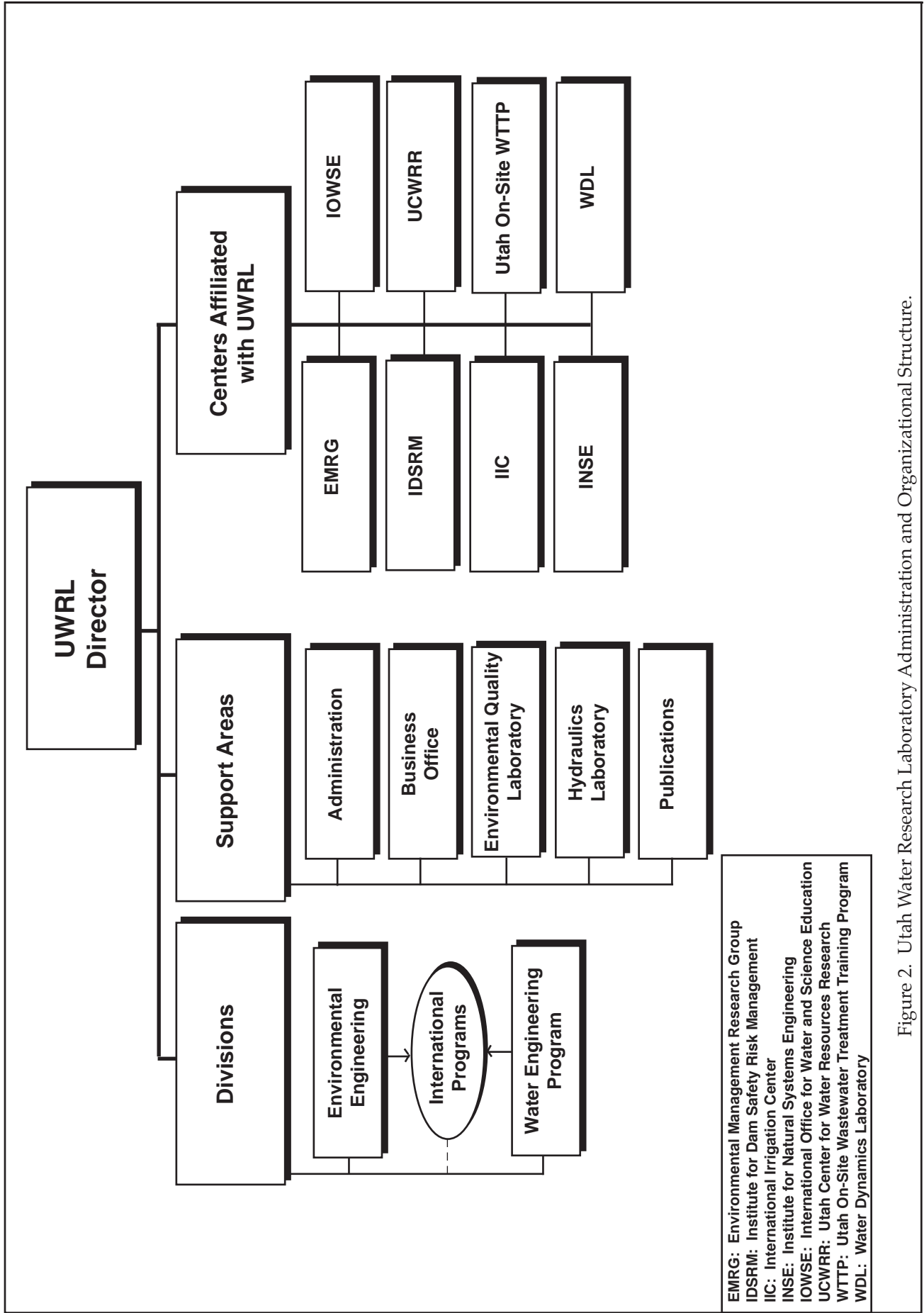


Figure 2. Utah Water Research Laboratory Administration and Organizational Structure.

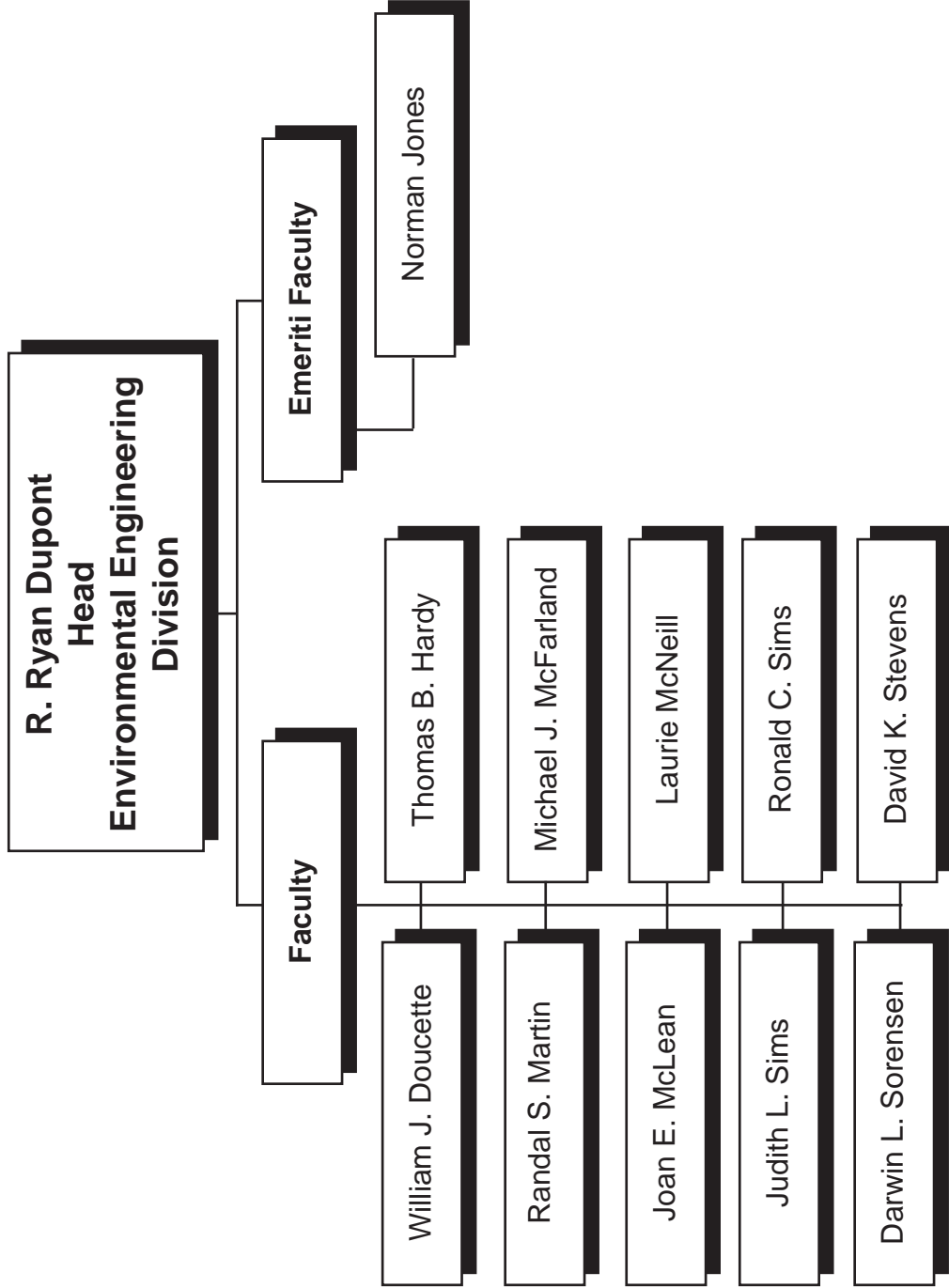


Figure 3. Utah Water Research Laboratory Environmental Engineering Division Organizational Structure.

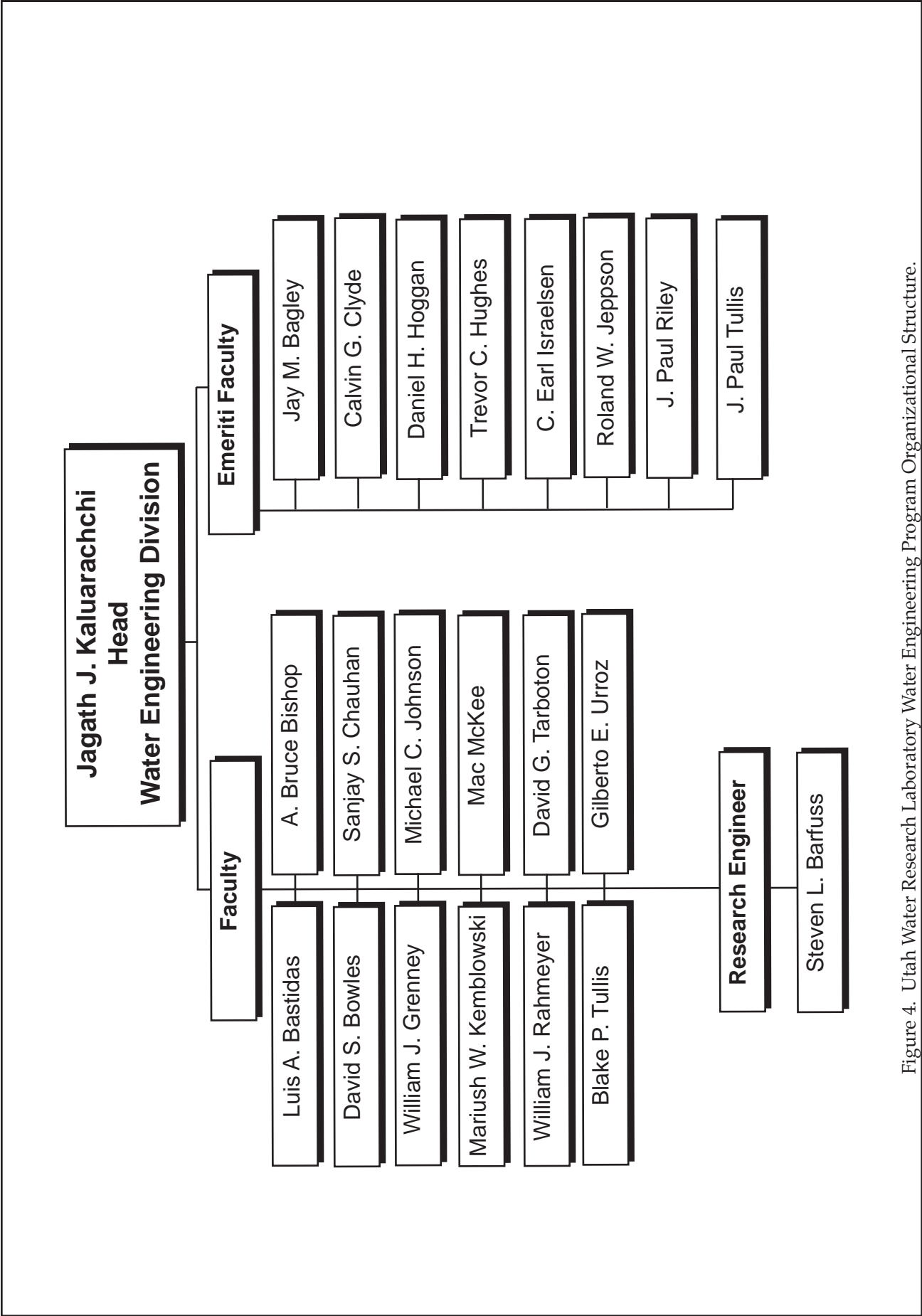


Figure 4. Utah Water Research Laboratory Water Engineering Program Organizational Structure.



Dr. R. Ryan Dupont

Environmental Engineering Division

Faculty within the Environmental Engineering Division are indicated in Figure 3. These faculty have joint appointments with the UWRL and with either the Civil and Environmental Engineering (CEE) or the Biological and Irrigation Engineering (BIE) Departments within the College of Engineering. The Environmental Engineering Division has focused research programs in Hazardous and Toxic Waste Management, Bioprocess Engineering, Geoenvironmental Engineering, Management of Air Quality Impacts, Water Treatment Science, and Natural Systems Engineering. A multimedia thrust within each program is carried out by a multidisciplinary group of engineers and scientists conducting basic and applied laboratory and field research in such areas as: fate and transport of toxic and hazardous contaminants in plant, soil and surface/groundwater environments; performance evaluation and design of biological and plant-based hazardous waste remediation systems; modeling and measurement of basin-scale water quality and ecosystem impacts of water resources and basin development; water and wastewater treatment; behavior and treatment of toxic metals in drinking water; infrastructure degradation; airborne particulates and visibility impacts; and natural systems physical habitat simulation modeling. The Environmental Quality Laboratory supports the experimental research program within the Division. Research in environmental engineering conducted at the UWRL is supported by a variety of funding sources including the State of Utah, industry, U.S. Environmental Protection Agency (USEPA), U.S. Geological Survey (USGS), National Science Foundation (NSF), Department of Defense (DoD), Department of Energy (DoE), and other federal agencies, consulting firms, and other private organizations.

Courses offered for academic credit in Environmental Engineering at the undergraduate and graduate level are listed in Section IV "Education Support." Information is provided that includes course title, instructor, and CEE course number.

