

MANAGEMENT PLAN

Organizational structure

The **PI** will manage the overall research process and project schedule, including but not limited to scheduling meetings, outlining agendas, monitoring overall budget and overseeing interactions with advisory groups such as the “pilot” municipality partners and the Evaluation Center throughout the duration of the research project (5 years).

Each **Co-PI** will lead the research process within a specific Thrust where the research activities within that are closely related to their disciplines and research expertise. The PI will serve as lead in the 5th year. (visualization/evaluation). A thrust “Lead” will be responsible for establishing and monitoring the goals, benchmarks, and products to be undertaken within that specific area. They will monitor budgets, resource allocation and provide updates at team meetings, and ensure that communication channels are functioning and problems or issues are relayed to PI and other team members for discussion and redress. They will also work together with the other Co-PIs whose activities overlap as the project transitions to ensure that the transitions run smoothly and all goals and deliverables are achieved.

The **PI**, **Co-PIs**, and **Senior Collaborators** will all focus on the particular types of research activities closely related to their expertise throughout the duration of the project. These activities may be focused largely within one thrust or span several thrusts. Though all members of the research team will be updated periodically through team meetings and have direct input throughout the entirety of the research project, as specific activities, goals, and milestones emerge within each thrust, teams of expertise will be formed within a particular “thrust” to undertake the specialized tasks and activities necessary to reach goals of that phase..

Reporting Structure

The research team will have bi weekly face to face or online meetings throughout the project to review and maintain a common understanding of research progress upcoming deliverable deadlines, and milestones reached. Meetings will inform key personnel of recent developments, set agendas & new research goals, review budgets and expenses, set and review deadlines for completion of work units and coordinate the distribution of work. During the meetings, the team will discuss issues and findings from a multi-disciplinary viewpoint and will involve process of ongoing feedback with the evaluation center to make sure communication is at the highest level possible. The partner municipalities (Ridgeway/Brighton) will be engaged at key points in the research process (mainly thrusts 2, 4, & 5) to validate preliminary findings and interpretations, as well as to align initial findings with their specific priorities and resource assets. The emphasis on active engagement with various disciplinary academic groups through national/international conferences will provide the team with the necessary disciplinary evaluation and feedback throughout the project.

Project Team: Qualifications and Experience:

PRINCIPAL INVESTIGATOR:

(PI/ CO-PI/Lead Thrust 5/Visualization & Evaluation) Michael Jenson: Architecture/UCD

Dr. Jenson’s current administrative responsibility as AVC for research is to identify, facilitate, and promote multi- investigator and disciplinary research activities that build strong and well-recognized programs in the creative arts, humanities, social sciences, and related areas. Besides investigating the potential for interdisciplinary teams to address issues systematically, his research interests include: theoretical intersections of sustainability, technology, design, and ethics within globalization, urbanization & architecture. His main research focus will be within the development of community priorities and resource assessment in the case studies (**thrusts 2 & 4**), as well being a major contributor to the chronical of historically significant urban patterns and sustainable materials utilized for the visualization process (**Thrust 5**)

CO-PRINCIPAL INVESTIGATORS:

(CO-PI CO-PI/Lead Thrust 1/FEW Modeling) Allison Goodwell/ Civil Engineering-UCD

Professor Goodwell’s research focus is on the study of complex ecohydrologic systems, and the use of information theoretic and other analysis tools to understand interacting processes in natural and intensively managed ecosystems. In the proposed work, Dr. Goodwell will primarily be involved in

the modeling, scenario generation, and model optimization thrusts (**Thrusts 1-3**). Her experience in complex systems techniques, environmental and climate data analysis, and hydrology will inform model development from the standpoint of integrating food, water, and energy interactions in the face of variable climate drivers, in addition to other sources of uncertainty.

(CO-PI CO-PI/Lead Thrust 2/Development of Scenarios) Alireza Vahid/ Electrical Engineering-UCD:

Professor Vahid's research interests include network information theory, wireless communications, statistics and machine learning. In this Nexus of FEW proposal, Dr. Vahid will be involved in the modeling, scenario generation, and the optimization (**Thrusts 1-3**) portion of the research. He will also work with other team-members in visualizing the theoretical results in the later phase of the proposal.

(CO-PI/Lead Thrust 3/Robust Optimization) Fernando Mancilla-David/Electrical Engineering-UCD:

Dr. Mancilla-David's research focus is on energy and power systems. He has conducted extensive research in modeling and control of several cyber-physical systems, (e.g., grid-connected photovoltaic & wind power plants), and has worked on a variety of problems related to optimal operation of systems (e.g., optimal power flow). In the proposed research, Dr. Mancilla-David will mostly participate in (**Thrusts 2-4**) relating to modeling, scenario generation, and robust optimization.

(CO-PI/Lead Thrust 4/Case Studies) William Swan/Public Affairs-UCD:

Professor Swann's research focuses on urban sustainability, city management, and collaborative governance. His research has developed novel ways of measuring how committed local communities are to sustainability through the application of item-response theory (IRT) and multivariate analytic techniques. Dr. Swann will be involved in the development of the modeling scenarios, (**Thrust 2**), municipal case studies (**Thrust 4**), and designing the communication/visualization tools for local policymakers and community stakeholders. (**Thrust 5**).

