

# Preview of Award 1208732 - Annual Project Report

## Cover

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## Accomplishments

### \* What are the major goals of the project?

The overarching goals of the Utah RII EPSCoR were developed in light our Vision and Mission:

**Vision:** The vision for iUTAH EPSCoR is to lead the nation in scientific, educational, and innovative solutions for water management and sustainability through innovative interdisciplinary research and systems-level knowledge of the interactions among water, demand, and climate and development of a state-of-the-art hydroinformatics program that incorporates large data with interdisciplinary modeling and visualization

**Mission:** The mission of iUTAH is to enhance collaborative partnerships to better understand how to sustain Utah's water resources by (1) developing novel approaches to integrated research and training, and (2) by expanding the state's economic, educational, and research competitiveness.

**Overarching Goals:** The overarching goals of the Utah RII Track-1 are to create sustainable infrastructure improvements to benefit water –related science and technology throughout the state, increase national research and development competitiveness, and expand our workforce of researchers, educators and practitioners to ensure a vital economy and sustainable future. Infrastructure improvements include:

*1. Enhanced research capacity of the biophysical, social and engineered water environment. This will be accomplished by building state-of-the-art water quality- and quantity- monitoring networks in three focal watersheds that encompass a range of urbanization and future development. In addition, a green infrastructure research facility will be constructed, allowing for new research activities, as well as providing an important educational and outreach facility. To accomplish this goal, three research focal areas have been identified with more specific goals.*

*2. Build on Utah's existing strengths in hydrologic modeling and cyber-infrastructure from the CI-WATER and Cyber-infrastructure (CI) NSF EPSCoR awards. This will be accomplished through interdisciplinary modeling approaches that will create new models; link currently disparate models, data and computing approaches; and provide greatly enhanced forecasting capabilities for water managers and stakeholders.*

*3. Build programs to increase participation of underrepresented groups that include women, Hispanics and Native Americans by increasing the individual, disciplinary, institutional, and geographic diversity of the STEM enterprise in Utah to address the water sustainability issues facing Utah and the Mountain West.*

*4. Provide educational opportunities for a scientifically literate Utah workforce citizenry. We will enhance the STEM (Science, Technology, Engineering, and Mathematics) workforce in Utah by developing programs for a diverse range of learners that inspire students to choose STEM careers by promoting the retention of students in STEM degrees and enhancing the success of faculty in STEM disciplines. A strong STEM workforce is critical to building and sustaining research capacity and economic growth.*

*5. Provide societally relevant science and education regarding current and future water resources. iUTAH has a rigorous external engagement plan in place that will include state, regional, county and local water management agencies and stakeholders. Our participatory modeling activities will provide first-hand knowledge of our enhanced sensor networks, data flows and scenarios modeling capabilities. In turn, our research questions and modeling activities will be directly informed by the needs expressed by our water resource managers and policy makers.*

**Project Component Goals:** These overarching goals will be accomplished through activities in our three Research Focal Areas (goal 1) Cyberinfrastructure (goal 2), Diversity Enhancement (goal 3), Workforce Development (goal 4) and External Engagement (goal 5). The research component-specific goals are provided below under the overarching goal below.

*Overarching Goal 1. Enhanced research capacity of the biophysical, social and engineered water environment.*

Research Focus Area (RFA) 1 – Biophysical Ecohydrologic System Goal: to improve Utah's capacity to monitor and understand the ecologic/climatic/hydrologic (hereafter ecohydrologic) system of the Wasatch Range Metropolitan Area (WRMA). This goal will be achieved by improving watershed-scale measurement capacities. This instrumentation will be used to conduct research aimed at gaining a better understanding of the biophysical processes that influence Utah's water resources.

Research Focus Area 2 – social and Engineered Systems Goals: improve the capacity of Utah's science community to gather and analyze social and engineering system data on coupled water systems; Understand the interactions between urban form, environmental change, built water infrastructure, and decision-making in terms of water use ; Model the impact of alternative infrastructure designs and policy options on water use behaviors, the water cycle, water quality, and interconnected social and environmental systems.

Research Focus Area 3 – Coupled Human-Natural Systems Goals: describe the water system as a whole, by defining and including the linkages between biophysical and social dynamics, using results from RFAs 1 and 2 and to Facilitate interactions with stakeholders and linkages among disparate datasets and models to improve capacity to study the complexity of local water issues.

*Overarching Goal 2. Build on Utah's existing strengths in hydrologic modeling and cyber-infrastructure from the CI-WATER and Cyber-infrastructure NSF EPSCoR awards.*

Cyberinfrastructure Goals: increase capacity for data collection, organization, management, sharing, and synthesis to higher-level products and Increase capacity for integration of data and models.

*Overarching Goal 3. Build programs to increase participation of underrepresented groups that include women, Hispanics and Native Americans.*

Diversity Enhancement Goal: The goal of Diversity Enhancement (DE) is to increase the individual, disciplinary, institutional, and geographic diversity of the STEM enterprise in Utah to address the water sustainability issues facing Utah and the Mountain West.

*Overarching Goal 4. Provide educational opportunities for a scientifically literate Utah workforce citizenry.*

Workforce Development Goals: Enhance the STEM (Science, Technology, Engineering, and Mathematics) workforce in Utah by developing programs for a diverse range of learners that inspire students to choose STEM careers by promoting the retention of students in STEM degrees and enhancing the success of faculty in STEM disciplines. A strong STEM workforce is critical to building and sustaining research capacity and economic growth.

*Overarching Goal 5. Provide societally relevant science and education regarding current and future water resources.*

External Engagement Goals: design and implement programs to enhance the development of a diverse, well-prepared STEM workforce and a more scientifically literate public in the state of Utah. iUTAH will use data and results from the RFAs to engage the public in discussions about water sustainability issues throughout the western United States.

The Goals, Activities and Timelines are provided in Table 1 in the supplemental documents.

**\* What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: *Goal 1: Enhanced research capacity of the biophysical, social and engineered water environment.*

Research Focus Area 1 – Biophysical Ecohydrologic System:

- Designed a hydrologic observatory for the Bear, Provo and Red Butte Watersheds
- Defined fundamental sensor units
- Identified vendors for instrumentation
- Identified locations for instrument installation
- Designed telemetry for integration of sensor data into the iUTAH Data Federation
- Coordinated with resource managers on placement and parameter sensors to ensure that
- GAMUT (Gradients Along Mountain to Urban Transitions) complements existing monitoring infrastructure while addressing existing monitoring gaps
- Recruited and hired three technicians
- Purchased and tested instrumentation

Research Focus Area 2 – Social and Engineered Systems:

- Facilitated cross-disciplinary and cross-campus collaborations and networking among social scientists, planners, and engineers
- Trained graduate and undergraduate students in the human dimensions of water systems
- Developed appropriate methods and instruments to document drivers of variation in water use behaviors
- Identified urban sites for intensive data collection (within GAMUT footprint as well as other study areas)
- Assessed and built an archive of existing data in selected study sites, including a range of social and engineering characteristics (e.g., sociodemographics, water use, and the existing built and green water infrastructure)
- Developed partnerships with local water system managers in study sites to coordinate data monitoring plans and to share data
- Began design Green Infrastructure Research Facility (GIRF)
- Developed methods and outcome metrics to assess sustainability of current built infrastructure
- Coordinated with RFA 1 to develop integrated research plans and to choose common sites for co-location of social, engineering, and biophysical data collection and monitoring activities

- Coordinated with RFA 3 and Education, Outreach, and Diversity teams to organize stakeholder interactions
- Worked with the Education, Outreach, and Diversity teams and stakeholders to clarify water management challenges and assess appropriateness of research design

Research Focus Area 3 – Coupled Human-Natural System:

- Held a series of interdisciplinary meetings and workshops across the campuses to establish new collaborations
- Developed a postdoctoral fellowship program and hired the first post-doctoral fellow
- Reviewed the activities in RFAs 1 and 2 to determine whether additional processes, relationships, and datasets are necessary to understand the system as a whole
- Evaluated the areas where ongoing activities can be relatively easily linked to improve the representation of water processes in modeling studies that are already underway
- Re-structured the vision of the modeling and visualization platform from a decision theater-type facility to an evaluation of best types and modes of information for collaboration and stakeholder involvement
- Facilitated interactions among individual scientists and science teams working at Utah universities to identify opportunities for data sharing, model improvements, and future collaborative research efforts
- Developed a working group to consider the scenarios to be studied in RFA3 that include understanding how to represent future land use change and decision-making, developing common scenarios across all modeling activities, and maximizing inclusion of stakeholders in the development of scenarios
- Developed a vision for a shared facility for off campus, interdisciplinary workshops and retreats
- Began to link models that individually represent specific aspects of the system, particularly hydrologic, climate, and urbanization

*Goal 2: Build on Utah's existing strengths in hydrologic modeling and cyber-infrastructure from the CI-WATER and Cyber-infrastructure (CI) NSF EPSCoR awards.*

- Hired a CI (Cyber-Infrastructure) Team consisting of a programmer/analyst, system administrator, data manager, and student programmers and technicians
- Designed and deploy a virtual server architecture to host the iUTAH Modeling and Data Federation (MDF)
- Assisted RFA1 researchers in the design of the GAMUT telemetry system
- Developed databases, web services, and software cyberinfrastructure for managing datasets from the GAMUT observatory
- Developed and conduct a survey to assist iUTAH researchers in identifying planned and existing data
- Developed and conduct a survey to assist iUTAH researchers in identifying existing models relevant to iUTAH
- Lead delivery of a graduate level course in Hydroinformatics across the USU, BYU, and UofU campuses in collaboration with CI-WATER

*Goal 3: Build programs to increase participation of underrepresented groups that include women, Hispanics and Native Americans.*

- Held first Diversity Conference in Blanding, UT targeting Native Americans
- Wrote Anthology of Effective Education for Diverse Audiences
- Began development of the iUTAH Multicultural Education and Outreach Program

targeting Hispanic K-12 students

- Held Hydro Innovation Field Trips in partnership with the Leonardo Museum that funded underrepresented and low income schools in the urban Wasatch Front

