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Integration: A New Framework and Strategy for Water Management in Towns and Cities

MEETING SUMMARY REPORT

Decentralized
Water Resources
Collaborative

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INTEGRATION: A NEW FRAMEWORK AND STRATEGY FOR WATER MANAGEMENT IN TOWNS AND CITIES

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July 2010

WERF

Decentralized Water Resources Collaborative

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INTRODUCTION

The Water Environment Research Foundation (WERF), in partnership with the Decentralized Water Resources Collaborative (DWRC), and the U.S. Environmental Protection Agency (U.S. EPA) hosted a meeting June 14, 2010, at the Ronald Reagan Building and International Trade Center, Washington, D.C. The meeting provided a forum for participants to discuss development of an integrated, sustainable water infrastructure for towns and cities in the United States and the role of federal agencies in supporting the transition to these new approaches. Meeting participants included approximately 100 federal agency staff, foundation representatives, researchers and academics, decentralized systems practitioners, and others interested in 21st century sustainable water infrastructure.

Historically, “siloed” bureaucracies have driven construction of single-purpose, centralized infrastructures to meet societal needs. To build a sustainable future, however, water management needs to integrate planning and design for all water systems, including drinking water, wastewater, stormwater, and water that provides recreational and other ecosystem services. (Ecosystem services are defined as ecological functions that sustain and improve human lives [Daily, 1997]). In addition, sustainable water management requires integration with other infrastructure systems, including energy, transportation, and building. Future smart "networks" will provide significant synergies of design, cost-savings, and positive benefits for society, such as increased green space, restoration of waterways, improved air quality, and economic development through creation of green jobs.

Experts in sustainable water infrastructure management presented new thinking on these integrated systems, including case studies from across the United States. Federal agency representatives shared their agencies’ vision and role in helping to develop and implement these new approaches to sustainability and design. Presentations included:

- *Integration: Restoring the Water Commons*, Valerie Nelson, Coalition for Alternative Wastewater Treatment

- *Integrated Resource and Infrastructure Management: Key Elements of an Emerging Sustainable Water Paradigm,* Victor D'Amato, Tetra Tech
- *Closed-Loop Water and Energy Systems: Implementing Nature's Design in Cities of the Future,* Patrick Lucey, Aqua-Tex
- *Integrated Water Centric Infrastructure Experience,* Ed Clerico, Alliance Environmental, LLC
- Peter Silva, U.S. EPA Assistant Administrator for Water
- John Simpson, U.S. General Services Administration (GSA) Office of Federal High Performance Green Buildings
- Josh Johnson, Senate Energy and Natural Resources Committee

The presentations were followed by a facilitated discussion session with all participants to allow ideas and information about ongoing and existing projects and other related efforts to be shared.

This meeting represented key concepts from a $16-million, multi-year collaborative effort by the DWRC and WERF under a grant from the U.S. EPA to support research and development on decentralized wastewater and stormwater systems. (The DWRC is formally known at the National Decentralized Wastewater Resources Capacity Development Project.)

The theme of integrated planning and design has emerged in several other WERF research projects and efforts. For example, at a February 2009 workshop, *Smart, Clean & Green – 21st Century Sustainable Water Infrastructure Workshop,* participants explored new approaches in sustainable water resource management (WERF, 2009a). In Baltimore, Maryland, September 2007, participants in WERF's *Decentralized Research Long-Range Planning Workshop* developed the *Baltimore Charter*, which outlined their commitment to work with natural systems and systems that mimic natural processes and to take an integrative approach to design of water management systems (WERF, 2007a, 2007b).

In addition, the theme of integration has emerged in several other venues, such as U.S. EPA's *Coming Together for Clean Water Summit*, held April 15, 2010, at which experts from around the country actively discussed the need for integrated designs to rebuild America's cities and towns. In addition, the Aspen Institute released their report, *Sustainable Water Systems* (2009), and the Johnson Foundation at Wingspread hosted a series of water-related summits on related topics between March 2009 and June 2010. The Clean Water America Alliance is planning to hold the *National Dialogue: Managing One Water* in late September, 2010.