For additional information on the undergraduate and graduate academic degree programs in environmental engineering, please contact Dr. R. Ryan Dupont at: rdupo@cc.usu.edu.

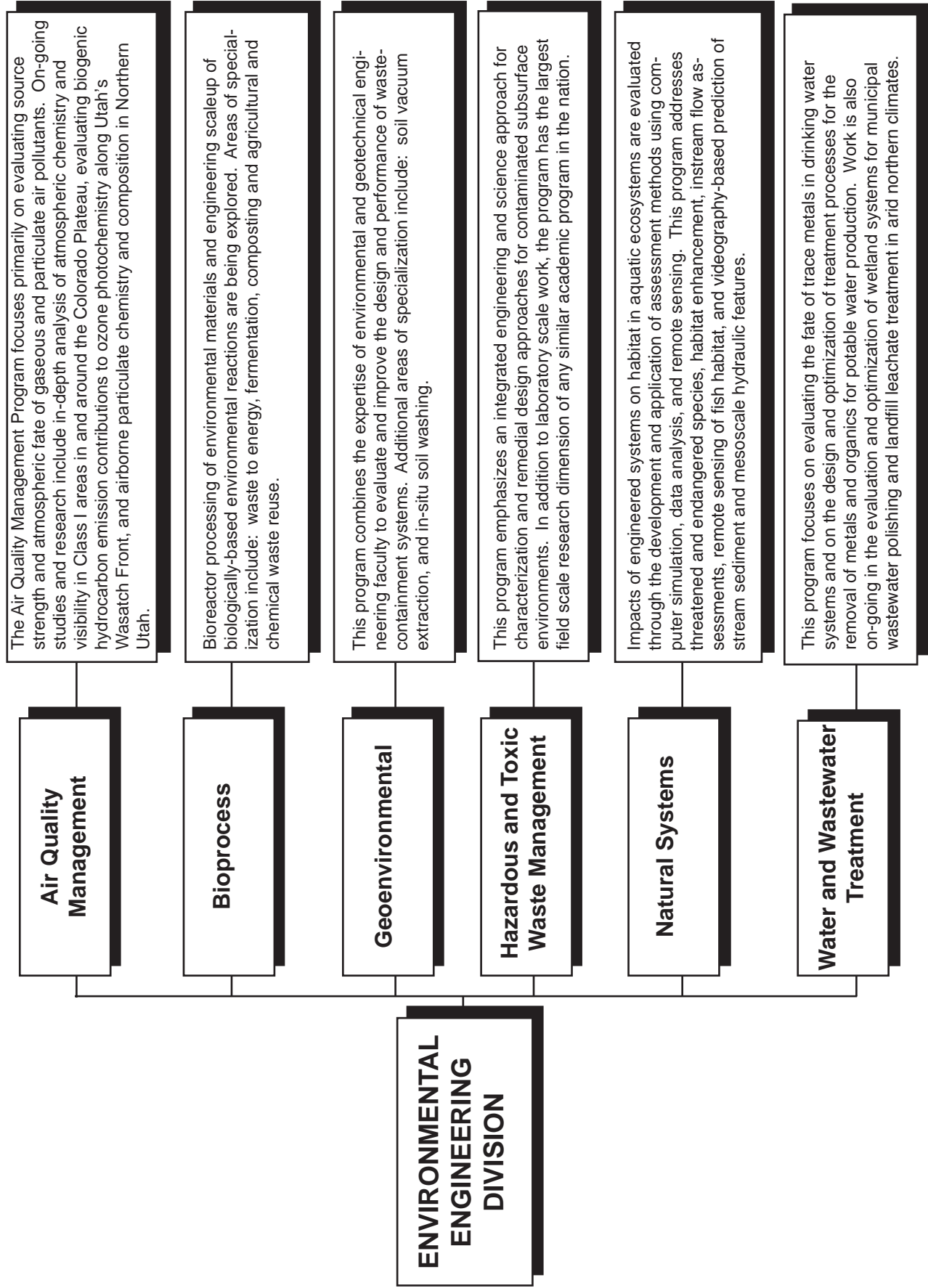


Figure 5. Environmental Engineering Division Subprograms.



Dr. Jagath J. Kaluarachchi

Water Engineering Program

Faculty within the Water Engineering Program are indicated in Figure 4. These faculty have joint appointments with the UWRL and with the Civil and Environmental Engineering (CEE) Department. The Water Engineering Program is supported by state and federal research funds. Speciality areas within the program include: Fluid Mechanics and Hydraulics, Groundwater, Hydrology, Water Resources Planning and Management, and Ecohydraulics. The academic curriculum supporting research is one of the most comprehensive offered in the U.S. Elements of ongoing research projects are routinely and effectively incorporated into the classes. The program combines research, training, and experience to understand the water issues and water resources management challenges in Utah, the United States, and the world.

Fluid mechanics, based on fundamental principles of conservation of mass, energy, and momentum, is the logical core for all water-related engineering research programs. Hydrology is a branch of geoscience concerned with the origin, distribution, movement, and properties of waters of the earth. The hydrology program at USU has strength in both theoretical and applied aspects of modern hydrology. A particular emphasis of the program is on spatial representation of hydrologic processes using geographic information systems. Groundwater engineering is concerned with the transport of fluids in the subsurface environment. Current research activities cover a well-balanced variety of topics, from theoretical (e.g., stochastic analysis of transport of contaminants in groundwater) to practical problems (e.g., design of cleanup technologies for gasoline-contaminated sites). Water resources engineers need a sound understanding of how water storage, delivery, and other management systems function. A focus area of the research program is to develop decision-support systems for sustainable water quantity and quality management in the United States and in developing regions of the world. Other areas include real time reservoir flood operations and dam safety risk management. Ecohydraulics focuses on multidisciplinary studies involving legal, institutional policy, and technical assessment frameworks for the integration of hydrology, operations modeling, water quality, channel maintenance, and fish habitat requirements in the determination of instream flows in water resource systems.

Courses offered for academic credit, including undergraduate and graduate, in Water Engineering are listed in Section IV, "Education Support."

For additional information on the academic graduate program, as well as undergraduate courses in water engineering, please contact Dr. Jagath J. Kaluarachchi at: jkalu@cc.usu.edu.

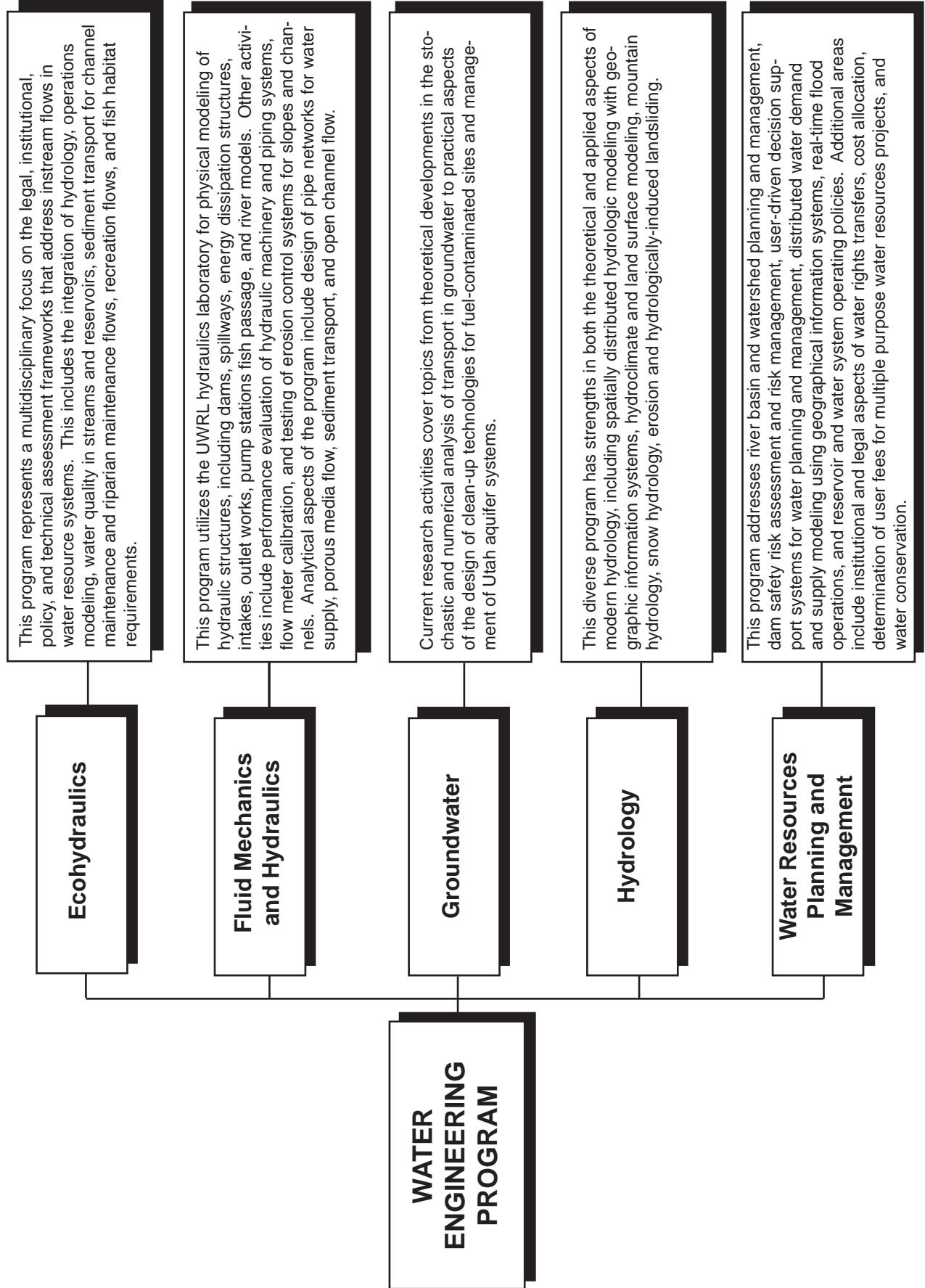


Figure 6. Water Engineering Program Subprograms.

International Program

Throughout its history, the UWRL has actively provided technical expertise and training services related to international water resources and environmental problems. UWRL personnel have implemented several major technical assistance and training projects and numerous smaller projects in water resources, with funding from the U.S. State Department, the World Bank, the Inter-American Development Bank, the Asian Development Bank, the U.S. Agency for International Development, FAO, the OAS, and various countries. The result is substantial improvements in the efficiency of water management, maintenance or improvement of water quality, implementation of integrated water resources planning and development policies, increased well-being of water users, and improvement of public health conditions in many developing countries.

A long tradition of interdisciplinary collaboration with other USU colleges is a major strength of UWRL international programs. Almost all international projects have required faculty from different colleges to work together. As a result, the UWRL has a significant number of associated faculty who are experienced in working on problems as a team, which greatly enhances the capability of the UWRL to quickly and successfully implement international projects. The UWRL can provide senior faculty, all with many years of international experience in the water sector, from Civil and Environmental Engineering, Irrigation Engineering, Economics, Sociology, Political Science, and other disciplines as necessary.

The UWRL, working in cooperation with the Departments of Civil and Environmental Engineering and Biological and Irrigation Engineering, actively recruits international students for educational opportunities in graduate programs in environmental engineering, hydrology, water resources, hydraulics, and irrigation. At present, international students comprise approximately three-quarters of the graduate enrollment in these programs.

For additional information on UWRL international projects in the water sector or water-related graduate programs, please contact Dr. Mac McKee at: Mac.McKee@usu.edu.

As populations grow in developing countries around the world, the need to supply water and meet the growing demand for food requires ever greater efforts to develop agricultural resources. UWRL personnel participated in the design and implementation of large irrigation projects on the Madroya River in the Mahaweli River Basin in Sri Lanka. This area first came under cultivation approximately 2,000 years ago, but political upheaval and military conflict caused an ancient Singhalese culture to abandon the region approximately 1,000 years ago. Some of this work involved the modernization of 2,000-year-old dams for supplying water to agricultural lands that have lain under jungle for nearly 1,000 years.



Two-thousand-year-old outlet works from a dam on the Madroya River in Sri Lanka. These ancient structures and the large dam from which they drew their water were in the same location as a modern dam and outlet works designed to serve the same irrigated area (Mahaweli River Basin, Sri Lanka)



Upgrade work (embankment and spillway) on a "tank", a small reservoir used to store monsoon season rainfall for later use for irrigation. This tank was originally built between 1,000 and 2,000 years ago and had not been used for more than 800 years. The design of the modern irrigation and drainage systems brought these ancient structures back into use (Mahaweli River Basin, Sri Lanka)



Modernized toe-drain on an ancient "tank" (Mahaweli River Basin, Sri Lanka)



The results of investments in irrigation facilities that integrate modern and ancient structures: The first crop of rice grown in the Madroya region in nearly 1,000 years (Mahaweli River Basin, Sri Lanka)

UWRL faculty have worked on water resources development problems in the Middle East for decades. Since 1993, UWRL personnel have provided technical assistance and training in support of the development of Palestinian water resources in the West Bank and Gaza Strip. Collaborative research, conducted by UWRL faculty and their counterparts from An-Najah National University in Nablus, West Bank (Occupied Palestinian Territories) is currently underway. Israeli-imposed restrictions on travel throughout the West Bank have presented difficult and sometimes dangerous restrictions on these efforts.