*Goal 4: Provide educational opportunities for a scientifically literate Utah workforce citizenry.*

- Created competitive research fellowships for graduate students
- Initiated internship program with private sector partners
- Initiated first summer research experience for undergraduates
- Hired watershed technicians
- Hired two post-doctoral fellows
- Hired two iUTAH supported faculty in hydroinformatics and social sciences
- Developed and implemented the Research Catalyst Program for PUI faculty

*Goal 5: Provide societally relevant science and education regarding current and future water resources.*

- Held Neighborhood Information Meetings with land-owners, managers and the general community about the climate, aquatic and sap-flow stations that will be installed on their neighborhoods
- Developed museum partnerships across Utah to provide interactive experiences for K-12 students and teachers
- Integrated iUTAH research into existing museum programs
- Engaged K12 students and their teachers in the Natural History Museum of Utah's (NHMU) Taking Learning Outdoors (TLO) program and the Leonardo's Water Workshops
- Aligned Utah Water Watch's (UWW) Citizen Science program to support relevant aspects of iUTAH research areas
- Engaged relevant Utah stakeholders in shaping research directions
- Established an iUTAH communications' strategy for the diverse set of iUTAH audiences, both within and outside of the project
- Developed an iUTAH website and complementary social media presence

Specific Objectives:

*Goal 1: Enhance research capacity of the biophysical, social and engineered water environment.*

Research Focus Area 1 – Biophysical Ecohydrologic System:

- Improve capacity to monitor Wasatch Range Metropolitan Area (WRMA) ecohydrologic system on the mountain-to-urban gradient
- Enhance capacity to understand ecohydrologic processes in the WRMA as they relate to water resource availability now and in the future

Research Focus Area 2 – Social and Engineered Systems:

- Ensure that research activities are relevant to decision-makers
- Improve capacity of Utah scientists to study human dimensions of water systems
- Improve capacity of Utah scientists to study the impacts of gray and green water infrastructure systems
- Ensure that social and engineering data can answer research questions
- Improve iUTAH's capacity to collect intensive data about water use, water decision-making, and stormwater runoff
- Improve iUTAH's knowledge of the built water infrastructure across the WRMA
- Improve iUTAH's capacity to use information about built infrastructure to model water system outcomes

Research Focus Area 3 – Coupled Human-Natural System:

- Identify, categorize, and centralize relevant datasets and models
- Link disparate models and datasets
- Enhance capacity for interdisciplinary research and training
- Link researchers, teachers, students, and stakeholders interested in water sustainability
- Enhance data/model visualization capacity

*Goal 2: Build on Utah's existing strengths in hydrologic modeling and cyber-infrastructure from the CI-WATER and Cyber-infrastructure NSF EPSCoR awards.*

- Develop infrastructure to support data collection and management activities of iUTAH facilities and researchers
- Identify, prioritize, and facilitate access to external datasets needed by iUTAH researchers
- Enable iUTAH researchers to share and access data using standard formats, protocols, and services
- Support iUTAH participants in discovering and accessing iUTAH and relevant external data
- Support iUTAH researchers in identifying and prioritizing modeling needs, models to be used, and access to computational resources
- Provide online resources for citizens, K-12, undergraduate, and graduate students throughout Utah

*Goal 3: Build programs to increase participation of underrepresented groups that include women, Hispanics and Native Americans.*

- Enhance the diversity of iUTAH team members
- Train iUTAH team members in the best practices for implementing culturally aware educational activities
- Strategically recruit and retain groups underrepresented in STEM (Science, Technology, Engineering, and Mathematics) for all iUTAH activities

*Goal 4: Provide educational opportunities for a scientifically literate Utah workforce citizenry.*

- Promote and maintain a STEM workforce focused on water sustainability
- Develop public-private partnerships
- Conduct formative assessment of programs and modify future activities

*Goal 5: Provide societally relevant science and education regarding current and future water resources.*

- Provide participatory iUTAH-related research experiences for K-12 students and teachers
- Engage public audiences and stakeholders in face-to-face activities designed to build connections with iUTAH researchers
- Disseminate iUTAH project information, research outcomes, educational materials, and participation opportunities through a dynamic communications strategy
- Incorporate assessment outcomes into future programming efforts

#### Significant Results:

Goal 1: Enhance research capacity of the biophysical, social and engineered water environment.

#### RFA (Research Focus Area) 1 – Biophysical Ecohydrologic System

The planning, design (Fig 1) and instrumentation purchases (Table 2) have been completed for the watershed observatories. Instrumentation is being installed in the Watersheds. Measured variables are provided in Table 3. A detailed example of site and instrumentation placement is provided for the Red Butte Watershed in Fig

2.

Determine the water cycle processes most important for the water balance along mountain-to-urban gradients - Fig 3 shows progress in developing a multidecadal mean water balance for the Wasatch Front for 1981-2010. Our modeling results estimate the net flow of water from the mountain to the valley assuming no annual mean change in mountain storage. The imbalance of water budget components suggests an increase in water storage in the SLC valley, and stems in part from our regional climate model's tendency to underestimate urban evapotranspiration.

#### Other Results

- Hired and are training 3 watershed technicians
- Purchased aquatic sensors and weather stations
- Have begun collecting and summarizing existing data sets
- Coordinated with water quantity and quality groups during observatory design phase
- Recruited three graduate students and one postdoc

#### RFA 2 – Social and Engineered Systems

To improve capacity of Utah's science community to gather and analyze social and engineering system data on coupled water systems we have:

1. Completed the design of the social sciences sampling design (Fig 4) in concert with the RFA 1 GAMUT (Gradients Along Mountain to Urban Transitions) team. Table 4 shows the variables that are being measured. This design will allow us to understand the interactions between urban form, environmental change, built water infrastructure, and decision-making in terms of water use.
2. The Green Infrastructure Research Facility (GIRF) planning team completed a conceptual design of the facility and obtained a preliminary cost estimate for the design and construction for three 200 ft<sup>2</sup> buildings and twelve 81 ft<sup>2</sup> multipurpose vegetated garden plots (Fig 5).

Specific research projects have also been initiated for our research question 'Determine how urban form interacts with water availability:

1. We employed the concept of "water-smart growth" as a holistic land-water planning approach to cope with rapid growth and water scarcity using SLEUTH (known as the Clarke Cellular Automata Urban Growth Model, initials from: slope, land use, urban, exclusion, transportation, and hill shading), a cellular automata model to simulate Cache County's urban growth from 1984 to 2030 (Fig. 6). Three growth scenarios, sprawl growth, smart growth, and "water-smart growth" have been simulated and visualized to determine the interactions between growth patterns and water use, water infiltration, and water runoff patterns in the urban environment.
2. To understand the effects of Green Infrastructure implementation on mitigating the hydrologic impacts of urbanization, we have begun to collect GIS data on the current Storm drain configuration. These data were used as the foundation of a Storm Water Management Model (SWMM) to characterize the storm water generated by the current infrastructure and to predict the mediation that could be achieved by implementing green infrastructure (Table 5). Model calibration will occur in May and June with the final green infrastructure implementation plan completed in July 2013.
3. An extensive literature review of regional and state level water management and planning documents & a review of barriers to climate adaptation has been conducted. We have developed a database of infrastructure projects funded by the Utah Board of Water Resources, which will provide a long-term record of infrastructure changes throughout the state (Fig 7).

## Other Results

- Held first cross-campus collaborative meetings – build RFA2 team
- Identified and collated existing socio-economic data sets; working to identify data gaps
- Provided input into RFA1/GAMUT design from social science perspective
- Designed social science research protocols and instruments
- Hired first doctoral & postdoctoral fellows
- Initiated contacts with stakeholders (statewide agency staff, Logan City and Cache County staff, Salt Lake City and County staff) to identify existing data and data gaps in study areas
- Identified strategies to involve more underrepresented groups and partners in our research – prioritized gender and race/ethnicity in review of undergraduate research positions, graduate fellowships, and postdoctoral searches.
- Attended Diversity conference and discussed strategies for future events or activities to highlight diversity awareness on team.
- Used existing datasets to develop a typology of urban forms across the WRMA (Wasatch Range Metropolitan Area)
- Select study neighborhoods representing gradient of urban forms
- Work with RFA1 team to design instrumentation strategies to capture impacts of urban form on water flows

### RFA 3 – Coupled Human-Natural System

The conceptual model and data-model coupling information is provided in Fig 8 and Table 6.

1. Bio-Economic Model for Water Use (Fig 9) - Using stream flow data from the Logan, Bear and Black-Smith Fork rivers, we established that uncertainty in future water supplies precipitates investment in more efficient irrigation technology. This effect is mitigated by the nature of water markets in Utah. We surmise that more uncertain future water supply will compel irrigation companies and municipalities to invest more in canal lining. These results are currently being validated by model calibration and sensitivity analyses. Also, a conceptual bio-economic model for water use in Logan has been established.

## Other Results

- Created PhD & post-doctoral program
- Began the inventory of existing data and models
- Built collaborations with stakeholders & EOD Team

Goal 2: Build on Utah's existing strengths in hydrologic modeling and cyber-infrastructure from the CI-WATER and CI NSF EPSCoR awards.

In year 1 we staffed the CI Team hiring a programmer/analyst, data manager, securing system administrator services, and 3 student programmers/technicians. We designed, purchased, and deployed a virtualization environment consisting of servers and storage to host the iUTAH Modeling and Data Federation (Fig 10). We designed and implemented web-based model and data inventories at <http://data.iutahepsco.org> for existing & planned models and data in collaboration with the RFAs. Additionally, we have begun software CI development activities with RFA1 to develop new databases and software tools for managing streaming sensor data from the GAMUT sites (Fig 11).