"What we've seen is a convergence of ideas around this central topic of integration," explained Jeff Moeller, WERF research program director, in the introduction to the briefing. "The challenge of integration is also one of change; it's going to require new ways of thinking and problem-solving and will require multidisciplinary and multi-agency approaches."

The primary objectives of the meeting were to:

- Present the latest information on new water infrastructure approaches to achieve ecosystem, economic, social, and other benefits for the nation.
- Share information about programs, activities, and interests related to these systems.
- Identify research needed to advance science and knowledge.
- Discuss the role of federal leadership and recommended strategies by agencies.

"We're bringing together the key lead thinkers in this new watershed approach and the key lead federal agencies in water policy and water management … to think about how we can really explore the potential for this new water management approach – integrated water," said Kimberly Brewer, Tetra Tech, meeting facilitator.

This report summarizes the speaker presentations and synthesizes major themes that emerged during the half-day meeting. The information presented in this report does not represent a consensus of opinion, but rather is based on a collective of ideas that came from the many individuals who participated.

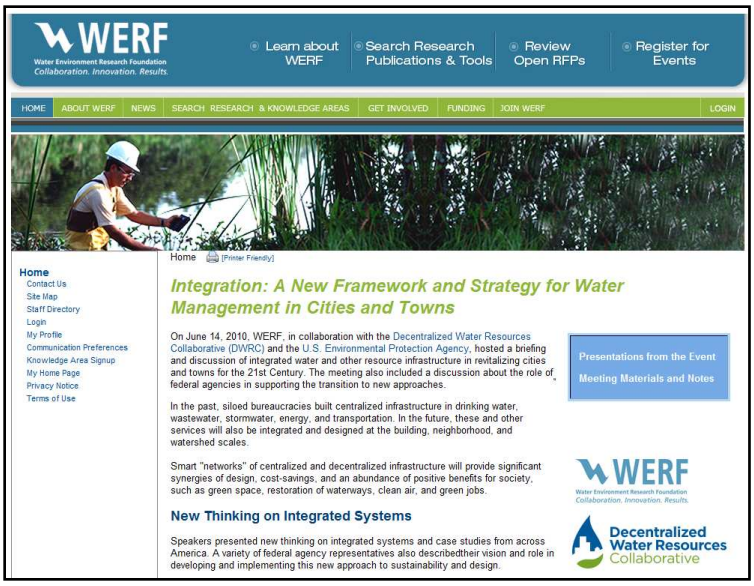

Figure 1. WERF created a website for the meeting that includes materials and supporting information, www.werf.org/integration.

Materials from the meeting, including speaker bios, an agenda, and a list of participants and additional supporting materials are available at www.werf.org/integration.

THE WATER COMMONS

Valerie I. Nelson, Ph.D., director of the Coalition for Alternative Wastewater Treatment, Gloucester, Massachusetts, explained the importance of integration in her presentation *Integration – Restoring the Water Commons*. Dr. Nelson also spoke about how an integrated approach was required to restore the water commons and to preserve ecosystem services.

The definition of integration is "bringing parts together into a whole". Integration is important because it is the central principle of sustainability. Nature operates as an integrated system; human management of those systems must also mimic nature to be sustainable, said Dr. Nelson. Infrastructure and building designs must integrate drinking water, wastewater, stormwater, and recreational and ecosystem service water needs along with energy, transportation, and use of materials at all scales to build a sustainable future. As stated in *The Baltimore Charter* (2007b):

> Water is at the heart of all life. In the past, we built water and wastewater infrastructure to protect ourselves from diseases, floods, and droughts. Now we see that fundamental life systems are in danger of collapsing from the disruptions and stresses caused by this infrastructure.
>
> New and evolving water technologies and institutions that mimic and work with nature will restore our human and natural ecology across lots, neighborhoods, cities, and watersheds. We need to work together in our homes, our communities, our workplaces, and our governments to seize the opportunities to put these new designs in place.

There are many different ways in which bringing separate parts into the whole can produce results. Integration also means bringing public, private, and civil society together in the same room to identify and implement solutions to challenges. The next step is reforming the institutions, markets, policies, and community decision-making to reflect and support these changes.

