Sustainable Urban Water Systems: Project Framing / Literature Scan

Urban Sustainability Directors Network
Innovation Network for Communities
November 1, 2013

Framework Progress to Date

- August 5, 2013 - First Advisory Board Call
  - Call Objective: to digest data and find what the most useful project focus is (*example: focus on innovations in urban water*)
    - Reviewed initial findings from literature review of urban water innovation
    - Reviewed findings from the interviews and profiles established from the survey
    - Discussed what to explore in interviews with urban water system leaders
- August 26, 2013 – Revised initial findings based on AB feedback
- October 13, 2013 – webinar for Advisory Board to review / approve subtopics

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30. Identify Key Systemic Strategies to Achieve Goals	• 31. Systematic Water Innovation Strategies • 32. Emerging Sustainable Water Management Innovations
33. Identify Innovations for Paradigm Shifting	• 34. Innovation Drivers • 35-36. Innovation Acceptance (including public outreach) • 37-40. Inventory of Water System Innovations • 41. Edge of Innovation
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47. Identify Advisory Boards' Priorities and Practices in Sustainable Urban Water	• 48-63: • Survey data, Interviews

USDN / INC Urban Water Project Description

Project Highlights

- **Purpose:**
  - Define innovations in sustainable urban water systems, identify barriers to implementing them, and discover how to address them.
- **Deliverables:**
  - Detailed sustainable water system strategies and an outline of emerging / proven practices that accelerate development of sustainable urban water systems
- **Participants by Region:**
  - New England: Boston, MA
  - Mid Atlantic: Washington, D.C.
  - Southeast: Miami-Dade County, FL, Knoxville, TN
  - Intermountain West: Tucson, AZ, Denver, CO
  - Midwest: Ann Arbor, MI, Cincinnati, OH, Dubuque, IA, Iowa City, IA, Milwaukee, WI
  - Texas: El Paso
  - California: Los Angeles, Santa Monica

Regional Distribution Map

Define Urban Water System

- Defining the Conversation
- Types of Urban Water Systems
- Control of Water System
- Linkages with Land Use
- Contextual Factors
- GHG Emissions Produced

Defining the Conversation: Traditional Definition of "Urban Water System"

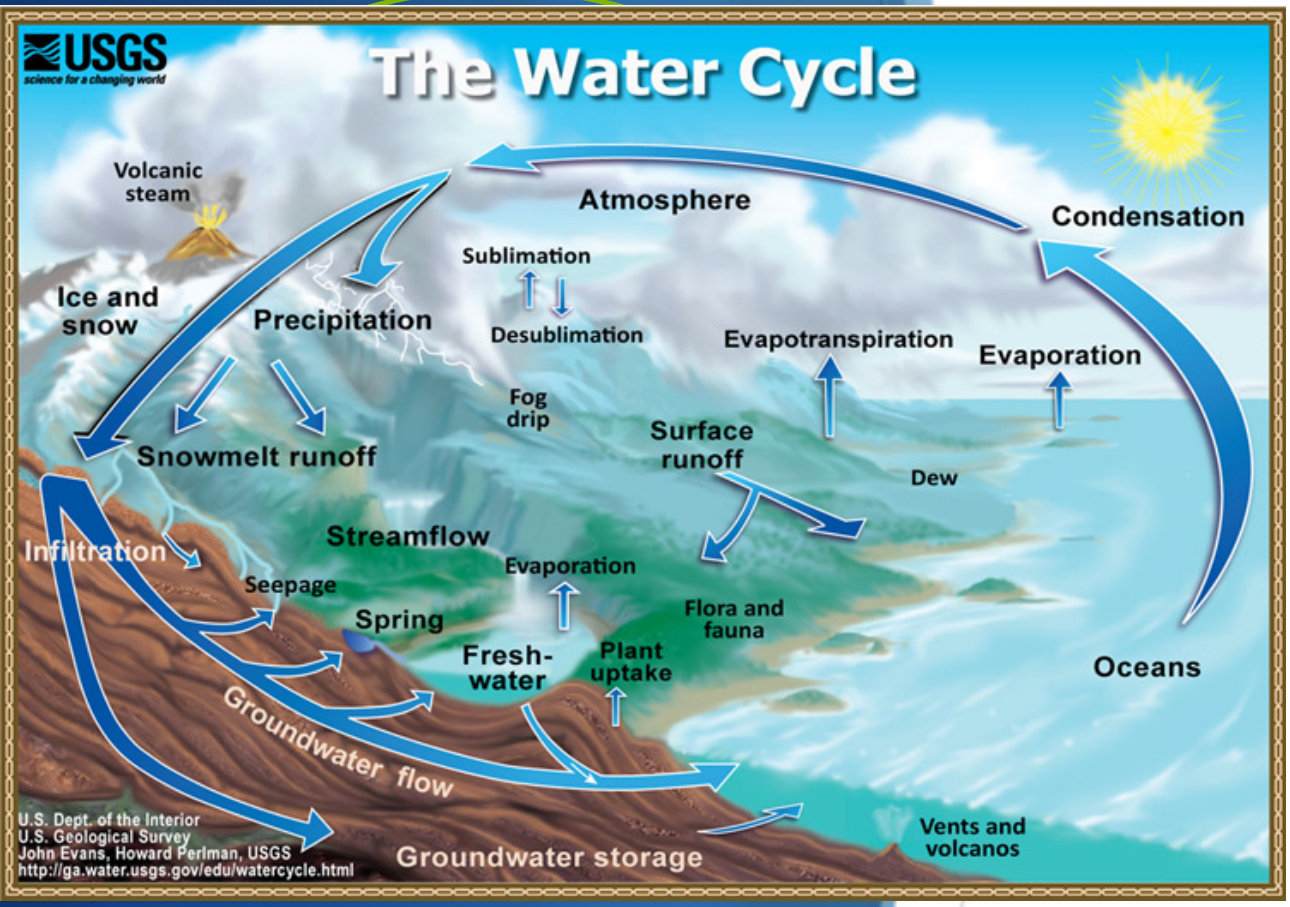
- "We have a 19th-century technology that was designed to address a 20th-century problem, and now we're facing a series of 21st-century challenges. Urban water systems were designed at a time of low population, unlimited energy, and a lack of complete understanding of the public health and environmental consequences."

  - David Sedlak, professor of civil and environmental engineering at UC Berkley

- Traditional water quality regulation and quantity (supply) are addressed and controlled through a defined set of regulatory and delivery schemes.

- Traditionally, urban water systems are defined as having three components:
  - water supply
  - wastewater
  - Stormwater

[1] Guy, A. " Remaking America's Urban Water Systems", *Breakthroughs: University of California at Berkley College of Natural Resources, Spring 2012.* http://nature.berkeley.edu/breakthroughs/sp12/remaking_americas_urban_water_systems



Quick Water System Refresher

A **Watershed** is the region draining into a river, river system, or other body of water.

A **River Basin** is the land area drained by a river and its tributaries.

Defining the Conversation: Redefining the Urban Water System

- There are two major, interacting systems:
- Natural (Green) and Engineered (Gray)
  - Natural – watershed/river basins locally or (transfers) used by the city
    - local water cycle (precipitation, etc.)
    - hydrology; water budget
  - Engineered/Built – supply (including bottled water), waste, storm, includes self-sourcing, etc.
    - Draws from/returns to natural system
    - Consumes water (embedded into products, etc.)
    - Closed loop water management

Types of Urban Water Systems

Water Supply: collection, treatment, storage, delivery:

- Publicly owned systems (51%), or privately owned systems (49%)
- Large non-residential water consumers (i.e., electric utilities / water consuming industries impact water supply from the non-potable standpoint
- Community Water System: supplies water to the same population year-round
- Non-Transient Non-Community Water System: regularly supplies water to at least 25 of the same people at least six months per year, but not year-round
- Transient Non-Community Water: provides water in a place such as a gas station or campground where people do not remain for long periods of time.
- Water supply utilities are often bundled with wastewater utilities

Wastewater: influent, primary treatment, secondary treatment, tertiary treatment, disinfection and effluent discharge

- Wastewater treatment expedites the natural process of water purification. Wastewater utilities are often managed in association with water supply utilities; they can also be combined with stormwater systems.

Stormwater: separate or combined with sewer

- Stormwater is water that originates during precipitation events. Due to increasing urban development, stormwater does not always soak into the ground and become surface runoff, which eventually flows or discharges into surface waterways. Runoff poses 2 major concerns: flood control and the increased risk of pollution/contamination.

[2] The Innovation Network for Communities, Background: Water Users, Suppliers, Issues and Solutions, "Water Utilities"," Wastewater Utilities", and "Stormwater Utilities" fact sheets, 2013 http://water.in4c.net/files/Water-Utilities.pdf

Types of Water Systems: Reframing the Conversation

- Gray and Green are both part of the answer and can interact effectively.
- The Social System (consumption management, behavior change) is a huge part of the answer to sustainable urban water.
- Transformational thinking: what is the appropriate fit for use standard for water, not just what are the highest possible standards.
- "One water" – integrate storm and wastewater combinations across systems.
- Look at the system from an interdisciplinary standpoint to think holistically (not just as engineers or as ecologists).

Control of Water Systems

- The **largest 3 Community Water Systems** (*Metropolitan Water District of Southern California, NYC Department of Environmental Protection, and Chicago Department of Water Management*) **serve over 33,000,000 people, almost 11% of the total US population – Cities have great leverage**.

- **Leading Public Utilities (by population served):**
  - New York Department of Environmental Protection
  - Los Angeles County Sanitary District
  - Metropolitan Water Reclamation District of Greater Chicago

- **US Water System Regulators:**
  - The U.S. EPA – Clean Water Act (water bodies, ecological impacts)
  - Safe Drinking Water Act (human consumption & health)
  - State Government Environmental Offices
  - Local Government Municipal Utilities (Waste and Stormwater)
  - Federal Agencies (USACE, TVA) that control major waterways and intakes

- **Leading Private Utilities by market share:**
  - Veolia
  - Aqua America
  - American Water
  - Suez (United Water)

[2] The Innovation Network for Communities, Background: Water Users, Suppliers, Issues and Solutions, "Water Utilities"," Wastewater Utilities", and "Stormwater Utilities" fact sheets, 2013 http://water.in4c.net/files/Water-Utilities.pdf

Linkages with Land Use

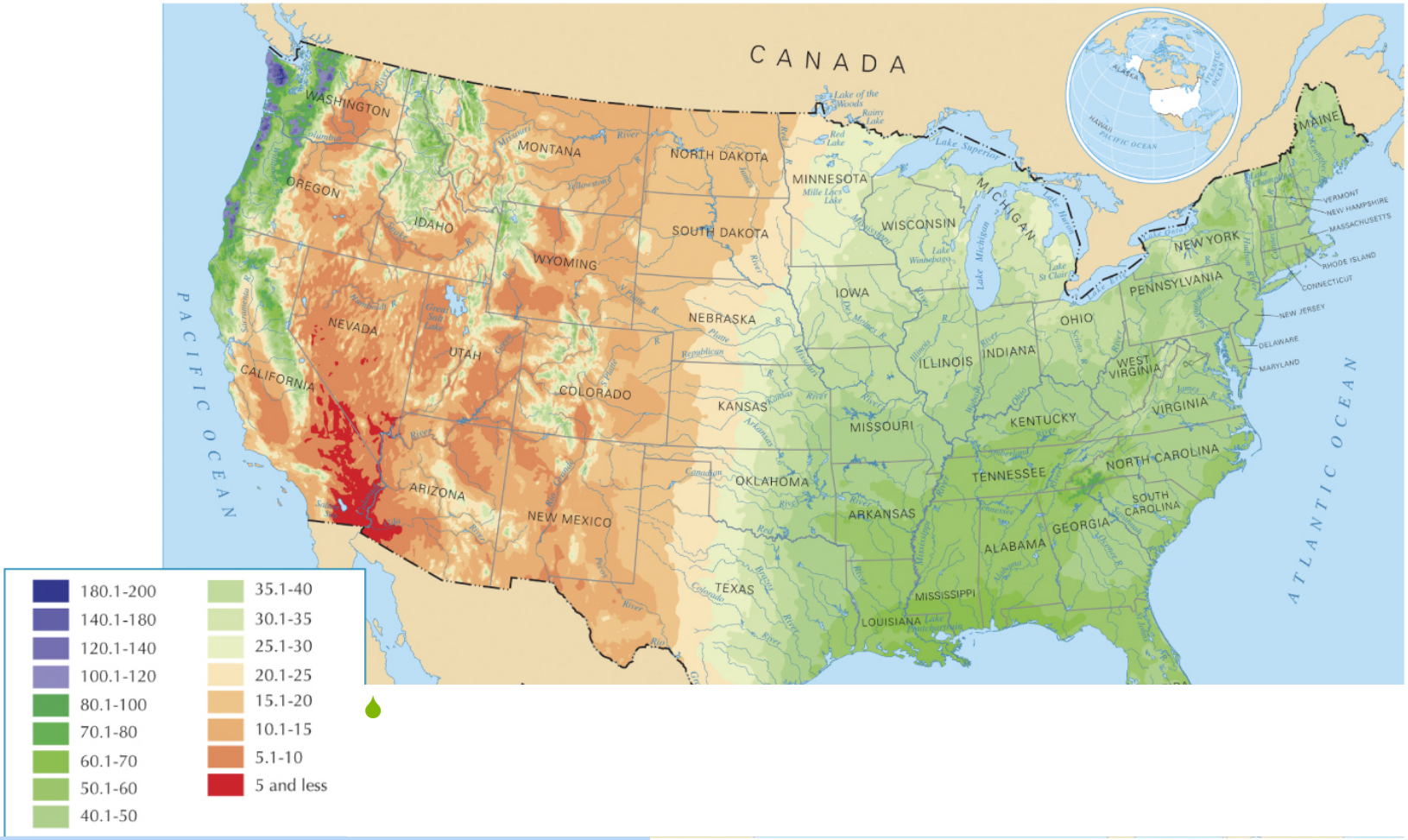
Land Use Activity	Water System Impacts
Above Ground – Development practices driven by zoning / codes	• Traditional "curb and gutter" street / subdivision development methods have water quality, quantity, and flow rate impacts • Complete street design incorporates filtration into above ground infrastructure, and blends gray and green infrastructure design • Retention ponds are a growing concern from an economic development, land use utilization, aesthetic and density standpoint
Below Ground– Construction activities that include municipal utilities infrastructure	• Aging pipes not prepared for impacts of climate change (increases / decreases in flow) • Disturbing soil releases sediment and pollutants to local waterways (sediment is leading cause of impairment per EPA)
Density – Population by concentration is directly linked to how water is delivered	• Dense: system overflows due to concentrated entry points / outdated infrastructure and capacity • Dense: increase pollutant loadings, e.g., pathogens, household chemicals, metals, fertilizers, pesticides, oil and grease • Dense: water consumption can decrease with less lawn, or increase with more households, so finding the zoning balance to maximize space while minimizing water consumption is key. • Sprawl: costly installation and maintenance ramifications • Sprawl: utilities may have difficulty getting water to some developed areas in times of drought due to low pressure / flows
Impervious Surfaces –roads, parking lots, rooftops and driveways	• Decrease groundwater infiltration of runoff • Increase runoff volumes and rates • Reduced groundwater recharge can negatively affect water supply • Changes in runoff volumes and rates can increase flooding, waterway erosion, sedimentation, and nutrient loading

[3] The Institute of Water Research, "Urban Land Use Effects on Water Quality", January, 1997. http://35.8.121.139/edmodule/water/wtrfrm20.htm
[4] The US EPA, "Growth and Water Resources: the link between Land and Water Resources", EPA 842-F-02-008, Office of Water, September, 2005.

