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Integrated Urban Water Management for Planners

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As the U.S. population becomes more urbanized, the social, economic, and environmental vitality of our growing cities are wholly dependent upon the planning and management of water. The water sector and the planning and development community have a symbiotic relationship which usually goes unrecognized, and therefore, is not realized. Without adequate water resources and water infrastructure, urban development and redevelopment can be stymied. Conversely, land use and development impacts the use of and need for water. It takes more than turning on the tap to bring safe, reliable drinking water to an urban area.

An approach gaining favor with water managers is Integrated Urban Water Management (IUWM), sometimes also called One Water. IUWM principles recognize that water from all sources must be managed holistically and cooperatively to meet social, economic, and environmental needs. But for IUWM to be fully effective, water managers need to cooperate and collaborate with other professionals and sectors, notably planners.

This *PAS Memo* explores the challenges and opportunities of IUWM and presents the need for cooperation and leadership among urban planners and water service personnel using IUWM to move toward more water-resilient and sustainable communities.

What Is IUWM?

Integrated urban water management (IUWM) is an approach for urban water utilities (ideally in concert with the planning community) to plan and manage urban water systems to minimize their impact on the natural environment, to maximize their contribution to social and economic vitality, and to engender overall community improvement. IUWM considers (Mitchell 2006):

- All parts of the water cycle — natural and man-made, surface and subsurface, and recognized them as an integrated system
- The full range of demands for water, both anthropogenic and ecological requirements
- The impact of water cycle management on the overall planning and management of cities
- The full range of water supplies available over time
- The practices which can provide water fit for purpose both in quality and quantity, and reduce the demand for potable water
- The sustainability of water service provision
- The local context and stakeholder views
- The scale, engineering, and functional aspects of the water system
- The means by which transition from current practice can be achieved

Because IUWM considers all aspects of the water cycle across the entire urban watershed and goes beyond individual jurisdictional boundaries, IUWM requires the coordination and collaboration between urban planners and the entities that manage drinking water, wastewater, and stormwater.

IUWM Challenges

Many challenges can impede implementation of IUWM. Because water resources are not confined to a single political jurisdiction, conflicts can arise from this fact as downstream communities can be impacted by upstream communities in terms of both water quality and quantity. Urban communities depend heavily on water infrastructure to protect human health and the environment, as well as economic viability.

Land-use planning and development directly influence the behavior of water systems. Development means roads, parking lots, rooftops, and driveways; all of these impervious surfaces reduce groundwater infiltration and increase the amount of stormwater that must be managed. Reduced groundwater infiltration can impact water supplies and reduce the amount of water in streams that are dependent on groundwater for part of their baseflow. Increases in stormwater can overwhelm combined sewers, cause localized flooding, increase water pollution, and increase erosion and sedimentation in streams and reservoirs (EPA 2005).

Before development or redevelopment occurs, water utilities and planners need to work together to assess and prevent negative consequences to water resources. Drinking water supplies, infrastructure conditions, wastewater treatment plant capacity, stormwater management practices, and any other water resources–related issue should be assessed as part of community planning and development decisions (EPA 2005).

Aging Infrastructure

Water infrastructure is typically buried in the ground, leaving it out of sight of the public. This means most people don't think about water unless there is a problem, like a broken water main that disrupts traffic or causes major flooding (see Figure 1). In many cities, the water infrastructure is as old as the city itself, with little replacement of water pipes or equipment over time. This means that a lot of water infrastructure has long surpassed its expected lifetime, increasing its vulnerability to problems.

As noted in the American Water Works Assocation's ***Buried No Longer*** report, the cost to replace this infrastructure is over $1 trillion over the next 25 years. Financing these improvements is going to be a major challenge, and current water rates in many communities do not cover infrastructure replacement, meaning they are going to likely face increased rates (Shanaghan 2012).