One of the goals of successful integration is to restore the water commons, said Dr. Nelson. Restoring the water commons means accounting for the link between water and climate change, quality of life in communities, energy use, land use, and biodiversity. It means thinking of all of these pieces as part of one plan – water supplies, stormwater management, flood control, energy, transportation, solid waste, jobs, quality of life – rather than as separate projects.

Moving toward an integrated, systems-thinking approach, however, will require a fundamental shift in how we view the world, Dr. Nelson explained. Initially, science was based on a mechanical notion of a world with parts and was a ““fragmented discipline”, in which these parts were studied separately and not considered as part of a whole. Many of our current institutions and practices are based on this outdated mindset. This specialization, in which institutions are focused on one issue or goal, has eliminated

cost savings and greater benefits that could be derived from a more coordinated approach.

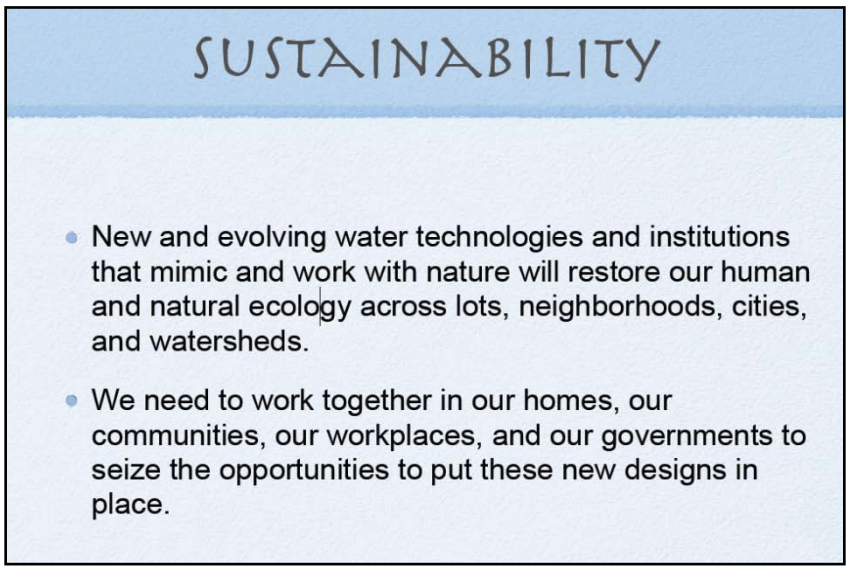

Figure 2. Sustainability needs to occur at all levels of society to ensure an integrated, systems-thinking approach.

Modern understanding of the complexity of systems has shown that we need to study the whole and that relationships are important. Several areas already are shifting to accommodate this system-thinking approach, including economics, architectural design, agriculture, and education.

"There is a fundamental shift in understanding that wealth and abundance is in examining and working in the whole and not in the fragmented parts," said Dr. Nelson. It used to be assumed that the parts are simple, and the whole is complex; but complexity actually is found at all scales.

A similar systems-thinking approach is needed in water to avoid a "tragedy of the commons". The tragedy of the commons refers to a situation in which multiple individuals, acting independently and in their own self-interest, ultimately will deplete shared limited resources to the detriment of everyone's long-term interest (Hardin, 1968).

If the whole is not considered, then silo-mission projects may achieve individual goals, but at the expense of creating other negative effects on the world, Dr. Nelson explained. The tendency of individuals and groups to protect their interests also leads to these "siloed" projects. Fundamentally, nature has become the sink for these fragmented,

projects that were each designed to achieve a single goal. This approach can lead to tragedies not only in loss of resiliency in natural systems, but in loss of communities and jobs and neighborhood vibrancy. An alternative approach would be one in which one project's externalities can help achieve the mission of another project.
The commons can be restored by:

(1) Setting prices or regulating to discourage negative externalities and to encourage positive externalities to change values and behavior; and
(2) Adopting whole-system designs that minimize wastes and disruption (footprint), maximizes value; one project's externality can be another project's mission.

Dr. Nelson cited a new approach to achieving sustainability known as "planetary boundaries", which was first described by an international group of leading scientists who met in the Fall of 2009. Lead author Johan Rockström, Director of the Stockholm Resilience Centre (2009), describes the importance of planetary boundaries: "The human pressure on the Earth System has reached a scale where abrupt global environmental change can no longer be excluded. To continue to live and operate safely, humanity has to stay away from critical 'hard-wired' thresholds in the Earth´s environment, and respect the nature of the planet's climatic, geophysical, atmospheric and ecological processes."