Contextual Factors

Population & Economic Activity	Increases/decreases in population and jobs drive increases/decreases in water use. (Note: US water use is below 1980's level, though population / economy have grown; per capita household use declined between 1995-2005).[5,6]
Regional Ecosystem Services and Urban Development	Planning for urban development by regional water supply issues is critical to addressing local water needs. For example: Denver's water supply is significantly impacted (from a water quality standpoint and storage capacity) by fires in the mountains, so they have to plan and implement with the regional implications in mind.
Legal Framework	US Water laws cover a myriad of topics and vary by region: public water (surface water / groundwater), flood control, environmental regulation, fishery regulation, water project development.[7]
Smart Technology	Combined sewer overflow mitigation, water conservation and smart metering, smarter irrigation for parks and golf courses, water and wastewater situational awareness and quality management, pressure and leak management, urban flood management, work scheduling optimization.[8]
Funding Sources	Many tools in the tool box: plenty of capital / good terms (long tenors, low rates, tax exempt), alternatives to debt (user fees, infrastructure tax). Mechanisms for sharing credit rating, opportunities for creativity.[9]
System Legacies	Design and condition of system assets drives need for major overhaul and investment: gray infrastructure is crumbling, outdated in capacity, and requires major upgrades to meet current needs and future demand.[10]

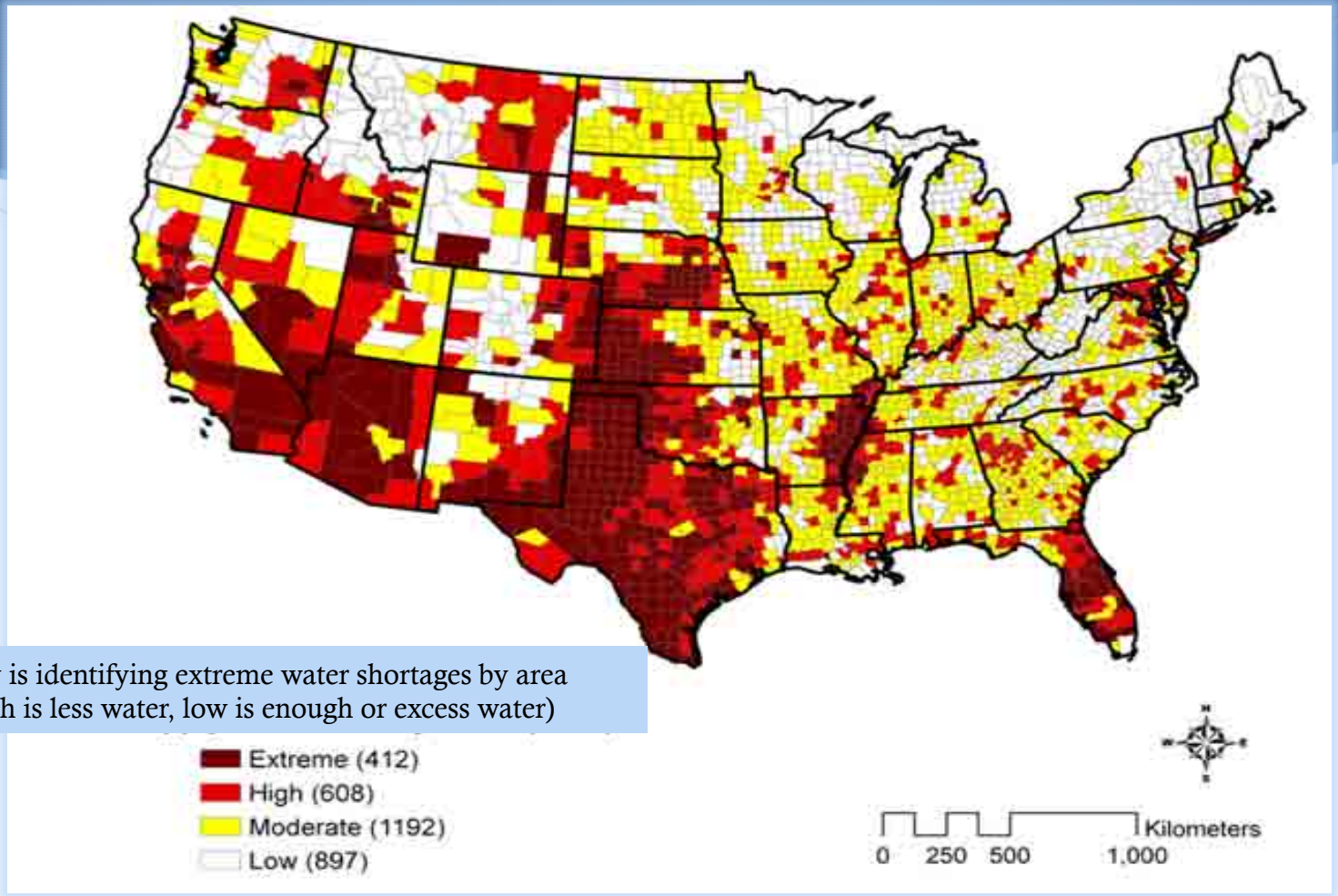
Contextual: Supply



(Key numbers are water supply in inches per year)

[11] The National Academy of Science Water Information Center, Drinking Water Basics. http://water.nationalacademies.org/basics_part_3.shtml

Contextual: Climate Change



Key is identifying extreme water shortages by area (high is less water, low is enough or excess water)

[12] The Natural Resources Defense Council, "More than One Out of Three U.S. Counties Face Water Shortages Due to Climate Change", August 2010. http://www.nrdc.org/media/2010/100720.asp

Contextual: Climate Change Impacts on Water Resources

- The Southwest, parts of the Southeast, the Great Plains, and the islands of the Caribbean and the Pacific surface and groundwater supplies are already affected and are expected to be reduced further by declining runoff and groundwater recharge, increasing the likelihood of water shortages for many off-stream and in-stream water uses.
- Meanwhile, some parts of country US are wet and getting wetter. Increasing flooding risk affects human safety and health, property, infrastructure, economy, and ecology in many basins across the U.S.
- In most U.S. regions, water resources managers and planners will encounter new risks, vulnerabilities, and opportunities that may not be properly managed with existing practices.
- Increasing resilience and enhancing adaptive capacity are useful strategies for water resources management and planning in the face of climate change. Challenges include:
  - competing demands for water resulting in stricter management of water supply
  - maintaining / improving water quality and watershed habitat for better storage (dealing with warming streams, for example)
  - Understanding how habitat and species destruction impacts water quality and supply
  - a variety of institutional constraints
  - lack of scientific information or access to it, or considerable scientific and economic uncertainties
  - inadequate information useful for practical applications
  - difficulties in engaging stakeholders.

[13] The National Climate Assessment Federal Advisory Committee, Climate Report Draft, "Water", Chapter 3, January 2013.

GHG Emissions Produced

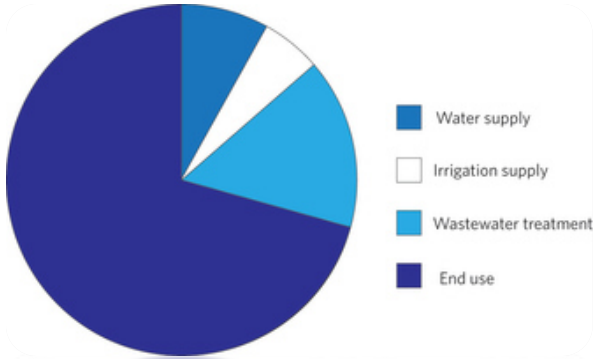
Energy Use in Water Treatment / Distribution:

- It's estimated that the U.S. consumes 50,000 GWh in water treatment / distribution, representing 1.4 % of the total national electricity consumption, and cost over $4 billion /yr
- Municipal systems are among the most energy-intensive facilities owned, accounting for about 35% of energy used by municipalities. [15]
- This 35% accounts for roughly 75 -80 % of the cost of water processing / distribution. [15-19]
- U.S. water systems use an estimated 3-4 percent of the nation's energy to move and treat water and wastewater, with the portion much higher in some places such as CA. (*Note: Pacific Institute reported these EPRI estimates are conservative and exclude end-use energy*) [5]

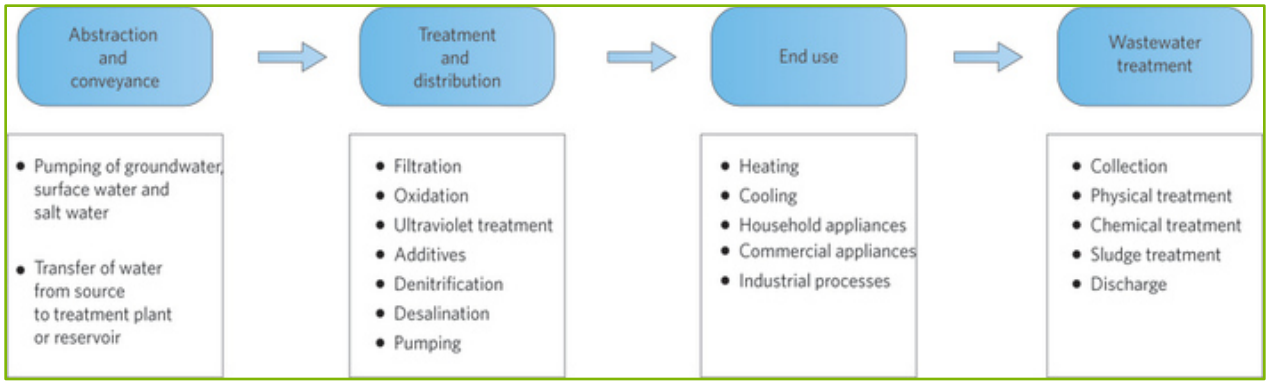
Water Use in Energy Creation:

- The California Energy Commission created a policy in 2003 that discourages the use of freshwater for power plant cooling, encouraging exploration of different generation mythologies. [20]

Distribution of carbon emissions from energy use in the US water sector (%):



A conceptual model of water-sector processes involving energy use:



[14] Rothausen, S., Declan Conway. "Greenhouse-gas emissions from energy use in the water sector", *Nature Climate Change,* July 2011. http://www.nature.com/nclimate/journal/v1/n4/abs/nclimate1147.html (Figures)

Identify Goals for Sustainable Water Systems

- Traditional System Goals
- GHG Reduction
- Adaptation/Resilience
- Sustainable Goals
- Barriers to Achieving Goals

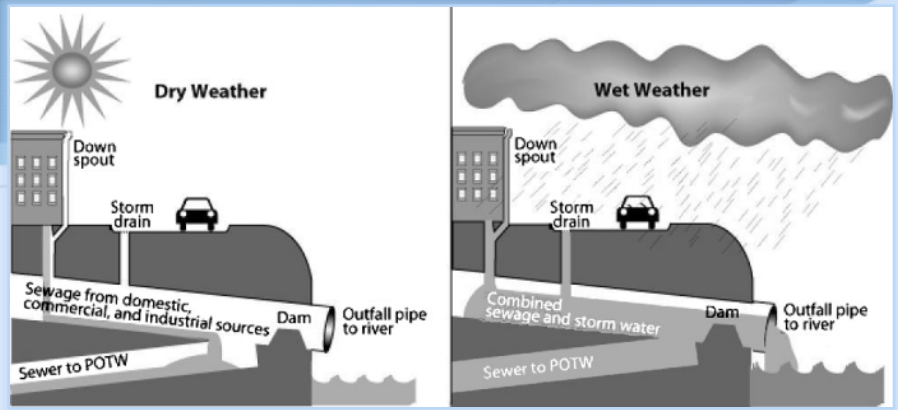
Traditional Water System Goals

Goal	Metrics
Consistent Service / Sufficient Quantity	• Pure drinking water (at the tap) • Managed stormwater (straightest path to the river) • Treated effluent (systematic, to standard management) • Infrastructure management / maintenance
Regulatory Compliance	• None or reduced citations / violations on water quality and overflows • Separate storm and waste water systems
Service Delivery	• Cutting waste from the system
Customer Satisfaction	• Satisfaction ratings
Safety: Flood Prevention & Property Protection	• Facilities in good state of repair • Water main breakage attended to quickly • Eliminate operations / maintenance related fatalities • Manage stormwater to reduce property / life risks
Waste Reduction	• Reduce system leakage of treated water
Resource Utilization	• Adopt energy efficiency retrofits, renewable energy, methane capture, waste to energy if possible
Financial Viability	• Operating revenues and capital debt management

[21] U.S. EPA "Water Sector Collaboration on Effective Utility Management" Fact Sheet, May 2007
http://water.epa.gov/scitech/wastetech/upload/fs_si_waterutility_collaborationeffectivemanagement.pdf

Traditional System Goals: Fit for Use & Consent Decrees

- Drinking water standards drive consent decrees
- National Primary Drinking Water Regulations (NPDWRs / primary standards) are legally enforceable (EPA) and apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water.
- List of EPA Contaminants by category
- http://water.epa.gov/drink/contaminants/index.cfm#List
  - *Micro organisms*
  - *Disinfectants*
  - *Disinfection Byproducts*
  - *Inorganic Chemicals*
  - *Organic Chemicals*
  - *Radionuclides*



The EPA has acknowledged the financial challenges the orders cause localities, writing in a recent notice in the federal register that state and local governments' "ability to finance improvements by raising revenues or issuing bonds has been significantly impacted during the ongoing economic recovery."

