# Evaluating the Multiple Benefits Associated with Distributed Rainwater Catchment Systems in Austin, Texas


## STUDENT AUTHORS

Bridget Gibbons
Master's Candidate, 2020
bridgetgibbons@bren.ucsb.edu | (716) 830-0505

Claire Madden
Master's Candidate, 2020
cgmadden@bren.ucsb.edu | (802) 282-2721

## CLIENT AND CO-AUTHORS

Sarah Diringer, Ph.D.
Senior Researcher, Pacific Institute
sdiringer@pacinst.org | (510) 251-1600

Cora Kammeyer
Research Associate, Pacific Institute
ckammeyer@pacinst.org | (510) 251-1600


## OBJECTIVES

This group project seeks to improve the quantification methods and expand the applicability of the Pacific Institute's multiple benefits framework for evaluating water projects through an in-depth test case of distributed rainwater catchment systems in Austin, Texas. Specifically, this group project will:

1. Determine methods and metrics for evaluating the benefits of the Austin Watershed Protection Department's (WPD) proposed distributed rainwater catchment systems, with a specific focus on the following program benefits:
    a. Reduced urban heat island effect
    b. Reduction in energy demands for water treatment and conveyance
2. Provide methodology for water managers to understand and incorporate the benefits into implementation and decision making on water projects, including the evaluation of equitable distribution of project benefits to community members
3. Utilize case study findings to provide recommendations for further refinement of the Pacific Institute's multiple benefits framework to improve effectiveness and applicability across varying water management projects and locations

## SIGNIFICANCE

Adapting to climate change and related water challenges will require significant investment in both constructed water systems and the natural environment. Adapting to or mitigating changes in water systems will require multifaceted strategies that can simultaneously address many challenges, ranging from flood management, to efficiency and water quality improvement, to stormwater capture. Many water management strategies will also provide key co-benefits, such as energy use reduction, lowering greenhouse gas emissions, and improving ecosystem and community health. While decision makers acknowledge the many co-benefits associated with water management strategies, there is no standardized approach for examining the benefits and costs of water investments across contexts and scales. To address this need, the Pacific Institute launched an initiative in 2017 to develop a framework to embed the co-benefits associated with water projects into investment decision making. The cost and benefits evaluated within the framework can be grouped into five themes: Water, Energy, Land and Environment, Risk and Uncertainty, and People and Community.

The group project will apply Pacific Institute's multiple benefit framework to a test case with Austin WPD's proposed distributed rainwater catchment system program. Over the course of the project, the group will quantify program benefits and tradeoffs specifically related to the reduction of the urban heat island effect (UHI) and the

reduction in water related energy use. With climate projections indicating a rise in Central Texas temperatures by 3 to 7 degrees over the next 50-100 years, it is increasingly important to take steps to reduce UHI given that high temperatures in urban areas can negatively impact public health, increase energy use, and increase greenhouse gas emissions (1). In our current system, water demand and energy use are highly linked due to the energy intensity of water conveyance, treatment and delivery. However, reducing water related energy use by increasing the availability of localized water supplies has the potential to increase community resilience and result in benefits to environmental quality, social equity and economic performance (3). As a result of the Austin test case, the group will provide information on benefit characterization and quantification of the two parameters outlined above to Austin WPD. In addition, the research will provide feedback to the Pacific Institute for further refinement of the multiple benefit framework.

## BACKGROUND

The proposed group project is part of a larger initiative led by the Pacific Institute (PI) to develop a framework and methodology for assessing the multiple benefits and costs of water investment strategies. During the first phase of the work, research staff at the Pacific Institute and Dr. Robert Wilkinson conducted an extensive literature review on multiple benefits and gathered stakeholder insights into barriers and opportunities for advancing multiple benefits. These efforts resulted in a draft multi-benefit framework, including a process for identifying multiple benefits and costs, quantifying benefits, and ultimately incorporating the benefits systematically into decision making.

During the second phase of the project, beginning in January 2019, PI is working to refine and scale the multi-benefit framework by working directly with partners on specific water management projects. One of the test cases, described above, is a collaboration with Austin Watershed Protection Department. The test case will explore the role the multi-benefit framework can play in advancing cooperation among agencies by providing a systematic approach to evaluate joint projects and identify beneficiaries.