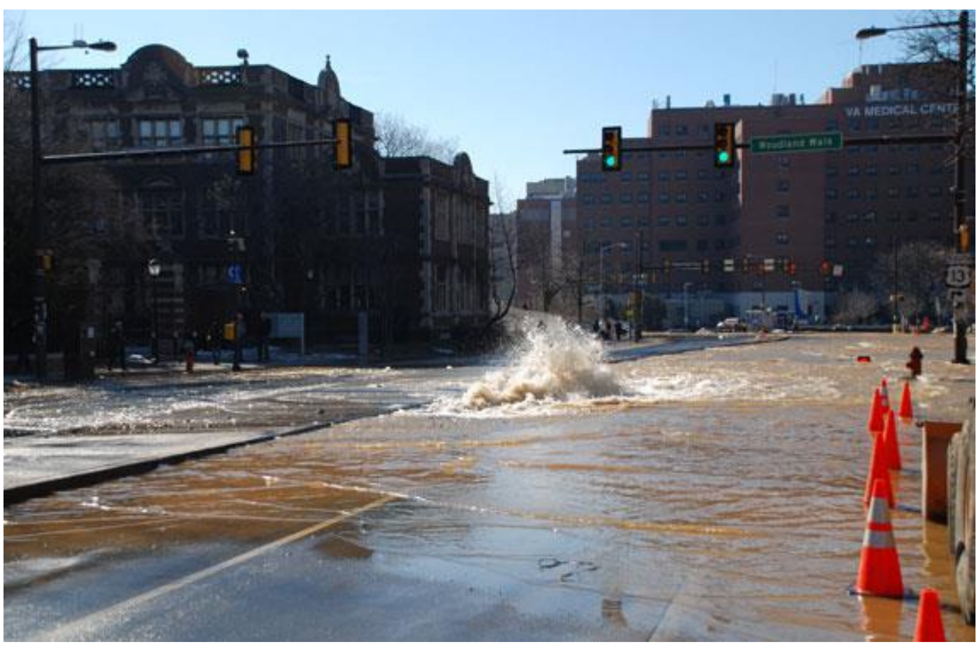

Figure 1. Utility distribution system main breaks can cause major flooding and traffic disruption. John Donges (CC BY-ND 2.0) (Philadelphia)

From a planning perspective, it is important to consider the issue of aging infrastructure as part of redevelopment or new development. For redevelopment, it is important that projects redeveloping portions of the urban core have reliable water infrastructure.

As part of redevelopment projects, planners should work with water agencies to determine whether water infrastructure upgrades are needed to ensure a reliable supply of potable water. In new developments, especially those on the fringes or outside the urban core, new water infrastructure may be needed. Planners should coordinate with water utilities to understand the water needs of the new developments and the cost of adding this new infrastructure. In some cases there may be a tradeoff of maintaining current infrastructure with adding new infrastructure.

Climate Change and Extreme Events

Climate change will put additional stresses on aging water infrastructure with increased temperatures and changes in precipitation patterns, leading to more extreme events such as flooding and drought (IPCC 2012). Flooding is an important consideration for water utilities and planners as it can cause many challenges to drinking water and wastewater systems, as detailed in the U.S. Environmental Protection Agency's 2012 report ***Climate Ready Water Utilities Adaptation Strategies Guide for Water Utilities*** (see Figure 2).

CHALLENGES BY GROUP		DW	WW
Drought	Reduced groundwater recharge	●	
	Lower lake and reservoir levels	●	
	Changes in seasonal runoff & loss of snow-pack	●	
Water Quality Degradation	Low flow conditions & altered water quality		●
	Saltwater intrusion into aquifers	●	
	Altered surface water quality	●	●
Floods	High flow events & flooding	●	●
	Flooding from coastal storm surges	●	●
Ecosystem Changes	Loss of coastal landforms / wetlands	●	●
	Increased fire risk & altered vegetation	●	●
Service Demand & Use	Volume & temperature challenges	●	●
	Changes in agricultural water demand	●	
	Changes in energy sector needs	●	
	Changes in energy needs of utilities	●	●

Figure 2. Water and wastewater utility challenges due to climate change. Source: USEPA 2012.

Changes in precipitation patterns may increase the amount of localized flooding, making it important to consider land-use planning to mitigate these potential impacts. Water utilities and planning organizations should consider moving water and wastewater facilities out of the flood zone, incorporating natural ecosystems into flood mitigation, implementing green infrastructure to reduce imperviousness and reduce stormwater impacts of heavy rainfall events, and updating master plans, codes, policies, and other efforts to ensure that water systems are protected before flood events and can be sustainably recovered after flood events.