-"Mayors Question EPA Consent Decrees", Governing Magazine, June 2012
http://www.governing.com/blogs/fedwatch/mayors-question-epa-consent-decreees.html

GHG Reduction: 3 examples

- **Sonoma County Water Goals:**
- Carbon Free Water
  - Water conservation
  - System efficiency
  - Develop/procure renewable energy
  - Projects of Regional Benefit

- **Seattle Public Utilities Goals:**
  - Enhance knowledge by engaging the science
  - Assess impacts and vulnerabilities ,
  - Establish collaborative partnerships
  - Strengthen institutions and people,
  - Mainstream adaptation into decision-making
  - Develop portfolios of approaches
  - Quantify and reduce our emissions

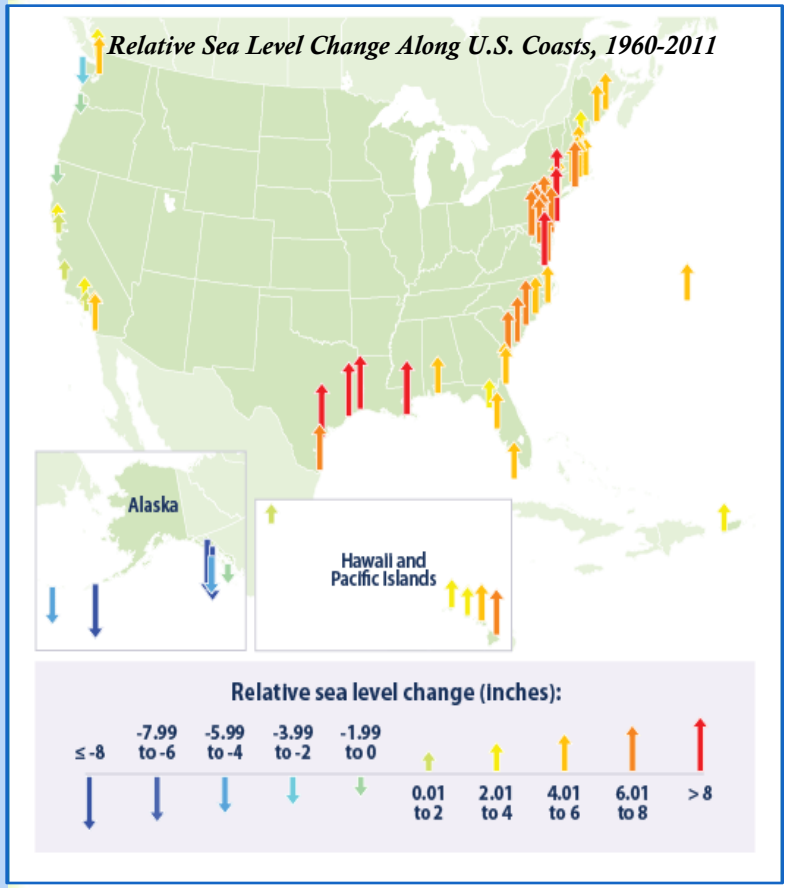
- **Santa Clara Valley Water District Goals:**
- Achieve carbon neutrality by 2020: Establish a District-wide internal carbon offset methodology to facilitate emission reduction including properly crediting emission reductions from water conservation programs, habitat restoration or enhancements renewable energy production and contributions to countywide emission reduction efforts.

- **Resources on Carbon Neutral Water Systems:**
  - EPA- *Energy Efficiency in Water and Wastewater Facilities: A Guide to Developing and Implementing Greenhouse Gas Reduction* [14]
  - Water Environment Federation: Energy and Water, Access Water Knowledge Center – *The Energy Roadmap: A Water and Wastewater Utility Guide to More Sustainable Energy Management* [15]

[22] **Applied Solutions Webinar, "Three Water Agencies in California & Washington Pursue GHG-Free Water", June 2013.**
[23] U.S. EPA, "Energy Efficiency in Water and Wastewater Facilities: A Guide to Developing and Implementing Greenhouse Gas Reduction Programs"
[24] Water Environment Federation: Energy and Water, Access Water Knowledge Center – The Energy Roadmap: A Water and Wastewater Utility Guide to More Sustainable Energy Management

Adaptation / Resilience

- **EPA "Climate Ready Water Utilities" Findings 2011:**
  - The water sector faces important and substantial climate change adaptation challenges
  - Proactive, climate ready actions enhance water sector resilience
  - Different local conditions will dictate different climate ready responses
  - Utility "climate readiness" is emerging and so should reflect adaptive management
  - To succeed, individual utilities need a robust enabling environment
  - Many utilities do not have the capacity to become climate ready
  - Climate change impacts create challenges for current regulation frameworks
  - Water utilities are overwhelmed with climate change information / lack of coordination by federal agencies, state agencies, and other water sector actors
  - The water sector is underserved by available climate science and by information regarding adaptation and mitigation costs and benefits
  - Water sector utility GHG mitigation efforts are an important aspect of the sector's climate-related strategy



[26] The Institute for Sustainable Communities, "Climate Leadership Academy: Climate Adaptation & Resilience: Water Resource Management & Infrastructure, A Resource Guide for Local Leaders Version 3.0", 2013. http://www.iscvt.org

[25] U.S. EPA, "Climate Ready Water Utilities", June 2011.

Two Sides to Water Adaptation

Wet: Sinking and Flooding

- Places like Miami, FL are dealing with issues rising sea levels, like salt water intrusion.
- Some areas experiencing massive increase in rainfall (ex: Cincinnati, OH, Knoxville, TN)
- Milwaukee, WI have more water than they'll ever need, though the levels of the Great Lakes are so low that some power plants have to use water displacement to continue to operate. [28]

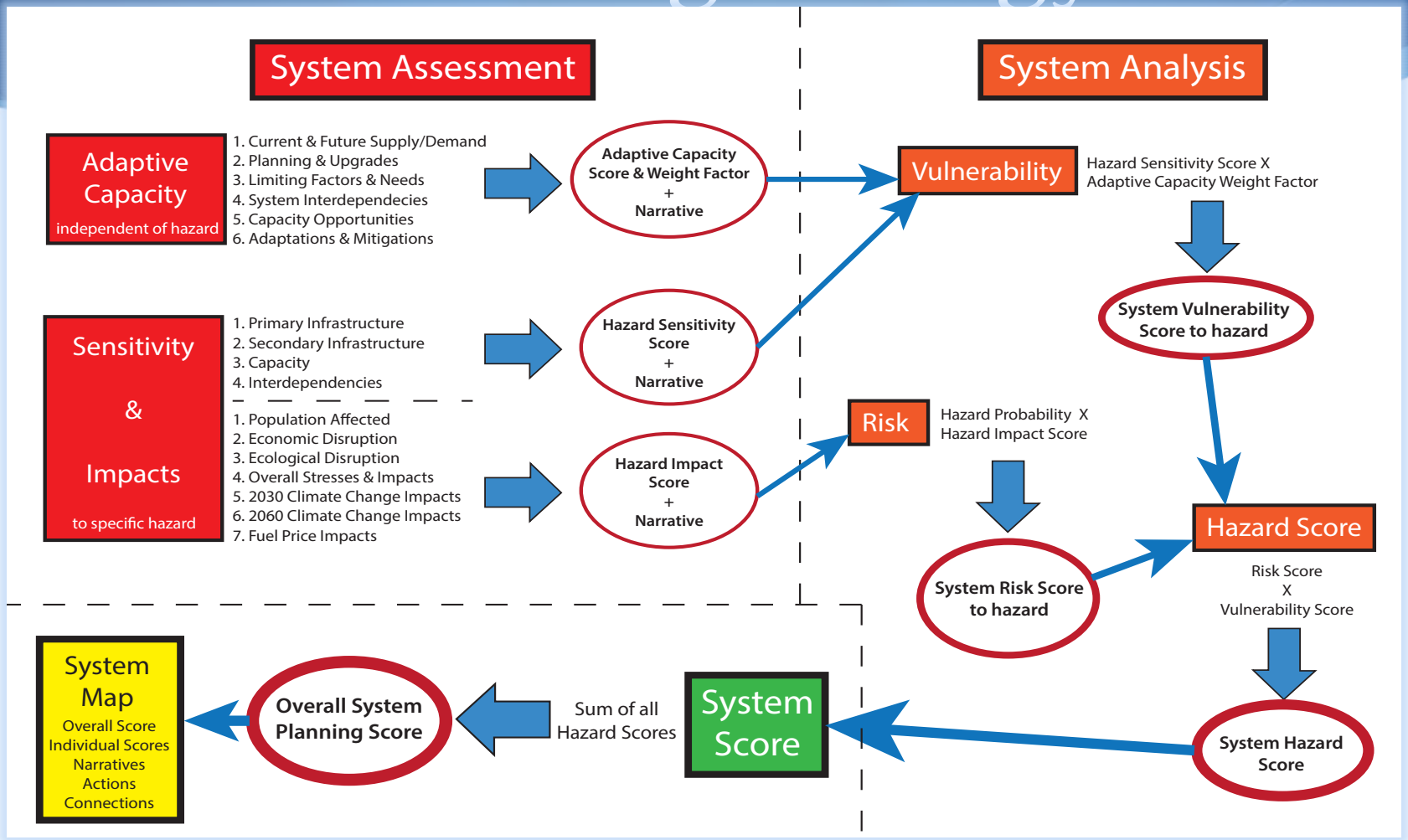
Dry: Parched and Burning

- Places like El Paso, TX going through major drought (lakes in the Panhandle red from bacterial blooms, herd culling)
- The largest irrigated crop is watered lawns: > 50% of municipal water in Texas goes to watering lawns (in places like Phoenix and Las Vegas, it's almost 80%). [29]

The Who and What of the Western Adaptation Alliance (WAA) [27]

- 10 local governments developing best practices in arid region urban adaptation (Colorado: City of Aspen, Boulder County, City/County of Denver and City of Fort Collins; Arizona: City of Flagstaff, City of Phoenix and City of Tucson; Utah: (City of Salt Lake City and City of Park City; Nevada: City of Las Vegas).
- Comprises ~ 25% of the population of 4 states, representing over 75% of the 4 state economies. Leadership on water use efficiencies and water resource management over several decades, and in some cases over more than a century.
- Formed because local government adaptation efforts were primarily focused on coastal issues / sea level rise. Case studies from inland communities (particularly from the arid to semi-arid American West) underscored the need for study applicable to a rapidly growing region, including water conservation and sustainable water resource management.

Example City Adaptation Planning Strategy



[30] City of Eugene, "Hazard-Climate-Energy Vulnerability Assessment Tool: A City Systems Approach to Assessing the Hazards of Climate Change Impact", 2013

Example City Water Sustainability Indicators

- Sustainable Water Indicators:
  - Drinking Water Quality
  - Gallons of Treated Municipal Water
  - Wastewater Quality
  - Biosolids
  - Sanitary Sewer Overflows
  - Green Roofs
  - Urban Stream Bank Conditions
  - River Water Quality
  - Local Stream Water Floodplain Management

[31] Iowa City, "Sustainability Assessment", 2013

Sustainable Water System Goals

Efficient	Water supply values conservation and using the least amount of water possible for the desired use; Wastewater system minimizes leakage and energy use; Stormwater system filters first flush and removes excess water.
Resilient	All water systems can withstand variations in water availability and quality caused by aging of infrastructure, population growth, climate change, and other factors.
Regenerative	All water systems manage water use to maintain the natural system's "water budget" as its regenerative capacity – clean (quality) and safe (supply).
Clean and Safe	Water supply system delivers water that is safe for its intended use and meets government/scientific standards from wastewater treatment standards; stormwater does not encroach on life and property.
Equitable	All water systems provide all segments of population with fair and fair and adequate access to water supply and services needed for health and life, while offering non-discriminatory opportunities to use water for economic gain or threatening life and property.

[5] The Innovation Network for Communities, "Accelerating the Development of Sustainable Urban Water Markets in the U.S." January, 2013.

Barriers to Sustainable Water System Goals

Efficient	Aging infrastructure loses water, profit is structured to coincide with consumption, so there's little incentive to conserve.
Resilient	There is a lack of recognized mechanisms for making linkages between drinking water supply, stream water quality issues, and stormwater quality/quantity. Aging of infrastructure, population growth, and climate change remain unaddressed in most systems, meaning they are not elastic. Lack of funds and political will stand in the way of this.
Regenerative	Gray infrastructure remains the primary stormwater management tool, so the system is hindered in its water recycling. Pressure on water supply induces over-withdrawal from the water system.
Clean and Safe	Changing weather patterns and increased storm intensity threatens water supply safety in the long term. Nonpoint sources pollution regulation is a continual.
Equitable	Access to water (keeping costs down) is critical to life and health. Flooding often happens in low income areas because they are located in low sewer and stormwater infrastructure investment areas. Underserved populations need education to be able to access the emerging job market surrounding green infrastructure and adaptation assessment.

Identify Key Systemic Strategies to Achieve Goals

- Systematic Water Innovation Strategies
- Emerging Sustainable Water Management Innovations

Systematic Innovation Strategies

New Principle	Some Features
Ecology – Mimic Natural Systems	• Preserve/restore natural systems • Value environmental services • Adopt biological technologies • Linking water planning to land use /economic system planning
Performance Management – Use Data and Standards to Drive System Changes	• Seek "whole system" outcomes • Conduct "one water" planning and management • Focus on water productivity • Match water quality to different water uses • Regional thought process to go beyond municipality based thinking
Market – Use Market Dynamics to Achieve Outcomes	• Use economic incentives to influence water consumption behavior • Adopt full life-cycle costing • Uncouple revenues from volume • Embrace competition among water providers
Adaptation – Maximize System Resilience	• Build climate change into risk assessment • Invest in/maintain resilience/flexible capacity • Adopt adaptive management

[5] The Innovation Network for Communities, "Accelerating the Development of Sustainable Urban Water Markets in the U.S." January, 2013.

Emerging Sustainable Water Management Innovations

Ecology	Management	Markets	Adaptation
• Green infrastructure • Dam/canal removal • Zero waste/recycling • Watershed protection / restoration	• Integrated planning • Land use planning • Community-based monitoring • Water use auditing • "Sustainable utility" performance standards • Water reuse/recycling • Consumer demand management • Fit-for-use water	• Wastewater mining • Markets for water rights • Markets for water-pollution credits • Insurance-driven incentives for investment in flood and pollution prevention • Seasonal block rates • Decoupled costs/rates • Full cost-of-service accounting • Water technology accelerators	• Risk/vulnerability assessment • Decentralized service models • Scenario planning

[2] The Innovation Network for Communities, "Accelerating the Development of Sustainable Urban Water Markets in the U.S." January, 2013.

Identify Innovations for Paradigm Shifting

- Innovation Processes
- Innovation Drivers
- Innovation Acceptance
- Inventory of Water System Innovations
- Edge of Innovation

Major Innovation Drivers

Underlying dynamics of the water market (demand and supply) are shifting in ways that increase the power of market forces.

- Four large, discernible trends are changing the U.S. water market:
  - Overall per capita water use is declining (some regional water use is increasing)
  - New market niches are developing (tradable rights / markets, pollution rights (water supply, some of which are unsustainable – mining groundwater)
  - The price of water is rising.
  - The economic value of water is increasing.

New drivers of change (the economy, climate change, and energy consumption) are growing in importance.

- Over the longer run, three relatively new factors will increase the demand for water sustainability.
  - The economy needs sustainable water.
  - Climate change is creating conditions and uncertainties that need new solutions.
  - The water-energy nexus drives water-system costs.

[5] The Innovation Network for Communities, "Accelerating the Development of Sustainable Urban Water Markets in the U.S." January, 2013.