The Austin WPD is embarking on an initiative, known as the “Waller-3” project, to improve watershed health, reduce flooding, and augment local water supplies in the Upper Waller Watershed by installing distributed rainwater systems. While the project is primarily focused on improving urban hydrology, Austin WPD staff are especially interested in maximizing additional co-benefits, including mitigating the urban heat island effect, ensuring adequate environmental flows, reducing energy consumption, and improving health and equity in the watershed. The group project proposed here will help advance the test case in Austin and the overall multi-benefit framework by expanding analyses into the impacts of distributed rainwater systems on urban heat island, the energy-water nexus, and equitable distribution of community benefits. In addition, the group project will provide feedback for improving the multi-benefit framework and methodology.

## AVAILABLE DATA

- Pacific Institute Multi-Benefit Initiative (see attached)
- Characterizing the Waller-3 Watershed
    - Precipitation and Streamflow Data (alternative water supply availability)
        - LCRA Hydromet - City of Austin Precipitation and Streamflow
        - USGS
        - NOAA
        - Austin WPD - Soil and Water Assessment Tool
    - Community demographics
        - Census Bureau - American Community Survey & American Housing Survey
- Water and Energy Use
    - Residential Water Demand Data

        - City of Austin - Total Pumpage Per Capita Per Day
    - Energy Consumption of Water Treatment and Supply Facilities
        - Pacific Institute - WESim Model
        - Austin Water - Water Plant Energy Consumption
    - Characterizing Urban Heat Island
        - National Weather Service - City of Austin Temperature Data
        - City of Austin - Land Use Cover and Permeability
            - Land use cover, tree canopy, and pervious surface data
        - Local-Scale Urban Meteorological Parameterization Scheme (2)

The data sources listed above are all publicly available, with the exception of the Austin WPD Soil and Water Assessment Tool, which will be provided for use by the Bren project team.

**APPROACH**

1. Quantify the following benefits and conduct a cost-benefit analysis for the catchment systems:
    a. Reduced urban heat island effect: Determine the projected impact of the catchment systems on land use within the watershed, and quantify the associated change to UHI in the context of air quality and public health by measuring the impact of the catchment systems on aspects of city land use including pervious surfaces, canopy cover/leaf area index, and associated emissivities
    b. Reduction in energy demands for water treatment and conveyance: Establish the projected reduction in water demand due to implementation of the catchment systems, and measure the associated reduction in energy required for the water system
2. Create informational materials for future partners on multiple benefits projects and provide feedback to further refine the Pacific Institute's multiple benefits framework.
    a. Examine priorities from additional city departments and other stakeholders (e.g., Austin Water Department and Austin Energy) to examine how their priorities align with project co-benefits
    b. Create materials highlighting the quantified benefits to encourage future collaboration and participation in water management projects
3. Examine the distribution of benefits throughout the city of Austin, with a particular focus on impacts to disadvantaged communities, identifying key political and social drivers.
    a. Map the primary locations within the watershed benefiting from the rainwater catchment systems
    b. Assess benefit distribution in relation to socioeconomic factors
4. Analyze Pacific Institute's multiple benefits framework in the context of the Austin test case and make recommendations for increased effectiveness of the tool.

**DELIVERABLES**

Along with the oral presentation, poster and policy brief, the proposed project includes four deliverables: 1) a report that evaluates and quantifies the benefits and tradeoffs associated with Austin WPD's proposed distributed rainwater catchment system program; 2) informational documents geared toward area utilities and other possible partners for future multiple benefits projects; 3) a policy memo outlining a methodology for consideration of equitable benefit distribution to be used in future projects; 4) based on outcomes from the Austin test case, present recommendations for further refinement of the Pacific Institute's multiple benefit framework to PI and the project's stakeholder advisory group.

**INTERNSHIP**

The Pacific Institute commits to host and mentor one paid intern ($6,500) for a Bren student during the summer of 2018. Additionally, financial support will be provided for the intern to attend events relevant to the larger multi-benefit framework project (see Client Letter of Support for more information).

## SUPPLEMENTAL MATERIALS

### References


1. City of Austin, Texas. Freezing the Urban Heat Island Effect. August 6, 2015.
2. Grimmond, C.S.B. & Oke, T.R. Turbulent Heat Fluxes in Urban Areas: Observations and a Local-Scale Urban Meteorological Parameterization Scheme (LUMPS). February 2, 2002.
3. Kenney, D.S. & Wilkinson, R. The Water-Energy Nexus in the American West. 2011.


### Budget & Justification

It is not anticipated that the proposed project would require additional funding beyond the $1,300 contributed by the Bren School.