Extreme events present redevelopment opportunities for water utilities and planners to coordinate together. Redevelopment after an extreme event presents an opportunity to rebuild in a more sustainable and resilient way. Planning for recovering from these events can help water utilities and planners work towards the most sustainable development option in advance, which will help the community's recovery from extreme events occur more quickly.

The U.S. EPA's Office of Sustainable Communities and FEMA have been working collaboratively on several recovery efforts including the Joplin, Missouri, tornado, and 2009 Iowa flooding. They have also developed ***Planning for Flood Recovery and Long-Term Resilience in Vermont*** (USEPA 2014b) to support Vermont's recovery from Tropical Storm Irene, which includes several examples of potential collaborative opportunities for water utilities and planners.

Institutional Issues

Research to date has shown that for the IUWM paradigm to be accepted and integrated into urban planning, the appropriate institutional structures need to be in place (Maheepala et al. 2010). Historically, water has been managed institutionally based upon single drivers such as water supply, stormwater/flood management, wastewater management, green infrastructure, energy production, or environmental protection. However, a holistic approach which considers two or more of these drivers is usually absent.

To support urban planners and policy makers, **Water Research Foundation** (WRF) and the **Water Environment Research Foundation** (WERF) sponsored a research project that will produce a "framework for transitioning to a one water (or IUWM) approach" which organizes the range of enabling actions required to make the transition against the corresponding institutional challenges at a variety of scales (i.e., project level, regional growth level, etc.). The literature review for the project grouped the institutional challenges into five broad sets:

- Planning and Collaboration: Planning that is uncoordinated and noncollaborative causes fragmented or siloed planning exercises, short-term fixes rather than long-term solutions, and a lack of flexibility.
- Economics and Finance: Economic and financial systems that are restrictive and traditional cause limited access to innovating funding solutions and small-scale solutions.
- Legislation and Regulations: Legislation and regulations are key drivers of how organizations structure themselves and strategize, plan, budget, and implement projects.
- Citizen Engagement: Engaging the community and creating demand for new services is imperative to achieving IUWM.
- Culture/Knowledge/Capacity: The process of achieving culture change in the management of urban water can be challenging and time consuming.

This research project is complete and includes numerous case studies. The report is anticipated in late 2014. Readers are encouraged to contact the authors of this *Memo* for more information.

IUWM Solutions, Innovations, and Opportunities

Challenges lead to solutions, innovations, and opportunities. For as many challenges as exist to impede progress in IUWM, there are a number of opportunities.

The U.S. EPA Office of Sustainable Communities' report ***Protecting Water Resources With Smart Growth*** presents 75 policies for implementation that provide a foundation for managing growth while protecting water resources. At a regional scale water utilities and planners should consider utilizing watershed planning, developing a regional comprehensive plan, considering watershed conditions in zoning decisions, and coordinating development and conservation plans. To protect natural watershed conditions, new growth is likely best directed to existing areas, so allowing higher densities may be necessary in some communities to redevelop urban areas to accommodate more people and development. Water and wastewater utilities can play a vital role in directing community growth by determining where new infrastructure will be built or where existing infrastructure will be improved. Coordination in advance of growth decisions by planners and utilities can ensure growth occurs in locations that best protect water resources and where water infrastructure is reliable and robust enough to support growth (USEPA 2004).

Recommended Ordinances for Better Water Management

Protecting Water Resources with Smart Growth (USEPA 2004) identifies seven types of ordinances and codes that water utilities and the planning and development community could coordinate on to implement land-use decisions that protect water resources.

