iUTAH Response Addendum

to the 2015 (Year 4) Reverse Site Visit Report

RII Award OIA-1208732

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BACKGROUND AND INTRODUCTION

As part of its oversight of Research Infrastructure Improvement (RII) Cooperative Agreements, the National Science Foundation (NSF) invited iUTAH to a Reverse Site Visit (RSV) at NSF headquarters in Arlington, Virginia, on September 10, 2015, during year 4 of the iUTAH project. The RSV provided iUTAH an opportunity to submit a detailed overview of progress relative to established goals and objectives; to report on results, accomplishments, and impacts to date; and to discuss plans for the future sustainability of its research, education, outreach and diversity programs. A panel of independent experts was asked to provide formative and summative assessment of iUTAH's activities based on presentations given by iUTAH researchers and project office staff. The RSV review panel's report was made available to iUTAH on October 23, 2015. In its report, the review panel assessed both strengths and weaknesses of each of the research focus areas (RFAs) and other project elements of the iUTAH research project; and revisited recommendations from the prior RSV on September 25, 2013; culminating in four recommendations intended to benefit the continued success and long-term sustainability of iUTAH. iUTAH submitted responses to each of these recommendations on 23 November 2015. Following review of these responses, NSF requested additional input to clarify iUTAH's responses to Recommendations 1b and 4a to satisfy the concerns that are summarized below.

REQUESTED CLARIFICATIONS

1. iUTAH would benefit from explicitly stating how the theoretical foundations and contributions of the team's work will have intellectual significance beyond Utah.

    b) Submit a plan for ensuring that the theoretical social science contributions regarding landscape transition and transformation build on progress to date, and that research findings will be disseminated, especially to the scientific community through peer-reviewed publications.

The response to this recommendation identifies several activities that iUTAH will focus on to ensure progress on landscape transition and transformation research. Having identified these specific activities, please respond to the remaining part of the recommendation by providing a plan for ensuring that these activities can progress through the remainder of the project period. For each of the four

activities, the plan should include:

1. Primary milestones, deadlines, outcomes, and outputs. The outcomes should include data sets or operable models that will be available to stakeholders after the completion of the project.
2. The names of lead researcher(s) who will carry out specific tasks; and
3. A timeline with metrics or milestones

iUTAH EPSCoR RESPONSE

Recommendation 1b—Explicitly state how the theoretical foundations and contributions of the team's work will have intellectual significance beyond Utah.

Overview—We appreciate the opportunity to provide more details about the timeline and outputs/outcomes related to iUTAH's research on landscape transitions and transformations.

Three overlapping teams are working to create datasets and models that have or will contribute to the goals listed above.

The first team is centered on work by iUTAH doctoral student Enjie Li in the Department of Environment and Society (ENVS) at Utah State University. Ms. Li is mentored by Dr. Joanna Endter-Wada (ENVS) and Dr. Shujuan Li (Landscape Architecture and Urban Planning) with additional input from Dr. Mark Brunson (ENVS) and Dr. Douglas Jackson-Smith (Sociology). Ms. Li's work has or will address all four focal areas noted in the request for more information.

A second team builds on models being developed by Caleb Buahin, a doctoral student in Civil and Environmental Engineering working under the mentorship of Dr. Jeffery Horsburgh. Mr. Buahin's work is focused on combining land change models with a coupled urban (SWMM) and rural (PIMS) hydrologic model of Logan City area. His specific connection to models of landscape transformation have been to (a) actively contribute to dynamic regression-based land change models being developed by Ms. Li, and (b) incorporate output from land use change models as inputs into his coupled model of the urban water system to evaluate the impact of those land use changes on stormwater flows and flooding risks.

A third group is the RFA coupled systems modeling team being led by Dr. Krishna Khatri (an iUTAH postdoctoral research fellow) under the mentorship of Dr. Courtenay Strong at the University of Utah. This team is developing a loosely coupled and calibrated HSPF model that is capable of using output from Ms. Li's land change model (and down-scaled climate change models) to simulate water demand and water availability in Salt Lake County.