### Client Letter of Support

(See Attached)

January 25, 2019

Pacific Institute
654 13th Street
Oakland, CA 94612
(510) 251-1600

Bren Group Project Coordinator
Bren School of Environmental Science and Management
2400 Bren Hall
UC Santa Barbara, Ca 93106-5131

To Whom It May Concern:

We enthusiastically support the submitted proposal to work with Bren School master's students on **Evaluating the Multiple Benefits Associated with Distributed Rainwater Catchment Systems in Austin, Texas**. The proposed work is integral for achieving the Pacific Institute's project goals and critical to advancing evaluation of multiple benefits and integrated water management throughout the United States.

**Project Overview**

The Pacific Institute is a global water think tank based in Oakland, CA that focuses on advancing science-based solutions to address the world's most pressing water challenges. In collaboration with a diverse team of stakeholders, we are developing a framework for incorporating multiple benefits and costs into water investment decisions. While many government agencies, businesses, and other acknowledge the value of multi-benefit projects, there are no standardized methodologies for evaluating co-benefits of water management systematically. As a result, the broad benefits and costs of water management strategies are not routinely included in decision making, and water managers cannot maximize the benefits investments.

In 2017, researchers at the Pacific Institute and Professor Bob Wilkinson of UC Santa Barbara launched an initiative to develop, build consensus around, and promote the uptake of a framework to embed the co-benefits of water projects into investment decisions (see Attachment 1 for more information). During the first phase of this work, completed in early 2019, the team proposed a framework for identifying multiple benefits of water investments. During Phase 2, currently underway, we are seeking to advance the framework through test cases and policy innovation.

**Current Work**

We have identified two test cases in which we are working with individual municipalities and businesses to apply the multi-benefit framework and examine how their water investment decisions can incorporate a broader range of benefits and costs. The first test case focuses on examining the benefits and trade-offs of sustainable landscapes on commercial and industrial properties in southern California, as well as identifying the public and private beneficiaries. The second test case explores the benefits of distributed rainwater systems in Austin, TX to examine opportunities for cooperation and co-funding among public agencies.

**Bren Group Project Contribution**

The proposed Bren School group project will contribute significantly to the Phase 2 test case focused on distributed rainwater capture systems in Austin, TX. For this test case, the Pacific Institute has partnered with the Austin Watershed Protection Department (WPD) to examine the multiple benefits and costs of implementing distributed rainwater capture systems in the upper Waller Creek watershed. The project includes an evaluation of flood control and water supply benefits resulting from these projects, as well as engagement with stakeholders to facilitate collaboration among city agencies.

The WPD staff identified urban heat island and the energy-water nexus as two areas of interest that have not been quantified. However, there are limited financial resources to investigate these areas. For this reason, assistance from the Bren GP would add considerable value to this project. In addition, there is growing interest from the WPD staff to incorporate equity into the evaluation of the implemented projects. While the multi-benefit framework has outlined a potential process for examining equity, we have not yet incorporated equity in the context of this work.

In addition to providing value directly to Austin WPD, the Bren group project would help to improve the usability and overall scalability of the framework. The proposed group project work includes providing feedback to the Pacific Institute team on how to refine the framework and better incorporate urban heat island and the energy-water nexus. In addition, the materials developed will be included in our online resources database to provide additional resources for future stakeholders interested in incorporating multiple benefits into their decision making.

**Data and Resource Availability**

The City of Austin WPD can provide data for analysis, including watershed characterization data (rainfall, impervious surface, flood probability), as well as implementation data (proposed project locations and sizes, rainwater capture strategies employed). These datasets will help with examining impacts of rainwater harvest projects on urban heat island. In addition, the City of Austin has a large

data repository, including information on potable water demand and energy demand, which can provide the basis for analysis on the energy-water nexus analysis.

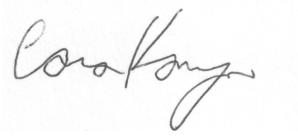
The group project can also incorporate data provided on the energy-water nexus from an excel-based model developed by the Pacific Institute and Dr. Bob Wilkinson, entitled the Water-Energy Simulator (WeSIM), which can examine energy requirements for water provision and use, from source extraction to discharge.

**Internship Funding**
Pacific Institute can commit $6,500 towards hosting one full-time summer internship in our Oakland, CA office. This amount will be paid directly to the intern over a 10-week internship. We can also provide additional financial support to attend relevant events that are associated with the larger multi-benefit project work, such as stakeholder meetings. Following the internship, we look forward to providing on-going research support and engaging with the project team.

We are very excited to be considered as a partner for this Bren School Master's project. We are confident that this work will be valuable experience for the group members and invaluable for meeting our overall project goal. If you have any additional questions or concerns, please do not hesitate to contact us. We look forward to hearing from you.