- *Stormwater Ordinances*. Some communities may not have a stormwater ordinance that provides legal authority for how property owners and developers manage stormwater. Stormwater ordinances can dictate stormwater management practices such as the amount of stormwater runoff allowed, structural and nonstructural solutions, and onsite management requirements.
- *Ordinances for Source Water Protection.* To enhance source water protection efforts already required under the Safe Drinking Water Act, local communities can adopt source water protection ordinances to prevent pollution from reaching drinking water sources. Source water protection ordinances can protect drinking water sources in several ways, such as by prohibiting storage of hazardous waste near drinking water intakes or recharge areas for wells.
- *Water-Saving Landscape Ordinances*. Water requirements for different landscape types vary across different climate regions. Landscape ordinances can encourage water saving landscapes such as xeriscaping (using plants with low or no water or maintenance needs).
- *Tree Ordinances.* Trees have a variety of water quality benefits. Tree ordinances can encourage additional tree plantings, list the types of trees that can be planted, and describe where trees should be planted to maximize water quality benefits.
- *Ordinances and Standards to Better Manage Development Along Waterways.* Developments adjacent to waterways can be designed to be more sensitive to potential water quality impacts from the added impervious surfaces that development brings. Ordinances can be designed to encourage the use of natural buffers along waterways which can help reduce pollution and improve water quality.
- *Zoning and Setback Requirements that Reduce Lot Sizes*. Some communities have zoning requirements that encourage low-density dispersed development, which can lead to water quality impacts as larger land areas are developed than are necessary to support the type of development desired. Smaller lot sizes can encourage denser development, reducing the acreage disturbed by new developments and reducing imperviousness, which can result in water quality impacts.
- *Reduced Minimum Parking Requirements*. Surface parking lots can take up a large area and increase the amount of imperviousness. In communities with parking minimums, alternatives should be explored such as encouraging on-street parking, directing development to areas with public transportation, or building multi-story community parking structures that spread the cost across developers.

In some cities with combined sewers, even small rain events can overwhelm their wastewater treatment plants, sending raw or partially treated sewage into receiving streams. As development occurs along these bodies of water, property values and the desire to live, visit, and recreate in these areas will decrease. This fact, combined with stresses on potable water supplies from drought, population increases, and water quality challenges, means that water utilities are looking for solutions to these issues within the built environment of our cities.

Low Impact Development/Green Infrastructure

Development and redevelopment present new opportunities to better manage stormwater through low impact development and green infrastructure, which offer yet more opportunities for planners and water utilities to work together.

Low impact development minimizes the environmental impact of development by managing stormwater close to its source, mimicking natural systems that would allow stormwater to infiltrate into the ground, or providing temporary storage so its release into the stormwater system is slowed. Modern cities have been designed with a lot of impervious surfaces, from roadways and sidewalks to roofs and parking lots. This change in the nature of the landscape causes much greater volumes of stormwater to run off the land and overwhelm streams, waterways, and stormwater treatment systems, including wastewater treatments plants in locations with combined sewers.

Green infrastructure has emerged as the main term used in the context of low impact development to describe the types of systems that can be used to manage stormwater in a more natural way. The May/June 2012 *PAS Memo* **"The Effectiveness of Green Infrastructure for Urban Stormwater Management"** (Jaffe 2012) nicely describes this topic. Green infrastructure techniques include rain gardens, permeable pavements, bioretention facilities, and vegetated rooftops. These systems infiltrate, evaporate, or reuse water in a way that returns it to the natural system in a more environmentally friendly manner. The technique that is best for each location is a matter of site-specific conditions depending on the size of the area, the amount of stormwater that is expected to be captured, the water quality goal, and several other factors (USEPA 2014a). A large amount of research is currently being conducted on the effectiveness of green infrastructure systems.

Philadelphia is taking a nationally recognized leadership role in managing its stormwater through green infrastructure. The goals are to reduce localized flooding, improve water quality, and reduce combined sewer overflows, all of which will ultimately improve quality of life for residents of the city. Philadelphia's ambitious green infrastructure program is part of the great debate on how to best manage combined sewer overflows. Rather than costly upgrades to centralized treatment plants, or complete separation of sewer systems, green infrastructure utilizes a distributed treatment and management approach. Distributed systems are counted on as being more flexible, resilient, and robust by adapting to local conditions. Managing stormwater holistically through green infrastructure allows implementation of tailored approached to each parcel of land being managed.

Philadelphia's vision is to use a variety of green infrastructure techniques (Figure 3), some of which have been detailed in prior *PAS Memos*. Even something many people take for granted, street trees, can greatly reduce the amount of stormwater. If designed properly, street trees can flourish providing a large canopy that prevents water from hitting the streets, and root zone that can uptake the water that does runoff through street tree trenches.

Figure 3. A vision of what green stormwater infrastructure tools would look like when implemented in Philadelphia's neighborhoods. Source: Philadelphia Water Department.