Filling facilities for tanker trucks at Ein Fara, near Nablus in the West Bank. These facilities provide water to be delivered to Palestinian homes in the northern part of the West Bank that do not have piped supplies or whose water supply has been interrupted as the result of violence in the region (Occupied Palestinian Territories)



Inspecting a flume for measuring and recording flows in the Wadi Fara Watershed near Nablus, West Bank (Occupied Palestinian Territories)



A flow measurement flume and bridge on a tributary to Wadi Fara (Occupied Palestinian Territories)



An irrigation canal (approximately 0.5-meter in width) which diverts water from Wadi Fara to Palestinian farmers in the valley (Occupied Palestinian Territories)

UWRL faculty have provided training on integrated river basin planning and management in many developing countries. This training, exemplified by our work done for the Central Water Commission of India at the Central Training Unit in Pune, India, emphasizes both the theory of basin-scale integrated planning and hands-on experience in the form of extensive field trips inside India and abroad.



A group of young irrigation engineers on a field trip to the Pennar River Basin in southern India receive instruction about major reservoir and canal components of the basin's irrigation supply system (Andhra Pradesh, India)



Stilling basin and an ancient Hindu temple downstream of a major dam on the Pennar River (Andhra Pradesh, India)



Lessons learned in the classroom and field in India are demonstrated and reinforced through a study tour of river basins and their management facilities in the United States, such as this visit to a water supply dam and reservoir in Colorado

Scarcity of water and the potential of international conflicts is a problem in many international river basins around the world. UWRL faculty have worked for the U.S. Department of State to bring technical training in water and wastewater treatment and reuse to managers of water systems from various countries in the Middle East. A key problem in many developing countries of the region is the proper treatment and reuse of municipal wastewater. UWRL faculty provided short courses on these topics, with concepts illustrated by field visits to treatment and reuse sites in Florida, in support of peace negotiations in the Middle East.



Trainees study methods for infiltrating treated wastewater into the Floridian Aquifer for later use in agriculture and domestic supply (Orlando, Florida)

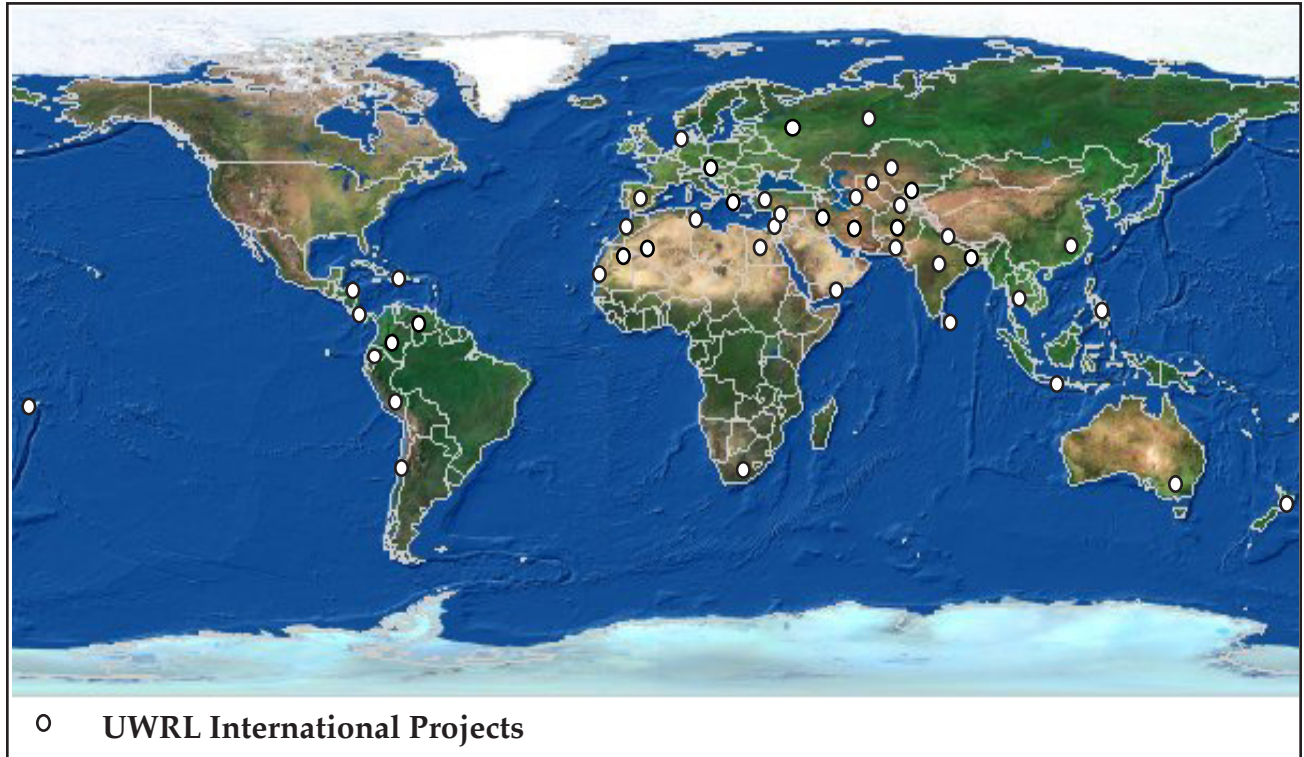


Trainees from the Middle East observe advanced wastewater treatment facilities at Disney World (Orlando, Florida)



Micro-sprinkler irrigation technology for citrus crops, using treated wastewater as the water source (Orlando, Florida)

Personnel from the UWRL have worked on water resources projects and training programs in more than 40 countries throughout the world.



- | | |
|------------------------|---------------------------|
| 1. Afghanistan | 24. Netherlands |
| 2. Albania | 25. New Zealand |
| 3. Australia | 26. Nicaragua |
| 4. Bangladesh | 27. Pakistan |
| 5. Chile | 28. Palestine |
| 6. China | 29. Peru |
| 7. Colombia | 30. Philippines |
| 8. Costa Rica | 31. Republic of Tatarstan |
| 9. Czech Republic | 32. Russia |
| 10. Dominican Republic | 33. Samoa |
| 11. Ecuador | 34. Senegal |
| 12. Egypt | 35. South Africa |
| 13. India | 36. Spain |
| 14. Indonesia | 37. Sri Lanka |
| 15. Iran | 38. Tajikistan |
| 16. Iraq | 39. Thailand |
| 17. Jordan | 40. Tunisia |
| 18. Kazakhstan | 41. Turkey |
| 19. Kyrgyzstan | 42. Turkmenistan |
| 20. Mali | 43. Uzbekistan |
| 21. Mauritania | 44. Venezuela |
| 22. Morocco | 45. Yemen |
| 23. Nepal | |



Centers Affiliated with the Utah Water Research Laboratory



Environmental Management Research Group

The Environmental Management Research Group (EMRG) is a research unit of the Utah Water Research Laboratory (UWRL) focused on integrated watershed management and systems analysis of environmental problems. Founded in 1998, EMRG combines the research talent and experience of several UWRL professors, research engineers and graduate and undergraduate students in civil and environmental engineering, biological and irrigation engineering, computer science and other disciplines. EMRG provides software development, watershed and water quality modeling, and GIS data analysis service to internal and external entities directed at solving integrated watershed and environmental management-related problems of a variety of scales.

EMRG projects have included TMDL water quality modeling and data analysis in both Utah and Idaho, water quality and quantity modeling training seminars (specifically using the EPA BASINS software package), development of sourcewater protection analysis tools, and the development of custom GIS and data visualization and analysis tools for integrated watershed information management. Additionally, EMRG researchers have developed probabilistic modeling approaches for integrated stakeholder-based watershed management, and continue to do research in new and innovative areas of physical and statistical modeling.

EMRG is currently directed by UWRL Research Engineers Jeffery Horsburgh and Bethany Neilson and employs a number of undergraduate and graduate students as software engineers, programmers, and research assistants. These students gain a broad and practical experience in water quality modeling, data analysis, and the development of engineering software tools. Some of the key research and development areas of EMRG include:

- Advanced geographic information system tools for programmers
- Watershed management decision support systems
- Internet-based watershed information systems
- Digital elevation model analysis software for watershed and channel network delineation and hydrologic model setup
- Water quality/quantity data collection and management
- Source water protection software
- Probabilistic collaborative decision modeling
- Total Maximum Daily Load (TMDL) water quality analysis

For more information visit the following web sites:

<http://emrg.usu.edu/>
<http://water.usu.edu/>



Institute for Dam Safety Risk Management

The Institute conducts research to advance the state of practice in risk-based approaches to dam safety management. Founded in 1999, its roots go back more than two decades at Utah State University. Approaches developed by the Institute are now being used by engineers, private and government dam owners, and regulators in many countries. These approaches help to improve the understanding and management of the risks associated with owning and operating dams with the overall goal of improving public safety. In addition to developing approaches for individual dams, the Institute has pioneered portfolio risk assessment for groups of dams. This approach is now a standard of practice in Australia, and is being adopted by the U.S. Army Corps of Engineers and in other countries.

Our research program includes strengthening the supporting areas for dam safety risk management, including the following: geotechnical and seismic analysis; flood hydrology and dam break modeling; risk modeling, including uncertainty analysis; spillway gate reliability analysis; risk evaluation and communication; and dam failure consequence estimation, including evacuation effectiveness and life loss estimation incorporating GIS.

The Institute has growing programs in security against terrorism for dams and water systems for the Department of Defense and in real-time reservoir flood operations for the US Bureau of Reclamation, the US Army Corps of Engineers, California Department of Water Resources, and others. In the latter area the Institute develops advanced software tools for forecast-based operations, forecast-coordinated operations of multiple reservoir systems, and advanced warning of spillway releases from major reservoirs, such as the Folsom Project above Sacramento, California, including consideration of forecast uncertainty.

The Institute organizes and hosts specialized national and international workshops. We also organize conferences, provide professional training, and have prepared and reviewed guidelines for the American Society of Civil Engineers, US Society on Dams, International Commission on Large Dams, Canadian Electricity Association, US Bureau of Reclamation, US Army Corps of Engineers, Construction Industry Research and Information Association (UK), Ontario Power Generation, and Australian National Committee on Large Dams.

Institute faculty have played a facilitation, coordination, or review role for risk assessment applications for more than 450 dams for dam owners and regulators in association with engineering firms in the US and overseas. We have also advised on incorporating risk management into dam safety programs at corporate, statewide, and national levels and conducted peer reviews of dam safety programs in the US and overseas.

The Core Institute faculty is David Bowles (Director), Loren Anderson, Terry Glover, and Sanjay Chauhan. Dean Mathias is a Senior Software Developer. Graduate students are an important part of the research

program. Strong links are maintained with the UWRL Hydraulics Group, which is heavily involved with physical modeling of spillways and other dam appurtenances.

For more information, please contact: David S. Bowles (435-797-4010) David.Bowles@usu.edu or the website: <http://www.engineering.usu.edu/uwrl/idsrm.htm>.



Institute for Natural Systems Engineering

Researchers in this unique program develop, test, and apply a wide range of analytical tools suitable for integration within multidisciplinary assessment frameworks. Research focuses on all aspects of physical, chemical, and biological processes necessary to evaluate impacts in watershed systems. Development, testing, and application of analysis tools and assessment frameworks range across basic life history of aquatic species, spatial sampling of river corridors using remote sensing, GPS and hydro-acoustics, 2- and 3-dimensional hydraulic modeling, and habitat modeling.

For more information contact: Dr. Thomas B. Hardy at: hardy@cc.usu.edu, or the website: <http://www.engineering.usu.edu/uwrl/inse/>.



International Irrigation Center

The International Irrigation Center (IIC) operates within a globalization context with regard to sustainable agricultural and rural environments, water resource management, and competitive agricultural production. The IIC addresses three specific areas: (1) provides students the opportunity to specialize in irrigation engineering as an academic discipline and degree program; (2) administers and conducts long-term international projects through training international irrigation engineers, irrigation government personnel, private industry professionals, and farmers/water users; and (3) designs and provides short-term training programs for international irrigation professionals in both government and private sectors in the United States and in other countries. The IIC collaborates with the Utah Water Research Laboratory on multidisciplinary projects involving irrigation and water resources planning and management aspects for sustainable development at the river basins and watershed scale.

For more information contact: Dr. Humberto Yap-Salinas at: hyaps@cc.usu.edu, or their website: <http://www.irri-net.org/projects/IIC/IIC.htm>.



International Office for Water and Science Education

The International Office for Water and Science Education (IOWSE) promotes water education projects through a cooperative effort among educators, scientists, and local entities. By adapting projects to local needs, IOWSE also provides inservice training for its users in addition to coordinating information as a resource center for national and international water education programs and needs.

By facilitating the production and marketing of water education materials, the IOWSE provides special services to individuals and groups with water-related interests or needs. IOWSE also focuses on promoting and carrying out adult education programs, as well as specialized training for substitute teaching. Three major programs are run out of IOWSE, the Substitute Teaching Institute, the Elementary CORE Academy, and water education/development activities beginning 05-06 in Kenya.

For more information contact Mr. Geoffrey G. Smith at: geoffrey.smith@usu.edu, or the website: <http://iowse.usu.edu/>.