Innovation Acceptance

Incremental: Adjusting at a local ecological and operational level	• Preserve and/or restore natural systems (rather than supplanting them with built) • Treat waste as a resource • Adopt biological technologies • Plan and manage at the watershed—hydrological system—level • Use decentralized, interdependent, "web" models instead of centralized, command-and-control models
Breakthrough: Change in technologies and operating systems / performance management styles	• Focus on water productivity • Seek "whole system" outcomes (success measured by environmental, energy, economic, and social impacts • Conduct "one water" planning, management, and policies (watershed level) • Measure, monitor, and continuously improve performance • Match water quality to different water uses • Manage demand as well as supply • Adopt decentralized/small-scale/cost-effective "end user" systems • Use water more than once • Assess and manage risk
Transformational: Market influence of new technology / thought processes / performance standards for adaptation	• Use economic incentives to influence water consumption behavior • Adopt full life-cycle costing • Uncouple revenues from volume • Embrace competition among water providers • Use market pricing • Incentivizing private investment and public-private partnerships • Build climate change into risk assessment • Invest in/maintain resilience and flexible capacity of systems • Adopt adaptive management

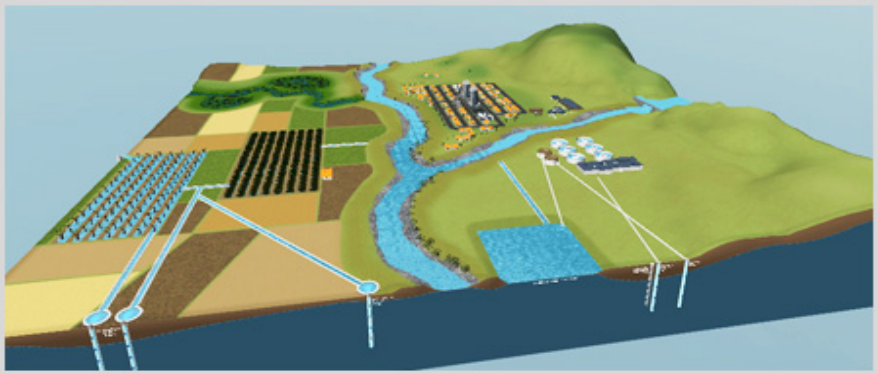
Innovation Acceptance

- Public Communication and Changing the Conversation:
- Tucson's game changing conversation: Water issues that resonate: think about this in a silo'd fashion; range of community goals so there's an element of management that needs to be articulated that will drive the smaller conversations (ie, supply, financing, etc.). Balancing and prioritizing needs to be more apparent (Pete: one of the challenges is that much of the goal structure has been about getting the water to you, but there's an equation with a lot of variables that needs to be outlined). It's a shift from thinking about water from the supply side to thinking more from a demand perspective: thinking about multiple uses, linkages across systems and meeting multiple needs with available water portfolio.
- Note Santa Monica's work on engaging community around water issues – probably should be another column in the topics matrix
- Paying attention to GHG in the water system.

Case Study: California Water Foundation

- **A Focus on Three Critical Areas: The California Water Foundation has chosen to focus its work on three critical areas that can have immediate benefits for California's water supply:**
- **Increasing Water Use Efficiency**. Maximizing efficiency through conserving water, recycling waste water, and capturing stormwater. Recycling and stormwater capture alone could meet approximately 20% of future urban water needs statewide, and that percentage can be even higher in certain regions of the state.
- **Improving Groundwater Management.** Reducing groundwater "overdraft" and increasing the amount of water stored in groundwater basins. Groundwater is a critical component of the state's water supply providing up to 60% of California's water needs in dry years. Restoring Key River Systems.
- **Improving the health of the Sacramento and San Joaquin river systems** to reduce conflict between water use, fish and wildlife, and flood protection. Today, California's two most important river systems are ill-equipped to handle increased flooding, support endangered species, or provide reliable water supplies.

- The CWF has over $100 million committed in the next 10 years to work on their 3 critical areas – they are the first water foundation of their kind, and there is foundation interest in replicating the effort on a national scale.
  - They convene stakeholders and influence policy decisions
  - They provide tools and resources for innovations / initiatives



http://www.californiawaterfoundation.org/index.php

Water Innovation: Ecology

Major Urban Water Innovations by Category		
ECOLOGY		
Innovation Name	**Description**	**Innovation Function**
Complete Streets	Policy for Street Design: vegetative bioswales / medians, infiltration planters, street trees	Operations
Dam / Canal Removal	Dismantling dams, canals and other engineered flows, restoring natural river / wetland flows, wetland creation	Operations
Green Infrastructure	Impervious Surface Treatment, Regional stormwater control, constructed wetlands, rain gardens, green roofs, pervious pavers, rain water capture for reuse (rain barrels, cisterns),	Operations
Land Repurposing	Rezoning for areas afflicted by flood conditions to remove the human factor	Planning
Waterway Revitalization	Vegetated riparian zones, pocket wetlands, floodplain protection	Operations
Zero Waste Recycling	Eliminating wastewater release into natural systems through treatment and recycling / reuse systems, treating used water and recycling it for targeted / fit for use or directing it to groundwater for further filtering	Operations

Water Innovation: Management

Major Urban Water Innovations by Category		
MANAGEMENT		
Innovation Name	**Description**	**Innovation Function**
Community Based Monitoring	Using Community Groups / Students to test local water supplies for quality, Surface and Stormwater monitoring	Education
Energy Efficiency / Renewables	Energy Reduction Targets, Incorporation of renewable energy supplies into daily operations, Carbon reduction targets	Operations
Integrated Planning	Regional water management planning across all system functions and with varying water sources	Operations
Low Impact Development	Smart Growth principles to decrease sprawl induced infrastructure costs, Zoning for high density, on site stormwater retention, and green infrastructure	Planning / Zoning
Residential Consumer Demand	Incentives to decrease water consumption through education campaigns, low flow appliance promotions, etc.	Education
Utility Performance Measures	Develop Sustainable Performance Measures for utilities, Set progress measurement metrics / performance review schedule	Operations
Water Use Monitoring / Foot printing	Organizational / Company water budgets, Performance Measures, metrics, and progress tracking processes	Operations

Water Innovation: Market

Major Urban Water Innovations by Category		
MARKETS		
Innovation Name	**Description**	**Innovation Function**
Decoupled Costs / Rates	Decoupling water fixed costs from sales to pursue conservation / efficiency, Removes the more you sell, the more you make concept, which discourages conservation	Policy
Full Cost of Service Accounting	New pricing to suggest actual costs, Encourages conservation and innovation	Financial
Green Jobs in Water	Utilizing the new water market / management paradigm to establish new job capacity	Education
Insurance market driven incentives to invest in flood prevention	Reduced insurance rates upon infrastructure investment to prevent disaster, "Wetrofitting" – preventative measures for homeowners to reduce insurance costs	Financial
Mining	Removing material (minerals, nutrients, fats) from wastewater to sell to agriculture or fuel (biodiesel) sectors	Operations
Property Tax Increased for Infrastructure Funding	Set-aside for use of a portion of property tax increases associated with growth and greater density in the sewer district to fund a transfer of development rights program, where the municipality becomes the banker/holder/reseller of acquired rights	Policy
Seasonal Block Rates	In dry months, unit costs of water increases (Seattle, Los Angeles, and Salt Lake City)	Financial
Septic System Utility	Charging a fee based on wastewater generated	Policy
Stormwater Utility	Charging a fee based on square footage of impervious surface	Policy
Water Rights	Voluntary trade (buying / selling) of water rights	Policy
Water Technology Business Clusters	Private Sector Research and Development: new finance mechanisms, University and Government labs: new water technologies, Public Private Supply Chains: managed more efficiently	Education

Water Innovation: Adaptation

Major Urban Water Innovations by Category		
ADAPTATION		
Innovation Name	**Description**	**Innovation Function**
Local Energy Assurance Planning	Insuring water intakes / treatment facilities are the first on the emergency energy supply list	Planning
Neighborhood Emergency Plans	Approaching a city strategy on a neighborhood by neighborhood basis, so emergency efforts are coordinated	Planning
Risk Assessment	Modeling scenarios in water supply and demand, Accounts for climate change	Planning
Sea Level Rise / Water Volume Increase Simulations	Long term modeling for Sea level rise and subsequent planning around future submerged infrastructure	Planning
Storm Surge / Sea Level Rise Infrastructure	Sea Level Rise measures for preventing the intrusion of salt water (sea walls / pumps)	Operations
Systematic Upgrades	Long term (25 year) Water Infrastructure Upgrade Plans with increased sea level / water intake estimations	Planning
Tool Kits	Toolbox for Water Energy Utility and GHG Emission Management	Planning

Edge of Innovation

- New Financial Policies (Decoupling Costs, Rate Setting, Cost of Service Accounting)
- New Revenue / Resource Capture Models (Waste to Energy, Wastewater Mining)
- New Cost Cutting Measures (Grey Water Use)
- New Sustainable Water Utility Performance Standards (Operating Methods)
- New Planning Processes (Adaptation / Resilience)
- Land Use (Zoning / Building Codes)
- New Infrastructure (Marrying Gray and Green)
- Interdisciplinary, Cross Sector Solutions (Water Business Clusters)

Map Communities of Practice in Sustainable Urban Water

- Differentiate the Practice Communities
- Each Community's Focus, Capacity
- Key Players in Each Community

Water Players: Ecology

Major Urban Water Players by Category			
ECOLOGY			
Name	**Major Water Contributions**	**Organization Function**	**Website**
American Rivers	American Rivers works to ensure clean water supplies, revitalizing habitat, improving recreation, and leaving a legacy of healthy rivers	Activist Network	www.americanrivers.org
Environmental Offices	Provide / enforce regulations, monitoring of waters, and funding (grants / loans) for water projects	State Government	Search by State
U.S Geological Survey (USGS)	Hosts the State Water Resources Research Institute (WRRI) Program, authorized by section 104 of the Water Resources Research Act (1984) and found at each land grant university	Research / Funding	www.water.usgs.gov
U.S. Environmental Protection Agency	EPA funds water research and state and local initiatives by Region	Federal Government	www.usepa.gov

Water Players: Management

Major Urban Water Players by Category			
MANAGEMENT			
Name	**Major Water Contributions**	**Organization Function**	**Website**
American Water	Own regulated operations and manage assets and provide water and wastewater services for others	For Profit Management	www.amwater.com
Aqua America	Provides water and wastewater services to approximately 3 million people in 10 states	For Profit Management	www.aquaamerica.com
Federal Emergency Management Agency (FEMA)	FEMA's mission is to support citizens / first responders to prepare for, protect against, respond to, recover from, and mitigate hazards: have flood plain jurisdiction	Federal Government	www.fema.gov
Stormwater / Wastewater Utilities	Provide / enforce regulations, monitoring of waters, and implement water infrastructure projects	Local Government	Search by City
Suez (United Water)	Provide water and wastewater management	For Profit Management	www.unitedwater.com
Tennessee Valley Authority	Water supply, waterway infrastructure, dredging, flow management	Federal Government	www.tva.gov
The Mayor's Innovation Project	MIP is holding a Mayor / EPA convening to discuss the new MS4 water policies.	Convening	www.mayorsinnovation.org
Safe Drinking Water Act	SDWA is the main federal law that ensures the quality of Americans' drinking water.	Federal Government	www.water.epa.gov/lawsregs/rulesregs/sdwa
U.S. Army Corp of Engineers	Water supply, waterway infrastructure, dredging, flow management	Federal Government	www.usace.army.mil
U.S. Environmental Protection Agency	EPA regulates the discharge and treatment of wastewater under the Clean Water Act. The National Pollutant Discharge Elimination System issues permits to all wastewater dischargers and treatment facilities	Federal Government	www.usepa.gov
U.S. Water Alliance	Business Advisory Council (National Roundtable on New Tools for Water Quality: Trading and Beyond).	Convening	www.uswateralliance.org
Veolia	Utility management of water and wastewater services for municipal and industrial clients.	For Profit Management	www.veoliawater.com

Water Players: Market

Major Urban Water Players by Category			
MARKETS			
Name	**Major Water Contributions**	**Organization Function**	**Website**
CDC: Driving Sustainable Economies	Environmental clearing house for companies and cities to measure, disclose, manage and share; working with GRI to increase disclosure metric alignment.	Research / Capacity Building	www.cdproject.net
Center for Neighborhood Technology	CNT's work in water is most notable for trying to create fiscally viable solutions for property owners and utilities to deal with flooding	Research / Capacity Building	www.cnt.org
Center on Wisconsin Strategy (COWS)	Does water based convenings with national groups like MIP, Clean Water, Healthy Cities Coalition, and Efficiency Cities Network	Research / Capacity Building	www.cows.org
Global Reporting Initiative (GRI)	Reporting for Ecological footprints, environmental social governance (ESG), triple bottom line (TBL), and corporate social responsibility (CSR). Tries to make sustainability reporting by all organizations routine and comparable to financial reporting.	Research / Capacity Building	www.globalreporting.org
Green for All	Water Works: Rebuilding Infrastructure, Creating Jobs, Greening the Environment	Research / Capacity Building	www.greenforall.org
Innovation Network for Communities (INC)	Study on Acceleration of Sustainable U.S. Water Markets; working with USDN and Foundations on water systems work	Research / Capacity Building	www.in4c.net
The California Water Foundation	CWF convenes to achieve CA water sustainability; initiative of Resources Legacy Fund: funding from S. D. Bechtel, Jr. Foundation and Pisces Foundation, and David and Lucile Packard Foundation, Walton Family Foundation, and Colleen and Robert D. Haas.	Research / Capacity Building	www.californiawaterfoundation.org
WBCSD: Business Solutions for a Sustainable World	The WBCSD is a CEO-led organization building work on alignment on global valuation of water.	Research / Capacity Building	www.wbcsd.org

Water Players: Adaptation

Major Urban Water Players by Category			
ADAPTATION			
Name	**Major Water Contributions**	**Organization Function**	**Website**
Institute for Sustainable Communities (ISC)	Water Resource Management and Infrastructure Manual	Research / Capacity Building	www.iscvt.org
National Climate Assessment	Advisory Board to develop climate report: Chapter 3 on the impact of climate change on water systems	Research / Capacity Building	ncadac.globalchange.gov
The Alliance for Water Stewardship	AWS is a collaboration committed to driving collective responses to shared water risk. AWS is building a global water stewardship standard.	Research / Capacity Building	www.allianceforwaterstewardship.org
The US Water Alliance	One Water Management Network, which works to stregthen partnerships, align research efforts, and assist with local decision making	Research / Capacity Building	www.uswateralliance.org/
Water Research Foundation	Toolbox for Water Energy Utility and GHG Emission Management	Research / Capacity Building	www.waterrf.org
Water Utility Climate Alliance	WUCA provides collaboration on climate change issues affecting the country's water agencies. Comprised of ten of the nation's largest water providers	Research / Capacity Building	www.wucaonline.org
World Resources Institute	working globally with governments, business, and civil society to build transformative solutions that protect the earth and improve people's lives. WRI developed Aqueduct, a water risk mapping tool.	Research / Capacity Building	www.wri.org
World Wildlife Fund	WWF has developed open source tools on evaluating water risk and is discussing common data sharing with WRI.	Research / Capacity Building	worldwildlife.org