Philadelphia is focused on eight program areas to help implement green infrastructure efforts. This breakdown into smaller units of the green infrastructure programs allows the city to customize the implementation of the program to the particular situation (Philadelphia Water Department 2014b). The eight programs are:

- Green streets
- Green schools
- Green public facilities
- Green parking
- Green parks
- Green industry, business, commerce, and institutions
- Green alleys, driveways, and walkways
- Green homes

Green Buildings

Green building provides a great opportunity for planners and water utilities to work together. Incentive programs like the U.S. Green Building Council's **LEED (Leadership in Energy and Environmental Design)** have proven themselves to be strong drivers for the development community to implement more environmentally friendly buildings, including those that better manage water use. One of LEED's main focuses in the water area is water efficiency. A useful tool for meeting water-efficiency goals is the U.S. EPA's **WaterSense** program, a labelling program that assists developers and consumers in identifying high performing yet efficient fixtures to install in buildings.

Seattle's **Bullitt Center** was designed to show what was possible with green building design (Figure 4). In addition to efficient, sustainable, and renewable energy components, the building features a number of innovative water management systems:

- Low flow toilets — In order to reduce potable water demands, an extremely low flow (two tablespoons) composting toilet was installed.
- Wastewater treatment — Waste collected from the toilets goes to composters, eventually yielding fertilizer.
- Wastewater use — Water collected from sinks and showers is stored and treated in a constructed wetland, infiltrated the water back into the ground to recharge the aquifer.
- Rainwater harvesting — Rainwater from the roof is collected and treated to provide potable water in the building, although regulatory approval to fully use this system is pending.

While some buildings may feature some of these design elements, the Bullitt Center is unique in its efforts to fully integrate its efforts to manage a sustainable water system within the building (Bullitt Foundation 2013).

Figure 4. Seattle's Bullitt Center features a number of innovative water management systems. Miller Hull (CC BY-SA 2.0)

Graywater Management and Onsite Reuse

Graywater management presents an opportunity for water utilities, planners, and developers to work together. Graywater systems use water from sources inside a building including sinks, laundry, and showers, but exclude wastewater from toilets and kitchen sinks. Typical uses of graywater systems include toilet flushing and irrigation. Graywater systems may be utilized in commercial or residential settings, and with either individual buildings or at larger neighborhood or community scales. Reusing graywater both reduces demand for potable water and decreases the amount of water that goes to wastewater treatment plants.

There are currently no standard federal regulations on graywater reuse, so water utilities and planners need to understand state and local ordinances before implementing graywater systems. A database of different state regulations is called ***Treatment, Public Health, and Regulatory Issues Associated with Graywater Reuse*** (Sharvelle and Roesner 2013). Water utilities and planners can work together to ensure appropriate policies and codes are in place for retrofitting existing buildings or encouraging their use in new construction.

The San Francisco Public Utilities Commission (SFPUC) has demonstrated its commitment to sustainable development and leading the way in developing and promoting onsite reuse with its headquarters building in San Francisco. Its **Non-potable Water Program** was established in 2012 to encourage use of alternate water sources for toilet flushing, irrigation, and other nonpotable uses. It has established guidelines for developers interested in installing these systems that includes water quality standards for this type of non-potable reuse.

WRF and WERF have been working with SFPUC to develop a how-to guide for communities interested in implementing onsite water treatment program. The resulting report, **"Blueprint for Innovation in Urban Water Systems: Expanding Onsite Water Treatment Systems,"** is anticipated in late 2014 (SFPUC 2014).

Growing With Water Scarcity

Several cities in the western U.S. are demonstrating it is possible to grow, even with water scarcity. The cities are employing a combination of water-demand and water-supply strategies.

While often criticized in the media for its water use despite its dry climate and declining levels in Lake Mead, the water utilities in the Las Vegas area progressively managed. They have implemented programs like turf replacement rebates, which have converted 168 million square feet of lawn to water-efficient landscaping, saving billions of gallons of water. Las Vegas also utilizes reclaimed water for a variety of applications including power plant operations and golf course irrigation. Additionally, a large percentage of Las Vegas's treated wastewater is actually returned to its source, Lake Mead (SNWA 2014). So rather than a consumptive use such as water used in agriculture or lost to evaporation, much of the water used in Las Vegas goes back to the source.