A plan including information about lead researchers, outputs, outcomes and a timeline with milestones is provided below. The plan also highlights ways in which stakeholders will be engaged in these efforts.

Activity A) Develop a dataset that links spatial land use and census demographic information

Lead researcher(s): Enjie Li; Shujuan Li, Joanna Endter-Wada

Outputs: We have been working to overlay National Land Cover Dataset (NLCD) from 2001 and 2011 with 2000, 2010 US census data respectively to produce a dataset that links spatial land use with information about population density, housing characteristics, and other demographic information.

Outcomes: The integrated spatial dataset will allow for multi-scale analysis, from census block to county level. Also, spatial display of census data will help other iUTAH researchers to understand certain social questions from a spatial perspective.

Timeline/Deadlines/Milestones: Data processing and compilation will be finalized in May 2016 and used in modeling activities described below. The completed dataset will be uploaded to iUTAH repository with open public access before the end of the iUTAH project period (July 2017).

Stakeholder Engagement Plans: Agency personnel in charge of producing and maintaining some of the databases used for the analysis are being consulted to ensure proper use and interpretation of the data. Analysis results will be presented to them for further stakeholder review prior to submission of manuscripts for publication.

Activity B) Use historic data from across the WRMA to develop models that characterize the past processes of land conversion

Lead researcher(s): Enjie Li; Shujuan Li, Joanna Endter-Wada, Caleb Buahin, Jeffery Horsburgh

Outputs: The spatial dataset mentioned above will be used to generate two types of outputs: 1) Maps characterizing historic spatial patterns of land use changes within the agricultural and urban landscapes; 2) Descriptive statistics summarizing historic trends in and spatial patterns of land conversion between different land use types across the WRMA; 3) an updated cellular automata (SLUETH) land change model that covers Salt Lake County (previously developed models have focused only on Cache County), and 4) initial versions of a Bayesian statistical regression land change models using parcel scale data for Logan City and Cache County that link attributes of parcels with their likelihood of conversion to different forms of urban development.

Outcomes: Urban growth and agricultural land conversion are the most contentious land use issues in the West. Characterizing and quantifying historical land use is important to monitor the process and consequences of landscape change. Quantitative analysis and characterization will help local, regional and state land use planners to better identify and understand historical land use trends and patterns, and provide insights to effectively address future land use related issues. In the context of water management, different rates, patterns, and processes of urban growth, and of agricultural land conversion, are expected to have varying impacts on water resources. The characterization and statistical modeling of landscape change processes provides a foundation to identify potential water management implications (described below).

Timeline/Milestones/Deadlines: Statistical modeling of WRMA historical land use data, with focus on urban growth characterization and how agricultural landscapes change in the face of urbanization has already been going on. The SLEUTH model for Cache County will be extended to Salt Lake County by March 2016. An alternative spatial regression based statistical model for Cache County

should be completed by August 2016. Manuscripts submissions based on these analyses are anticipated by Fall 2016. Models developed at this stage will be used to accomplish the activities listed below.

Stakeholder Engagement Plans: The maps and models developed in this activity will be made available to researchers within or outside iUTAH to conduct fine-scale investigations of the causes and consequences of local patterns of land use transformations. Also, results will provide the basis for generating land use change simulations and scenarios that can serve to inform discussions with local and state water managers about the implications of expected patterns of urban growth.

Activity C) Use land change models to simulate expected patterns of future landscape transformation; incorporate model output into coupled models of urban water systems

Lead researcher(s): Enjie Li (Shujuan Li, Joanna Endter-Wada); Caleb Buahin (Jeffery Horsburgh); and Krishna Khatri (Courtenay Strong, Martin Buchert).