Identify Advisory Board Priorities and Practices in Sustainable Urban Water

- Survey data
- Interviews

Summary of Advisory Board Interests

- Primary Innovations Being Considered:
  - Waste to energy (Example: Orlando recycles about 95% of its treated water for secondary uses)
  - Grey water use (Example: Orlando has researched one emerging technology (Super Critical Water Oxidation), and actively designing use of FOG and food waste to energy for our other plant).
- Advisory Board Wants to Know More About:
  - Sustainable Water Utility
  - Performance Standards
  - Wastewater mining
  - Decoupling costs /Rate setting
  - Water Business Clusters
  - Cost of Service Accounting

Summary of Advisory Board Primary Water Issues

City	Types of Issues														
	ECOLOGY					MANAGEMENT					MARKET			ADAPTATION	
	Broader Community Goals: Communications and Eco system Valuation	Energy Water Nexus: Revenue Building Infrastructure	Flooding	Green Infrastructure / Reuse of Runoff	Nonpoint Source Pollution	Water Portfolio / Alternative Technologies	Gray / Green System Interaction	Metropolitan Collaboration	Utility Performance Standards	Waste / Gray Water	Economic Development / Business Clusters	Business Models (incl. decoupling & cost sharing / accounting)	Linkages Between Systems: Land Use / Development / Planning Financing/	Adaptation / Resilience (incl. salt water intrusion)	Supply & Demand: Groundwater Level/ Storage Capacity
Boston		X			X									X	
Washington D.C.	X		X		X		X					X			
Knoxville		X		X	X		X		X		X		X	X	
Miami-Dade County	X	X				X		X			X	X	X	X	X
Ann Arbor		X	X									X	X	X	
Cincinnati	X			X	X							X			
Dubuque					X	X				X	X	X	X		
Iowa City			X	X		X									X
Milwaukee		X				X					X	X			
Denver				X			X	X		X	X	X	X	X	X
Tucson	X			X		X		X			X	X	X	X	X
El Paso						X	X						X		X
Los Angeles				X			X						X	X	X
Santa Monica	X			X			X			X				X	X

New England: Boston

City: **Boston, Massachusetts**
USDN Sustainability Director: **Carl Spector**

Water System Priorities	• Climate adaptation for dealing with sea level rise, coastal storm surge, and how that affects the stormwater system. • There's concern about nonpoint sources of pollution – Boston Water and Sewer Commission just signed a new EPA agreement to deal with phosphorous, coastal pollution, etc. • An ongoing concern about groundwater levels—keeping the water table up to protect the pilings in several parts of Boston.
Water System Characteristics: **Ecological** **Built** **Governance**	• Boston affected by three rivers: Charles, Neponset, and Mystic. None is connected to the Quabbin Reservoir (main supply). • Boston is a built-out city, so intersection with land use/growth is not a big issue. Have had water infiltration issues due to the water table, but that's part of the regular thinking. Due to the clean-up of Boston Harbor, a huge amount of $ has been put into infrastructure, and land use issues were thought through. • Water and sewer for most of eastern Massachusetts is under regional authority (MA Water Resources Authority); they control the Quabbin Reservoir 50-70 miles to the west of Boston, all the way to the Deer Island Water Treatment facility in the Boston harbor. Then the Boston Water and Sewer Commission (quasi-independent agency of the city) handles service in the city. Stormwater is city controlled, with some MWRA overlap. • The Mayor has some appointment authority for the BWSC and the MWRA boards. Coordination with the BWSC is good.
Recent Investments / Rate Drivers	• Rate increases have been driven by New Regulations (EPA / State / Regional Authority / City / Utility) • There's been a lot of work on combined sewer overflows (CSOs) – may be a matter of MWRA providing funding to reduce CSOs, thereby reducing demand on treatment facilities.
Recent Innovations	• Lots of green infrastructure in place.
Desired Learning from Project / Deliverable	• Climate adaptation issues – need to expand understanding • To better understand the nexus between energy and water. • Nonpoint sources of pollution: this goes beyond what water systems operators are generally used to dealing with. What's the relationship between gray and green infrastructure?

Mid Atlantic: Washington D.C

City: **District of Columbia**
USDN Sustainability Director: **Brendan Shane**

Water System Priorities	• Water, stream, river cleanup is a high priority on the sustainability side but not necessarily at the top. • Restoration of waterways has been a driver for a long time.
Water System Characteristics: **Ecological** **Built** **Governance**	• Water quality issues in the Potomac, Rock Creek, Anacostia • Flooding is an issue; have all of the major threats in play (storm surge i.e. the Sandy scenario) – have a funnel problem up the Potomac: biggest floods have been coming down the Potomac. Not insignificant flooding of homes and commercial entities, caused by rain in the city. Storm water is separate. • Drinking water from Potomac via USACE, with the DC Regional Authority manages. DCRA is owned / controlled by DC and treats wastewater from a large area but only provides drinking water to DC. There are regional agreements to allocate costs across 3 states for wastewater treatment. • DC Water (drinking and waste, permitted for combined system) and USACE (permitting for separate system), controls system, so split Federal consent for long term CSO management. • City administration chairs DC Water Board, have an agreement to provide tunnel capacity. • The relationship between DC Water and USACE is good though a decade before there have been huge problems like spike of lead levels in the mid 2000's.
Recent Investments / Rate Drivers	• Rate increases have been driven by New Regulations (EPA / State / Regional Authority / City / Utility) • Infrastructure upgrades: water bills raised by double digits each year to pay for supply and water treatment and CSO are rising rapidly. Discussion to pay for infrastructure is a topic of general consumption. Impacts on bill – vast majority of cost slated to be carried by rate payers. • 2.5 billion in projects, politics with EPA, USACE, DC Water.
Recent Innovations	• Trying some green infrastructure here and there.
Desired Learning from Project / Deliverable	• The financing piece is huge, with a massive backlog of unmet infrastructure needs. • Would like to know about ecosystem interactions, natural and wildlife corridors; DC has a legacy with national parks. • What are the cutting edge water policies? Is there an opportunity to collaborate with the US Water Alliance initiative?

Southeast: Knoxville

City: **Knoxville, Tennessee**
USDN Sustainability Director: **Erin Burns Gill**

Water System Priorities	• Water quality is an issue in the city – many urban streams are listed impaired with contact advisories • Systematic infrastructure upgrades are ongoing • Green infrastructure and Stormwater Utility exploration
Water System Characteristics: **Ecological** **Built** **Governance**	• Supply comes from the Tennessee River, is managed by the Knoxville Utilities Board (KUB) within the Tennessee Valley Authority (TVA) river system. • Water quality and flooding are primary concerns, not supply. • Steady decrease in water consumption, largely due to a decrease in thermoelectric power generation in the TN Valley • Stormwater is managed by the City, sewer by KUB which is a municipal utility but separate in all aspects of operation. The only shared overlap is in the right of way and infrequent board appointments by the Mayor, so city influence is slight.
Recent Investments / Rate Drivers	• New Regulations (EPA / State / Regional Authority / City / Utility) drive rate increases. • The $530 million, ten-year wastewater system improvement program works to clean up area waterways and meet regulatory requirements (PACE 10). The program includes a mix of ongoing maintenance programs, replacement and rehabilitation projects, and wet weather wastewater storage. Projects have been under way throughout Knoxville / Knox County since 2004, decreasing the number of sewer overflows. Substantial modifications required two of KUB's wastewater treatment plants increase total spending to nearly $650 million by June 2021.
Recent Innovations	• Work with Advocacy Groups, State Environmental Office, and Water Networks on water quality issues. • Have captured 2 State grants to fund new green infrastructure projects and are weaving GI into redevelopment budgets.
Desired Learning from Project / Deliverable	• There is a fear that the State won't credit green infrastructure, so often a full gray stormwater system is designed below them, negating any cost benefit. They are considered more costly to install and requiring more maintenance. Is anyone else dealing with this?

Southeast: Miami-Dade County

City: **Miami-Dade County, Florida**
USDN Sustainability Director: **Patricia Gomez**

Water System Priorities	• The Mayor and Commission recognize water as part of the economy, so supporting infrastructure plays a critical role. • Miami Dade has an aging system and is responding to the CWA lawsuit (consent decree; significant recession held off development but now activity is picking up, so demand is rising.
Water System Characteristics: **Ecological** **Built** **Governance**	• Water supply comes from the Biscayne Bay Aquifer and the Floridian Aquifer with a steady decrease in consumption – adequate supplies are predicted for the next 20 years. • There's a 10 year drought cycle, but right now having flood control issues, impacting Everglades restoration efforts. There's not enough storage capacity to deal with more than 1"/hr. so localized flooding is expected. Occurs 50-100 year storm event; 20 named storms last year but mostly went east or west. Used to the effects of tropical storms/ carrying insurance. • Supply is good quality, but there's been nutrient loading and salt intrusion discussion; water supply well fields have moved west to limit the extent. • Primary Suppliers is Miami-Dade Water and Sewer Department (municipal utility over storm / sewer), the Department is part of Miami-Dade County government and reports to the Board of County Commissioners – city controls all facets. • There is a state agency responsible for managing 16 counties water systems; stormwater is primary canal system operated by 1 of 5 FL water management districts. Have a system of pumps to remove flooding or recharge groundwater. Primary & secondary canals are managed by the public works dept. and a localized management system operates smaller canals. • There are 425,000 retail accounts representing a billion people, and 37 municipalities manage local drainage systems.
Recent Investments / Rate Drivers	• Utility rates are inverted block, encouraging conservation through pricing. Have a stormwater utility in place. • $4 billion in bond authorization in the next 5-8 years • Water rates have increased in 2013. Increase is pending for new budget due to consent decree with EPA
Recent Innovations	• Active water conservation program in place, reduced daily demands over the last 6 years by 10,000,000 / day based on conservation program – so using same amount of water as 20 years ago even with 700,000 more people. Redevelopment includes low flow as part of the building code. • Working with State on water issues
Desired Learning from Project / Deliverable	• Interested in technologies that provide alternative water supply. • Resources / money are of interest. Used to be 75% clean water act money, so capital planning is paramount.

Midwest: Ann Arbor

City: **Ann Arbor, Michigan**
USDN Sustainability Director: **Matt Naud**

Water System Priorities	• 30% Renewable Energy goal – this includes saving energy from water and waste water systems esp. running waste water off of renewable energy. • Ann Arbor is well established in this realm. Water isn't such a huge issue, not a big priory because the system is working
Water System Characteristics: **Ecological** **Built** **Governance**	• Primary source is the Huron River; lost one water source due to groundwater contamination, but otherwise live in water plenty and manage it skillfully. There is no marked demand rise / fall. • Prone to natural disasters: tornadoes –do a fairly reasonable job with emergency management. Own 4 dams, so constantly consider the risk of flooding / dam breaching. • Water conservation isn't an issue. City created an inclining block rate structure for water rates - $1 for 1st 7 units (ccs), $2 for the next 8-14, $3 for the next level, etc. (so they are selling less water than expected, pricing is setting the usage). • Ground water quality a slight concern, but have a strong watershed council (oldest in state – huge volunteer base for stream restoration). City helped fund this; pays attention to quality / quantity. • The city works with FEMA (and matches funds out of the stormwater utility) to remove structures in the flood plain as needed. Have a flood mitigation plan, and understand that the subsidy for flood insurance is going away – which may drive people out. • City has 2006-established stormwater utility, which generates $5,000,000 per year. Every 3 years the City collects flyover data and charges by amount of pervious payment. Every 3 years the rate may be readjusted. The rate structure is not linear – there are 4 different rate buckets but you have to significantly change the amount of impervious pavement (1,000 sq. ft, or more, for example) to make it into a new rate bucket. • City of Ann Arbor controls everything without a water board.
Recent Investments / Rate Drivers	• Building new 100 efficient wastewater treatment plant • Rate increases reflect costs to maintain infrastructure • CIP contains any project over $100,000 built into 6 year plan.
Recent Innovations	• Strict stormwater retention on new construction • Some studies looking at personal care products in water. • Established, implementing many of the innovations listed in survey; working with advocacy groups and the State. • Phosphorus ordinance and evaluation. Paying for street trees as part of storm water.
Desired Learning from Project / Deliverable	• Ann Arbor bases decision on good science and innovation across the county – the report will be a helpful showcase.

Midwest: Cincinnati

City: **Cincinnati, Ohio**
USDN Sustainability Director: **Larry Falkin**

Water System Priorities	• Under an EPA consent decree to reduce CSO's, which are somewhere in the 2-3 billion gallons / yr. • There's an industrial portion of Cincinnati protected by a flood levee, and in the last 3 years FEMA raised flood levels of the Ohio, so existing flood walls are decertified. • The cost of removing the wall is billions, no plan in place yet.
Water System Characteristics: **Ecological** **Built** **Governance**	• Ohio River is source, with no threat to quality or supply. • Major tributary to the Ohio called Mill Creek; 10 years ago it was one of the most polluted waterways in the country. WQ has been steadily improving; have a group who've organized over 80 canoe trips; urban pioneers who are staking the claim to it being an asset instead of a liability. • Water conservation to save energy, minimize impact on combined sewers, not supply related. • City is part of a significant portion of the country that is wet and getting wetter, which poses its own sustainability issues (stormwater management, flood control). • Delivered by Greater Cincinnati Water Works (GCWW). Sewer and Storm is Metropolitan Sewer District (MSD) is owned by the county and operated by the City (control of operating / ROW/ goal setting and planning but not of board appointments or capital budgets); demand decreasing. • Drinking water: Greater Cincinnati Water Works (owned by Hamilton County, operated by City, has a service territory larger than either). Goes under OH River, supplies parts of KY. Sewer: Metropolitan Sewer District, essentially a sewer dept. operating by an enterprise fund. Sewer director answers to City manager. Relationships are good as long as City Council and the County get along. Stormwater is a city capacity.
Recent Investments / Rate Drivers	• 8% per year for last 4-5 years – aggregate 40% rate increase, mostly driven by consent decree implications. From the sublet drinking water side, water production facilities are over-built. • Water demand is low; facilities are at 50% capacity – high OPR • Reduce CSOs by 2 billion gallons per year by 2017, based on federal consent decree.
Recent Innovations	• Working with Foundations / activist groups on water quality.
Desired Learning from Project / Deliverable	• Under the CWA, billions of unfunded mandates. How do you transform system into an asset to get value out of it (recreation, development magnet, stream blue way, wildlife corridor?). • How in the face of declining supply make use decisions around water? How is use prioritized?