Las Vegas also has some of the best water conservation programs in the country. Since 2004, the Las Vegas Valley Water District has detected almost 1,600 leaks, saving more 290 million gallons of water. Additional water conservation efforts have led to a 29 percent reduction in water use, lowering per capita demand from 314 gallons/person/day in 2002 to 222 gallons/person/day in 2011 (LVVWD 2014a & 2014b).

Although land-use and water coordination is largely focused on the demand side, supply development can also benefit from coordination. Rather than develop new supplies, Aurora, Colorado, built the **Prairie Waters Project** to reuse water, greatly increasing the available supply for up to 300,000 residents. Enabled through Aurora's unique water rights, which allow the city to reuse water after it is discharged back into the South Platte River, the Prairie Waters Project recaptures and treats part of the water supply over and over again. This helps protect Aurora's water supplies in dry years, and reduces the need for additional transmountain diversions and new storage capacity. This also helps Aurora reduce its environmental and land use impacts. In combination with aggressive water conservation measures, this new water supply project will provide a reliable supply during droughts and reduce reliance on other supply alternatives (Kathlene et al. 2010).

During years when Aurora has excess water, it is cooperating with Denver Water on the **Water, Infrastructure and Supply Efficiency (WISE)** project. WISE will provide excess water from Denver and Aurora to South Metro Water Supply Authority to help reduce their demand on nonrenewable groundwater (Denver Water 2014). Prairie Water and WISE will help support new growth and influence land use planning in terms of where water will be available to support new development. Aurora Water has also been active with land-use planners in Aurora as the city expects a large amount of growth in the next several decades.

Designing Natural Urban Systems

Opportunities exist to transform our cities from "hard and gray" to "soft and green" with major benefits to water resources management. Greening our streets is one place to start. Tapping into the benefits of natural systems can not only improve water resources management, but it can improve quality of life and increase property values, as described in the January/February 2013 *PAS Memo*, **"Valuing Ecosystem Services to Inform Conservation and Development Decisions"** (Lewis 2013).

Trees provide shade on hot days, cooling buildings and sidewalks, lowering energy costs for cooling, and providing a refuge from the sun for pedestrians. At the same time, these trees are collecting rainwater so that it evaporates instead of hitting the ground and entering the sewer system. Beneath the ground, properly designed street tree boxes help infiltrate water back into the ground while also keeping tree roots watered.

Curb build-outs allow stormwater to pass through a vegetative area with gravel bedding that allows water to infiltrate and evaporate while watering plants and reducing flows of stormwater to the sewer collection system. They also provide benefits that planners can support such as traffic calming and reducing the distance for street crossings, improving pedestrian safety.

Bioswales along roadways (Figure 5) and stormwater planters along street curbs and sidewalks (Figure 6) provide places for stormwater to be stored, infiltrated, and evaporated, reducing the volume of water entering the sewer collection system. They also provide landscaping opportunities that can bring natural beauty to roadways or streetscapes, improving the attractiveness of the street and potentially attracting more pedestrians.

Figures 5 and 6. Bioswales and street planters are green infrastructure elements that help store, infiltrate, and clean stormwater runoff. Aaron Volkening (CC BY 2.0) (bioswale, Greendale, Wisconsin); Chris Hamby (CC BY-SA 2.0) (street planter, Elmhurst, Queens, New York)

Stormwater planters along street curbs and sidewalks provide places for stormwater to be stored, infiltrated, and evaporated, reducing the volume of water entering the sewer collection system. They also provide a landscaping opportunity that can bring natural beauty to the streetscape, improving the attractiveness of the street and potentially attracting more pedestrians.

Green roofs use vegetative matter and soil to store and use water, slowing the speed of stormwater entering the sewer collection system. Green roofs can also reduce the heat island effect and provide natural park-like space on top of buildings.

Rain gardens are designed to collect runoff from impervious surfaces such as walkways and parking lots. They are designed to pool water, allowing plants to use the water while it slowly infiltrates back into the ground. Rain gardens can improve the attractiveness of otherwise dull landscapes like parking lots while supporting improved water management (Philadelphia Water Department 2014a).