SENIOR PERSONNEL (SP)

(SP) Jody Beck/Landscape Architecture-UCD:

Dr. Beck researches the philosophical, political, and practical application of landscape architecture theory to food systems and spaces of food production to guide the creation of food policy and innovative municipal and county governance structures in support of urban and peri-urban agriculture. His project role will focus on setting appropriate variables, goals, and criteria for the scenario generation (**Thrusts 2 & 4**) and developing highly sophisticated visualization and analytical packages to inform the development strategies for the collaborating local government units. (**Thrust 5**)

(SP) Stephen Billups/Mathematical & Statistical Sciences-UCD:

Dr. Stephen Billups research focuses on the development of algorithms for solving optimization and related problems, and has been published in top journals in optimization, including the SIAM Journal on Optimization, Mathematics of Operations Research and Mathematical Programming. In the proposed research, Dr. Billups will participate in the thrust related to robust optimization (**Thrust 3**). He will work closely with Dr. Mancilla-David to develop mathematical programming formulations and uncertainty sets with appropriate mathematical structure to yield robust models for FEW resource planning that are computationally tractable.

(SP) Steven Smith/Economics & Business-Colorado School of Mines:

Dr. Steven M. Smith is an assistant professor in Economics and Business at the Colorado School of Mines and serves as an affiliated faculty of the Hydrological Sciences and Engineering program. His research focuses on property rights (economic institutions), studying both their emergence and impact on natural resource use. Frequently the research is conducted in the context of water and has drawn on historical episodes to better understand how water institutions evolve and influence the economic outcomes. Dr. Smith will be involved throughout the project, but he will be especially helpful in achieving the objectives of scenario modelling (**Thrust 3**) and case studies (**Thrust 4**). He will provide inputs in economic parameters and relating scenarios to economic measurements including dynamic benefit and cost analysis.

(SP) Dane Webster: Associate Professor/Visual Arts/University of Colorado/Denver:

Professor Dane Webster is the Associate Dean of Academic and Student Affairs for the College of Arts and Media at the University of Colorado Denver. He also serves as the Director of the Digital Animation Center within the Department of Visual Arts and co-Director of the Comcast Media and Technology Center. For this project, Prof. Webster and his students will be focusing on creating interactive visualization tools that can help both researchers and policy makers “see” outcomes (**Thrusts 4 & 5**) While several production pipelines will be explored, the initial focus will be to develop workflows that fuse the accuracy of ESRI’s City Engine software with the visual fidelity of modern immersive environment authoring tools, like the Unity game engine.

Plan of Collaboration/Advisory Roles:

At strategic points in the research process different stakeholders organizations and individuals representing relevant expertise will serve in an advisory role. These individuals/organizations are:

The Evaluation Center @ University of Colorado at Denver: Given the broad range of disciplines and working styles involved with this research team, as well as the added complexity of the relationships with municipal partners and other institutions, an outside assessment body will be contracted to ensure that communication loops are maintained, intermediate milestones/goals are met and the relationships between institutions are streamlined and efficient.

The Town of Ridgeway: John I. Clark, Mayor & Jennifer Coates, Town Manager

The City of Brighton: Gary Wardle/Director Parks and Recreation

Bureau of Land Reclamation/Denver: Economist Stephen Piper will advise in the areas of resource valuation, interactions of resource use, trade-offs associated with resource use, and understanding of how people make decisions and the information used to make decisions.

Project implementation schedule:

Thrusts and research tasks	Year 1	Year 2	Year 3	Year 4	Year 5
Thrust 1 - Modeling FEW resources on multiple time scales					
(a) Develop prototypical models for suburban FEW system at multiple time horizons	x	x			
(b) Develop input criteria and linkages between models at different scales	x	x			
(c) Prepare publication on feedbacks between FEW components in model framework		x			
Thrust 2 - Scenario development					
(a) Identify natural, social, policy, and institutional constraints on FEW systems	x	x			
(b) Develop a set of potential scenarios and the corresponding probabilities	x	x			
(c) Incorporate natural, social, policy, and institutional constraints into the model	x	x			
Thrust 3 - Robust modeling of the FEW nexus including policy					
(a) Construct robust counterparts of deterministic models including policy-based scenarios		x	x		
(b) Perform out of sample simulations to assess quality of robust solutions			x	x	
(c) Prepare publication on the application of robust optimization to FEW systems			x	x	
Thrust 4 - Case studies					
(a) Gather information to develop baseline understanding of local communities FEW systems		x			
(b) Compare robust modeling solutions to local communities' current situations		x	x		
(c) Develop survey and interview questionnaires for in-depth probe into FEW/development		x	x		
(d) Analyze communities' FEW/development needs, constraints, and capacity for change		x	x	x	
(e) Prepare publications on case study local communities			x	x	
Thrust 5 - Visualization					
(a) Develop data visualization tool from robust optimization modeling				x	x
(b) Use visualization to identify alternatives for better FEW management in development				x	x
(c) Study how local communities use visualization to make FEW/development decisions					x
(d) Integrate project outcomes and visualization techniques into broader community outreach					x
(e) Prepare publication on how local communities utilize data visualization in FEW decisions					x

- project component led by Co-PI Goodwell
- project component led by Co-PI Vahid
- project component led by Co-PI Mancilla-David
- project component led by Co-PI Swann
- project component led by PI Jensen