Outputs: The statistical land change models developed in Activity B above will be used to generate maps and GIS layers of predicted urban growth patterns through 2040 (on an annual timestep). The simulated land use dataset will include information about predicted land use types (i.e., agriculture, urban, grassland, forest, and water). These land change simulation models will also be loosely coupled with the urban water systems models being developed by Mr. Buahin. Specifically, outputs from the land change model will be used as inputs for the Stormwater Management Model (SWMM) and Penn State Integrated Hydrologic Model (PIHM) that are components of the urban water system model for Cache County that is being developed by Mr. Buahin. Similarly, the major future drivers that may have impact on the water availability in the region will be analyzed by Dr. Khatri and the larger RFA3 coupled system modeling team. They will develop a watershed model (based on HSPF model) and apply the framework to Salt Lake Countywide watershed. The HSPF model will be loosely coupled with a land use change model and downscaled climate models so that outputs from these models

can be considered for the future scenarios analysis. The model will also be applied to understand the important future change drivers in the study area and analyze future water availability. In both cases, initial coupled modeling will be based on the SLEUTH model output; future efforts will incorporate output from the Bayesian spatial regression land change models if those models prove to be reliable.

Outcomes: The land use simulations provide an empirical basis for the development of the loosely coupled systems models that are important outputs in this last phase of the iUTAH effort. The simulations and coupled model output will also inform decision makers and professionals on projected future changes in land use, climate and population, and how these changes will impact water demand, water availability and flooding.

Timeline/Milestones/Deadlines: The formal simulations of future land use patterns in the WRMA are expected to be completed by August 2016. Manuscripts will be submitted in Spring 2017. Model code and model simulations will be published on the iUTAH data repository with open public access before the end of the iUTAH project (July 2017).

Stakeholder Engagement Plans: The RFA3 team, led by Dr. Khatri, plans to hold a 1/2 day meeting/workshop with local stakeholders in late summer or early fall 2016 to verify the assumptions and review the initial output from the coupled urban water system model for Salt Lake County. This workshop will help to build the technical capacity of local professional such as planners, engineers, and analysts to apply the developed computer models and to understand the implications of urban growth patterns for urban water supply and demand. Key stakeholders include: Salt Lake City Public Utilities; the Utah Division of Water Quality, and the Utah Division of Water Resources.

Activity D) Development and use of alternative scenarios to inform public policy

Lead researcher(s): Enjie Li (Joanna Endter-Wada, Shujuan Li); Krishna Khatri (Courtenay Strong and Martin Buchert) in collaboration with other iUTAH RFA3 members

Outputs: This group of iUTAH researchers will use the results of the research and stakeholder engagements listed above to develop and evaluate a set of alternative urban growth scenarios and their implications for urban water systems in Utah. These scenarios will be designed to reflect or address the concerns of Utah's water system managers, but capture alternative approaches to land use and water resource policy. Previous iUTAH work by Ms. Li utilized three core scenarios (Plan Trend, Agricultural Land Preservation, and Water Resource Protection) to assess impacts on water resources and ecosystem services in Cache Valley (publication forthcoming). Future scenarios will build on that model, but will reflect the results of interactions with key stakeholders.

Outcome: Alternative scenarios are a valuable tool to visualize the implications of various land use and water management policy options. The development of coupled models that link land use changes with water system outcomes (described in Activity C above) provides unique and valuable information about the systemic consequences of alternative public policies, and can highlight trade-offs between alternative public goals.

Timeline/Milestones/Deadlines: The outlines of alternative growth scenarios will be developed in consultation with key stakeholders and the broader iUTAH RFA3 research team by October 2016. The resulting scenarios will be used to guide another round of simulation modeling in the winter of 2016/17. Manuscripts with outputs of alternative scenarios of land use will be ready for submission in Spring 2017.

Stakeholder Engagement Plans: This activity relies heavily on engagement with key water stakeholders, including public utility staff, local and state water managers and elected officials, and representatives of various agricultural, environmental, business, and real estate development interest groups. The workshop with Salt Lake County stakeholders outlined in Activity C above will be supplemented by additional meetings and workshops with stakeholders in Cache County in the fall of 2016. Ongoing interactions with key stakeholders to review draft scenarios and model outputs will continue through July 2017.