## Other Results



- Designed, purchased and deployed virtual server and storage hardware deployed
- Deployment of databases, software, and web services to support streaming sensor data from GAMUT sites
- Hired and trained 2 student programmers, 1 technician, 1 data manager, 1 programmer/analyst, and 1 system administrator
- Designed and deployed web-based inventories of existing and planned datasets and models in support of RFA1, RFA2, and RFA3
- Established open source code repositories for ongoing software development
- Developed new software tools for managing streaming data from GAMUT sites
- Led development and delivery of a graduate level course in Hydroinformatics

Key outcomes or  
Other achievements:

EOD Results

**Goal 3: Build programs to increase participation of underrepresented groups that include women, Hispanics and Native Americans.**

*Diversity Conference:*

iUTAH partnered with the Four Corners School's Bioregional Outdoors Education Project to hold their annual conference on Utah State University's Blanding Campus in March, 2013. This year's conference, entitled Elements of Effective Diverse Education, addressed best practices in learning techniques for students with culturally diverse backgrounds and involved participants from across Utah and the surrounding Four Corners region. Over 30 iUTAH team members attended, including a dozen iUTAH graduate research fellows.

*Anthology of Effective Education for Diverse Audiences:*

The Diversity Enhancement team created a workbook of readings on cultural knowledge for the relevant cultural groups in Utah, entitled "Honoring the Past, Embracing in the Present, Teaching for the Future: An Anthology of Effective Education for Diverse Audiences", compiled by: Sabrina L. Carlson (Fig.12).

*Hydro Innovation Field Trips:*

iUTAH provided support for over 500 middle school students from groups underrepresented in STEM in Utah, primarily Hispanic Americans, to attend the Leonardo Museums' Hydro Innovation Field Trips. Over 500 students and 20 teachers attended (Figure 13, Table 7).

*iUTAH Multicultural Education and Outreach:*

iUTAH partnered with The Leonardo Museum to create a new hands-on curriculum in which students explore the chemical and physical properties of water, water quality, and water conservation. This curriculum support Utah's standards for grades 5 through 9 and integrates principles from science, technology, engineering, math, and arts. All materials have been translated into Spanish, so this information can be available to the growing Hispanic population of K-12 students.

*Other Results:*

iUTAH has designed brochures and other resources to teach land-owners, managers and the general community about the iUTAH monitoring sensors that are being installed, including climate, aquatic and sap-flow stations (Figure 14).

All iUTAH posters, pamphlets and other communications instruments are produced

in both Spanish and English.

iUTAH staffed booths at five major national conferences to recruit underrepresented graduate students and postdocs.

**Goal 4: Provide educational opportunities for a scientifically literate Utah workforce citizenry.**

*Undergraduate research fellows (iFellows):*

The iUTAH Fellows (iFellows) Program provides an opportunity for undergraduate students from all Utah institutions of higher learning to gain first hand research experience. iFellows will participate in a 9-week summer research internship where they will work side-by-side with iUTAH faculty and a graduate student near-peer mentor. iFellows will present their results at the annual iUTAH Symposium and at the Utah Conference on Undergraduate Research the following spring. For 2013, 10 iFellows were selected to participate in the summer research program.

*Research Catalyst Grants (RCGs):*

RCGs provide opportunities for faculty and students from Primarily Undergraduate Institutions (PUIs) to develop partnerships with Utah's research universities and advance the research objectives of iUTAH. For 2013, 5 RCG projects were funded, with PIs from Southern Utah University, Westminster College, Utah Valley University, and Weber State University (Table 8).

*Summer Institute:*

For the first iUTAH Summer Institute, teams of graduate students, undergraduate students, teachers and K-12 students will spend one week conducting research projects in the Red Butte Creek Watershed with iUTAH researchers. Participants will present their results at the annual iUTAH Symposium. Teachers will work with iUTAH education experts afterwards to develop curriculum to implement in their classrooms

*Internship program:*

iUTAH partnered with Utah agencies and private companies to provide internships for undergraduate students. Internship opportunities were posted on iUtahEPSCoR.org as well as on iUTAH's Facebook and twitter feeds. Students applied directly to the internship sponsor and will be hired as interns for 12 weeks during the summer. For 2013, two interns were hired by Campbell Scientific, Inc., one by Utah Division of Water Quality, one by Utah Geologic Survey, one by USU Water Quality Extension, and one by Salem City Public Works.

*Other Results:*

iUTAH has hired 45 staff, students and technicians and has 136 participants since August, 2012. A table is provided in supporting documents with the accompanying position descriptions/advertisements (Table 9).

**Goal 5: Provide societally relevant science and education regarding current and future water resources.**

*K-12 Museum Programs:*

iUTAH partnered with the Natural History Museum of Utah (NHMU)'s Taking Learning Outdoors (TLO) program sponsored a series of outdoor learning activities for K-12 students held at the Bear River Watershed in Northern, Utah (Figure 15). Activities included a series of water workshops, water tests and scientific discussions focusing on the topic of water sustainability.

*Citizen Science:*

iUTAH partnered with USU Water Quality Extension (WQE) to create a citizen science project to investigate rain barrels' potential to reduce storm water runoff (Figure 16). Rain barrels and rain gauges were installed at a number of high schools in the Salt Lake City area and volunteers were trained to collect and analyze the rain barrel data. iUTAH partnered with Utah Water Watch (UWW) to train new volunteers to conduct citizen science projects and collect water quality data at the iUTAH watersheds.

*Science Unwrapped:*

iUTAH partnered with USU Science Unwrapped program to sponsor monthly presentations focused on water sustainability in the West. On March 29th and April 26th, 2013, iUTAH hosted hands-on activities after each seminar for the audience. Over 500 attendees from the surrounding communities attended each event, including K12 students and teachers, undergraduates, graduate students, faculty, and the general public.

*Other Results:*

In conjunction with the annual Spring Runoff Conference, iUTAH arranged a screening of the movie "WATERSHED: Exploring a new water ethic for the New West" for conference attendees and the general public (Figure 17).

*Communications:*

The Communications team has created 4 websites – the State Utah EPSCoR site, the iUTAH RII Track 1 site, the iUTAH Modeling and Data Federation's data sharing site, and the Drupal reporting data entry. From August 2012 to April 2013, the iUTAH web site has had over 6,600 visitors (Figure 18).

iUTAH also has created a social media presence, as part of its communication strategy. From the initiation of these accounts in August, iUTAH now has a solid cohort of followers on both twitter and facebook.

Newsletter – iUTAH has produced bimonthly newsletters to keep team members, as well as the State Committee, university administrators, and other interested parties aware of iUTAH activities. The Newsletters are posted at [iutahepscor.org/resources/newlsetters.html](http://iutahepscor.org/resources/newlsetters.html).

All External Engagements events are described in Table 10.

**\* What opportunities for training and professional development has the project provided?**

This award is supporting the development of new opportunities for all iUTAH participants, including faculty, graduate students, post-doctoral fellows and teachers and students at the secondary level. It also has provided opportunities for citizens and stakeholders. A special focus has been given to STEM education, especially that oriented to promote formal education with research-based approaches to minorities, underrepresented groups and gender education. Thus, the most important activities are comprised of: the deepening and refining of research skills, the peer-review process of publications, communication and presentation of research findings, proposal writing and reviews, developing of web

sites and applications, database building and sharing, mentoring students from all levels, and collaborating with other scientists within social, ecological and hydrological disciplines and among disciplines.

The value of diverse research and community education in Utah has been included in this award. During the course of the first year, we have provided summer research experiences for undergraduates to work jointly with iUTAH scientists and graduate students, with special emphasis on recruiting from primarily undergraduate institutions and those with high enrollment of diverse groups. We created a Summer Institute program as a vehicle for undergraduate and graduate students to work with K-12 students and teachers to gain experience with K-12 education, serve as near-peer mentors for students, and help teachers incorporate iUTAH research into the curriculum.

By integrating research and education activities into the annual Summer Institute, we are bringing together teams of students and teachers to work with iUTAH researchers at each of the monitored watersheds. This provides opportunities for informal science educators to work with Summer Institute participants to translate iUTAH research results into outputs for community use, such as a digital or off-line product targeted for either informal or formal education use. As a result, resources developed by iUTAH Summer Institute teams through a number of different avenues are expected to be disseminated by the Natural History Museum of Utah (NHMU) and The Leonardo, the iUTAH web site, and the Utah Education Network (UEN).

iUTAH is also bringing opportunities for graduate students to apply for competitive research fellowships to work with iUTAH researchers on interdisciplinary research projects, including both the natural and social sciences. A post-doctoral fellowship program has been set up to allow fellows to work with an iUTAH research team while spending significant time with at least two mentors from different disciplines and institutions. Awardees are mentored by participating faculty to work with iUTAH researchers on one of the three RFAs. iUTAH has conducted several events for all participants that include presentations by students, teachers, faculty, informal science educators, and other partners to focus on discussions among the participants about iUTAH's main goals, including lessons learned from previous experiences.

The most relevant training opportunities for "Goal 1: Enhance research capacity of the biophysical, social and engineered water environment," were: a Loggernet training course given by Campbell Scientific and a Sapflux workshop at the University of Utah, both given as part of RFA 1. For RFA 2, an 'Integrated Modeling Workshop' was organized by Doug Jackson-Smith; a large group of iUTAH & non-EPSCOR collaborators participated. Under RFA 3, iUTAH, Salt Lake City and Salt Lake County have partnered with the University of Utah to participate in several interdisciplinary courses in multiple departments that focused on Red Butte Creek during spring semester. Agency staff spoke with students and will attend an external engagement event on May 1 in which students will present the outcome of interdisciplinary research in ecology, urban planning, and civil engineering outlooks on Red Butte Creek.