Sincerely,

Sarah Diringer, Ph.D.
Senior Research Associate
sdiringer@pacinst.org
(510) 251-1600 x128



Cora Kammeyer
Research Associate
ckammeyer@pacint.org
(510) 251-1600 x114

**Attachment 1. Pacific Institute Multi-Benefit Initiative Description**

# Maximizing Water Investments through Achieving Multiple Benefits

## Goal

We envision a future where water decision makers carefully consider the broad benefits and costs of water management investments and pursue strategies that support equity, sustainability, and resilience. To meet this end, the Pacific Institute – in collaboration with a diverse team of stakeholders – is developing a framework for systematically assessing the multiple benefits and costs provided by water management strategies.

## Background

There is broad recognition that adapting to climate change, coupled with the need to address aging infrastructure and population growth, will require public and private investments in man-made water systems and the natural environment. These investments will take many forms, ranging from watershed restoration to efficiency improvements and stormwater management, and will address a combination of flood risk, water quality, and water supply objectives. In addition to meeting water-related objectives, many of these strategies can also provide important co-benefits, such as reducing energy use and greenhouse gas emissions, providing habitat, and enhancing community livability.

Many government agencies, businesses, and others acknowledge the value of multi-benefit projects and the need for consistent approaches for investment decision-making. However, there are no standardized methodologies for identifying and evaluating co-benefits of water management systematically. As a result, the broad benefits and costs of water management strategies are not routinely included in decision making, and water managers cannot maximize the benefits investments. Effectively comparing water management and investment options requires careful consideration of the costs and benefits associated with each strategy.

To address this challenge, researchers at the Pacific Institute and Professor Bob Wilkinson of UC Santa Barbara launched an initiative in 2017 to develop, build consensus around, and promote the uptake of a framework to embed the co-benefits of water projects into investment decisions. During the past year, the team has proposed a framework for identifying multiple benefits of water investments and is seeking to advance the framework through test cases and policy innovation.

## The Multi-Benefit Framework

The goal of the multi-benefit framework is to outline a strategy for identifying the benefits and trade-offs of water management investments and describe opportunities for incorporating them into decision making. The framework can be used by the public sector, for example, when evaluating which water supply or water quality intervention to pursue. Or, it can be used by the private sector, when assessing which projects to invest in within their value chains or as part of their philanthropic activities.

In order to achieve this, we have identified three phases of work. During the first phase, completed in early 2019, the project team developed a draft framework and supporting methodology for evaluating multiple benefits of water projects by engaging with a diverse set of stakeholders from government, corporations, NGOs, and community members. During the second phase of work, currently underway, we will refine and advance the framework through test cases, development of resources, policy innovation. Finally, during the third phase of work, beginning in 2020, we will focus on embedding the framework into policy and planning.

During Phase 1, we have identified that there are substantial opportunities to expand the analysis of multiple benefits to systematically include both qualitatively and quantitatively evaluation of benefits and costs of water management strategies. Some of the benefits associated with these categories can be quantified and even monetized to be included in traditional economic evaluations while other benefits are more difficult to quantify. Thus, the incorporation of multiple benefits happens on a continuum from qualitative consideration of benefits to quantification and monetization, and ultimately incorporation into decision making (Figure 1). The progression provides an illustrative process for increasingly robust consideration of co-benefits.

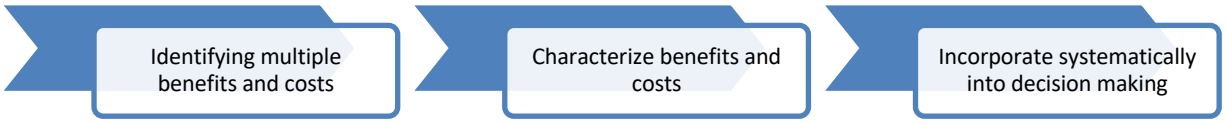



*Figure 1. Continuum of multiple benefits from recognizing and identifying multiple benefits to systematically incorporating multiple benefits and costs into decision making.*

One of the key challenges of carefully considering multiple benefits is identifying the broad range of potential benefits and trade-offs associated with water management projects. To advance the first stage of multi-benefit consideration, we sought to provide a structure for identifying benefits and costs systematically. By examining the literature on multiple benefits and conducting interviews and convenings with stakeholders, we categorized the benefits and costs of water management strategies into five broad themes: Water, Energy, Land and Environment, Risk and Uncertainty, and People and Community (Figure 2). These themes provide an outline for characterizing multiple benefits and costs and enable more transparent consideration of trade-offs.