Midwest: Dubuque

City: **Dubuque, Iowa**
USDN Sustainability Director: **Cori Burbach**

Water System Priorities	• **Flooding is linked to land use issues.** • **Agricultural runoff into rivers upstream impacts water supply.**
Water System Characteristics: **Ecological** **Built** **Governance**	• Proximity to Mississippi means community is aware of water issues. • No water shortages and utility rates are fairly low. • The National Mississippi River Museum is here; community sees water as an physical and cultural asset. • Dubuque has a population of 60,000, in county with total of 90,000. • City owns/operates supply, wastewater, and stormwater; has a new county watershed authority.
Recent Investments / Rate Drivers	• Building new wastewater treatment plant to address agricultural runoff and water quality issues.
Recent Innovations	• With IBM, piloted smart meters on 300 homes, saw 8% reduction in water use; business and industrial users want this commodity now. • Day lighting Bee Branch Creek for flood control; deconstructed 70 homes, created a linear park. • State recently permitted formation of county-level watershed management authority; Dubuque County has started one. No funding sources yet for the authority. • County adopted "smart planning" principles—uniform development codes, best practices – link land use to water system.
Desired Learning from Project / Deliverable	• Learn about changing water rate models (e.g., for wastewater). • Current billing is based on water flow volume—so how to encourage conservation?

Midwest: Iowa City

City: **Iowa City, Iowa**
USDN Sustainability Director: **Brenda Nations**

Water System Priorities	• **Iowa River is on the impaired river list.** • **The city is thinking about doing a different waste technology that might take a lot of water to do – no one is thinking about impact of this on water supply.**
Water System Characteristics: **Ecological** **Built** **Governance**	• Iowa River watershed and multiple creek watersheds is primary supply. Water demand has no marked rise or fall. • Iowa River has alluvial wells, deeper groundwater wells, and a reservoir. • There are 3 streams in the city – one especially prone to flooding. • Local aquifers levels are declining, and in parts of the state there are water quantity issues. • Iowa City is part of a cluster of adjacent communities with growing suburbs. These have un-collaborative relationships, which spills into water issues. • Even when there's been flooding, each city dealt with own problems; more recently emergency management coordination for flooding • Primary utility (sewer & stormwater) is the City of Iowa City – they have control over budgets: capital and operating.. • All water systems are city owned and operated, except university, which has own water system.
Recent Investments / Rate Drivers	• Legislature passed requirements that city wastewater had to be more compliant with nutrient levels, but for agriculture it's voluntary. • Water used to be drawn from the river, but the new water plant draws from effluvial wells and groundwater wells. • The new water plant was built for better water quality.
Recent Innovations	• There is a lot of water expertise locally: university, state and federal capacity. • With the floods, the City is modeling streams and stream management.
Desired Learning from Project / Deliverable	• Interested in stormwater management, because the city is trying to encourage permeable pavement, rain barrels, etc. • Interested in dealing with floods and dropping ground water levels.

Midwest: Milwaukee

City: **Milwaukee, Wisconsin**
USDN Sustainability Director: **Matt Howard**

Water System Priorities	• **Industrial redevelopment – water infrastructure is central to job creation goals.**
Water System Characteristics: **Ecological** **Built** **Governance**	• Primary water source is Lake Michigan, and there's more than enough water. • Have a national low rating in terms of natural disasters, local flooding is a big issue, though rain storms are increasing. • In general water conservation is low on the priority level due to plenty. • Water quality awareness high because of the 3 rivers that flow through downtown and serve as a source of recreation. • Water protection has been more prevalent in the past 3-4 years, now people are looking to see if they are in flood plains. • Infrastructure upgrades have been kind of taken for granted. Local government is highly aware • Funded through rate increases. Dichotomy is that model is based on selling more water. • City owns/operates Milwaukee Water Works, which does storm and waste water functions. The energy provider is investor owned and separate.
Recent Investments / Rate Drivers	• Rates rising due to re-cooping fixed costs in infrastructure/O&M • City replaces about 2 miles of water pipe per year.
Recent Innovations	• City is deep into innovations and considers them good investments; works with advocacy groups, foundations, and water networks. • The city/sustainability website has a water tab, and there's plenty of outside web resources detailing a well-developed system • H2Oscore.com, allows residents to determine use and benchmark themselves • H2Ocapture.com helps with conservation
Desired Learning from Project / Deliverable	• Biggest thing is funding the infrastructure piece; how are cities doing this?

Intermountain West: Denver

City: **Denver, Colorado**
USDN Sustainability Director: **Celia VanderLoop**

Water System Priorities	• Starting to grapple with water as a limit to growth. • Interested in green infrastructure and how stormwater can make city a green livable community, moving on from irrigation. • Looking for new storage and maximize/manage current capacity. Have found that where there have been significant forest fires, the reservoirs fill with sediment. • Denver Water financed by water supply fees so conservation means a decrease in revenue.
Water System Characteristics: **Ecological** **Built** **Governance**	• The South Platte, the Colorado, and the Arkansas Rivers drainage basins are source; with storage in reservoirs Water quality is an issue, even though water shortage is felt as droughts increase with climate change. Significant funds are spent on nutrient loading; using more recycled water and some communities here have installed wells next to wastewater plant discharge points and using it as potable water. • Even so, there has been a decline in overall usage though it's temperature-dependent (goes up when in a drought year). • Metro area is growing rapidly; some of suburbs are water short; some development mining water and water table is dropping. • City transfers a lot of water through the mountain tunnel from the Colorado River and brings in some from the Arkansas. • Denver Water Authority (DWA) is an independent municipal authority, with a board appointed by the Mayor. DWA is good at research / planning but they would like to see more systems integration (ex: Mayor wants to develop around airport so it's critical to ask DW how that will happen. Storm/ wastewater also operating • Metro WW/ Urban Drainage is a regional service. DWA supplies city and suburbs / control any hydropower Stormwater is controlled by the city. There is no centralization of control three separate systems.
Recent Investments / Rate Drivers	• Metro wastewater is building a $3 billion 2015 treatment plant and upgrading a plant for nutrient criteria. • New Regulations (EPA / State / Regional Authority / City / Utility) drive rates, which have risen significantly.
Recent Innovations	• Western Adaptation Alliance (WAA) working on water system adaptation and everybody is interested in green infrastructure. • Working on a streetscape design that will incorporate green infrastructure. • Lots of planning around water, relating to economic growth.
Desired Learning from Project / Deliverable	• Would like better integration of the water, wastewater and stormwater systems. How can we use land use to achieve this? • How to foster metro collaboration in water systems planning?

Intermountain West: Tucson

City: **Tucson, Arizona**
USDN Sustainability Director: **Leslie Ethen**

Water System Priorities	• More emphasis on green rather than gray infrastructure. • Supporting greener infrastructure in communities – crusade for shade and water conservation, water efficiency.
Water System Characteristics: **Ecological** **Built** **Governance**	• Regional water supply is just enough, but there's a lot of uncertainty, because of the Colorado River Larger western focus is on projected water use and changes in flow. Scenarios aren't modeled with historic levels, so there are skewed projections; people want to be optimistic, so regional water planning is not looking at situation realistically. • 40% of annual use is banked every year, so it's perceived that shortages will have minimal impact. Doesn't factor in population growth which slowed with the recession. • Water conservation is the largest topic education for 20 years. • Water quality is good because of recharge. Have some water quality issues related to TDS from the Colorado Do have FEMA areas, some flood insurance – storm water issue from first flush, but only an issue for a few days / yr. • City owns 90% of the potable water supply, also supply areas of unincorporated townships. • City controls storm water, waste water (90%), drinking water (90%). Decades of the City / County relationship: county only supplies for public purposes, not really private use. • Smaller communities have a tiny allocation – haven't had their own infrastructure. Negotiated some of the 10% with the small communities / county. Water Dept. is trusted by the community.
Recent Investments / Rate Drivers	• Water conservation is pushed to reduce user costs, but it actually increases per unit costs. • Infrastructure upgrades –the City is doing a good job; increasing rates are felt but aren't a huge discussion.
Recent Innovations	• Beat the Heat and Keep the Beat Campaign to conserve water. • WAA network participation in water adaptation planning / GI.
Desired Learning from Project / Deliverable	• Two things of the greatest importance: what's the level of uncertainly and risk, and is that being adequately captured? • How are we getting our hands around understanding climate change and surface / ground water supplies? • How do communities in the face of declining supply make use decisions around water? How is use prioritized? Some supply to quality of life, some to economic development purposes; do you reach a point where you calculate jobs created per gallons consumed? The old conversation's not working, • How do you start having these new conversations? How do we frame up a water supply? What's your most secure portfolio, how to best use the finite?

Texas: El Paso

City: **El Paso, Texas**
USDN Sustainability Director: **Marty Howell**

Water System Priorities	• **Challenges with distribution of water locally.** • **In a drought: only 1 year in last12 has had above average rainfall. Normally city turns on irrigation flow from reservoir spring to fall but can only do 2 weeks now.** • **Couldn't serve peak demand last summer. This year lake storage was down 6% in spring; river had water for a few weeks, then they shut reservoir flow down again.** • **Have water, but struggles to get it to meet all the needs (west).** • **Water system looking for ways to fund shift to solar energy**
Water System Characteristics: **Ecological** **Built** **Governance**	• Hueco Bolson Aquifer is primary water supply but there are four sources of supply and purchased water rights from farms 60 miles away (for use in long-term). • World's largest inland desalination plant—treats brackish water, brine injected back into brackish aquifer to prevent incursion into clean aquifer; the aquifer crosses Mexican border, so El Paso engages with Juarez on water conservation. • Population is 700,000, with small downtown and sprawl, but a steady decrease in water use. • El Paso Water Utility controls sewer and storm; utility is city owned / operated but controlled by an independent board appointed by the Mayor; who also sits on the governing board. • Council can over-ride some votes, but isn't involved in operating issues; the city utility acts as a regional provider – has no control over budgets / operating / some over ROW. • 20 years ago instituted full-scale conservation program, all the tools, changed the culture.
Recent Investments / Rate Drivers	• Created stormwater utility to deal with flooding / sinkholes and a long-term master plan for stormwater • Rates haven't changed much.
Recent Innovations	• Created a stormwater master plan after severe 2006 flooding that details the use of the stormwater fee to upgrade / maintain the City's stormwater system, including land acquisition. • Engaging with developers / engineers to rewrite drainage plan, try to incorporate low impact drainage into the code for new development and redevelopment.
Desired Learning from Project / Deliverable	• Resilience focus: 1) water resources: when it comes, how much, what quality? What is good research, which utilities are leading being proactive? 2) Stormwater—is our stormwater plan good enough? There's a community building aspect to this resilience. • Need the elevator speech for low impact design/drainage – to make the case to old school developers that it's good for community and good for them.

California: Los Angeles

City: **Los Angeles, California**
USDN Sustainability Director: **Jonathan Parfrey / Beth Jines**

Water System Priorities	• **Increase percentage of water supply that is local (boost from 11% to 37% by 2035) through conservation, recycling, stormwater capture. This is in the 3-year old Water Management Plan drives Water & Power utility.**
Water System Characteristics: **Ecological** **Built** **Governance**	• City owns / operates water agency: LA Department of Water & Power relies heavily on imported water via the wholesaler, Metropolitan Water District of Southern California. City owns wastewater and contracts with smaller cities to process theirs: Los Angeles Bureau of Sanitation • The stormwater system is operated outside the city of LA by LA County Flood Control District and the USACE. The city's Los Angeles Bureau of Sanitation works with the County on joint management. • 100-year history of engineering water system. LA River could support 400,000 residents and now there's 4 million. City built aqueduct. State built conveyance system from northern CA. • LA imports most of its water, from as far away as 900 miles, but recycles little of its local water. 350 million gals/day go through the water treatment plant and into the ocean. A regional pipe system being built. • Best areas for groundwater capture are polluted (aviation industry). • Climate change increasing vulnerability of water sources: CO River, snowpack in the Sierra Nevada Mountains. • Increasing local water supply a hedge against uncertainties of state and regional (southern CA) water politics. • LA purchases most of its water supply from Southern CA Metropolitan Water District; city does not have a dominant voting on the district board. City not assured of its allocation. • A big state-level issue that will affect LA: what will be decided about the Delta (Sacramento River) water system in northern CA, used for agriculture and transferred to southern CA? Env. Groups split on this: is southern CA economic viability dependant on the conveyed water? • Water systems have been siloed for years, but good coordination now (major leaps for more integrated approach) an Integrated Regional Water Control Planning Process involves all of the water agencies in the region. The environmental community has had enough political clout to force a lot of these integrated approaches to happen.
Recent Investments / Rate Drivers	• City pays $700-900 per acre-foot for Metro District water. Anticipate the price could double / triple in ~ 30 yrs. • State water conservation goal: all systems use 20% less than 2009 by 2020. LA is at 12-15% reduction so far. City is now pushing a "tear up your grass" initiative – paying $2 per sq foot of lawn that is removed. Did a huge effort in the 1990s, working with community organizations, which replaced 90% of city toilets; offered free low-flush toilets. Now focus is on outdoor water use, around 40% of all water use in city is for landscaping.
Recent Innovations	• Land use/water planning– any new development, parking lots and runoff, is regulated • City worked with financial institutions to develop bond to pay for conservation, recycling, stormwater capture system with revenue that would be saved by not having to buy District water (unique to LA). Possible city ballot issue in 2014 (requires 2/3 vote) for a bond/property tax assessment to do complete streets, stormwater capture for green streets, cool streets for climate – urban heat island effect. Proposal being developed, coalition being built.
Desired Learning from Project / Deliverable	• How to bring along the LA public so they willingly tax themselves to generate the revenue for water system fixes?

California: Santa Monica

City: **Santa Monica, California**
USDN Sustainability Director: **Shannon Parry**

Water System Priorities	• **Goal of 100% self-sufficient (no imported water) by 2020; currently at 72%** • **Strategy to achieve self-sufficiency: (1) additional groundwater from unused wells; (2) treatment of urban runoff; (3) conservation; (4) wastewater processing/reuse** • **Would retrofit and enhance current stormwater recycling (for parks irrigation and flushing toilets) for sewage water; plan is to finance this through rate payers** • **In process of a water rate study; this strategy less expensive than continuing to buy water from the regional district, due to cost of moving the water**
Water System Characteristics: **Ecological** **Built** **Governance**	• Owns water supply utility, a division reporting to city manager; pays regional treatment facility for sewer and wastewater treatment—built a reverse osmosis treatment facility. • City won case against oil & gas companies for contaminating groundwater • First water shortage in 1917, so community aware of conservation for long time • We're a water literate community." A coastal community, so much of tourism and community wealth is related to water. Some national and regional community activists like EnvironmentNOW, and Heal the Bay • City has goal of reducing GHG emissions 15% below 1990 level. But turning on the reverse osmosis plant increased municipal GHG emissions significantly
Recent Investments / Rate Drivers	• A big chunk of our need is investments in efficiency and conservation. • Making huge investments in groundwater, remediation, new wells, and protecting from salt water intrusion due to climate change
Recent Innovations	• City hired consultant to dos community engagement and outreach, to build a branding campaign around Santa Monica water and self-sufficiency goal
Desired Learning from Project / Deliverable	• What are other cities doing about urban runoff remediation? • How are cities keeping community dialogue open, given there is a ratepayer impact?

Potential Work Collaboration

What can we do together?