In the Cyberinfrastructure goal, researchers involved with iUTAH and our Track 2 CI-WATER developed a collaborative course on Hydroinformatics (<https://usu.instructure.com/courses/127332>) offered for graduate students; it began on August 28, 2012. The course was jointly taught by faculty from USU, U of U, and BYU, with plans to expand to U of WY next fall. In addition to providing new content and opportunities for interaction among students at all three institutions, this was the first time for most faculty to teach using the UEN Interactive Video Conferencing (IVC) system. The course was recorded using software currently in the pilot phase at Utah State. UEN is monitoring their feedback closely to test the software's applicability to other courses. The course combines synchronous video lectures with asynchronous student discussions, assignments, and grading using a new Learning Management System called Instructure Canvas. Instructors include Jeff Horsburgh (USU), David Rosenberg (USU), Dan Ames (BYU), Jim Nelson (BYU), Steve Burian (UU), and Christine Pomeroy (UU). Enrollment (and demographics) for the course are as follows:

USU – CEE 6930: Hydroinformatics -- 7 Males, 1 Female, no disabilities; 3 white Males, 2 Palestinian males, 1 Chinese female, 1 Ethiopian male, 1 Nepalese male

BYU – CEEEn 594R: Hydroinformatics – 15 Males, 0 Females, no disabilities; 11 white U.S., 4 Latino

UU – CVEEN 7920: Hydroinformatics – 4 Males, 2 Females, no disabilities; Two Chinese, two Iranians, two white

UU - ATMOS 6910: Hydroinformatics – 1 white Female, no disabilities.

UEN coordinated several planning calls with faculty and campus faculty assistance centers to initiate the course.

**\* How have the results been disseminated to communities of interest?**

iUTAH participants have aggressively engaged schools, universities, local, state and federal resource agencies, stakeholders as well as a myriad of professional societies. Over 45 presentations have been given that provide information regarding iUTAH activities. A complete list of presentations is provided in the Products section of this report. There is also a Table in the supporting documents section showing the complete list of 'External Engagement Activities.'

We have 5-7 peer-reviewed publications that are either in press, submitted or will be submitted prior to July 31, 2013 (see products pdf).

Main dissemination activities besides research presentations and outreach activities have been accomplished through the 4 websites that were created to engage participants and the general public:

- UtahEPSCoR.org – State EPSCoR site
- iUtahEPSCoR.org – RII Track 1 site
- data.iUtahEPSCoR.org – the iUTAH Modeling and Data Federation's online system for sharing data, models, and other digital resources
- report.utepscor.org – Drupal reporting data entry system

More than 6,000 visits have been reported to these websites, since August of last year. iUTAH also has created a social media presence, as part of its communication strategy. From the initiation of these accounts in August, iUTAH now has a solid cohort of followers on both Twitter and Facebook.

iUTAH has also produced bimonthly newsletters to keep team members, as well as the State Committee, university administrators, and other interested parties aware of iUTAH activities. The Newsletters are posted at: [iutahepsco.org/resources/newsletters.html](http://iutahepsco.org/resources/newsletters.html).

**\* What do you plan to do during the next reporting period to accomplish the goals?**

iUTAH has immediate plans to follow up with first year activities, including the negotiation of memorandums of understanding with property owners for access to site locations and proceeding with the installation of instruments and sensors. We will also develop standard operating procedures (SOPs) for instrument operation and maintenance as well as develop data collection and sample analysis plans. iUTAH will engage graduate students in watershed instrumentation plans and mentor students in writing successful fellowship applications. We expect that undergraduate research fellows to identify and propose research themes/potential projects to research mentors.

Additionally, we need to put immediate effort into current activities such as coordinating with RFA1-RFA3 to identify CI needs, designing and deploying a large data storage infrastructure in collaboration with the CI-WATER EPSCoR project to provide storage resources for data and modeling, and identifying and developing relationships with existing agencies, data providers, and cyberinfrastructure projects.

We will continue to installation and maintain the GAMUT (Gradients Along Mountain to Urban Transitions) Observatory. In the next reporting year, we will publish GAMUT Data to the iUTAH Data Federation under RFA (Research Focus Area) 1's specific objectives. We will also mentor graduate student research projects on climate modeling, solute transport, microbial ecology, groundwater/snow chemistry, plant water use and other water cycle processes. We plan to mentor a postdoctoral researcher studying watershed hydrobiogeochemistry.

Under RFA 2, we will continue development of social & engineering data archives, initiate collection of primary data on social aspects of water management and collect data on biophysical outcomes related to human/built water infrastructure. After the data collection, we will develop/improve models to simulate the impact of changes in water infrastructure on sustainability outcomes. As with RFA 1, we will mentor graduate student research projects on social science data collection and analysis, water use and management decisions, green infrastructure and a postdoctoral researcher on social aspects of water decision-making.

In RFA 3, we will prepare a collaborative publication on the conceptual framework for the coupled human-natural water system and continue working on the synthetic modeling workshops, as well as complete the iUtah model inventory. We expected to build new collaborations with stakeholders and form a working group to explore methods and tools for engaging diverse participants and stakeholders. Mentoring is also within our next year's plan. Similar to the mentoring of RFA 3, we will recruit a postdoctoral researcher in coupled human-natural water systems and recruit graduate students for mentoring in participatory modeling, informatics, and data-model integration.

Under the cyberinfrastructure goal, we will finalize the deployment of large storage infrastructure at the University of Utah, continue the development of software tools and systems for streaming sensor data management, metadata catalog and data discovery capabilities.

We will focus on the development of the iUTAH data policy and the continued development of partnerships with data providers and consumers. Additional servers and storage to iUTAH MDF (Modeling Data Federation) virtualization infrastructure will be installed to complete the proposed Data Federation Cyberinfrastructure as it was laid out in this award proposal.

A strong STEM (Science Technology, Engineering, & Math) workforce is critical for building and sustaining research capacity and economic growth. In the second year, we will focus our attention on the implementation of recruitment, selection, placement and evaluation processes and create the K-12 curriculum materials from Summer Institute #1. Summer Institute #2 will be implemented following the feedback and recommendations of Year 1. We will recruit iFellows for the undergraduate research program and place students in iUTAH internships. Other activities for our STEM workforce will include: the near-peer mentoring program, including the training of near-peer mentors, recruit students from groups underrepresented in STEM in Utah and follow up with a workshop on best practices for student retention in STEM.

As the main External Engagement (EE) activity for Year 2, a diverse participant recruitment plan will be implemented, expanding our EE team statewide so that we can integrate our EE activities with RFAs. This will include the engagement of new museum partners across the state and an expansion of social media as a main communication source and data entry portal for participants via our website. We will recruit and engage new iUTAH Taking Learning Outdoors (TLO) & Utah's Water Watch's (UWW) cohorts and solicit ideas for new iUTAH communication and engagement events.

As the main purpose of our new Diversity Enhancement activities, we will partner with Workforce & Engagement Teams to increase the diversity of leadership teams' participants in all iUTAH activities. We will continue to design museum programs for target populations. The first diversity-training workshop for iUTAH participants connecting iUTAH scientists w/diverse institutions, leaders & communities was conducted in March 2013.

## Supporting Files

Filename	Description	Uploaded By	Uploaded On
SignificantResult_SupportingDoc_1a.pdf	Figures and Tables of Significant Results of Goal 1: Enhance research capacity of the biophysical, social and engineered water environment, RFA 1 Biophysical Ecohydrologic System.	Todd Crowl	04/30/2013
SignificantResult_SupportingDoc_2a.pdf	Figures and tables of Significant Results of Goal 1: Enhance research capacity of the biophysical,	Todd Crowl	04/30/2013

social and engineered water environment, RFA 2 Social and Engineered Systems.

SignificantResult_SupportingDoc_3a.pdf	Figures and tables of Significant Results of Goal 1: Enhance research capacity of the biophysical, social and engineered water environment, RFA 3 Coupled Human-Natural System and Goal 2: Build on Utahs existing strengths in hydrologic modeling.	Todd Crowl	04/30/2013
KeyOutcomes&Achievements_SupportingDoc_4b.pdf	Figures and Tables of Key Outcomes or Other Achievements: Goal 3: Build programs to increase participation of underrepresented groups, Goal 4: Provide educational opportunities for Utah workforce citizenry, and Goal 5: Provide relevant science.	Todd Crowl	05/02/2013

## Products

### Journals

Rivera, S., K. Landom and T. Crowl (2013). Monitoring Macrophytes Cover and Taxa in Utah Lake by Using 2009-2011 Landsat Digital Imagery. *Revista de Teledetección*. unknown unknown.

Status = AWAITING\_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

### Books

### Book Chapters

### Thesis/Dissertations

### Conference Papers and Presentations

Strong, Courtenay (2013). *"Future precipitation and snowpack along the Wasatch Range"*. American Water Resources Association Utah Section Annual Conference. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Strong, Courtenay (2013). *"Global change and its local impacts"*. Monthly meeting of Humanists of Utah. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Strong, Courtenay (2012). *"Current and future hydrologic cycle of the Wasatch Range and Front"*. Graduate Seminar Department of Plants, Soils and Climate at Utah State University.. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Strong, Courtenay (2013). *"High resolution climate projections for the Great Basin made accessible to diverse stakeholders and research communities"*. 11th Annual Climate Prediction Applications Science Workshop.. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Strong, Courtenay (2012). *"Using a multiple-box model validated by observations to study water vapor balance and its sensitivity to projected climate variability in the Salt Lake Valley"*. American Geophysical Union Fall Meeting. San Francisco, California.

Status = OTHER; Acknowledgement of Federal Support = Yes

Strong, Courtenay (2012). *"Snow and water resources of the Great Salt Lake Basin: historical perspective and projections for the future"*. Salt Lake Countywide Watershed Symposium. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Neilson, Beth (2012). *"Analysis of two-zone transient storage parameters using analytical transport solutions, moment statistics and a convolution of solutions"*. American Geophysical Union Fall Meeting. San Francisco, California.

Status = OTHER; Acknowledgement of Federal Support = Yes

Neilson, Beth (2012). *"Roles of heat transport in transient storage modeling"*. American Geophysical Union Fall Meeting. San Francisco, California.