REQUESTED CLARIFICATIONS

4. Submit a plan for sustaining project activities and infrastructure beyond the period of the RII Track-1 funding. Address in particular the strategies for:

   a) Securing funding to sustain key infrastructure such as observations in GAMUT and cyberinfrastructure facilities;

   Please resubmit your response to Recommendation 4a). A key intent of this recommendation is for iUTAH to identify and prioritize key infrastructure components, such as specific components of GAMUT or cyberinfrastructure assets, with a focus on how these investments might be sustained beyond the duration of the RII Track-1 award. In the response please identify which infrastructure will be prioritized and how further prioritization will proceed for the remainder of the project. Please provide specific examples and strategies (with timelines and milestones) for how these assets will be sustained (other than pursuing federal funding through proposals).

Recommendation 4a—Submit a plan for sustaining project activities and infrastructure beyond the period of the RII Track-1 funding.

Overview—We appreciate the opportunity to clarify our infrastructure prioritization and strategy for sustainability. These are addressed in turn below.

Prioritization of key infrastructure—Prioritization of infrastructure investments has proceeded using input from quarterly assessment of milestones and metrics as outlined in iUTAH's strategic plan, in addition to external input from the iUTAH External Advisory Board, AAAS, and reports from our External Evaluator, Jacque Ewing-Taylor. This process will continue moving forward over the remainder of the project.

iUTAH has identified the GAMUT sensor network and the data management and sharing of sensor output as the most important investment to sustain post-iUTAH. The GAMUT includes 12 terrestrial stations and their sensors, 16 aquatic stations and their sensors, 6 storm drains and their sensors. Data management and sharing includes the telecommunications platform, software and hardware that enable data QA/QC, data sharing, and webservices that are provided by the iUTAH Cyberinfrastructure team.

The analytical facilities that enable sample analysis associated with the iUTAH observatory are a second priority. Parallel analytical equipment now exists at BYU, UU, and USU that enable sample processing using common standard operating procedures for many analyses, as well as specialized analyses at each institution. These services are available to students and other researchers state-wide, and will be maintained by analytical cost recovery and support at each institution.

Tertiary priorities are the green infrastructure research facility and the iUTAH visualization lab. Given that these facilities were re-scoped mid-project, outputs and outcomes are coming forward. As additional progress is made in using these facilities the iUTAH Leadership Team and Management Team will reassess priority in March and July 2016.

Strategies for sustainability—Sustaining project activities and infrastructure beyond the period of Track-1 funding is a key objective for the iUTAH Leadership Team and project participants over the next year. The Leadership Team is taking a multi-faceted approach to secure resources to sustain key research infrastructure. Our strategy includes working with the State EPSCoR committee and university government relations officers, university administrators, city and county stakeholders, and federal funding programs. Targeted federal funding programs were listed in tables 2 and 3 of the initial iUTAH RSV response. In tablular form below, we describe our goal, specific strategies, timelines, milestones, accomplishments to date, and anticipated outcomes of our activities. Many of these activities have been ongoing for the past 18 months and were described in narrative form in the initial response to the RSV.

Goal. Institutionalize iUTAH's research infrastructure and research collaboration among Utah's institutions of higher education.

This has been iUTAH's priority since inception and will be accomplished by legislative appropriation to establish the Institute for Utah's Air and Hydro-systems (iUTAH)

Strategy 1. Build coalition to document need among stakeholders in Utah (users of water data)