Utah Center for Water Resources Research

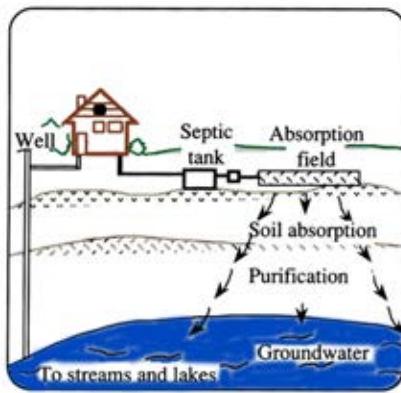
The Utah Center for Water Resources Research (UCWRR) was established by the Water Resources Research Act of 1964 and is currently eligible to receive grants under the provisions of Section 104 of the Water Resources Research Act of 1984. Purposes of the UCWRR are to 1) foster interdepartmental research and educational programs in water resources; 2) administer the State Water Research Institute Program funded through the U.S. Geological Survey at Utah State University for the State of Utah; and 3) provide University-wide coordination of water resources research.

The governing body for the Utah Center for Water Resources Research is a council composed of the deans of the Colleges of Agriculture, Engineering, Natural Resources, Science, and Humanities, Arts, and Social Sciences; directors of the Utah Agricultural Experiment Station, the Utah Water Research Laboratory, and the Ecology Center; and the Vice President for Research. The UCWRR office is located at the Utah Water Research Laboratory. All University faculty engaged in water resources education or research are considered associates of the center. The center promotes and coordinates the development of research and instructional

programs that will further the training of water resource scientists and engineers. It maintains liaison relationships with appropriate state, national, and international organizations and agencies having similar objectives.

For more information contact Dr. Mac McKee at: Mac.McKee@usu.edu, or the UWRL website: <http://www.engineering.usu.edu/uwrl/niwr>.

Utah On-Site Wastewater Treatment Training Program



The Utah On-Site Wastewater Treatment Training Program was established in January 1998. The mission of the training program is to assist in the protection of public health and the environment by providing technology transfer, training, and information dissemination in on-site wastewater treatment to stakeholders in Utah and the surrounding region, and by raising the level of public awareness and knowledge in on-site wastewater treatment issues.

The Program provides classroom and field training to site evaluators, regulators, designers, operators and maintenance personnel in support of the statewide certification program for on-site wastewater professionals. About 12% of all Utah households use on-site wastewater treatment systems, and in six of the twelve local health department regions, this percentage is as high as 30 to 60%. About 2,000 new systems are added annually in Utah.

For more information contact Ms. Judith L. Sims at: jlsims@cc.usu.edu, or the UWRL website: <http://www.engineering.usu.edu/uwrl/training>.





Water Dynamics Laboratory

The Water Dynamics Laboratory (WDL), a part of the Utah State University Research Foundation, assists Utah State University and supports the Utah Water Research Laboratory in achieving its mission by providing student support and training through contracts and projects that utilize the UWRL physical facilities of the UWRL Hydraulics Laboratory. WDL-supported students, staff, and faculty are involved in the areas of hydraulic structure physical model studies. Examples of model studies include: dams and spillways, river channels, diversion structures, pumping plants, gate structures and erosion-control structures. WDL is also involved in the calibration of flow measurement equipment, valve performance tests, pipe and fitting pressure loss tests, pipe burst tests, pump tests, hydraulic research and product development, fish screen and fish passage issues, storm water system testing and field flow problems.



Employing students in the Civil and Environmental Engineering Department to work in the hydraulics laboratory at the UWRL produces several positive results. The students receive a real-world hands-on experience performing engineering tasks as they assist with WDL projects performed at the laboratory. Employment also provides opportunities for faculty/client/student interaction. After graduation, many students are hired by past laboratory clients. A high percentage of undergraduate student employees at the UWRL have pursued advanced degrees at USU because of the experience gained while working at the laboratory on WDL projects.

For more information contact Mr. Steven L. Barfuss at: barfuss@cc.usu.edu, or the website: <http://www.usurf.usu.edu/units/wdl>.

III. Facilities



The 102,000 square-foot UWRL facility contains offices and laboratories that house engineers, scientists, laboratory technicians, and students from a variety of engineering and water science disciplines. Designed to meet the needs of these disciplines, the UWRL has well-equipped environmental quality and hydraulics laboratories; computer facilities; conference rooms; and administrative, faculty, staff, and student offices.

Environmental Quality Laboratory



The 11,000-square foot Environmental Quality Laboratory (EQL) at the UWRL is equipped for analyses of organic and inorganic constituents in air, water, and soil. The EQL consists of chemistry, microbiology, radiological, and analytical instrumentation laboratories; two constant temperature rooms; bioassay and research project areas; and refrigerated sample storage area.



A safety plan for the EQL has been submitted to and approved by the Environmental Health and Safety Office (EHSO), Utah State University, in compliance with the Occupational Safety and Health Administration standard entitled "Occupational Exposure to Hazardous Chemicals in Laboratories." The EQL plan includes information on chemical hygiene and proper handling and disposal of hazardous substances, including radioisotopes. All laboratory personnel are required to attend the laboratory safety seminar provided by the EHSO. EQL instrumentation and facilities are listed in the following table:

<u>Organic Chemicals</u>	<u>Inorganic Elements</u>
<ul style="list-style-type: none"> • 6 Gas Chromatographs with 5 Detectors • 2 High Performance Liquid Chromatographs with UV & Fluorescence Detectors • 2 GC/MS Instruments • Headspace Autosamplers for Volatile Chemicals • Supercritical Fluid Extractor 	<ul style="list-style-type: none"> • Inductively Coupled Plasma-Mass Spectrometer • Atomic Absorption Spectrometer with Graphite Furnace and Mercury/Hydride Atomizers
<u>Radiochemical Analyses</u>	<u>Anion Analyses</u>
<ul style="list-style-type: none"> • 2 Liquid Scintillation Counters for Tritium, ¹⁴C, ³²P, ³⁵S, and ¹²⁵I • 2 Biological Oxidizers used for Soils, Biosolids, and Plants 	<ul style="list-style-type: none"> • Dionex LC25 Ion Chromatograph • Dionex LC25 Ion Chromatograph with UV/VIS for CR⁺⁶
<u>Microbiology and Toxicity</u>	
<ul style="list-style-type: none"> • Microbics Toxicity Analyzer for microtox measurement of cellular toxicity and mutatox measurement for mutagenicity • Ames Salmonella/Mammalian Microsome Assay • ATP analysis with integrating photometer • Gilson Respirometer for microbial respiration 	





Additional analytical instrumentation includes a total dissolved organic and inorganic carbon analyzer, surface area (BET) analyzer, universal fractionator for separation of particles and macromolecules, laser photometer and a DSP interferometric refractometer for molecular size analysis of separated particles and XAD resin chromatography and a freeze dryer for concentrating humic substances from water or soil extracts.

Field Instruments and Analyses

Water Quality



- YSI Dissolved Oxygen/Conductivity
- Hach Colorimeter for Nutrients, Fe, Mg
- Portable GC/FID instrument
- 2 Gastech Gastechotor Carbon Dioxide/Oxygen Analyzer
- A Gidding Soil Corer and Standard Soil Augers
- Portable Mud Rotary Drill (Deep Rock, Inc.) for observation well installation, and groundwater sampling to depths of approximately 120 feet
- Redi Flo2 Electric Pump (Grundfos Pumps Corp.) for purging ground water from sampling wells
- ES 125 single channel Seismograph for shallow refraction surveys of soil and stratigraphy, and depth to water table



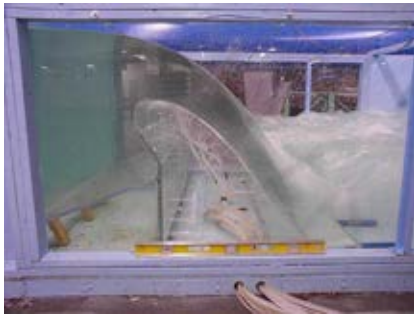
Air Sampling

- High Volume Sampler
- Personal Monitoring Pumps
- Combustible Gas Meter
- Real-time monitors for CO and O₂
- Stainless steel whole air canisters, collection media and supports
- DO Meters
- MSA Detector Kits
- Draeger Detector Kits
- Air Velocity Meters



Hydraulics Laboratory

The 50,000 square-foot hydraulics section of the Utah Water Research Laboratory contains a variety of flumes, channels, pumps, pipelines, equipment, and instrumentation for conducting hydraulic research, model studies, valve testing, and flow meter calibrations. Water is supplied by gravity flow up to rates exceeding 200 cfs from an upstream reservoir through a 48-inch diameter pipe to the laboratory. The reservoir supplies a constant pressure head of 25 feet to the main laboratory level and 35 feet to the lower laboratory level. A network of steel piping (18-, 24-, and 36-inches in diameter), located under the floor, supplies water to various parts of the laboratory. Other under-the-floor channels conduct water from the experiments back to the river, to recirculating pumps, or to precise flow measurement facilities. Laboratory research is supported by carpentry and machine shops which are utilized for physical model construction, custom steel and acrylic fabrication, and heavy equipment maintenance. The laboratory uses two forklifts, a mobile crane, and two skid-loaders to aid in the construction of experiments.



Also contained within the Hydraulics Laboratory is a 400 square-foot rainfall simulator, and a sunlight simulator integrated with a tilting soil-filled test flume. These facilities enable students and faculty to conduct a wide range of studies related to erosion, runoff, infiltration, and crop production.



Laboratory facility summary:

NIST Traceable Flow Measurement Equipment

- 1,000-lb weigh tank
- 30,000-lb weigh tank
- 300,000-lb weigh tank
- 835-ft³ volumetric tank
- 3,545-ft³ volumetric tank
- Master venturi meters (48-inch, 24-inch, 12-inch, 6-inch, 2-inch)
- 48-inch ultrasonic meter



Pressure Measurement Equipment

- Adjustable-range pressure transducers/transmitters
- Precision pressure gauges
- U-tube manometers (blue fluid and mercury)

Data Collection Equipment

- Data acquisition software and hardware
- Digital data analyzer
- Multimeters
- Decibel meters
- Accelerometers
- Thermometers



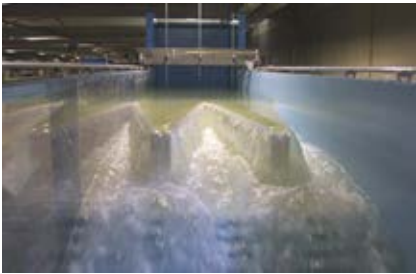


Pipe and Fitting Inventory

- US steel pipe sizes (1/2-inch through 60-inch)
- Uncommon steel pipe sizes (upon request)
- Control valves (1/2-inch through 48-inch)
- Elbows, reducers, tees, etc., for pipeline simulation tests
- Flange clamps for flanges other than 150 pounds
- Dresser couplings (2-inch through 48-inch)

Flow and Pressure Capabilities

- Reservoir: 11 psi upper level, 15 psi lower level at shutoff, over 200 cfs maximum
- 1 stage, 100-hp vertical turbine pump, 1770-rpm, 5000-gpm runout, 70-ft shutoff
- 2 stage, 200-hp vertical turbine pump, 1770-rpm, 5000-gpm runout, 170-ft shutoff
- 10 stage, 100-hp vertical turbine pump, 1770-rpm, 1000-gpm runout, 680-ft shutoff
- 350-hp centrifugal pump, 1780-rpm, 3000-gpm runout, 580-ft shutoff
- 15-ft constant head tank



Test Flumes

- 6-ft x 8-ft x 500-ft concrete flume
- Tilting 3-ft x 4-ft x 24-ft steel/acrylic research flume
- Tilting 2-ft x 3-ft x 48-ft steel/acrylic research flume



IV. Education Support

Undergraduate and graduate students are involved in research, testing, design, training, technology transfer, and outreach activities at the UWRL. Engineering graduate students with science and/or engineering academic backgrounds are recruited to participate on projects for theses and dissertations, and are competitively supported through UWRL- and client-supported assistantships. These students are primarily associated with the Department of Civil and Environmental Engineering; however, students can also be affiliated with other academic departments and interdisciplinary academic units. A description of education support activities, including graduate course offerings, theses and dissertations awarded, senior design projects, and scholarship offerings follows.

For more information concerning the Water Engineering and Environmental Engineering academic programs contact Dr. William J. Rahmeyer, Head of the CEE Department at: rahmeyer@cc.usu.edu; for Environmental Engineering information contact Dr. R. Ryan Dupont at: rdupo@cc.usu.edu; for Water Engineering Program information contact Dr. Jagath J. Kaluarachchi at: jkalu@cc.usu.edu.