Status = OTHER; Acknowledgement of Federal Support = Yes

Neilson, Beth (2013). *"Investigating the impact of higher spatial resolution parameter information on stream solute transport predictions"*. Spring Runoff Conference 2013. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Andrew Hobson, Beth Neilson and Nick von Stackelberg (2013). *"A tool to identify numeric nutrient criteria with QUAL2k"*. Spring Runoff Conference 2013. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Carla Trentelman, Dan Bedford, Todd Crowl and Rita Teutonico (2013). *"iUTAH comes to campus: Water as a focus for campus sustainability"*. Intermountain Sustainability Summit 2013. Ogden, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Christine Pomeroy (2013). *"Research in Urban Stormwater Management"*. USWAC. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Enjie Li, Joanna Endter-Wada (2013). *"Water-Smart Growth: Integrating water management and land use planning"*. 2013 Spring Runoff Conference. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Bo Yang, Sam Taylor, Chris Binder, Nicholas Decker, Stephen Peaden, and Jordan Ward. (2013). *USU Green Roof Initiative*. 2013 Spring Runoff Conference. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Bo Yang, Pamela Blackmore, Devon Gibby, Scott Krumm, Gordon Wood, Enjie Li. (2013). *"Water in the West: Conserving water on a campus research farm"*. 2013 Spring Runoff Conference. Logan, UT.



Status = OTHER; Acknowledgement of Federal Support = Yes

Carlos Licon (2012). *"A sustainability assessment of Utah's 29 counties"*. 53rd Annual Conference of the Associated Colleges and Schools of Planning (ACSP). Cincinnati, OH.

Status = OTHER; Acknowledgement of Federal Support = Yes

Bo Yang and Jeff Horsburgh (2013). *"Green Infrastructure Design in the Intermountain West, USA: A Case Study of Daybreak Master-Planned Community."* 7th International Association for China Planning (IACP) Conference. Shanghai, China.

Status = OTHER; Acknowledgement of Federal Support = Yes

Andrea Armstrong & Douglas Jackson-Smith (2013). *"Constructing a database of infrastructure changes in Utah."* 2013 Spring Runoff Conference. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Douglas Jackson-Smith (2013). *The People Puzzle: Using Social Sciences to Address Water Sustainability Challenges in Utah*. USU Sunrise Sessions. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Douglas Jackson-Smith (2013). *"Beyond Cadillac Desert: Reframing the Western Water Sustainability Paradigm"*. Global Change and Sustainability Center seminar series. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Andrea Armstrong (2013). *"Collective actions from within: Municipal managers' responses to stormwater regulations."* 2013 International Symposium for Society and Resource Management. Estes Park, Colorado.

Status = OTHER; Acknowledgement of Federal Support = Yes

Dan Bedford (2013). *"iUTAH opportunities for engagement"*. Intermountain Sustainability Summit. Ogden, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Dasch Houdeshel, Christine Pomeroy and Kevin Hultine. (2013). *"Uptake of stormwater nitrogen in bioretention systems determined from 15N Tracer Techniques"*. American Geophysical Union annual meetings. San Francisco, California.

Status = OTHER; Acknowledgement of Federal Support = Yes

Augustina Odame (2013). *"Water-Saving Infrastructure Investment under Uncertainty"*. 2013 Spring Runoff Conference. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Baker, Michelle (2013). *"Applying tools from ecosystem ecology to water quality management: case studies from Utah"*. Department of Plant and Wildlife Sciences, Brigham Young University.. Provo, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Dasch Houdeshel, Christine Pomeroy and Kevin Hultine (2013). *"15N Tracer Techniques used to verify plant's roles in bioretention treatment of stormwater nitrogen"*. Environment Water Research Foundation Annual Congress. Cincinnati, OH.

Status = OTHER; Acknowledgement of Federal Support = Yes

Philip Stoker (2013). *"Drivers of urban water use"*. Global Change and Sustainability Center Symposium. Salt Lake City,

UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Carlos Licon (2012). *"A sustainability assessment of Utah's 29 counties"*. Annual Conference of the Associated Colleges and Schools of Planning. Cincinnati, OH.

Status = OTHER; Acknowledgement of Federal Support = Yes

Diane Pataki (2013). *"Ecosystem services and regional tradeoffs: Resolving the desert forest paradox"*. National Academy of Sciences. Washington, DC.

Status = OTHER; Acknowledgement of Federal Support = Yes

Diane Pataki (2012). *"Urban greenspace: Ecosystem, architecture, or infrastructure?"*. Utah State University. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Sarah Null, Craig Miller and Wayne Wurtsbaugh (2013). *"Influence of diking and climate on the salinities in Gilbert and Gunnison Bays of the Great Salt Lake"*. Great Salt Lake Technical Team event. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Jeff Horsburgh (2013). *"iUTAH Cyberinfrastructure to Support Large Scale Collaborative Water Research"*. 2013 Spring Runoff Conference. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Amber Jones and Jeff Horsburgh (2013). *"iUTAH Cyberinfrastructure to Support Data Collection and Management for the GAMUT Monitoring Network"*. 2013 Spring Runoff Conference. Logan, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Jeff Horsburgh (2013). *"Using CUAHSI HIS to Support Large-Scale Collaborative Research in Utah"*. Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS) Cyberseminar Series. unknown.

Status = OTHER; Acknowledgement of Federal Support = Yes

David Tarboton, Jeff Horsburgh, Fred Ogden, Norm Jones. (2012). *"Advancing cyberinfrastructure to support high resolution water resources modeling"*. American Geophysical Union Fall Meeting. San Francisco, California.

Status = OTHER; Acknowledgement of Federal Support = Yes

Jeff Horsburgh (2012). *"Sensors, cyberinfrastructure, and water quality in the Little Bear River: Adventures in continuous monitoring"*. 2012 SACNAS National Conference: Creating a Healthy World through Science, Diversity & Technology. Seattle, WA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Todd Crowl (2012). *iUtah EPSCoR: Building Scientific and Human Infrastructure to Sustain Utah's Water Resources*. Eco Summit 2013. Columbus, OH.

Status = OTHER; Acknowledgement of Federal Support = Yes

Court Strong, Kimberly Smith, Adam Kochanski, Carolyn Stwertka (2013). *The future balance of water along the Wasatch Range and Front*. Utah Geological Association Monthly Meeting. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Bethany Neilson (2012). *Determining Key Heat Fluxes Necessary for Instream Temperature Predictions*. American Geophysical Union Fall Meeting. San Francisco, California.

Status = OTHER; Acknowledgement of Federal Support = Yes

Todd Crowl (2013). *iUtah EPSCoR: Building Scientific and Human Infrastructure to Sustain Utah's Water Resources*. Weber State Sustainability Summit. Ogden, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Todd Crowl and Rita Teutonico (2012). *iUtah EPSCoR: Building Scientific and Human Infrastructure to Sustain Utah's Water Resources*. Ecological Society of America 2012. Portland, OR.

Status = OTHER; Acknowledgement of Federal Support = Yes

Todd Crowl (2013). *From Genes to Human-dominated Landscapes: Theory Driven, Place-based, Long-Term Research*. Washington State University, Center for Environmental Research, Education and Outreach (CEREO) seminar. Washington State University.

Status = OTHER; Acknowledgement of Federal Support = Yes

Richard Gill (2013). *Using Systems Biology to Understand Global Change: Examples from Utah*. Majors Introductory Biology Seminar, BYU. Provo, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Thomas Walsh (2013). *The Global Change & Sustainability Center presents: The Red Butte Creek Revitalization*. GCSC Research Symposium. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Brian Bailey (2012). *Coherent Turbulence Structure Detection in Plant Canopies using a coupled Eulerian-Lagrangian Detection Method*. American Geophysical Union Fall Meeting 2012. San Francisco, California.

Status = OTHER; Acknowledgement of Federal Support = Yes

Eric Pardyjak, P. Willemsen, S. Halverson, D. Alexander, J. Clark (2013). *Radiative Heat Transfer in Urban Environments using Real-Time Ray Tracing*. 8th International Conference on Urban Climate – ICUC 8 and 10th Symposium on the Urban Environment. Dublin, Ireland.

Status = OTHER; Acknowledgement of Federal Support = Yes

Eric Pardyjak, P. Willemsen, R. Stoll, B. Addepalli, S. Halverson, D. Alexander, D. Johnson, J. Steenburgh, A. Kochanski, T. Harman, B. Bailey (2012). *Development of Tools for Studying the Impact of Green Infrastructure on Urban Microclimate and Air Quality*. 8th International Conference on Urban Climate – ICUC 8 and 10th Symposium on the Urban Environment. Dublin, Ireland.

Status = OTHER; Acknowledgement of Federal Support = Yes

Todd Crowl (2013). *From Genes to Human-dominated Landscapes: Theory Driven, Place based, Long Term Research*. University of Maryland Center for Environmental Science. Annapolis, MD.

Status = OTHER; Acknowledgement of Federal Support = Yes

Thomas Walsh (2012). *Red Butte Creek watershed*. University of Utah HONR3700 Panel. Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

Thomas Walsh (2013). *Student Research in Red Butte Creek*. University of Utah, GCSC Global Changes and Society (BIOL7961). Salt Lake City, UT.

Status = OTHER; Acknowledgement of Federal Support = Yes

### Other Publications

Beth Nielson, Ian Gowing, Austin Jensen (2013). *Capturing aerial imagery on the San Rafael River, Utah using an unmanned aerial vehicle to monitor and assist in evaluating restoration efforts..* Proposal - Awarded.

Status = OTHER; Acknowledgement of Federal Support = No

Beth Neilson (2012). *QUAL2Kw modeling for numeric nutrient criteria*. Proposal - Awarded.

Status = OTHER; Acknowledgement of Federal Support = No

Beth Neilson (2013). *Incorporation of heat into solute transport models*. Proposal - awarded.

Status = OTHER; Acknowledgement of Federal Support = No

Z.T. Aanderud, S. Jones (2013). *Critical zone processes mediating and responding to dust generation and transport..* proposal - submitted to NSF.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Sarah Null Beth Neilson Michelle Baker Douglas Jackson-Smith David Rosenberg Jeff Horsburgh Charles Sims (2013). *Nutrient loading, transformations, and management in irrigated agroecosystems*. Proposal - submitted to USDA.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Michelle Baker and Robert O. Hall, Jr. (2013). *Preliminary proposal: Rivers and the carbon cycle: Understanding transport and transformation in rivers from the bottom-up*. Pre-proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Dasch Houdeshel, Christine Pomeroy (2013). *Campus Stormwater Runoff Monitoring in Red Butte Creek*. Proposal - awarded.