In addition to designing natural systems to support improved stormwater management, natural systems can also be managed and developed to protect drinking water resources. Many water utilities rely on protection of source-water landscapes to ensure high quality drinking water. In some cases these source water areas are near the urban area, but in some cases the water travels a long distance. As rural areas develop, there may be water quality and water impacts to these source-water areas that urban systems rely on.

Rural development can disrupt hydrologic conditions, reducing groundwater recharge, creating new pathways for water contamination, increasing pollutant loads in streams and rivers, and diverting water supplies to support this development. Urban water utilities need to ensure that they understand the risks to development in their source-water protection areas and work with land-use planners and developers in rural communities as well. The connection between these urban water resources that may be located outside of the urban area may not be recognized by those outside of the water utility.

How Can Planners Help IUWM?

Water utilities that are seeking to manage water resources in a more integrated manner will try to engage a wide range of stakeholders, including planners and the development community. When water utilities reach out to planners, it is important for planners to know what roles they may play in implementing integrated urban water management systems. Although mandatory, regulation-driven coordination may exist in some locations, the myriad laws and institutions governing land use and water management may make finding the right pathway for water utility and land-use coordination seem like a daunting task. This section will attempt to provide some suggestions on possible venues for coordination.

Many water utilities are public agencies, but they can also be part of special districts or private entities. While some water utilities deal with the full range of water issues, others are set up to specialize only in a single area, such as drinking water, wastewater, or stormwater. Almost all water utilities maintain a website with information on the utility and contacts for different issues. EPA's **Envirofacts** website also allows the public to search for drinking water and wastewater treatment utilities by geographic area.

Larger water utilities may have staff who specialize in areas with stronger connections to the planning and development community. These specialties may include water supply planners, water resources managers, source water protection specialists, conservation managers, green infrastructure managers, and other specific positions designed to deal with the types of issues highlighted in this article. In addition, there may be other organizations in the community that are important to connect with, such as watershed management associations.

Another good way to connect with water professionals is through water associations that support water utilities, similar to the ways in which APA and other planning organizations support the planning and development community. **AWWA**, the **Association of Metropolitan Water Agencies (AMWA)**, and the **National Association of Water Companies (NAWC)** are the main associations for drinking water utilities, and **Water Environment Federation (WEF)** and **National Association of Clean Water Agencies (NACWA)** are the main associations for wastewater and stormwater utilities. The **Water Research Foundation** and the **Water Environment Research Foundation** both support the research needs of the water community.

One way planners can help water utilities is through demand forecasting. Several key planning elements may help inform the utility about what its future demands for potable water and wastewater treatment may be. Population change is one key factor. As communities grow or shrink, so does the amount of water demand. The water utility and planning department should coordinate to understand development projects and patterns that may help inform future demand planning by utilities. Besides population growth, new industry or other development activity that will increase water use is another important coordination point. Finally, the type of development occurring will be important to know for utility demand planning purposes. Since outdoor irrigation is a large water use, especially in western states during the summer, the landscape design of the new development will be an important factor.

To limit outdoor water use, water utilities and planners could coordinate with developers to limit the amount of landscape that needs to be irrigated. This could be implemented through voluntary agreements with developers or by changing ordinances and policies to require this as part of future development or included in retrofits. Municipalities can lead the way by making these changes on locally managed property, which can provide valuable lessons learned for the planning community to take these actions on a broader scale, including private property. Another landscape coordination discussion between water utilities and planners relates to trees. Although trees initially require a large amount of water to get established, they ultimately provide great benefits including shade, stormwater management, and reduced water demand. Most water utilities will recognize the value of trees to a community, but coordination may be needed between utilities and planners to balance the water supply needs with the eventual benefits trees provide.

The type of development and redevelopment being planned can have a great impact on water resources management. For example, the Colorado Water Conservation Board estimates that for every 10 percent increase in population density, there will be a five percent reduction in water demand. This is largely due to reduced demands for outdoor water use (Bornstein, Reidy, and Rowan 2010).