Environmental Engineering- and Water Engineering-Related Courses

CEE Course Number	Title	Instructor
1880	CEE Orientation/CEE Orientation Lab	William J. Rahmeyer
3030	Uncertainty Engineering Mech.	Gilberto E. Urroz
3500	CEE Fluid Mechanics	William J. Rahmeyer
3510	CEE Hydraulics/Hydraulics Laboratory	Michael C. Johnson
3610	Environmental Management/Environmental Management Laboratory	Laurie S. McNeill
3780	Solid and Hazardous Waste Management	R. Ryan Dupont
3870	Professional/Technical Writing	Sonia Manuel-Dupont
4200	Engineering Economics	A. Bruce Bishop
4790	Environmental Engineering Design II	R. Ryan Dupont
4870	Civil Engineering Design II	Loren R. Anderson
4930	Independent Study	William J. Rahmeyer
5240	Urban/Reg. Trans. Plan.	R. Ryan Dupont
5350	Foundation Analysis/Design	Jagath J. Kaluarachchi
5430	Groundwater Engineering	Mac McKee
5460	Water Resources Engineering	William J. Rahmeyer
5500	Open Channel Hydraulics	Blake P. Tullis/
5540	Hydraulic Structural Design	Joan E. McLean
5610	Environmental Quality Analysis	Joan E. McLean
5610	Environmental Quality Analysis Laboratory	William J. Doucette
5620	Aquatic Chemistry	Thomas B. Hardy/ Craig Addley
5690	Natural Systems Engineering	William J. Doucette
5730	Environmental Contaminants	Blake P. Tullis
5760	Hydraulic Structure Field Course	Ronald C. Sims
5810	Biochemical Engineering	Michael J. McFarland
5830	Management of Biosolids/Waste	Randal S. Martin

CEE Course Number	Title	Instructor
5860	Air Quality Management	R. Ryan Dupont
5880	Remediation Engineering	Loren R. Anderson
6290	Trans. Network Analysis	Loren R. Anderson
6330	Ground Reinforcement, Improvement and Treatment	James Bay
6340	Geotech Lab and Field	Joseph Caliendo
6350	Found Analysis/Design	James Bay
6360	Geotechnical Principles	Reynold Watkins
6400	Physical Hydrology	Luis Bastidas
6430	Groundwater Engineering	Jagath J. Kaluarachchi
6440	GIS Water Resources	David G. Tarboton
6460	Water Resources Engineering	Mac Mckee
6500	Open Channel Hydraulics	William J. Rahmeyer
6510	Num/Stat Methods	Gilberto E. Urroz
6540	Hydraulic Structural Design	Blake P. Tullis/ Steve Barfuss
6610	Environmental Quality Analysis/Environmental Quality Analysis Laboratory	Joan E. McLean
6630	Process Dynamics/Process Dynamics Laboratory	David K. Stevens
6660	Environmental Data Analysis	David K. Stevens
6690	Natural Systems Engineering	Thomas B. Hardy/ Craig Addley
6710	Environmental Engineering Microbial Ecology	Darwin L. Sorensen
6710	Environmental Engineering Microbial Ecology Lab	Darwin L. Sorensen
6730	Environmental Contaminants	William J. Doucette
6800	Environmental Graduate Seminar	R. Ryan Dupont
6800	CEE Graduate Seminar	William J. Rahmeyer
6810	Biochemical Engineering	Ronald C. Sims
6830	Management of Biosolids/Waste	Michael J. McFarland
6840	Application of Technology	Loren R. Anderson
6900	Directed Reading	William J. Rahmeyer
6930	Special Problems	William J. Rahmeyer
6930	Special Problems	Darwin L. Sorensen
6930	Special Problems	Blake P. Tullis
6930	Special Problems	Randal S. Martin
6930	Special Problems	R. Ryan Dupont
6970	Thesis Research	William J. Rahmeyer
6990	Continuing Graduate Advisement	William J. Rahmeyer
7150	Effective Engineering Instruction	Sonia Manuel-Dupont
7170	Research Methods in Engineering	Laurie S. McNeill
7970	Dissertation Research	William J. Rahmeyer
7990	Continued Graduate Advisement	William J. Rahmeyer
ENG 2440	Strength of Materials	Loren R. Anderson
ENG 2200	Engineering Num. Meth I	William J. Grenney
ENG 2200	Engineering Num. Meth I	William J. Grenney
ENG 2200	Eng. Num. Meth. I Laboratory	William J. Grenney
ENG 2200	Eng. Num. Meth. I Laboratory	William J. Grenney

Theses and Dissertations Awarded

2004 DOCTOR OF PHILOSOPHY

- Almasri, Mohammad Nihad. Optimal Management of Nitrate Contamination of Groundwater. Major Professor: Dr. Jagath J. Kaluarachchi.
- Ghabayen, Said M.S. A Probabilistic Expert Systems Approach for Analysis and Optimization of a Large-Scale Water Resources System. Major Professor: Dr. Mac McKee.
- Nieman, Jochim Karl C. Bound Residue Formation in Bioremedial Polycyclic Aromatic Hydrocarbons and Pentachlorophenol-Contaminated Soil as an Acceptable Treatment Endpoint. Major Professor: Dr. Ronald C. Sims.
- Mohamed, Ahmed Said. Exploring an Innovative Watershed Management Approach: From Feasibility to Sustainability. Major Professor: Dr. David K. Stevens.
- Yin, Tong. Quantifying Uncertainty of Water Quality Data and Its Application in the National Pollutant Discharge Elimination System (NPDES) Program. Major Professor: Dr. David K. Stevens.
- You, Jinsheng. Snow Hydrology: The Parameterization of Subgrid Processes Within a Physically Based Snow Energy and Mass Balance Model. Major Professor: Dr. David G. Tarboton.

2004 MASTER OF SCIENCE

- Anderson, Ryan David. Field Measurement Methods for Arsenic in Drinking Water. Major: Civil and Environmental Engineering. Major Professor: Dr. Laurie S. McNeill.
- Bhosle, Mikhail Chandrakant. Estimating Uncertainty in Fish Habitat Modeling Using Two-Dimensional Hydraulics. Major: Civil and Environmental Engineering. Major Professor: Dr. Thomas B. Hardy.
- Bose, Thirumurugan. Major: Civil and Environmental Engineering. Major Professor: Dr. Mac McKee.
- Bradford, Jason E. Major: Civil and Environmental Engineering. Major Professor: Dr. Michael C. Johnson.
- Bundy, Michael Monroe. Design and Test of a Bench-Scale Drinking Water Treatment Plant for the Evaluation of Pharmaceutical Fate. Major: Civil and Environmental Engineering. Major Professor: Dr. Ronald C. Sims.
- Burdick, Alan Lester. Major: Civil and Environmental Engineering. Major Professor: Dr. Jagath J. Kaluarachchi.
- Chen, Yan. Silica Effects on Corrosion of Iron Pipes under Anaerobic Conditions. Major: Civil and Environmental Engineering. Major Professor: Dr. Laurie S. McNeill.

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- Chinnayakanahalli, Kiran. An Objective Method for the Intercomparison of Terrain Stability Models and Incorporation of Parameter Uncertainty. Major: Civil and Environmental Engineering. Major Professor: Dr. David G. Tarboton.
- Gill, Muhammad Kashif. Soil Moisture Data Assimilation Using Support Vector Machines and Ensemble Kalman Filters. Major: Civil and Environmental Engineering. Major Professor: Dr. Mariush Kemblowski.
- Gogate, Saurabah Vasant. Groundwater Modeling for a Source Water Protection Pool. Major: Civil and Environmental Engineering. Major Professor: Dr. Darwin L. Sorensen.
- Hall, Kevin Alan. Development of a Genetic Probe for Polycyclic Aromatic Hydrocarbon (PAH)- Degrading Mycobacteria in Soil. Major: Civil and Environmental Engineering. Major Professor: Dr. Ronald C. Sims.
- Hunsaker, Ross Nils. Gaseous Criteria Pollutant Concentrations and Behaviors at Canyons and Grand Canyon National Parks. Major: Civil and Environmental Engineering. Major Professor: Dr. Randal S. Martin.
- Kaheil, Yasir H. Major: Civil and Environmental Engineering. Major Professor: Dr. Christopher M.U. Neale.
- Lai, Han. Chromium Redox Chemistry in Drinking Water Systems. Major: Civil and Environmental Engineering. Major Professor: Dr. Laurie S. McNeill.
- Lentz, Dale Joseph. Major: Civil and Environmental Engineering. Major Professor: Dr. Blake P. Tullis.
- Matagi, Iosefa Martinus. Major: Civil and Environmental Engineering. Major Professor: Dr. Jagath J. Kaluarachchi.
- Millican, Hans J. Major: Civil and Environmental Engineering. Major Professor: Dr. Thomas B. Hardy.
- Pruitt, Matthew Rhodes. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.
- Pu, Min. Impact of Vegetable Oil on the Distribution of Trichloroethylene in Groundwater during Enhanced Bioremediation. Major: Civil and Environmental Engineering. Major Professor: Dr. R. Ryan Dupont.
- Mortensen, Dustin Gene. Major: Civil and Environmental Engineering. Major Professor: Dr. Michael C. Johnson.
- Stout, Michael Troy. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Tao, Hua. A New Windows User Interface for QUAL2E Model. Major: Civil and Environmental Engineering. Major Professor: Dr. David K. Stevens.

Thompson, Jason William. A Methodology for Assessing Aquatic and Riparian Habitat Quality at the Watershed Scale. Major: Civil and Environmental Engineering. Major Professor: Dr. Thomas B. Hardy.

Twarakavi, Navin Kumar C., Groundwater Quality Assessment of Water Resources Inventory, Area 1 Washington. Major: Civil and Environmental Engineering. Major Professor: Dr. Jagath J. Kaluarachchi.

Wheeler, Bryan R. Evaluating the Uptake of Nonylphenol and Nonylphenol Ethoxylates by Crested Wheatgrass. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Doucette.

Zaugg, Nathan Warren. The Impact of Mature Trees on the Fate of Trichloroethylene at Hill Air Force Base, Operable Unit 4. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Doucette.

Zhu, Yibing. One-Dimensional Versus Two-Dimensional Hydrodynamic Analysis for Life Loss Estimation. Major: Civil and Environmental Engineering. Major Professor: Dr. David S. Bowles.

2004 MASTER OF ENGINEERING

Anderson, Justin Glenn. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Campbell, Brent Orlan. Major: Civil and Environmental Engineering. Major Professor: Dr. Blake P. Tullis.

Giles, Bart Lee. Major: Civil and Environmental Engineering. Dr. William J. Rahmeyer.

Jamal, Hosam A. Major: Civil and Environmental Engineering. Major Professor: Dr. R. Ryan Dupont.

Lui, Xiongfei. Major: Civil and Environmental Engineering. Major Professor: Dr. David G. Tarboton.

Nidamarthi, Jayakrishna. Major: Civil and Environmental Engineering. Major Professor: Dr. R. Ryan Dupont.

Shrestha, Bimayendra. Major: Civil and Environmental Engineering. Major Professor: Dr. David G. Tarboton.

2005 DOCTOR OF PHILOSOPHY

Asefa, Tirusew. Statistical Learning Theory: Concepts and Applications in Water Resources Management. Major Professor: Dr. Mariush Kemblowski.

Khalil, Abedalrazq Fathi. Computational Learning and Data-Driven Modeling for Water Resources Management and Hydrology. Major Professor: Dr. Mac McKee.

Twarakavi, Navin Kumar C. Assessment of Aquifer Vulnerability to Heavy Metal Contamination and Implications on Water Policy Issues. Major Professor: Dr. Jagath J. Kaluarachchi.

2005 MASTER OF SCIENCE

Brown, Chad H. Major: Civil and Environmental Engineering. Major Professor: Dr. Blake P. Tullis.

Child, Daniel Ryan. Major: Civil and Environmental Engineering. Major Professor: Dr. Jagath J. Kaluarachchi.

Guerrero, Holly C. Fate of Sulfolane in Hydroponic Cattail System. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Doucette.

Harms, Paul Wesley. Water Use Database Development and Analysis of Residential Water Use in Salt Lake City, Utah. Major: Civil and Environmental Engineering. Major Professor: Dr. Mac Mckee.

Jensen, Jeff Paul. Major: Civil and Environmental Engineering. Major Professor: Dr. Jagath J. Kaluarachchi.

Jones, Kathleen Watkins. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Meyer, William F. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Nanadoum, Kinagoto. Major: Civil and Environmental Engineering. Major Professor: Dr. David S. Bowles.

Nataraj, Ramya Cuduvalli. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Grenney.

Robinson, Samuel Collin. Hydraulic Characteristics of a Buried Invert Elliptical Culvert Inlet and Quantifications of Culvert Exit Loss. Major: Civil and Environmental Engineering. Major Professor: Dr. Blake P. Tullis.

Sharp, Jacob Lance. Major: Civil and Environmental Engineering. Major Professor: Dr. Michael C. Johnson.

Shelley, Tyler Dale. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Stoeber, Michael Wayne. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Ten Eyck, Clayton H. Evaluation of Pharmaceutical Fate in Pilot and Bench Scale Drinking Water Treatment Plans. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Doucette.

Worthington, Scott A. Major: Civil and Environmental Engineering. Major Professor: Dr. Blake P. Tullis

Senior Design Projects

The senior design project was initiated in the Fall of 1997 and provides opportunities for each senior student in water engineering and environmental engineering to work in a team environment with other students on a practical problem identified and supported by a university collaborator. USU partners include industry, government agencies, other research institutions, and private consulting firms. Student teams work under the direction and supervision of mentors comprised of university and client staff. The basic elements of the senior design project include: (1) design, (2) build, and (3) test/monitor. The senior design project begins in the spring semester of the junior year, with emphasis on problem definition and conceptualization, and progresses through the design, data collection, and results presentation phases of the project in the students' senior year. The facilities and resources of the UWRL are utilized in the design, fabrication, assembling, and testing of many of the water engineering and environmental engineering senior design projects. Several design projects have been donated to the UWRL since the design projects were started that provide working models that are used for teaching and demonstration for students and for the general public.

Spring 2003 - Spring 2004

Denitrification Potential in Shallow Ground Water in Western Weber County, UT.
Advisor: Dr. Darwin L. Sorensen. Student Team: Erik Dettenmaier, Jacob Rukavina, Jenny Paget, Wil Pineda.