Status = OTHER; Acknowledgement of Federal Support = No

Ryan Dupont (2013). *Quantification of Water Quality Improvements through the 900 S Oxbow Restoration and Stormwater BMP Renovation Project..* Proposal - awarded.

Status = OTHER; Acknowledgement of Federal Support = No

Charles Sims & Augustina Odame; non-EPSCoR collaborator: Paul Jakus (2013). *Uncertain investments in center pivot irrigation by Utah farmers*. Proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Charles Sims, James Powell Travis Warniniack Ben Crabb Sandra Ryan-Burkett (2013). *Analyzing the impact of fire and mountain pine beetle on watershed values..* proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Sarah Hinnners Christine Pomeroy Diane Pataki Brenda Bowen Danielle Endres (2013). *The Role of Green Infrastructure in the Transition to the Sustainable City*. proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Carlos Licon and Shujuan Li (2013). *Urban growth patterns: a century of transformation in Utah communities..* proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Shujuan Li (2013). *Water Resource Management for Wildlife under Climate Change –A Case Study of Cache Valley.* proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Bo Yang, Linrui Du, Hanqin Zhang, Jinnan Huang, Yuhong Zhou, Jindong Jiang, Chen Li, Cheng Xiang, Xue Li, Jie Hu (2013). *Research on the Water Space Planning Methods for Low Impact Development in the Urban Area.* Proposal - Submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Christine Pomeroy and Doug Jackson-Smith; Defne Apul (2013). *Green Infrastructure Monitoring, Performance Database, and Sustainability Analysis Framework to Advance Use in Urban Areas.* Proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Diane Pataki (2013). "WSC-Category 3: Collaborative: *The role of local water resources in the water sustainability of Los Angeles.*". Proposal - awarded.

Status = OTHER; Acknowledgement of Federal Support = No

Jim Ehleringer, Diane Pataki, Eric Pardyjak, Rob Stoll, Courtenay Strong, Todd Crawl, David Bowling, Sarah Hinners, Christine Pomeroy, Steve Burian. Nan Ellin Gabriel Bowen Phillip Dennison John Lin Fred Adler Tariq Banuri Otakuye Conroy Ramesh Goel A. Chris Nelson Reid Ewing (2012). "IGERT: *Ecological Planning in Cities (EPIC).*". Proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Eric Pardyjak, Steve Burian, Rob Stoll, Courtenay Strong; Li Yin, SUNY Buffalo. Philip Dennison, Utah - Geography. Reid Ewing, Utah - Metropolitan Planning. Adam Kochanski, Utah - Atmospheric Sciences (2012). *Decreasing urban vulnerability to climate change using interdisciplinary computational modeling strategies.*". proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Eric Pardyjak, Rob Stoll, Non-EPSCoR Participants Listed on the Grant: John Lin, Utah - Atmos. Sci. Adam Kochanski, Utah - Atmos. Sci. Xuesong Zhou, Utah - Civil Engineering. Peter Willemsen, U. of Minnesota, Duluth - Computer Science. (2013). *Collaborative Research: CyberSEES: Type 2: Engineering cities through simulation science: using optimization to solve the atmospheric source-sink problem..* proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Jeff Horsburgh, Non-EPSCoR Participants Listed on the Grant: Anthony Aufdenkampe, Robert M Cheetham, Kerstin Lehnert, Emilio Mayorga, David Valentine, Ilya Zaslavsky. (2013). *Collaborative Research: SI2-SSI: The community-driven BiG CZ software system for integration and analysis of bio- and geoscience data in the critical zone..* proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Nancy Huntly, Karen Mock, James Long, Mimi Recker. (2013). *Managing forests for rapidly changing climates: development of decision-making tools, silvicultural protocols, and educational programs for aspen in the Intermountain West..* proposal - submitted.

Status = SUBMITTED; Acknowledgement of Federal Support = No

Brian Greene & Nancy Mesner (2013). *Citizen Science Rain barrel project..* proposal - awarded.

Status = OTHER; Acknowledgement of Federal Support = No

## Technologies or Techniques

Nothing to report.

## Patents

Nothing to report.

## Inventions

Nothing to report.

## Licenses

Nothing to report.

## Websites

Title: iUTAH website

URL: <http://iutahepscor.org>

Description: Official website for the iUTAH EPSCoR project.

Title: DRUPAL

URL: <http://report.utepscor.org>

Description: DRUPAL is a web-based platform, has been developed to upload, collect, share and report the produced information among the iUTAH participants.

Title: <http://data.iutahepscor.org>

URL: An interim collaborative data and file sharing application

Description: <https://usu.instructure.com/courses/127332>

Title: Materials from the Hydroinformatics course are available openly online

URL:

Description: <http://cloudshare.iutahepscor.org>

Title: A website to host the iUTAH Modeling and Data Federation

URL:

Description:

## Other Products

Product Type: Software or Netware

Description: A beta release of a software program for managing and performing quality control of streaming sensor data was developed and released.

Other: Software or Netware

Product Type: Existing tools from the CUAHSI Hydrologic Information System (databases, web services, etc.) have been deployed in anticipation of managing the streaming sensor data from GAMUT.

Description:

Other: Software or Netware

Product Type: An extension to the existing CUAHSI HIS Observations Data Model (ODM) has

- Description: been developed to assist RFA1 researchers in managing the sensor and data collection infrastructure across the GAMUT site.
- Other: Software or Netware
- Product Type: A beta release of a web based graphical user interface has been developed for the iUTAH GAMUT sensor data management database.
- Description: iUTAH GAMUT sensor data management database.
- Other: Databases
- Product Type: Geospatial Data Bases. (Joanna Endter-Wada)
- Description: Working with Enjie Li (iUTAH graduate fellow), Shujuan Li (iUTAH faculty member), and RFA2 researchers more generally to build social layers of geospatial databases for urban modeling.
- Other: Databases
- Product Type: Exploratory interviews of water managers. Andrea Armstrong (Andrea Armstrong & Augustina Odame)
- Description: This is a qualitative dataset of meeting observations and semi-structured interview notes. Armstrong is the lead on this data collection, with Odame participating in multiple data collection events.
- Other: Databases
- Product Type: Database for Water Infrastructure Investment. (Augustina Odame)
- Description: Using stream-flow data on the Bear, Blacksmith Fork and Logan Rivers from USGS, irrigation cost data from the NRCS (Utah Field Data) and water pricing data from the Water strategist as well as lease records, databases for water infrastructure investment costs, as well as water price and supply volatility were created.
- Other: Databases
- Product Type: Qualitative interview data. (Zhao Ma)
- Description: A semi-structured interview protocol has been created and will be approved by the IRB at USU in May. This protocol will be used to collect qualitative data through interviews with key informants in a number of local, state and private agricultural and urban water management agencies and organizations, as well as relevant federal agencies. A total of 10-12 interviews will be conducted in June.
- Other: Databases
- Product Type: Stochastic water supply and demand Excel simulator. (Charles Sims)
- Description: An Excel file that simulates potential future water supply and water market prices based on historic streamflow and volatility data.
- Other: Educational aids or Curricula
- Product Type: Hydroinformatics Course Materials. (Jeff Hosburgh)
- Description: Materials are available for a graduate level course in Hydroinformatics that was jointly held across the USU, UofU, and BYU campuses during Fall Semester 2012. The course will be offered again Fall 2013. Materials are available at: <https://usu.instructure.com/courses/127332>. Development of the course materials and delivery of the course were performed in collaboration with the UTAH CI-WATER EPSCoR project.

- Other: Databases  
 Product Type: Data Collection for Red Butte Creek. (Thomas Walsh)  
 Description: Data is being compiled from multiple stakeholders, but is currently not available to the research community. Decisions governing availability and use will be made in the future.
- Other: Databases  
 Product Type: Utah BWR Infrastructure Database (Andrea Armstrong)  
 Description: This database development effort is collecting information on the Utah Board of Water Resources (BWR) water infrastructure projects from 1947 - present. We are developing this database to include information from a range of disciplinary interests, and to facilitate spatial coupling of infrastructure project information with other forms of hydrologic and landcover data.
- Other: Models  
 Product Type: SWMM Model of Red Butte Creek Between Reservoir and Foothill. (Christine Pomeroy)  
 Description: Graduate student class at UU (CVEEN 7440) created EPA Stormwater Management Model (SWMM) of Red Butte Creek Watershed between reservoir and Foothill Drive. Evaluated potential impacts of Green Infrastructure on Red Butte Creek.
- Other: Other  
 Product Type: 2013 College of Science Undergraduate Research Mentor of the Year, Michelle Baker  
 Description:
- Other: Honors & Awards  
 Product Type: Other  
 Description: USU College of Agriculture Faculty Researcher of the Year, Scott Jones (2013)
- Other: Honors & Awards

## Supporting Files

Filename	Description	Uploaded By	Uploaded On
Products_Table_SupportingDoc.pdf	Table showing all Products	Todd Crowl	05/02/2013

## Participants

### Research Experience for Undergraduates (REU) funding

#### What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Todd A Crowl	PD/PI	6
Rita A Teutonico	Co PD/PI	6



Ellen Burns	Other Professional	5
Terra M Huff	Other Professional	4
Janet Ross	Consultant	2
Jennifer Schultz	Other Professional	6
Samuel Rivera	Postdoctoral (scholar, fellow or other postdoctoral position)	5
Morey Burnham	Graduate Student (research assistant)	4
Charles Sims	Faculty	2
David Rosenberg	Faculty	2
Robert Ramsey	Consultant	1
Paul Hesselbee	Faculty	1
Michelle A Baker	Co PD/PI	2
Nancy Huntly	Faculty	2
Douglas Jackson-Smith	Co PD/PI	2
Jiming Jin	Faculty	1
Shujuan Li	Faculty	1
Carlos Licon	Faculty	2
Nancy Mesner	Faculty	1
Bethany Neilson	Faculty	2
Sarah Null	Faculty	2
Zhao Ma	Faculty	1
Sam St.Clair	Faculty	1
Marv Bennett	Other Professional	4
Bo Yang	Faculty	2