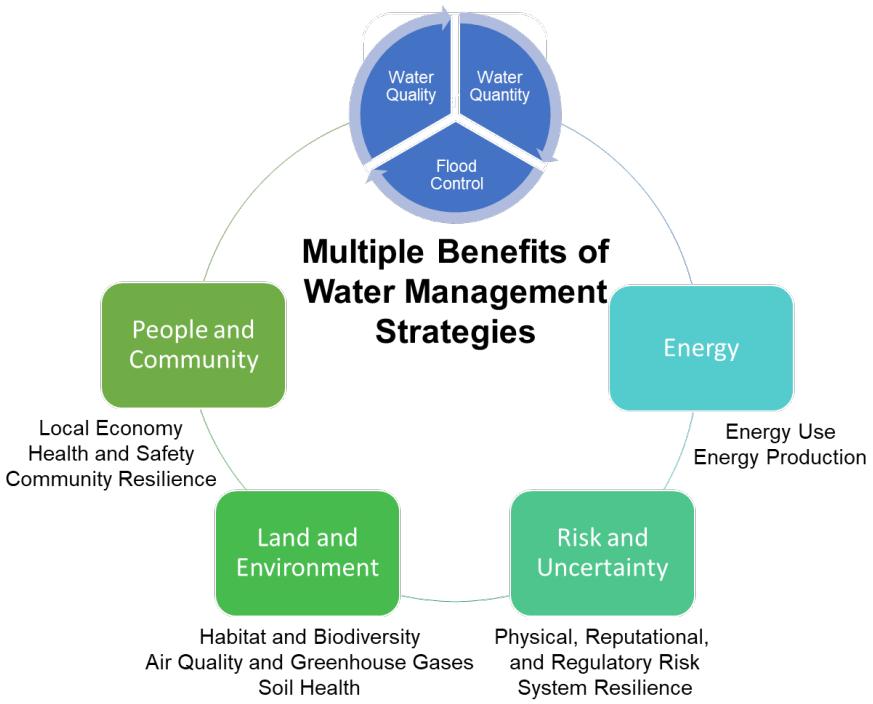



*Figure 2. Framework for evaluating multiple benefits of water management strategies.*

**Advancing the Framework**

We are currently embarking on Phase 2 of this work and are seeking to improve and advance the framework through test cases, development of resources, and policy innovation. For this effort we are working to:

- Refine the multi-benefit framework based on application to real-world water management decisions and stakeholder input;
- Develop and provide online resources for analysts, decision makers, and advocates to identify and examine multiple benefits of a broad range of water management strategies; and
- Identify pathways to embed multi-benefit analyses and resultant information in policy and investment decision-making, such as promoting uptake of the framework in funding proposal requirements and in integrated water management planning at the local, state, and federal levels.

We are currently implementing the framework through two test cases. The first test case focuses on advancing sustainable landscapes on commercial and industrial properties in southern California by identifying benefits and trade-offs, as well as the public and private beneficiaries. The second test case explores the benefits of distributed rainwater systems in Austin, TX to examine opportunities for cooperation and co-funding among public agencies and encourage uptake by the public.

To implement the test cases, we will:

- Work collaboratively with partners stakeholders to understand a specific water management decision, such as optimizing green infrastructure locations, evaluating the return on investment for water reuse, or developing a comprehensive integrated water strategy.
- We will apply the framework to develop relevant tools with the stakeholders and decision makers that assist in evaluating multiple benefits and incorporating them into the decision-making process;
- Examine the effectiveness of the tools and iteratively work to refine and improve the framework.

The test cases and stakeholder engagement will provide valuable insights to our partners while allowing us to improve the framework's usability and identify pathways for larger scale implementation and policy innovation.

**About the Pacific Institute**

The Pacific Institute is a global water think tank that provides science-based thought leadership with active outreach to influence local, national, and international efforts in developing sustainable water policies. The Pacific Institute's mission is to create and advance solutions to the world's most pressing water challenges. From working with Fortune 500 companies to disenfranchised communities, we create and advance innovative sustainable water policies and deliver meaningful results.

**Funders**

This work has been generously supported by the Pisces Foundation, Department of Water Resources, Environment Now, Mitchell Foundation, Disney Foundation, and the CEO Water Mandate-endorsing companies that have supported the initiative's California-focused work – Nestlé, Netafim, Anheuser Busch InBev, Ecolab, Mars, Coca-Cola, Hilton, Ericsson, Microsoft, and Firmenich.