According to Dr. Nelson, this group believes that society is focused far too much on climate change when there are many life systems at risk, several of which are linked to water as indicated below:

- climate change (water)
- biodiversity (water)
- nitrogen cycle (water)
- phosphorus cycle (water)
- ozone layer
- ocean acidification

- freshwater usage (water)
- land use change (water)
- aerosols
- chemical pollution (water)

To restore the water commons, society needs to start thinking far beyond water management and account for the interrelationships between all of these life systems. Systems need to mimic and work with nature and design and planning needs to be integrated at all scales. Essentially, she said, we need to think in terms of whole systems and to:

- Redesign systems rather than develop individual technology innovations as in current approach.
- Restore natural hydrology and protect ecosystem services and benefits.
- Blend decentralized and centralized networks.
- Use water more efficiently, rather than the high-volume potable water and wastewater systems currently in place.

Like nature, to restore the water commons, society needs to innovate and adapt, close loops by reusing water locally, and create no waste by recovering energy, nutrients, and chemicals. A result of this will be creation of a green economy and high-skill jobs and healthy and "enriched" communities that are beautiful. Dr. Nelson suggested that all building can be based on the concept of a "mini-watershed" so that the entire area benefits.

NEW WATER MANAGEMENT PARADIGM

Victor A. D'Amato, PE, Tetra Tech, spoke of the need for a new paradigm that integrates land use and water management, and where water and waste-related resources are managed in a closed loop in his presentation, *Integrated Resource and Infrastructure Management: Key Elements of an Emerging Sustainable Water Paradigm.*

The water commons are threatened, and the existing water paradigm is flawed. Basic water quality needs are not being addressed and many waters are still polluted. Existing single-purpose, centralized water systems are energy intensive; every step in the process requires energy. Aging infrastructure, increasing water shortages, climate change, and the need for greater efficiency are further complicating the capabilities of the existing water management paradigm, said Mr. D'Amato.

Addressing increasingly complex 21st Century challenges will require more integrated, systems-oriented management approaches. A new paradigm is needed in which water and other resources are managed using localized systems that can be multifunctional and integrated into landscapes and buildings; are more holistic in their ability to recover and reuse water, nutrients, and energy; and can restore hydrologic function through land application and other localized approaches to reuse water. These integrated systems are also more adaptive and resilient.

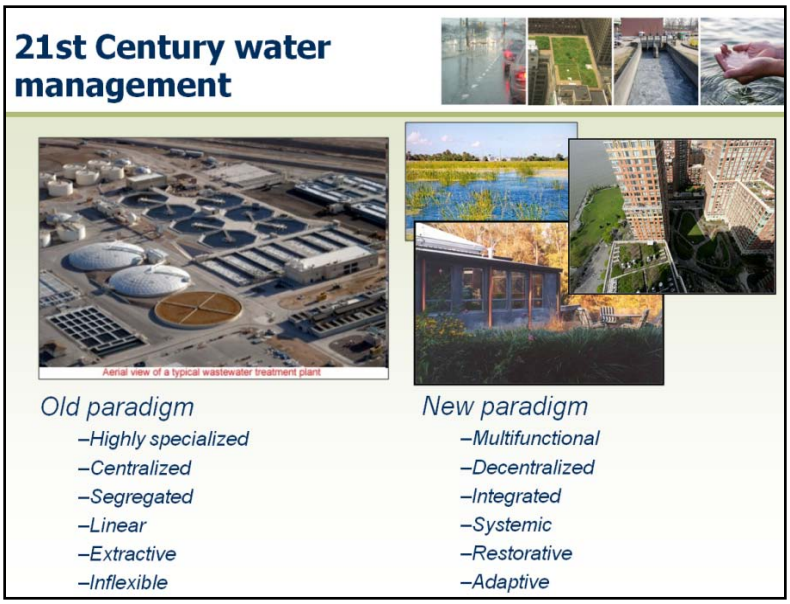

Figure 3. Water management systems need to be more holistic in their ability to recover and reuse water, nutrients, and energy than they were in the past.