Specific actions	Timeline	Milestones	Lead (s)	Accomplishments in year 4	Anticipated Outcome
Presentations of Household Survey Results to municipalities	November 2015 – June 2016	5 presentations/ discussions scheduled through June 2016	RFA2	4 presentations	1. Access to water use data for informing models 2. Participation in coupled modeling workshops 3. Signatory to or support for legislative request
Presentations of iUTAH water cycle and social science results to state agencies	Ongoing through October 2016	5 presentations/ discussions scheduled through June 2016	iUTAH LT, RFAs	Presentation scheduled to UT Div. Water Resources scheduled 2/2016	1. Access to water use data for informing models 2. Participation in coupled modeling workshops 3. Signatory to or support for legislative request
Presentations of iUTAH water cycle/storm water results to city planners	Ongoing through October 2016	3 Presentations/ discussions scheduled through June 2016	iUTAH LT, RFAs		1. Participation in coupled modeling workshops 2. Signatory to or support for legislative request
Outreach to other stakeholders	Ongoing through October 2016	3-5 booths, presentations or similar events 3-5 articles in local	iUTAH LT, RFAs	Salt Lake County Watershed Symp. Utah Water and Energy Summit Intermountain	Raise awareness by elected officials and public

		newspapers		Sustainability Summit	
Engagement with governor's office	Ongoing through October 2016	2-3 meetings	iUTAH LT, University government relations/ Presidents	USU's presentation to governor 2/2016	
Strategy 2. Strengthen support among university administrators and faculty for iUTAH's infrastructure and research capacity					
Specific activities	**Timeline**	**Milestones**	**Lead(s)**	**Accomplishments in year 4**	**Anticipated outcome**
Presentations to administrators	Ongoing through October 2016	3-5 presentations/ discussions with executive level administrators 3 presentations to college Deans	iUTAH LT/MT	Weber State	Signatory to or support for establishment of Institute, legislative request
Engagement of faculty who are not part of iUTAH	Ongoing	Host conference/workshop 3-5 new faculty engaged	iUTAH LT/MT, RFAs	Spring Runoff Conference 4/2016 2 new faculty engaged	Support for establishment of Institute
Strategy 3. Develop funding request to Utah legislature to establish the Institute for Utah's Air and Hydro-systems					
Specific activities	**Timeline**	**Milestones**	**Lead(s)**	**Accomplishments in year 4**	**Anticipated outcome**
Institute white paper	Feb. 2016	1 white paper	Brooks, Baker, Ehleringer	Draft in progress	Form talking points
Meetings with EPSCoR ExComm	Ongoing	5-6 meetings	Baker, Brooks	3 meetings	Codify message (need, mission, benefits, etc.)
Meetings with government relations	Ongoing	3-4 meetings	EPSCoR ExComm, Baker	1 meeting	Translate message to legislature
Legislative request	Fall 2016/ Winter 2017	Proposal to legislature	EPSCoR ExComm, Baker via gov't relations/ University presidents		Funding for iUTAH 2.0

Risks and mitigation strategy—Legislative appropriation to sustain the key research infrastructure as a core facility to facilitate collaboration among Utah's institutions of Higher Education is admittedly risky. iUTAH leadership and State EPSCoR committee members recognize this. Risks include elected officials that bristle at phrases such as "climate change" and "population growth." At the same time, recent events at the state level include a legislative audit (May 2015) showing that data and information used to back proposals for water development in the Bear River (serving the Wasatch Front) and Colorado River (In Southern Utah) were insufficient to justify water development projects estimated at $1B. iUTAH has and continues to position our work in concert with the state's efforts to inform such issues. As such, we recognize this as an important and timely opportunity to best capitalize on the transformations afforded to our jurisdiction by NSF EPSCoR's investment.

There are several potential outcomes of our strategy, the worst of which would be that the universities opt not to go forward with a proposal to the legislature, or that the legislature does not vote for our proposal. Even if this is the outcome of the 2017 legislative session, we are confident that the process of coalition building among stakeholders and university administration will lead to sufficient funds to maintain the core sensor network and data management/sharing infrastructure. This support will be codified via memoranda of understanding and financial commitment. Already we have had such discussions with key university administrators and city officials, and will have at the ready memoranda to codify financial agreements to be signed in late summer/early fall of 2016.