Next Steps: 5 Topics to Research

- Adaptation/Resilience
  - What are the categories of climate-change risk in water systems?
  - What are the adaptation strategies for addressing them
  - How can the public be engaged in understanding the system's adaptation requirements?
- Integrated Watershed Planning
  - How can planning for water supply, wastewater, and stormwater be integrated with land-use planning at the watershed / regional level?
- Market Signals
  - What market signal changes—e.g., pricing structures, vulnerability assessment—can induce more sustainable behaviors in water systems?
- Water-Driven Economic Development
  - What are ways that a city's water system can be an asset for local sustainable economic development (e.g., water business clusters, neighborhood development, water mining, environmental services)?
- Water Utility Performance Standards
  - What are the leading ideas/initiatives about setting utility performance standards?
  - How far has standard development proceeded, and what is the prospect for accelerating the development and implementation of industry-wide standards?

Questions from the 5 Topics

Appendix 1

Project Development

What: Project Summary

- This project:
  - Defines the leading-edge innovations for sustainable urban water systems
  - Identifies key barriers to implementing them
  - Identifies the ways that innovators are addressing these barriers
- Drawing from the experiences / knowledge of practitioners across North America, this project:
  - Provides a detailed set of road maps of strategies
  - Outlines emerging and proven practices for accelerating the development of sustainable urban water systems

Why: Project Need

- Some USDN cities are recognized leaders in sustainable water innovation: Philadelphia, Boston, Cincinnati, Kansas City, and San Francisco. Some USDN cities are in areas with chronic water shortages: Denver, Phoenix, Tucson, Los Angeles, and Atlanta.
- Emerging factors, including climate change, growing economic dependence on water supply, and advocacy for "sustainable water," are driving fundamental changes in the nature of water system management North American cities.
- Control of urban water systems is fragmented—divided between water, wastewater, and stormwater—and is often separated from city government.
- This makes it challenging for urban sustainability directors to influence urban water utilities, even though the sustainability of water systems is a crucial city concern.
- By bringing together North American urban sustainability directors and gaining access to the leaders in their water systems, this project will capture and package practical knowledge that sustainability directors can use to influence their city's water systems.

Why: Project Purpose

- To support USDN members who are engaging with their local water systems and trying to accelerate the system's shift toward more sustainable practices, by providing them with a framework and deep, but not highly technical information, about innovations, barriers, and how barriers can be addressed. USDN members will be able to use the project deliverables to further influence their cities' water systems.

- To engage a number of urban water practitioners, with access/engagement facilitated by USDN members, to better understand how this "community of practice" might be supported down the road to accelerate the implementation of innovative sustainable-water practices

Why: USDN Member Value

- It is anticipated that the project, through its processes and products, will likely generate two types of follow-on activities:
  - An ongoing User Group of USDN members who want to build on the project to establish a shared learning-and-doing agenda for accelerating the development of sustainable water systems in their cities.
  - The development of a network of "leading edge" urban sustainable water practitioners that, perhaps in coordination with USDN, develops an innovation-acceleration agenda and strategy.

Who: Guidance Board Design

USDN participation has been designed to include cities:

- located in recognized water "hot spots" due to shortages
- recognized as innovators
- representing the regional networks USDN supports

USDN is seeking a project that will allow it test the potential for collaboration across regional networks. USDN members will serve on a Guidance Board that:

- provides "voice of the customer" advice to the project and ensures their needs for ideas are met
- facilitates project access to their city/region water system leaders
- supports efforts to disseminate project results within USDN and regional networks

Who: Advisory Board Members

- The 14 USDN members committed to serve on the Guidance Board:
  - New England: Carl Spector (Boston)
  - Mid Atlantic: Brendan Shane (Washington, D.C.)
  - Southeast: Patricia Gomez (Miami), Jake Tisinger (Knoxville)
  - Intermountain West: Leslie Ethen (Tucson), Celia VanderLoop (Denver)
  - Midwest: Matt Naud (Ann Arbor), Larry Falkin (Cincinnati), Cori Burbach (Dubuque), Brenda Nations (Iowa City), Matt Howard, (Milwaukee)
  - Texas: Marty Howell (El Paso)
  - California: Jonathan Parfrey (Los Angeles), Shannon Parry (Santa Monica)

How: Scan Deliverables

- The spectrum of innovative practices in sustainable urban water management and their stage of development (from concept – prototype – implementation – scaling), as well as where they fit into the emerging sustainable water management paradigm.
- Variations in local and regional context (water budget, legal framework, regulations and public policies, etc.) that affect which innovations to use in different urban areas.
- Key barriers to implementation and the methods innovators are using to address barriers.
- Philanthropic/government/and sustainable-water field resources and initiatives supporting urban water innovation.

Note: *Project deliverables will be posted in a separate section of the INC web site, along with links to other relevant Web sites, as well as on the USDN web site with any additional arrangements USDN would like. Along with the deliverables above, INC will post an index with links to published reports and other resources used to develop the deliverables.*

How: Key Tasks

- **Literature scan: assemble comprehensive inventory of innovations in sustainable urban water concepts / practices; identify case studies, technical information, and barriers to implementation**
- Framework: organizing the innovation inventory into a framework for city leaders to choose relevant concepts / practices to pursue and demonstrate their value
- Who's who: Identifying key urban water practitioners and interviewing them to learn more about their priorities for innovation and the barriers they face and how they are addressing them
- Road Maps: Developing innovation implementation road maps for the major categories of innovations in the framework
- Testing the road maps with selected practitioners for validity/ accuracy/additional expertise
- Identifying areas where USDN might do follow-on work through its members on urban water innovations
- Revising and completing road maps, based on feedback in task 5, and disseminating the report

When: Pre-Scan Research Conducted

- Project builds on the Innovation Network for Communities' January 2013 report to the Rockefeller Foundation, and feedback sessions with selected funders /practitioners. The report highlights a paradigm shift in water management in the U.S. and the leveraging opportunities in urban water system development (http://water.in4c.net).

- Though much attention in urban water management has focused on the expanding use of large-scale green infrastructure, the INC report, as well as other studies, identified a broad paradigm shift in sustainable water management and a wide range of urban innovations that are emerging, with some leading-edge cities in different regions or water-shortage "hot spots" around North America.

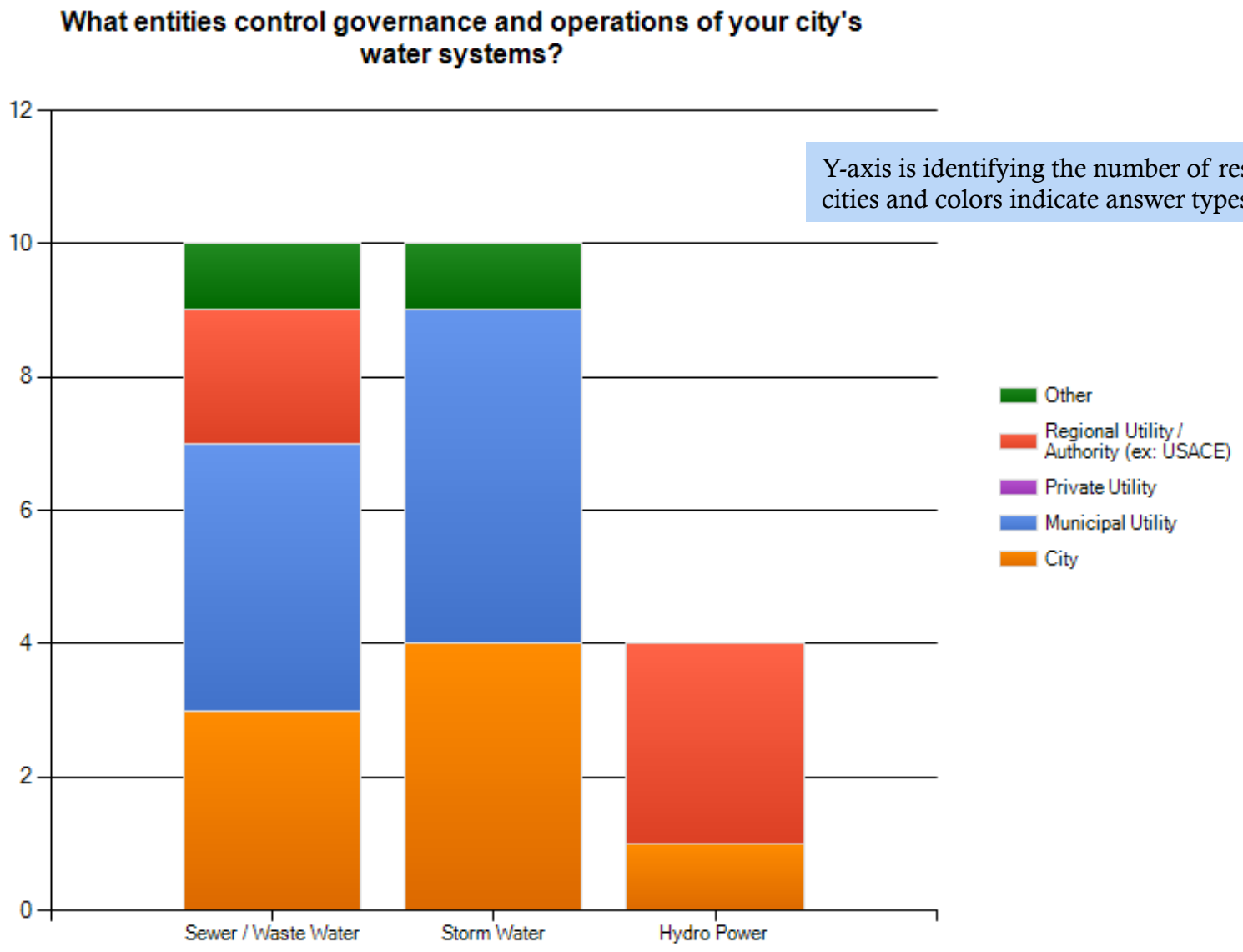
- Simultaneously, philanthropic funders such as the Surdna, Kresge, and the Walton Family Foundations are turning more of their attention to urban water issues, especially the challenges of adaptation and resilience. For example, Walton has funded the USDN-related Western Adaptation Alliance's water-adaptation project. Surdna is supporting "next generation" urban water infrastructure development.

When: Timeline of Deliverables

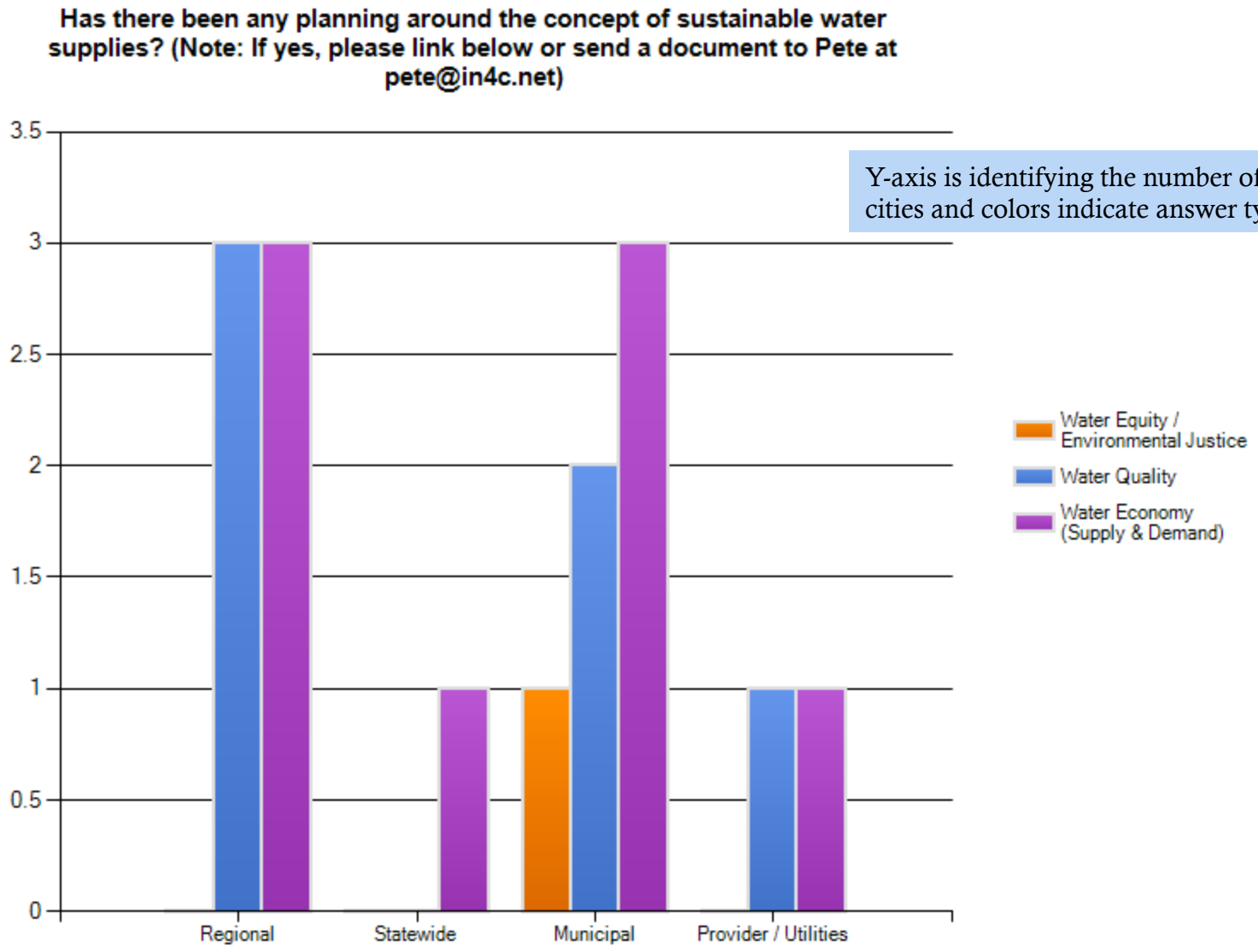
- Project Timeframe: June 2013 - first quarter 2014
- Literature Scan: 1st draft complete July, revised August 2013
- Framework: September - October 2013
- Identifying key urban water practitioners / interviewing: June - November 2013
- Road Maps: November - December 2013
- Testing Road Maps: January 2014
- UDSN Next Steps Identified: February 2014
- Revising / completing road maps, disseminating report – March 2014

Appendix 2

Municipal Survey Data



Y-axis is identifying the number of responses from cities and colors indicate answer types.