New, more sustainable water management and infrastructure systems are emerging in rural, suburban, and urban communities across the United States, explained Mr. D'Amato. One approach to this challenge has been to integrate decentralized systems with existing traditional, centralized conveyance and treatment networks, known as "distributed management". This topic is covered in more detail in the WERF project, *When to Consider Distributed Systems in an Urban and Suburban Context* (2009b) (www.werf.org/distributedwater).

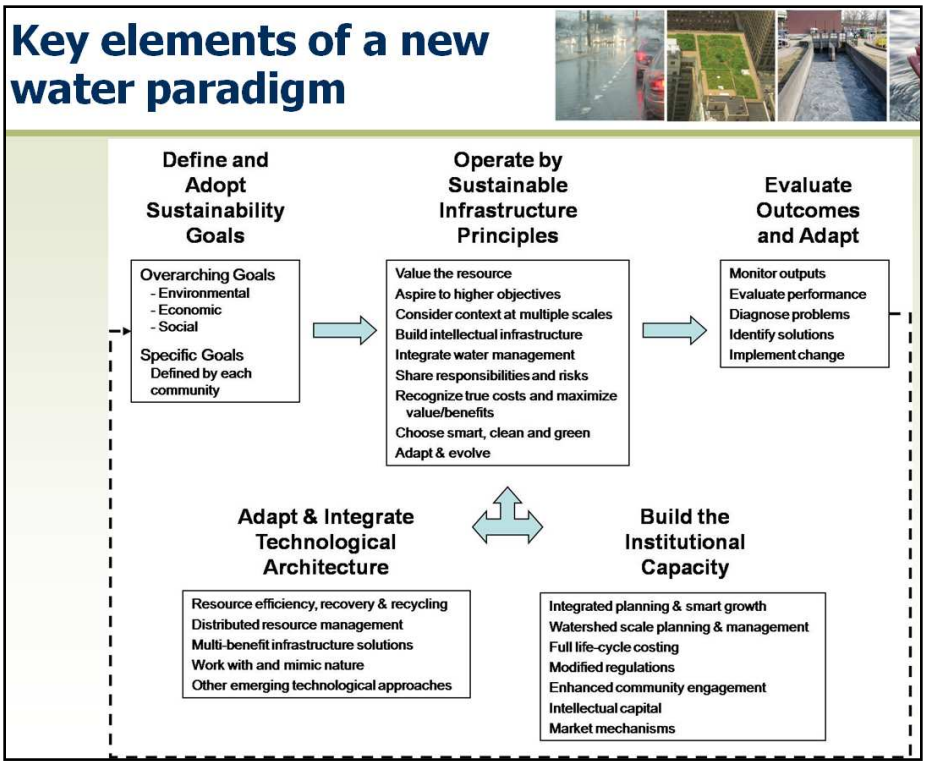

Figure 4. A more sustainable approach to water will require integration across scales, from a single site to a watershed to the world and will encompass many technical disciplines and institutions.

Case studies were used to show where these new approaches are being used and to chart a course that empowers communities to embrace the new paradigm driven by green building, community independence, and the optimization of traditional utility operations and service. Shifting to a more sustainable water management approach, however, will require setting objectives that include economic, environmental, and societal goals. “If we start with these broad objectives, we can really change the way we design and plan water management systems,” said Mr. D’Amato. This paradigm shift also will require integration across scales, from a site to a watershed to the world and encompasses a variety of technical disciplines and institutions. For these changes to occur on a broader scale, existing institutions will need to change.

Some of the institutional tools for shifting toward a more sustainable approach include:

- Integrated planning and smart growth

- Watershed scale planning and management
- Full life-cycle costing
- Improved regulations
- Enhanced community engagement
- Investment in intellectual capital
- Improved market mechanisms

Mr. D'Amato summarized key points that came out of a recent expert retreat exploring the actions that communities can undertake to move toward a more sustainable water management paradigm with the overarching statement that, "Change is good, change is necessary and the biggest risk that we have is not changing."

CASE STUDIES

After discussing the big picture issues of the need to restore and protect the water commons through integration and a general discussion of how this can be accomplished, speakers at the meeting turned to providing specific case study examples of where new approaches to water and resource management are being implemented.