Spring 2004 - Spring 2005

Feasibility Design of a Spawning/Rearing Channel for Woundfin Adjacent to the Virgin River. Advisor: Dr. Thomas B. Hardy. Student Team: Mark Greenwood, Lisa Kent, Kori Moore.

Evaluation of Phosphorus Management in the Logan Wastewater Treatment Lagoons.
Advisor: Dr. R. Ryan Dupont. Student Team: Greg Sullivan, Rachel winters, and Amber Spackman.

If you are interested in obtaining more information on senior design projects, or in sponsoring a senior design project in Environmental Engineering, contact Dr. R. Ryan Dupont at: rdupo@cc.usu.edu; in the Water Engineering Program please contact Dr. Jagath J. Kaluarachchi at: jkalu@cc.usu.edu.

Scholarships and Internships

Graduate student scholarships are competitive and are generally available from two primary sources: (1) internal UWRL-supported assistantships, and (2) client-supported assistantships. More than 20 internal UWRL-supported assistantships are available each academic year. The number and type of client-supported assistantships vary, but average approximately 40 per year. Assistantships are renewable based on demonstrated productivity. Over the period of time addressed in this report, approximately 70 graduate students affiliated with the UWRL received scholarships and/or fellowship support. The UWRL also actively supports a variety of undergraduate internships ranging from Civil and Environmental Engineering to Business Information Systems.

V. Outreach

The mission of the UWRL includes outreach activities related to public service, information dissemination, technology transfer, and short courses. These activities are provided for the benefit of Utah state and local agencies, elected officials, Utah citizens, and the nation. Outreach is provided by faculty, staff, and students associated with the UWRL. Additional outreach is provided through our World Wide Web (WWW) site: <http://www.engineering.usu.edu/uwrl>.

For more information on UWRL outreach activities, including public service, information dissemination, technology transfer, short courses, and field training, refer to the specific website address provided, or contact Ivonne Harris at: iharr@cc.usu.edu.

Public Service

UWRL faculty serve on state and local advisory panels to provide technical expertise, input, and review of water-related issues. Specific panels include: Utah Water Quality Board, Utah Solid and Hazardous Waste Control Board, Lake Powell Technical Advisory Committee, Salt Lake County Solid Waste Management Council, the State of Utah Wastewater Treatment Plant Operator Certification Committee, and the Utah Drinking Water Board. In addition, UWRL personnel are frequently invited to provide technical and informational presentations before state and national professional groups, such as the American Water Works Association which benefited from five UWRL luncheon speakers at various training workshops conducted in FY 05 in Salt Lake City.

Information Dissemination and Technology Transfer

UWRL information dissemination, outreach, and technology transfer activities include the publication of research results in professional journals (listed in the Publications section of this report), distribution of information on various UWRL and UCWRR web pages, presentations before various professional societies and interest groups at meetings in the state and around the country, and sponsorship and participation in numerous short courses and training programs.

The UWRL web page (<http://www.engineering.usu.edu/uwrl>) provides general information about the UWRL and its personnel, and from time-to-time provides a feature article on different research projects, faculty, students, and groups from the UWRL. The Utah On-Site Wastewater Treatment Training Program at the UWRL provides on-site wastewater training in support of the State of Utah certification program for on-site wastewater treatment professionals. Undergraduate and graduate students participate through projects that involve hands-on, real-world activities. Additional information can be found at: <http://www.engineering.usu.edu/uwrl/training>.

The UWRL has provided donations to the Society of Women Engineers (SWE), Utah State University Chapter, enabling 12 members to attend the annual SWE conference in San Diego. The UWRL has hosted meetings of the Utah Solid and Hazardous Waste Control Board, including lunch and tour of the UWRL. The UWRL has also hosted meetings of the Utah Association of Local Boards of Health.

Utah Solid and Hazardous
Waste Control Board
touring the Utah Water
Research Laboratory
on June 9, 2005



Outreach and service support provided by faculty of the UWRL have been recognized by the Girl Scouts of Utah for assistance in providing math, science, and engineering experience to girls in Cache Valley, aged 5-15, for the 2003-2005 years.

In the course of a year the UWRL hosts numerous delegations from other countries that have interest in the research conducted at the UWRL and in the capabilities that UWRL professionals could offer to the solution of their water problems. In the past year, these have included visits by delegations from Argentina, Peru, Pakistan, Iraq, and the Philippines.

Some examples of UWRL staff involvement in conducting technology transfer to audiences external to USU include:

- UWRL faculty are assisting Utah Department of Environmental Quality (UDEQ) personnel in the evaluation of state needs regarding Total Maximum Daily Loads (TMDLs) for many of Utah's lakes, rivers, and streams. This has resulted in the development and transfer of analytic techniques and models to UDEQ and the private sector that can be used to more efficiently analyze and document TMDL issues.
- Results of our laboratory investigations continue to provide cost-saving methods for improving the performance of dam spillways in Utah and can be expected to play an important role in future dam safety rehabilitation in the state.

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- UWRL faculty and staff taught on-site wastewater treatment workshops throughout the State of Utah over the past 24 months to local health department personnel and contractors that included: Level 1: Soil Evaluation and Percolation Testing; Level 2: Design, Inspection, and Maintenance of Conventional Systems; and Level 3: Design, Inspection, and Maintenance of Alternative Systems.
 - The Utah On-Site Wastewater Association (UOWA) provides a major technology transfer service regarding site selection, installation, maintenance, and monitoring for Utah local health departments, UDEQ, and other on-site professionals.
 - Real-time management of irrigation systems in the Sevier River Basin is being implemented in collaboration with the U.S. Bureau of Reclamation and the Sevier River Water Users Association using computer models developed at the UWRL to increase the efficiency of basin-wide water management. This is especially useful when the total quantity of water decreases as in the recent drought conditions in Utah.

Diversion structure for the Richfield Canal in the Sevier River, Utah



Short Courses and Field Training

UWRL staff provide short courses both on-site at USU and off-site within the State of Utah, regionally, as well as globally. Generally offered from one- to five-days duration, short courses are tailored to meet the needs of the requestor. A list of short courses, field training, and involvement of UWRL staff are indicated below.

July 2003 - June 2004

“Dam Safety Risk Assessment for Individual Dams and Portfolios of Dams.” Invited Seminar presented to Fuji Research Institute Corporation, Tokyo, Japan. October 2003. D.S. Bowles.

“Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, September 18, 2003. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, November 11-12, 2003. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, April 16, 2004. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Vernal, Utah, September 11, 2003. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Tooele, Utah, October 2, 2003. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Moab, Utah, October 14, 2003, Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, St. George, Utah, March 24-26, 2004. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Heber City, Utah, May 20-21, 2004. Judith L. Sims and Peg Cashell.

“Failure Modes Analysis: The Australian Experience.” Invited presentation at the U.S. Society on Dams Workshops on: *Lessons Learned and Benefits Gained from the Potential Failure Modes Analysis Process*. St. Louis, Missouri, March 2004. D.S. Bowles, L.R. Anderson, and R. Fell.”

“One-Week National Workshop on Isotope Techniques in Dam Safety and Monitoring Land-slide Activity with Emphasis on Risk Assessment.” Chisinau, Republic of Moldova. Sponsored by the International Atomic Energy Agency (IAEA), Vienna, Austria, October 2003. D.S. Bowles and W. Wallin.

“Risk Assessment and Risk Management.” Invited presentation at the Regional Workshop on the Management and Safety of Mine Tailings Dams, Sinaia, Romania. Sponsored by The Government of Romania, The World Bank, and The Global Environment Facility, October 2003. D.S. Bowles.

“Risk Assessment in Dam Safety Management for Individual Dams and Portfolios of Dams.” Invited Seminar presented to the Japan National Committee on Large Dams (JN-COLD), Tokyo, Japan, October 2003. D.S. Bowles.

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Vernal, Utah, September 9-10, 2003. Judith L. Sims and Peg Cashell.

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Tooele, Utah, September 30 - October 1, 2003. Judith L. Sims and Peg Cashell.

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, St. George, Utah, March 23-24, 2004. Judith L. Sims and Peg Cashell.

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Heber City, Utah, May 18-19, 2004. Judith L. Sims and Peg Cashell.

“U.S. EPA BASINS Training.” Utah State University, Logan, Utah, May 3-7, 2004. Bethany Neilson, David Stevens, and Jeff Horsburgh.

July 2004 - June 2005

“Dam Safety Portfolio Risk Assessment Workshop.” Invited Two-day Workshop for U.S. Army Corps of Engineers, Cincinnati, Ohio, September 2004. D.S. Bowles and L.R. Anderson.

“Dam Safety Portfolio Risk Assessment Workshop.” Invited Three-day Workshop for U.S. Army Corps of Engineers, Sacramento, California, April 2005. D.S. Bowles, L.R. Anderson, and S.S. Chauhan.

“Dam Safety Risk Assessment.” Pre-Conference Invited Short Course, 15th Southeast Asian Geotechnical Conference (SEAGS), Asian Institute of Technology, Bangkok, Thailand, November 2004. D.S. Bowles and L.R. Anderson.

“Dam Safety Risk Assessment.” Provided for Division of Dam Safety and Inspections, Federal Energy Regulatory Commission, Washington DC by IDSRM, Utah State University, Logan, Utah, January 2005. D.S. Bowles, M.W. McCann, Jr., L.R. Anderson and S.S. Chauhan.

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- “Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Ogden, Utah, October 7-8, 2004. Judith L. Sims, Peg Cashell, and Richard Jex.
- “Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, July 14-16, 2004. Judith L. Sims, Peg Cashell, and Richard Jex.
- “Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, August 6, 2004. Judith L. Sims, Peg Cashell, and Richard Jex.
- “Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, November 3-5, 2004. Judith L. Sims and Brian Cowan.
- “Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, November 19, 2004. Judith L. Sims and Brian Cowan.
- “Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, May 26-27, 2005. Judith L. Sims and Brian Cowan.
- “Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, April 14, 2005. Judith L. Sims, Peg Cashell, and Brian Cowan.
- “Introduction to Dam Safety Risk Assessment.” Invited presentation at the National Dam Safety Program Technical Seminar # 12 “Potential Failure Mode Analysis and Monitoring”, Emmitsburg, Maryland, February 2005. D.S. Bowles.
- “Linking Dam Safety and Security at a Corporate Level.” Invited presentation at FERC Workshop on *Responding to Natural Hazards and Human Threats at Dams: Unifying Dam Safety and Security*, Forth Worth, Texas, February 2005. D.S. Bowles.
- “Physical Habitat Simulation and Habitat Time Series Short Course.” Utah State University, Logan, Utah, May 9-13, 2005. Thomas B. Hardy.
- “Risk Analysis Applied to Dam Safety.” Two-day invited course as part of the Doctoral course, “Dam and Reservoir Safety Evaluation” funded by a Quality Award from the Spanish Ministry of Education, Universidad Politécnica de Valencia, Valencia, Spain, March 2005. (D.S. Bowles).
- “Risk Analysis Applied to Dam Safety in Spain.” Universidad Politécnica de Valencia, Valencia, Spain. March 2005. (D.S. Bowles)

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Ogden, Utah, October 5-6, 2004. Judith L. Sims and Brian Cowan.

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, May 24-25, 2005. Judith L. Sims and Brian Cowan.