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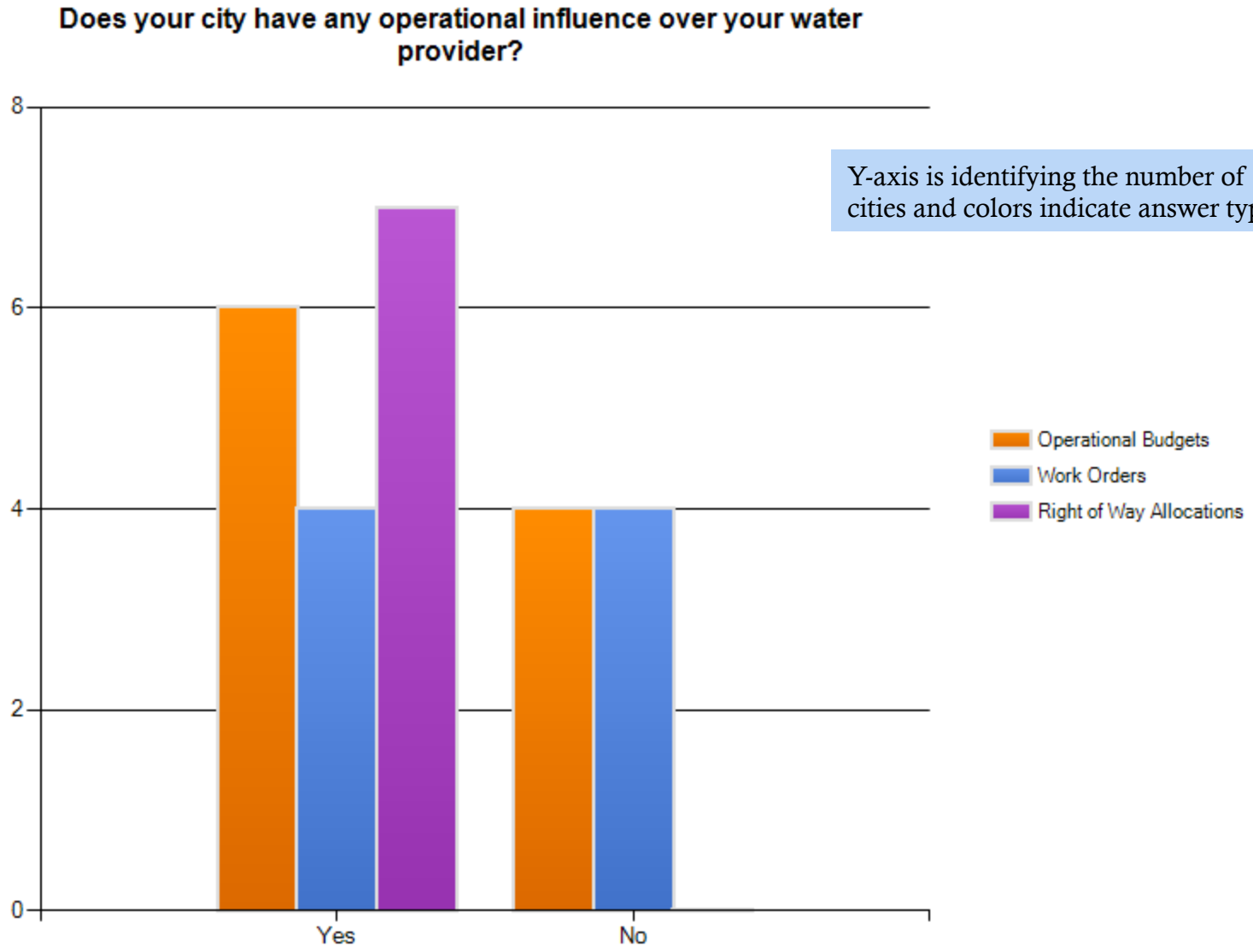
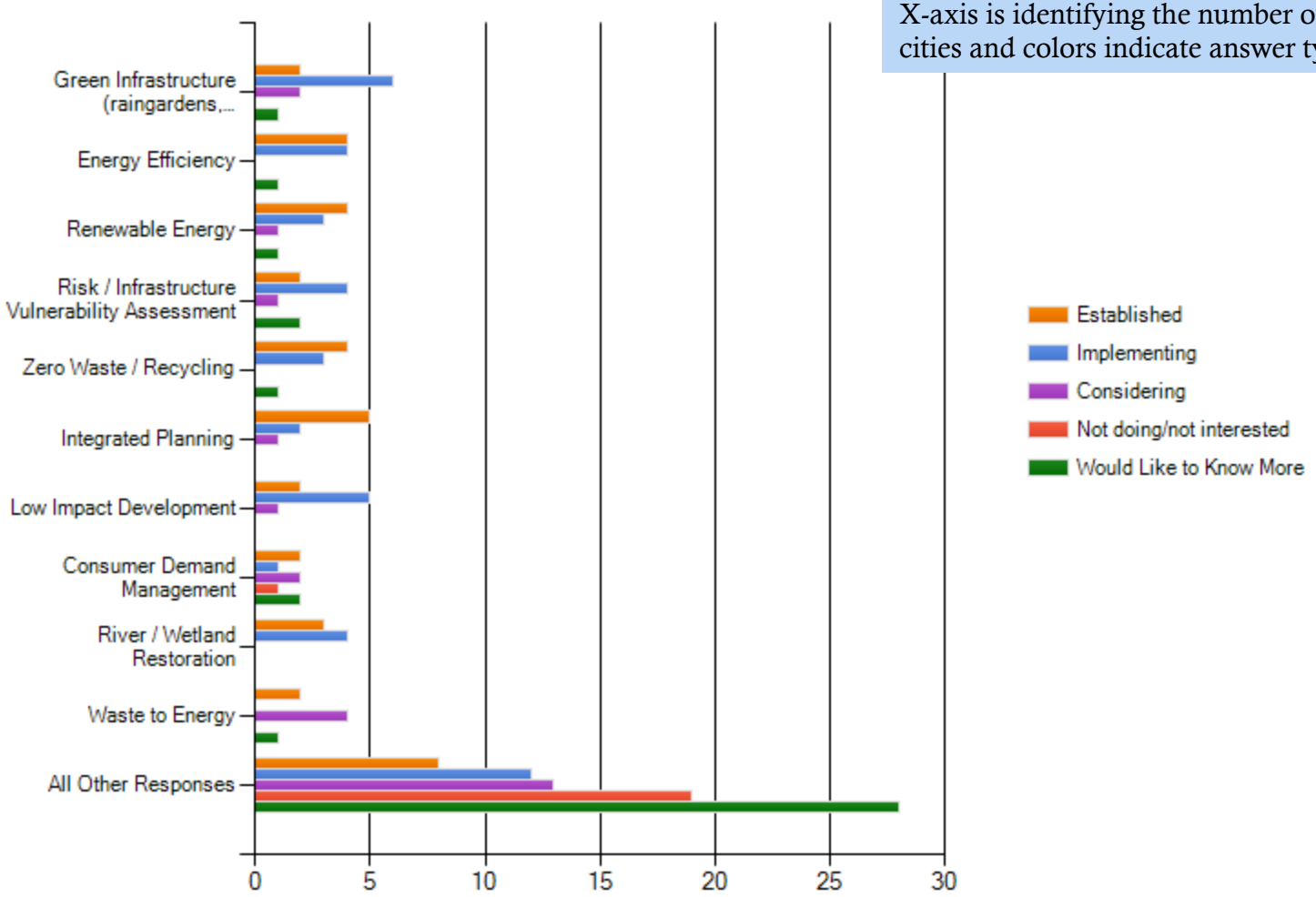


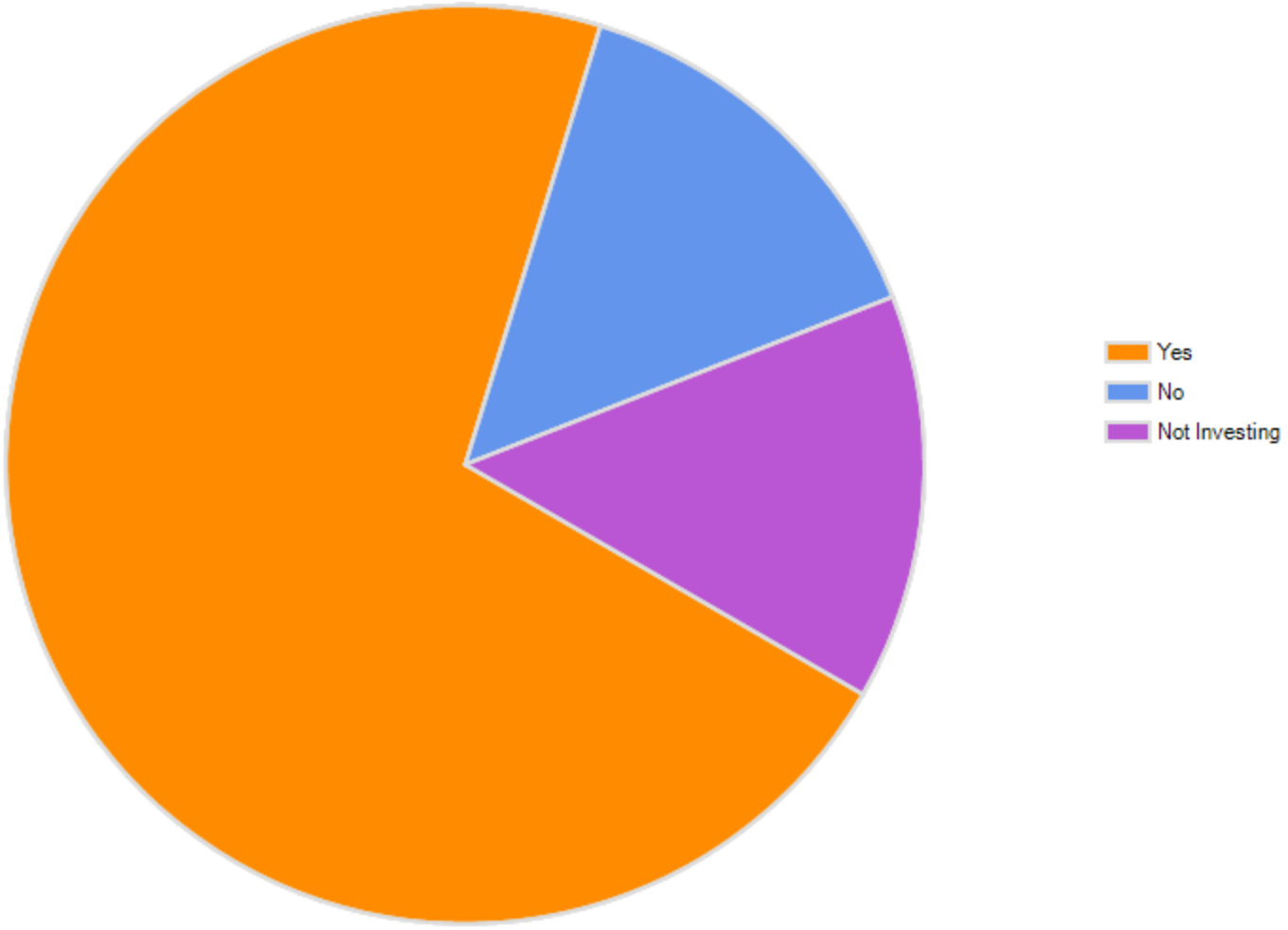
Y-axis is identifying the number of responses from cities and colors indicate answer types.

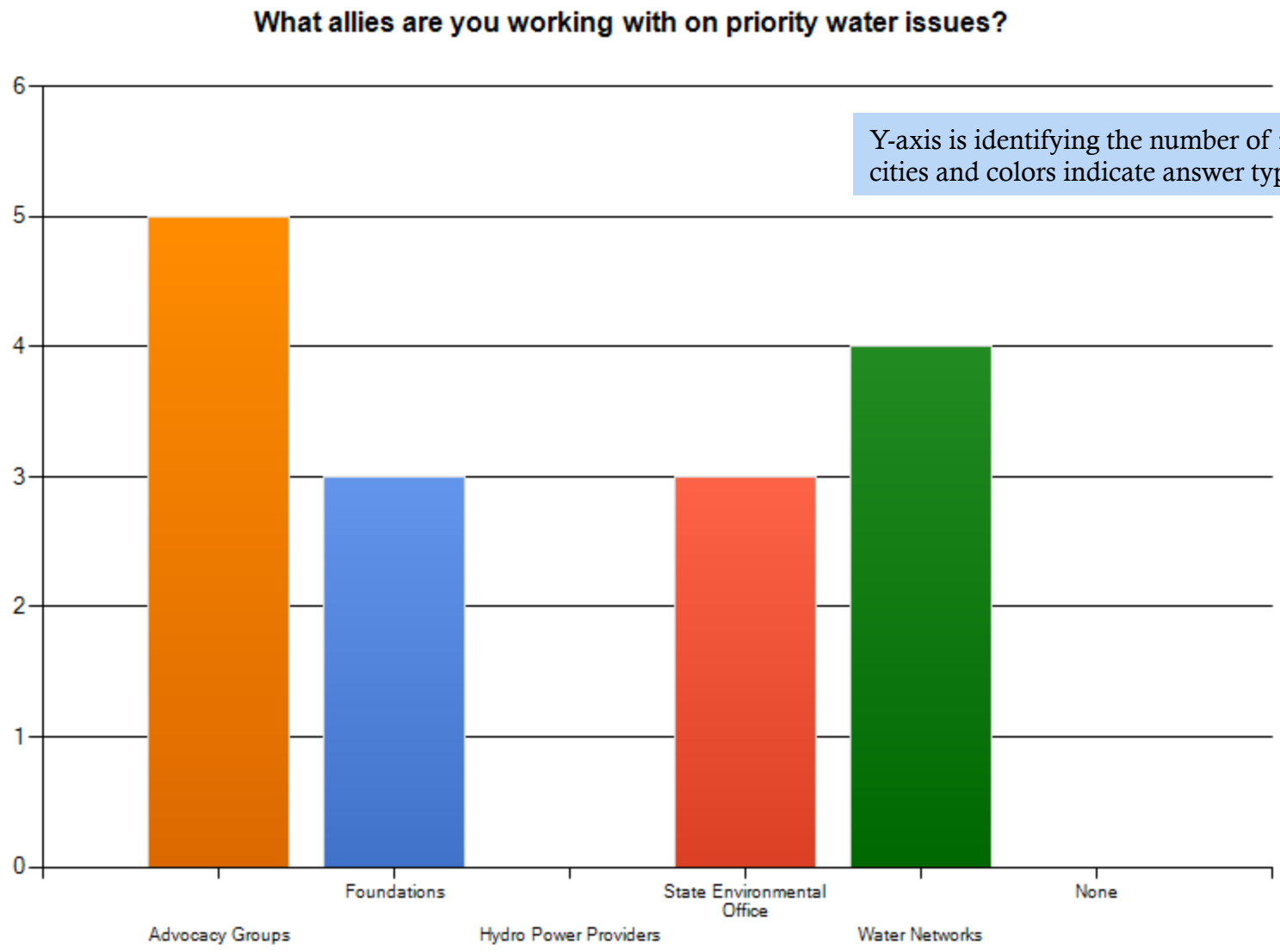
In the following list of possible innovations, please select the ones your city's systems are already incorporating and the ones you are interested in knowing more about:

X-axis is identifying the number of responses from cities and colors indicate answer types.



If your jurisdiction / provider has invested in any innovative stormwater systems, are they considered effective in helping the jurisdiction meet permit requirements?





Y-axis is identifying the number of responses from cities and colors indicate answer types.