Laura Vernon	Graduate Student (research assistant)	5
Lauren Petty	Undergraduate Student	4
Joanna Endter-Wada	Faculty	1
Scott Jones	Faculty	2
Diane E Pataki	Co PD/PI	1
Betsy Bancroft	Faculty	2
Terri Hildebrand	Faculty	2
James Patton	Undergraduate Student	7
Jeff Horsburgh	Faculty	2
Stephanie Reeder	Technician	6
Amber Jones	Technician	5
Juan Caraballo	Undergraduate Student	4
Nate Mouzon	Technician	6
Mauriel Ramirez	Undergraduate Student	3
Pabitra Dash	Technician	1
Scott Bates	Faculty	1
Brian Anderson	Undergraduate Student	4
Suzanne Walther	Faculty	2
Thomas Walsh	Graduate Student (research assistant)	6
Carla Trentelman	Faculty	1
Carolyn Stwertka	Graduate Student (research assistant)	6
Court Strong	Faculty	2
Philip Stoker	Graduate Student (research assistant)	6
Paul Spruell	Faculty	2

Zachary Scott	Undergraduate Student	3
Madlyn Runburg	Other	1
Jacob Richardson	Graduate Student (research assistant)	2
Christine Pomeroy	Faculty	2
Omar Perez-Reyes	Graduate Student (research assistant)	6
Stephen Peaden	Undergraduate Student	2
Augustina Odame	Graduate Student (research assistant)	6
Lorie Millward	Other	2
Jon Meyer	Graduate Student (research assistant)	4
Matt Lorimer	Technician	2
Enjie Li	Graduate Student (research assistant)	4
Kevin Landom	Other Professional	6
Karthik Kumarasamy	Graduate Student (research assistant)	4
Julia Kelso	Graduate Student (research assistant)	4
Christopher Keleher	Other	1
Rusty Keele	Technician	2
Erin Jones	Graduate Student (research assistant)	2
Ryan Jensen	Faculty	1
Dasch Houdeshel	Graduate Student (research assistant)	6
Brian Greene	Technician	6
Timothy Goodsell	Graduate Student (research assistant)	3
Carolina Gomez-Navarro	Graduate Student (research assistant)	6
Steven Emerman	Faculty	1

Dave Eiriksson	Technician	7
James R Ehleringer	Co PD/PI	1
Joe Crawford	Technician	7
Chris Cox	Technician	7
Steve Corbato	Faculty	5
Scott Christensen	Graduate Student (research assistant)	6
Allison Chan	Graduate Student (research assistant)	6
Jobie Carlisle	Technician	5
Molly Cannon	Technician	2
Steve Burian	Faculty	1
Martin Buchert	Faculty	1
Dave Bowling	Faculty	2
Daniel Bedford	Faculty	1
Jim Barta	Faculty	1
Harsha Balam	Graduate Student (research assistant)	4
Brian Bailey	Graduate Student (research assistant)	6
Andrea Armstrong	Graduate Student (research assistant)	6
Jessica Anderson	Technician	3
Zachary Aanderud	Co PD/PI	1

### What other organizations have been involved as partners?

Name	Location
AAAS	Washington, DC
Campbell Scientific, Inc.	Logan, UT
Central Utah Water Conservancy District	Cache County, UT
Central Utah Water Conservancy District	Utah

Consortium of Universities for the Advancement of Hydrol	Washington D. C.
Edith Bowen Laboratory School	Logan, UT
Envision Utah	Salt Lake City, UT
Georgia Tech	Georgia
HydroShare	Utah
Logan city	Logan, Utah
Mountainland Association of Governments	Utah
National Ecological Observatory Network (NEON)	USA
Natural History Museum of Utah	Salt Lake City, UT
North Carolina Museum of Natural Sciences	North Carolina
Pleiades Software, Inc.	Salt Lake City, UT
Provo City School District	Utah
Salt Lake Center for Science Education	Utah
Salt Lake City	Salt Lake City, Utah
Salt Lake City School District	Utah
Salt Lake Community College	Salt Lake City, UT
Salt Lake County	Salt Lake City, Utah
State of Utah Dept. of Natural Resources	Salt Lake City, UT
The Leonardo	Salt Lake City, UT
U. of Alaska	Alaska
U. of Hawai'i	Hawai'i
U. of Nevada-Reno	Nevada
U. of New Hampshire	New Hampshire
U. of New Mexico	New Mexico

U. of Vermont	Vermont
UEN - Utah Education Network	Salt Lake City, UT
USDA	Maryland
USFS	Washington, DC
USGS	Moab, UT
USTAR	Utah
University of Wyoming	Wyoming
Utah CI-WATER	Utah
Utah Division of Water Quality	Utah
Utah Governor's Office	Salt Lake City, UT
Utah Rural Schools Association	Utah
Utah State Office of Education	Salt Lake City, UT
Utah System of Higher Education	Salt Lake City, UT
Wasatch Front Regional Council	Utah

### Have other collaborators or contacts been involved? Y

## Impacts

### What is the impact on the development of the principal discipline(s) of the project?

During the first nine months of this project, the research teams have made progress on five distinct fronts. First, they have identified the sites for sensor locations along montane-to-urban gradients within three watersheds along the Wasatch Front. In addition to planning the deployment of the sensor network, they have engaged scientists, citizens and students in the process of ecosystem modeling and public involvement. Second, we have developed inclusive research groups that span across multiple campuses. The involved disciplines include: Atmospheric Science, Biology, City and Metropolitan Planning, Climate Science, Civil and Environmental Engineering, Ecology, Engineering, Hydrology, Landscape Architecture and Environmental Planning, Soil Physics, as well as resource sociology, water sociologist and resource economics. We have developed close-working teams within and across disciplines and gathered baseline data about our study areas. Third, with respect to modeling, we have also improved downscaled climate models and transient storage models and designed a research infrastructure that will enhance research and training opportunities in Utah for students in the social and engineering sciences. Developing new software tools for managing streaming sensor data is also having an impact on the main discipline of this project. Fourth, through these initial collaborations, we have developed a group of faculty interested in bringing the newer discipline of coupled human-natural water dynamics to our campuses. Fifth, we have designed a cyberinfrastructure that will enhance research and training opportunities in Utah. Lastly, the initial research planning and its results have been presented by graduate students and faculty at professional meetings as well as at a number of university seminars throughout the U.S. (winter 2012/13 and

spring/summer 2013).

### **What is the impact on other disciplines?**

The broader impacts of this project on other disciplines span aquatic ecology, atmospheric science, biogeochemistry, urban ecology, and urban planning. We have built close-working relationships with colleagues within and outside of iUTAH who represent non-social or engineering disciplines and have participated in cross-disciplinary collaborative meetings to plan the full research infrastructure for iUTAH, having presented our social and engineering science work to natural science audiences. A dialogue with the other disciplines in iUTAH on the synthesis of disciplinary research to understand complex coupled human-natural dynamics is being developed. Involving citizen scientists in the use of climatic and aquatic monitoring devices to collect data for their communities and academic researchers has also had an impact on other disciplines.

### **What is the impact on the development of human resources?**

For this reporting year, iUTAH has had a direct impact on the development of human resources at the undergraduate student, graduate student, and technician levels.

In RFA 1, we trained 6 graduate students (3 female, 3 male) and contributed to the development of a technical workforce (3 male). A postdoctoral fellow was hired and he will begin in August 2013.

In RFA 2, we trained 6 graduate students (3 female, 3 male) and 2 undergraduate students (2 male). We also recruited and trained 1 female technician. We conducted a national search that resulted in the hiring of a new faculty member in sociology (iUTAH-sponsored hire; Utah State) and a postdoctoral fellow in social/engineering sciences both of whom will begin in August 2013.

In RFA 3, we trained four graduate students (2 female, 2 male, one Hispanic). A female postdoctoral fellow was hired and she will begin in August 2013.

The cyberinfrastructure component of this project has trained 2 undergraduate students (2 male) and recruited and trained one technician (male). The cyberinfrastructure group has contributed to the professional training of 2 females and 1 male. We offered a multi-campus Hydroinformatics course, in which there was participation by 30 across 3 universities.

Involving citizen scientists in the use of monitoring devices to collect data for the academic researchers has also had an impact on human resource development in the communities of Utah.

A table showing the new iUTAH EPSCoR hires since our Aug 1 start date are provided in Table 9.

### **What is the impact on physical resources that form infrastructure?**

A central physical infrastructure of iUTAH during year 1 has been the design and construction of a climate-hydrologic observatory across mountain-to-urban gradients in three watersheds. It is a network of climate and aquatic monitoring stations referred to as GAMUT (Gradients Along Mountain to Urban Transitions), designed to be installed in three contrasting watersheds along the Wasatch Front in the summer of 2013. The sites have been selected and the network has been designed to monitor the Logan River, Red Butte and Provo River watersheds. We have acquired all of the required analytical equipment for both the research and training parts of this physical infrastructure improvement.

To complement the GAMUT network and provide stronger coupling among RFA1, RFA2, and RFA3, we are installing multiple storm drain monitoring equipment so that we can monitor water runoff from different urban drainages (representing contrasting urban forms) in the urbanized Red Butte Creek watershed. This stormwater monitoring network was designed to record real-time flow data from the four primary and contrasting storm drainage systems that convey runoff to Red Butte Creek. This will characterize the stormwater generated by the current infrastructure and to predict the mediation that could be achieved by implementing green infrastructure. Upon final approval, the hardware will be purchased and installed in May; model calibration will occur in May and June with the final green infrastructure implementation plan to be written in July.