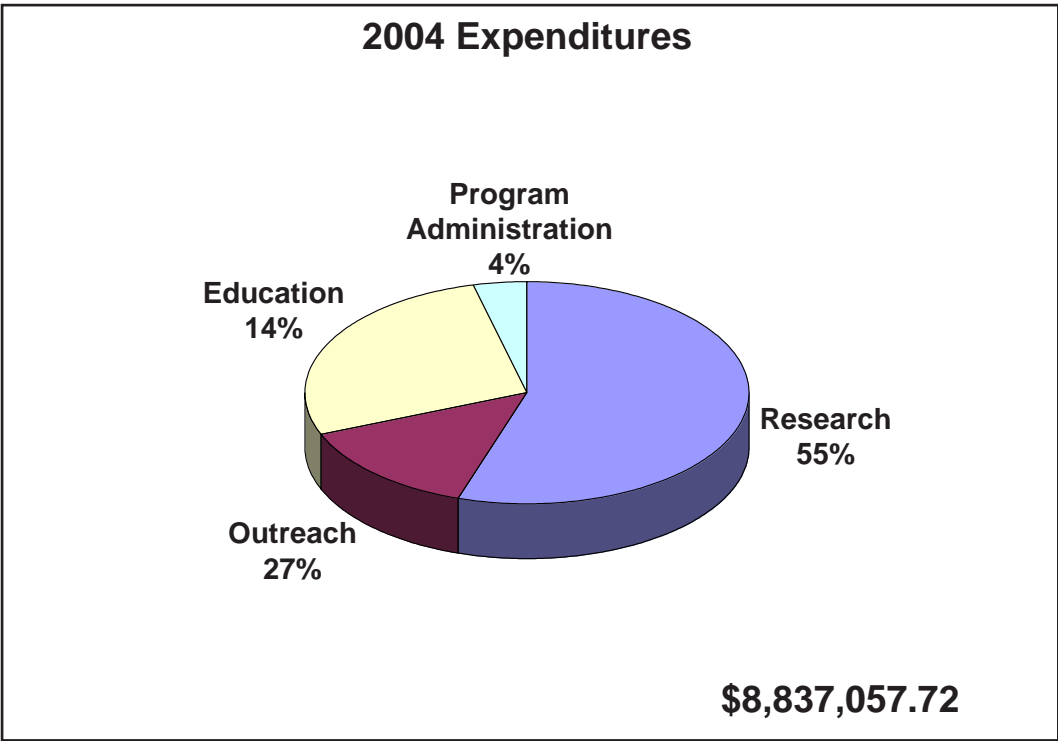
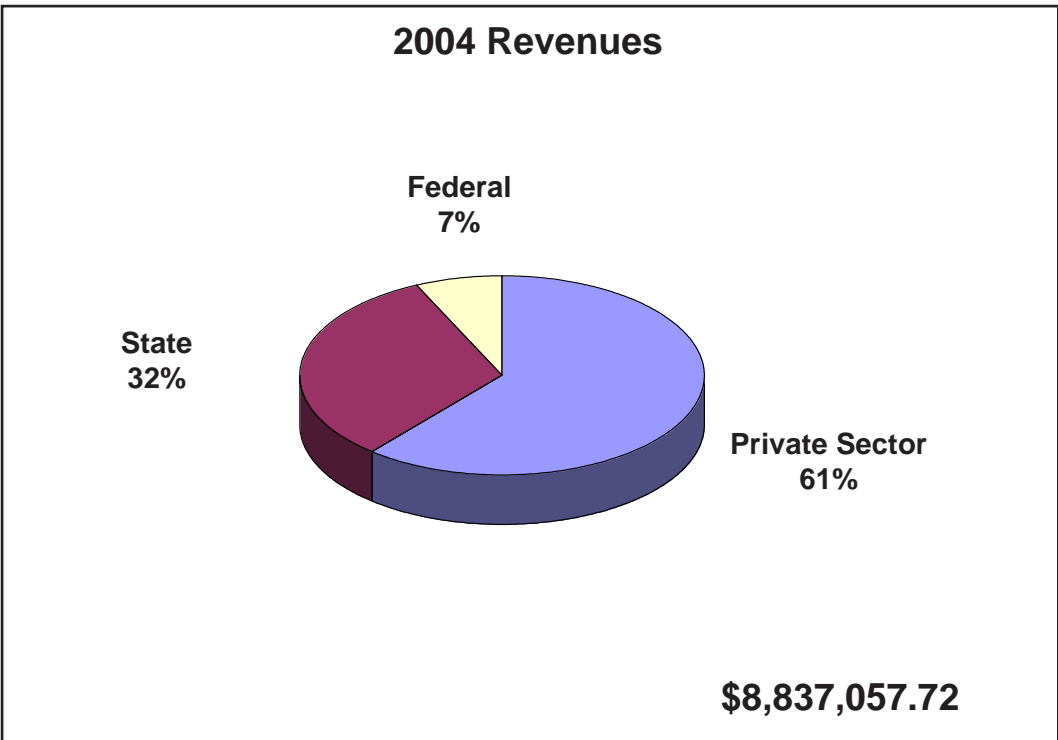


Figure 7. Revenues and Expenditures for Fiscal Year July 1, 2003 - June 30, 2004.

VI. Finances

Revenues and expenditures for the fiscal year from July 1, 2003 through June 30, 2004, are shown in Figure 7, and are representative of fiscal year 2005. Categories of revenues include State of Utah, federal, private, and Utah State University. Revenues from the State of Utah total 32% of the UWRL budget, and federal and private sector support totals 68%. Categories for expenditures include research, education support, outreach, and UWRL program administration. Research expenditures include those costs associated with faculty salary, supplies and expendables, publication, and travel. Education support includes expenditures related to undergraduate and graduate stipends and travel. Outreach activities costs are related to information dissemination, short courses, and salary for staff and faculty directly involved in outreach activities. Program administration includes the UWRL Director's Office, Business Office, publication support, and secretarial support for the faculty. Our expenditures indicate that research is the main activity, accounting for approximately 55% of the total budget, with education support at 14%. Outreach and program administration expenditure categories are similar at 27% and 4%, respectively.

Sources of Support

The UWRL is supported by the State of Utah, Utah State University, and other collaborators that include a variety of private and government agencies. Support from the State of Utah and Utah State University, over the last two years, amounts to approximately \$2.3 million on an annual basis. Additional state resources are frequently provided by the Utah Department of Environmental Quality and the Utah Department of Natural Resources, for specific problem-solving tasks. Additional collaborators typically provide a total of \$6.5 million for grant, contract, task, and outreach-related activities on an annual basis. Examples of UWRL clients over the two-year period addressed in this report include:

Alkylphenols & Ethoxylates Research Council	Bio/West, Inc.
Buckeye Technologies	Centre for Ecology and Hydrology
Cirrus Ecological Solutions, L.C.	City of Glendale, California
Coldbond	EPRI
Gardner Engineering	Georgia Industries
Huntsman Corporation	Inland Northwest Research Alliance, Inc.
JM Manufacturing	JM Pipe
MBK Engineers	McGuire Environmental Consultants, Inc.
National Cooperative Highway Research Program	Owen Ayres and Association
Pacificorp	Parsons
Planning and Management Consultants, Ltd.	Profile Products
Profile Products	Psomas
RAC Engineering	Red Valve
Science Applications International Corporation	Select Engineering Services

State of Utah, Department of Environmental Quality	State of Utah, Department of Environmental Quality (Flow through Agency: Federal)
Sverdrup Technology, Inc.	Thomas R. Payne and Associates
University of Colorado	University of Iowa
University of Utah (Flow through Agency: Federal)	U.S. Department of Agriculture
U.S. Department of Defense, U.S. Air Force	U.S. Department of Defense, U.S. Army
U.S. Department of Defense, U.S. Army Corps of Engineers	U.S. Department of Justice
U.S. Department of the Interior	U.S. Department of the Interior, Bureau of Reclamation
U.S. Department of the Interior, U.S. Geological Survey	U.S. Environmental Protection Agency
US Filter	Utility Submeter
Washington County Water Conservancy District	Whatcom County

The UWRL has also been involved with hydraulic testing, evaluation, and calibration activities for private firms. Revenues and expenditures for these projects are in addition to those indicated in Figure 7.

ADS Corporation	APCO
BIF	Bio/West Incorporated
Boeing-Rocket Dyne	Boyle Engineering
Buckeye Technologies	Colbond
Cla-Val Company	Contech
Daniel Industries Canada	Dial Discoveries
Energy Northwest	Enertech
Flowserve	Franson Noble Engineering
Freese and Nichols	Gardner Engineering
Georgia Industries	Hach
Hartman Valve	Henry Pratt Company
ISLO	JM Manufacturing
Kiewit Pacific	McCrometer
N.A. Green	Nebraska Public Power
Nyloplast	Owen Ayers & Association
Preso	Primary Flow Signal
Profile Products	Red Valve
Renaissance Instruments	Rodney Hunt
Schnabel	SeaMetrics
Soutek	Triad Measurement and Equipment, Inc.
Turbines, Inc.	University of Iowa
Watts ACV	

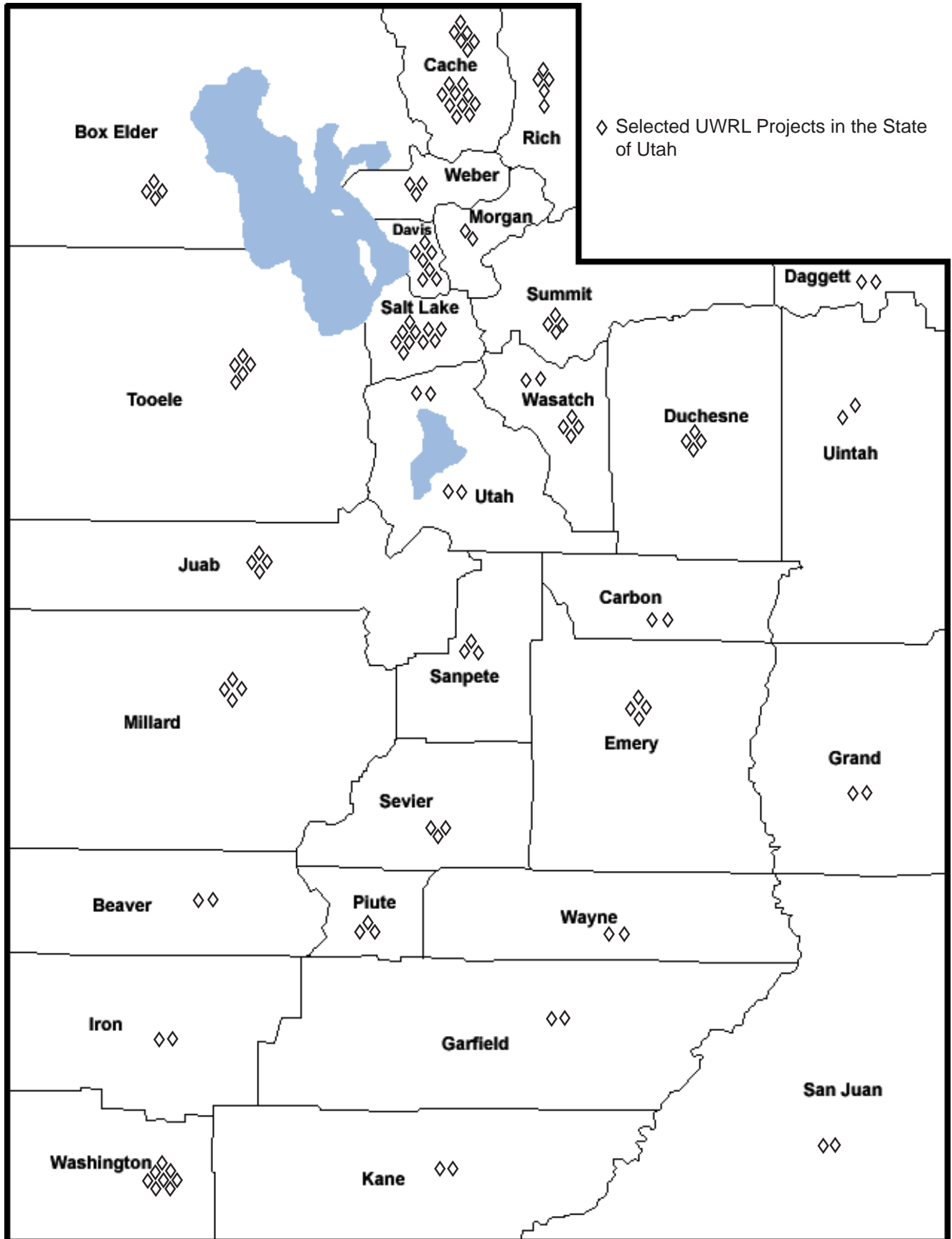


Figure 8. Distribution of Projects Conducted Throughout the State in FY 05.

VII. Summary of Projects

UWRL research and testing projects for 2004-2005 fiscal years are identified below. Descriptive titles, project sponsors, and principal investigators are indicated. Additional information concerning individual projects can be obtained by contacting the principal investigator. Selected projects within the State of Utah are indicated by the “◇” symbol and are shown on the state map in Figure 8.

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
FY 2004/2005		
2-Dimensional Instream Flow Modeling-Mckenzie River (Smith & Carmen Bypass)	Stillwater Sciences	R. Craig Addley
2D Hydraulic and Habitat Modeling on the Klamath River	Thomas R. Payne and Associates	R. Craig Addley
CATAWBA-WATEREE Project	Devine Tarbell and Association	R. Craig Addley
GIS Support to UDWR◇	State of Utah, Division of Wildlife Resources	R. Craig Addley
Klamath River Bioenergetics Analysis	Pacificorp	R. Craig Addley
Limiting Factor Research, Temperature Model Validation and Woundfin Acute and Chronic Temperature Growth◇	Washington County Water Conservancy District, UT	R. Craig Addley
Provo River Flow Study◇	Bio/West Incorporated	R. Craig Addley
Temperature and Flow Monitoring and Assessment (Virgin River Basin)◇	Washington County Water Conservancy District, UT	R. Craig Addley
Investigation on the Application of Non-Uniform Grids for Land Surface Modeling Over Semi-Arid Areas	Vice-President of Research – CURI	Luis Bastidas
Multi-Scale Medium Resolution Modeling of the Rio Grande Basin	University of Arizona (National Science Foundation)	Luis Bastidas
Corps of Engineers Working Group Meeting	U.S. Department of Defense, U.S. Army Corps of Engineers	David S. Bowles
Folsom Dam Modifications, Update Flood Management Plan, American River and Folsom Dam, CA	U.S. Department of Defense, U.S. Army	David S. Bowles