In addition to more dense development and urban infill, new green developments can also offer opportunities to reduce demand. Strategies such as requiring xeriscapes (landscape designs that require little or no maintenance or irrigation), drip irrigation, low-flow water fixtures, water audits, sub-metering in multifamily housing, education, turf replacement, and conservation-oriented water rates can also help support demand reductions. In a state like Colorado, where population is expected to double by 2050, and water demand is projected to be 20 percent greater than supply by 2030, implementation of these practices in coordination with water utilities and land use planners is vitally important (Kathlene et al. 2010).

Water utilities are increasingly seeking public input on water management activities. Large developments, whether new construction or redevelopment projects, are often approved by a local government agency, with some type of public notice provided. Large water projects with sizeable budgets are likely to face some type of public review, either city council review or another type of public input. Planners may be interested in these large projects, and if they have not been engaged prior to the public input stage of a project, this may provide a coordination opportunity.

The **Land Use Leadership Alliance (LULA)** training program at Pace University Law School is another opportunity that can bring together land-use planners and water utilities. LULA is designed as a four-day training program to meet participants' needs around foundational or cutting-edge land-use issues. The trainings cover key legal, planning, and policy tools and techniques, along with national case studies and simulations to help appreciate the collaborative nature of the issues between water and land use.

Nearly 30 participants from Front Range communities in Colorado participated in this training in 2013. Although LULA can be designed for a number of different land use issues, this particular training focused on water. Several utilities and water management associations, along with their planning counterparts, helped identify the key water and land-use issues to cover during this particular training. The training was designed to foster dialogue and collaboration between city managers, planners, developers, water providers, and local elected officials that recognize more sustainable water management is key to meeting water demands from future development. Recognizing the connection between conservation, demand reduction, containment of sprawl, and preservation of agriculture was key to one participant's understanding of the water and land use connection. By establishing a peer-to-peer network of water utility and planning officials, this training is designed to lead to enhanced collaboration in the future as well. Planning for water as new development occurs is much cheaper than making retrofits later (APA Colorado Chapter 2013).

Water associations, including research organizations like the Water Research Foundation, are increasingly interested in topics like integrated water resources management and land-use planning. This is largely being driven by the interests of our utility subscribers. Opportunities may exist for planners to connect with water utilities through water association activities like project advisory committees, workshops, and conferences. Some of the major water associations are mentioned above. Visiting each association's website will provide background on the key issues of interest to each association and list major events. WEF and AWWA also have local sections, typically at the state or regional level, which also provide good opportunities to connect with water utility professionals.

Conclusions

Water resources are vital to protect public health and the environment, and to support community development and the economy. Now more than ever water resources face threats from climate change, population growth, aging infrastructure, declining revenues, and a variety of other localized challenges. In order to overcome these challenges, an increasing number of water utilities are using the concept of integrated water management to take a more holistic approach to water resources management.

As part of this more holistic approach to water resources management, water utilities and land-use planners need to coordinate to overcome these water resources challenges. Planners and utilities should work together to implement more green infrastructure to better manage stormwater, more onsite reuse to reduce potable demand, and more green buildings to reduce potable demand and better manage water within buildings. They should coordinate on demand forecasting and conservation measures, and generally coordinate on new development projects. A variety of venues exist for this coordination, and both water utilities and planners should actively seek each other out to develop relationships and collaborate on new initiatives.

About the Authors

John Y. Whitler is a research manager at the Water Research Foundation, specializing in integrated water management with emphasis in water supply diversification. Jennifer Warner is a senior account manager at the Water Research Foundation, specializing in source water protection and watershed management. The Water Research Foundation works with a variety of professional partners to identify, prioritize, fund, manage, and communicate scientifically sound research across the globe. Since 1966, WRF has managed more than 1,000 high-impact research studies valued at more than $500 million. WRF is a 501(c)(3) nonprofit organization that carefully invests research dollars from more than 950 subscribing organizations in the U.S. and abroad to tackle an array of issues related to water.

Resources

Planners interested in additional information on the key topics presented in this article may be interested in some of the resources provided below.

Land Use Leaders (LULA): **www.law.pace.edu/land-use-leadership-alliance-training-program**

Water Research Foundation's Source Water Protection Vision and Roadmap: **www.waterrf.org/Pages/Projects.aspx?PID=4176**

Water Research Foundation's/Water Environment Research Foundation's Institutional Issues of Integrated Water Management: **www.waterrf.org/search/Results.aspx?k=4487**

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