A virtual server and storage infrastructure has also been designed and deployed with the USU enterprise data center to host the iUTAH Modeling and Data Federation (MDF). All other components of iUTAH have provided contribution of data to the iUTAH Data Federation. We designed, purchased, and deployed a virtualization environment consisting of servers and storage to host the iUTAH Modeling and Data Federation. We designed and implemented web-based model and data inventories at <http://data.iutahepscor.org> for existing and planned models and data in collaboration with the RFAs. We conducted the deployment of databases, software, and web services to support streaming sensor data from GAMUT sites.

A Green Infrastructure Research Facility (GIRF) is the other physical infrastructure being designed and developed during the first year of iUTAH. The GIRF planning team has completed a conceptual design of the facility and obtained a preliminary cost estimate from the University of Utah Office of Campus Design and construction for three 200 ft<sup>2</sup> buildings and twelve 81 ft<sup>2</sup> multipurpose soil systems. The buildings could be used to evaluate household or structure energy use implications of green infrastructure (GI) such as green roofs, green walls, and bioretention surrounding the buildings. The soil systems will be used to measure total water loss associated with different types, evaluate design of GI plant communities, to optimize stormwater and graywater treatment functionality in arid areas, and assess cultural demands (such as aesthetics) to improve adoption likelihood.

### **What is the impact on institutional resources that form infrastructure?**

iUTAH strengthens and improves the institutional resources of all participating institutions. The institutional resources of all participating universities and collaborating partners and agencies have been benefited from the first year of the iUTAH project. As a result, six journal articles have been published, 51 presentations have been made, and most importantly, and 22 proposals were submitted. Five websites were developed; 9 databases were developed and went live for the public to use.

Two honors and awards were given to faculty participating in iUTAH this year. M Baker received graduate mentor of the year and S. Jones received the researcher of the year award, both at USU.

The GAMUT (Gradients Along Mountain to Urban Transitions) and GIRF (Green Infrastructure Research Facility) facilities will provide important place-based infrastructure for research and education for the foreseeable future.

### **What is the impact on information resources that form infrastructure?**

The Cyberinfrastructure component of the iUTAH project has begun developing the hardware and software systems that will not only support management of the data collected under the iUTAH project, but will also facilitate a greater degree of collaboration among iUTAH students and scientists. One major impact of the iUTAH Cyberinfrastructure is the recognition among iUTAH researchers that it is no longer sufficient to work and collect data independently within



disciplines or subgroups. The iUTAH Cyberinfrastructure is seen as an integral component of the overall project and necessary to promote data and model sharing and collaboration among the iUTAH research teams.

The server hardware that we have deployed provides us with a flexible platform to implement the systems needed by iUTAH researchers. For example, we have deployed an interim data sharing web application at <http://cloudshare.iutahepscor.org> and are now supporting a website at <http://data.iutahepscor.org>, where we are hosting online data and model inventories to assist iUTAH researchers in cataloging and prioritizing existing datasets and models. We are now working on deploying the databases, web services, and software required to manage the continuous, streaming datasets from the GAMUT network. The major impact of this infrastructure will be to enable management of the data across the participating institutions and broad access to these data across iUTAH project participants and partners.

Another major impact is in training the next generation of engineers and scientists. The iUTAH Cyberinfrastructure Team has collaborated with the Utah EPSCoR CI-WATER project in the development and delivery of a graduate level course in Hydroinformatics across the three major Utah research universities. In this course we trained 30 engineering students in data management, modeling, and Hydroinformatics concepts to better prepare them to work in a data and computationally intense work and research environment. The Cyberinfrastructure team has also integrally involved three computer science undergraduate students in development of the iUTAH data management-related software.

In less than one year, we have developed 4 websites that can be used as repositories of information available for all iUTAH participants and the public. These sites are:

1. <http://iutahepscor.org>, our main public and researcher websight was developed and deployed.
2. <http://report.utepscor.org>, our Drupal site where all reporting information is uploaded and displayed was designed in concert with our other Drupal Collaborators and functioned as our primary source of information for this report
3. <http://data.iutahepscor.org>, a site for online model and data inventories were developed and deployed
4. <http://cloudshare.iutahepscor.org>, a site for interim collaborative data and file sharing
5. <https://usu.instructure.com/courses/127332>, a site for materials from the Hydroinformatics course

In addition, 9 databases have been developed and uploaded into the World Wide Web to be available to the final users. These databases are:

1. [Geospatial Data Bases](#). Joanna Endter-Wada
2. [Exploratory interviews of water managers](#). Andrea Armstrong
3. [Database for Water Infrastructure Investment](#). Augustina Odame
4. [Qualitative interview data](#). Zhao Ma
5. [Stochastic water supply and demand Excel simulator](#). Charles Sims
6. [Hydroinformatics Course Materials](#). Jeff Horsburgh
7. [Data Collection for Red Butte Creek](#). Thomas Walsh
8. [Utah BWR Infrastructure Database](#). Andrea Armstrong
9. [SWMM Model of Red Butte Creek Between Reservoir and Foothill Dr.](#) Christine Pomeroy

This information is now available to other researchers and the public.

### **What is the impact on technology transfer?**

During the course of this award, four software packages have been made available to the public as a part of the technology transfer objectives of this year's activities.

1. A beta release of a web-based graphical user interface has been developed for the iUTAH GAMUT (Gradients Along Mountain to Urban Transitions) sensor data management database.
2. A beta release of a software program for managing and performing quality control of streaming sensor data was

developed and released.

3. Existing tools from the CUAHSI HIS (Consortium of Universities for the Advancement of Hydrologic Science, Inc - Hydrologic Information System) have been deployed in anticipation of managing the streaming sensor data from GAMUT.
4. An extension to the existing CUAHSI HIS Observations Data Model (ODM) has been developed to assist RFA1 researchers in managing the sensor and data collection infrastructure across the GAMUT site.

## What is the impact on society beyond science and technology?

This award has two broader impacts that reach beyond science and technology:

- the workforce development and enhancement of graduate and undergraduate training in Science, Technology, Engineering, and Mathematics (STEM)
- a growing collaboration with local water resource managers (cities, county, irrigation/canal companies).

Workforce development and the expansion of the STEM opportunities are critically important to sustain the growth of the state of Utah's high technology sector. Guiding principles for iUTAH's workforce development plan have included integrating research and education, providing near-peer mentoring, encouraging diversity, and creating public-private partnerships. Research and education activities are planned for: K-6 students, middle school and high school students and teachers, undergraduates at community colleges, primarily undergraduate institutions (PUIs), and the major research universities, graduate students, postdoctoral fellows, and early career faculty and established faculty. These experiences are directly related to iUTAH's research questions, so the focus will be on the watershed observatories and modeling activities in the three RFAs.

Collaborations with local waters resource managers and the public include outreach, communication, and dissemination activities to translate iUTAH efforts to diverse audiences in order to engage key stakeholders and the general public in the results and outputs from iUTAH research. These partnerships are bringing together researchers, educators, students, stakeholders, and policy makers to design and develop decision-making exercises. Mixed models of social and hard sciences are being used for both collaboration and evaluation as a novelty in the iUTAH process. Workforce Development and Diversity Enhancement goals are also incorporated into this work.

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## Changes

### Changes in approach and reason for change

There is only one aspect that we could mention as a change in approach. This is related to the measurements of physical environmental variables in the urban scenarios. There is not a consensus on urban eddy covariance measurements as originally proposed because of lack of human resources needed to manage and analyze the data and because of potential methodological issues. Therefore, we have shifted from organizing around a physical data/modeling visualization facility to a more distributed approach.

### Actual or Anticipated problems or delays and actions or plans to resolve them

We are basically facing two problems or delays that we are trying to solve. First, permits for the location of instruments in the field, specifically on US Forest Service property, are still in process. We are working on this; it may take six months to resolve.

At the advice of the advisory board, we have re-envisioned the main Research Focus Area 3 facility from a decision-theater to a varied and distributed series of modeling and visualization tools for collaboration, outreach, and stakeholder involvement. We have been actively engaging stakeholders and students in the rapidly evolving restoration plans for Red Butte Creek, which are on a fast track for construction and scheduled to be completed this summer. The elimination of the decision theater will result in a delay as we conduct exploratory research on the most effective tools and methods for visualizing models and data to promote collaboration and engagement.

## Changes that have a significant impact on expenditures

We will request to carry over approximately \$587,000 of unobligated funds or roughly 15% of our original budget. This includes approximately \$71,000 in salaries, benefits and wages; \$67,000 in sample processing and supplies; \$68,000 in travel; \$55,000 in Participant Support Costs; \$25,000 in Tuition; and \$300,000 in major equipment.

The majority of travel and Participant Support Costs (PSC) carryover is due to our annual symposium and external advisory board review being held on July 27, 2013, right at the end of this year's budget.

The majority of the equipment carry over is for our urban eddy flux towers. We are currently working with NEON (National Ecological Observatory Network) to co-place our iUTAH and NEON towers. In addition, we are exploring a new, mobile flux tower.

The majority of supplies, analytic costs and wages are due to not hiring all personnel right at the beginning of the project and not having all of our sampling regimes in place.

## Significant changes in use or care of human subjects

Under the Research Focus Area 2 component of this award, individual investigators or teams pursued and received Institutional Review Board (IRB) permission for human subjects research where appropriate.

## Significant changes in use or care of vertebrate animals

Nothing to report.

## Significant changes in use or care of biohazards

Nothing to report.

## Special Requirements

### Responses to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements.

Our State Science and Technology Plan was submitted to NSF and approved. Our revised education plan was submitted to NSF and approved. Our Strategic Plan was submitted and revised and accepted on April 27, 2013 and is attached as a pdf. Our External Advisory Board Report is also attached as pdf.

### Supporting Files

Filename	Description	Uploaded By	Uploaded On
iUTAH_Strategic Plan_final_accepted_25Apr13.pdf	PDF of final, NSF-approved Strategic Plan.	Todd Crowl	04/30/2013
iUtah EPSCoR EAB review 2012.pdf	External Advisory Board Report	Todd Crowl	05/01/2013