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
Folsom Reservoir Emergency Operation Study: Uncertainty Simulation Version of Reservoir Release Forecast Model	U.S. Department of the Interior, Bureau of Reclamation	David S. Bowles
Life-Loss Estimation for Dam Safety Risk Assessment	U.S. Department of Defense, U.S. Army Corps of Engineers	David S. Bowles
Loss of Life Estimation for Dam Safety Risk Assessment (Stage 2)	Planning & Management Consultants, Ltd.	David S. Bowles
Master Agreement for Task Orders Under RAC Engineering	RAC Engineering	David S. Bowles
Proposal Preparation and Revisions	MBK Engineers	David S. Bowles
Teaming Agreement with SAIC	Science Applications International Corporation	David S. Bowles
Bench Scale Reactors for Determining the Fate of Pharmaceuticals in Municipal Water Treatment Facilities◊	Pfzifer, Inc.	William J. Doucette
Determination of the Terrestrial Fate of Nonylphenol Ethoxylates (NPE) and Nonylphenol (NE) in Biosolids/ Soil/ Plant Systems	Alkylphenols & Ethoxylates Research Council	William J. Doucette
Greenhouse Study and Field Sampling to Determine the Uptake of Trichloroethylene by Fruit Trees◊	U.S. Department of Defense, U.S. Air Force	William J. Doucette
Memorandum of Agreement for Optional Tasking	Select Engineering Services	William J. Doucette
Miscellaneous Analysis to Various Private Agencies	Parsons Engineering Science, Inc.	William J. Doucette
Phytostabilization Study at Vanderberg AFB, CA	Earthtech	William J. Doucette
SDL Analysis Project◊	Utah State University Research Foundation	William J. Doucette
TCE Sampling from Specified Air Force Bases	Parsons Engineering Science, Inc.	William J. Doucette
Carbon Tetrachloride Bioremediation in Groundwater by Enhancing Natural Attenuation	Inland Northwest Research Alliance, Inc.	R. Ryan Dupont

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
Evaluate Efficacy of Enhanced Bioremediation (Veg. Oil Addition) at OU5◇	Sverdrup Technology, Inc.	R. Ryan Dupont
Identification of Potential Risks to Utah Drinking Water from Chlorinated Solvents◇	Vice-President of Research - CURI	R. Ryan Dupont
INRA Fellowship for Jing Zhou◇	Inland Northwest Research Alliance, Inc. (INRA)	R. Ryan Dupont
Microcosm Study of TCE Biodegradation on Samples Collected From Operable Unit 1: Edwards AFB	North Wind, Inc.	R. Ryan Dupont
OU2 Source Zone Polishing Project, Hill AFB◇	URS Corporation	R. Ryan Dupont
Selection of Industrial Coatings Based on Environmental and Societal Impact Characteristics	Michigan Technologies University	R. Ryan Dupont
Affordable Trip Feasibility Scheduling for Rural Paratransit Systems	University of Utah	William J. Grenney
Peak Flow for Design	State of Utah, Department of Transportation	William J. Grenney
Development and Classification of Shasta River Digital Multi-Spectral Imagery System	Coastal California Fish and Wildlife Office	Thomas B. Hardy
Long-Term Monitoring of the Lower Sevier River Fish Company◇	Consolidated Sevier Bridge Reservoir Co.	Thomas B. Hardy
Partnership Agreement: Hydrologic, Data Reduction Tools and Support	U.S. Department of Agriculture, Forest Service	Thomas B. Hardy
Phase III Technical Studies for WRIA 1 Watershed Management Project	Whatcom County	Thomas B. Hardy
Rapid Assessment of Physical Habitat Sensitivity to Abstraction (RAPHSA)	Centre for Ecology and Hydrology	Thomas B. Hardy
Snake River Basin Adjudication for Water Related Resources	United States Department of Justice	Thomas B. Hardy
Supplemental SOW-Lower Klamath Basin-Instream Flow Assessment	United States Department of Justice	Thomas B. Hardy
Upper Salmon River Water Related Resources	U.S. Department of Agriculture, Forest Service	Thomas B. Hardy

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
Virgin River Basin Integrated Resource Management and Recovery Program◊	Washington County Water Conservancy District, UT	Thomas B. Hardy
Virgin River Chub Monitoring Plan◊	Bio/West Incorporated	Thomas B. Hardy
Testing and Multifactor Approach for Developing Watershed Classification Relevant to the Bioassessment	U.S. Environmental Protection Agency	Chuck Hawkins
Bear River Laboratory Watershed Information System Project◊	Water Initiative - E&G	Jeffery Horsburgh
Great Salt Lake Basin Long Term Hydrologic Observatory (LTHO) Website◊	University of Utah	Jeffery Horsburgh
Newton Reservoir TMDL Support◊	Cirrus Ecological Solutions, L.C.	Jeffery Horsburgh
Otter Creek TMDL Support◊	Cirrus Ecological Solutions, L.C.	Jeffery Horsburgh
Real Time Streamflow and Water Quality Monitoring Station in the Logan River◊	Water Initiative - E&G	Jeffery Horsburgh
TMDL Water Quality Study of Echo Reservoir◊	Cirrus Ecological Solutions, L.C.	Jeffery Horsburgh
Upper Bear River TMDL Support◊	State of Utah, Division of Water Quality	Jeffery Horsburgh
Student Support - Miscellaneous Support◊	State of Utah, Utilities Submeter	Michael Johnson
Core Block 7 Course	Inland Northwest Research Alliance, Inc.	Jagath J. Kaluarachchi
INRA Fellowship for Aklilu Tesfamichael◊	Inland Northwest Research Alliance, Inc.	Jagath J. Kaluarachchi
INRA Fellowship for Inbrahim Khadam◊	Inland Northwest Research Alliance, Inc.	Jagath J. Kaluarachchi
INRA Fellowship for Navin Twarakavi◊	Inland Northwest Research Alliance, Inc.	Jagath J. Kaluarachchi
Teaching Partnership Between USU and An Najah National University, Nablus Palestine	Bureau of Educational and Cultural Affairs	Jagath J. Kaluarachchi

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
CORE Academy Mathematics and Science Partnership	State of Utah, Utah State Office of Education	Max Longhurst
DP-1 for PM2.5 Saturation Study◊	State of Utah, Dept. of Environmental Quality	Randal S. Martin
GAANN (Graduate Assistance in Areas of National Need) ◊	U.S. Department of Education	Randal S. Martin/ Laurie S. McNeill
Investigations into Wintertime Particulate Formation in Cache Valley◊	Vice-President of Research - CURI	Randal S. Martin
VOC Sampling Study in Cache County◊	State of Utah, Department of Environmental Quality	Randal S. Martin
Application of Lime Stabilized Biosolids on Alkaline Rangelands◊	State of Utah, Department of Environmental Quality	Michael J. McFarland
Technical Evaluation of the Biosolids Land Application Program at the Tooele City, Utah Wastewater Treatment Plant◊	Tooele County, Utah	Michael J. McFarland
Emery County--Resource Management/Conflict Resolution Network◊	Emery Water Conservancy District	Mac Mckee
Hydraulic Time and Material Support for Blake Tullis	Utah State University Research Foundation	Mac Mckee
Hydraulic Time and Material Support for Blake Tullis	Utah State University Research Foundation	Mac Mckee
Hydraulic Time and Material Support for Michael Johnson	Utah State University Research Foundation	Mac Mckee
Hydraulic Time and Material Support for Steve Barfuss	Utah State University Research Foundation	Mac Mckee
IPA For Daniel Hoggan, Los Angeles District, California	U.S. Department of Defense, U.S. Army	Mac Mckee
IPA Work for Daniel H. Hoggan for Army Corps of Engineers, Los Angeles, CA	U.S. Army Corps of Engineers	Mac Mckee
Managing the Impacts of Small Reservoir Sluicing◊	State of Utah, Dept. of Environmental Quality	Mac Mckee

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
Master Agreement for Task Orders Under RAC Engineering	RAC Engineering	Mac Mckee
Multi Sensor Data Assimilation for Water Resources◇	Utah State University Research Foundation/VP of Research	Mac Mckee
Analysis for City of Glendale Water and Power	City of Glendale, CA	Laurie S. McNeill
Occurrence Survey of Boron and Hexavalent Chromium	McGuire Environmental Consultants	Laurie S. McNeill
Process Performance Indicators for Arsenic Removal◇	AWWARF	Laurie S. McNeill
Research Project for Hexavalent Chromium Removal	McGuire Environmental Consultants, Inc.	Laurie S. McNeill
Selenium Sampling at Mallard Springs WMA◇	State of Utah, Division of Wildlife Resources	Laurie S. McNeill
Wet Analytical Results	US Filter, University of Colorado	Laurie S. McNeill
Basins Workshop in Frederiksted	U.S. Virgin Islands Government	Bethany Neilson
Developing Training Materials for Basin/Hydrologic Simulation Program Fortran Modeling Workshops	U.S. Environmental Protection Agency	Bethany Neilson
Flow Test M-94 Hydrant	US Pipe	William J. Rahmeyer
Flow Testing of 5BR250 Hydrant	East Jordan Iron Works	William J. Rahmeyer
Hydraulic Modeling of Intake Well for FFP Fusegate Spillway, Terminus Dam, Lake Kaweah, CA	U.S. Department of Defense, U.S. Army	William J. Rahmeyer
Miscellaneous Valve Testing and Calibration◇	Georgia Industries	William J. Rahmeyer
Physical Model Study of Gilboa Dam Spillway	Gannett Foundation	William J. Rahmeyer
Proposal for a Physical Model of Success Dam	Owen Ayres and Association	William J. Rahmeyer
Test 20" Cone Valves	Mueller Co.	William J. Rahmeyer

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
Test Flow of 4" Silenet Check Valve	Val-Matic Valve & Manufacturing Corp.	William J. Rahmeyer
Testing of Two 12" Series 35d Tideflex Valve	Red Valve Co., Inc.	William J. Rahmeyer
Development of a Guide and Video on On-Site Wastewater Treatment and Disposal Systems for Use by Local Boards of Health◊	National Association of Local Boards of Health	Judith L. Sims
On-Site Wastewater Treatment Field Training Enhancement Project◊	State of Utah, Department of Environmental Quality	Judith L. Sims
Evaluating Hyporheic Zone Biodegradation/Attenuation of MTBE and other Oxygenates	American Petroleum Institute	Ronald C. Sims
INRA University Programs Coordinator (UPC)	Inland Northwest Research Alliance, Inc. (INRA)	Ronald C. Sims
Streamflow Model Development	U.S. Geological Survey	Ronald C. Sims
USGS 104 Program Management and Source Water Protection Assessment Tools Development	U.S. Geological Survey	Ronald C. Sims
Utah Training Center for On-Site Waste Water Treatment◊	State of Utah, Dept. of Environmental Quality	Ronald C. Sims
CORE Implementation Model	State of Utah, Utah State Office of Education	Geoffrey G. Smith
Statewide NPS Pollution Education Related to On-Site Wastewater Treatment◊	U.S. Department of Agriculture	Darwin L. Sorensen
Fates of Chemicals in Deepwells	Huntsman Corporation	David K. Stevens
Investigation of Changes in Water Quality in the Little Bear River Watershed, in Response to Implementation of Best Management Practices◊	U.S. Department of Agriculture	David K. Stevens
Strawberry Reservoir TMDL Support◊	PSOMAS	David K. Stevens
USEPA Targeted Watersheds Grant in the Bear River Basin◊	U.S. Environmental Protection Agency	David K. Stevens
WINHSPF Model Building and WARMF Comparison Study in the Oostanaula Watershed	Electric Power Research Institute (EPRI)	David K. Stevens

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
CUAHSI Hydrologic Information System Cyber Systems	University of Texas at Austin (through National Science Foundation)	David G. Tarboton
GIS-Based Analysis Tools for Forest Roads	U.S. Department of Agriculture, Rocky Mountain Research Station	David G. Tarboton
Air Venting Slide Gates◇	State of Utah, Division of Water Resources	Blake P. Tullis
Erosion Control Testing	Profile Products	Blake P. Tullis
Hydraulic Loss Coefficients for Culverts	National Cooperative Highway Research Program	Blake P. Tullis
Miscellaneous Purchase Orders for Grad. Student Work	Miscellaneous Companies	Blake P. Tullis
Miscellaneous Testing	Buckeye Technologies	Blake P. Tullis
Miscellaneous Testing	Colbond	Blake P. Tullis
Miscellaneous Testing	JM Manufacturing	Blake P. Tullis
Miscellaneous Testing	JM Pipe	Blake P. Tullis
Miscellaneous Testing	Profile Products	Blake P. Tullis
Miscellaneous Testing	University of Iowa	Blake P. Tullis
Narrows 2 Flow Bypass Project	Christensen Associates	Blake P. Tullis
Riprap Design for Bottomless Culverts	Alaska DOT and PF	Blake P. Tullis
Testing M-294 Corrugated Pipe Under Circumferential Strain	ADS Corporation	Blake P. Tullis
Revision, Updating, and Expansion of NRCS Engineering Field Handbook (EFH), Chapter 3 (EFH 650.03), Hydraulics	U.S. Department of Agriculture, Natural Resources Conservation Service	Gilberto Urroz
Chapter 12, Land Leveling, National Engineering Handbook (NEH) Section 15 Review	State of Utah, Department of Natural Resources	Wynn Walker
Chapter 4, Surface Irrigation, National Engineering Handbook(NEH) Part 623	U.S. Department of Agriculture	Wynn Walker

VIII. Publications

The publications listed below have been restricted to peer-reviewed publications in professional journals and conference proceedings for UWRL/collaborator projects, primarily for the fiscal years 2004 and 2005. Research reports, presentations, and specially formatted reports are not included.

Articles in Refereed Journals

- Aboelata, M., D.S. Bowles, and D.M. McClelland (2004). A Model for Estimating Dam Failure Life Loss. *ANCOLD Bulletin*, 127:43062, August.
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- Martin, R.S. and G.W. Koford (2004). *Ambient Particulate Matter (PM10 and PM2.5) in Northern Utah's Cache Valley*. Paper No. 624. Presented at the 97th Meeting of the Air and Waste Management Association, Indianapolis, IN, June 22-25.
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