Closing the Loop

Wm. Patrick Lucey, Aqua-Tex, said, "I'd like to start by simply pointing out that it's a huge fallacy that we have an energy problem or a water problem; we do not. What we have is a management and a behavior problem." In his presentation, *Closed-Loop Water & Energy Systems: Implementing Nature's Design in Cities of the Future*, Mr. Lucey stressed the need to move away from open-ended, "single-use" infrastructure systems toward closed-loop systems that use the same resource many times and turn wastes into profitable new resources.

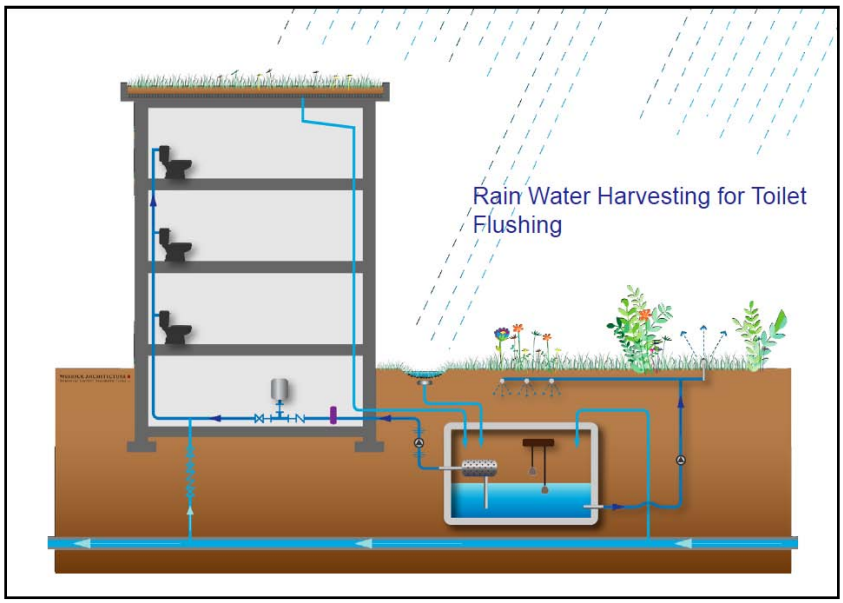

Figure 5. A slide from Mr. Lucey's presentation illustrated a system for harvesting rainwater for use in toilet flushing in a building.

Large municipal water and wastewater infrastructure systems were built in the late 19th and early 20th centuries to provide sanitation services and protect public health, he explained. Heavy investment in water and wastewater and energy infrastructure made modern cities possible, by improving living standards, reducing infant mortality, and enhancing longevity. To sustain these improvements, however, requires that we rethink the way in which we manage both water and energy, said Mr. Lucey.

Mr. Lucey discussed three projects that show the spectrum across which integrated designers must work to change the trajectory of urban development away from water and energy intensive design toward resource recovery and reuse: 1) the North Shore regional communities of Metro Vancouver, Canada, 2) the campus of the College of the Desert in Palm Desert, California, 3) and the community of Southeast False Creek (the site of the 2010 Vancouver Olympic Village).

The North Shore Communities of Metro Vancouver, Canada, are in a concept-level planning exercise to determine the optimal design of new solid and liquid waste infrastructure. This includes planning for conversion of both wet and dry organic waste into energy, potential extraction of heat from wastewater and a gasification plant and its redistribution through a 7.5-mile district energy loop, reclamation and distribution of water, and ecological enhancement and regeneration.

The College of the Desert, Palm Desert, California, is engaged in setting performance targets and standards for an entirely new campus adjacent to Palm Springs, California, designed around principles of sustainability. These principles include the 13 broad categories of education, policy and governance, social, economics, ecology, water, energy, waste, transportation, GHGs, health and wellness, agriculture and food, and materials.

The goal is to create a new campus with an operational system boundary that encompasses its neighboring communities and creates new sources of sustainable energy, while reducing waste, reclaiming resources from community waste, supporting agriculture, and creating a healthy learning environment for students who will engage in studies that prepare them for the green economy. The first phase of the development will begin in fall 2010.

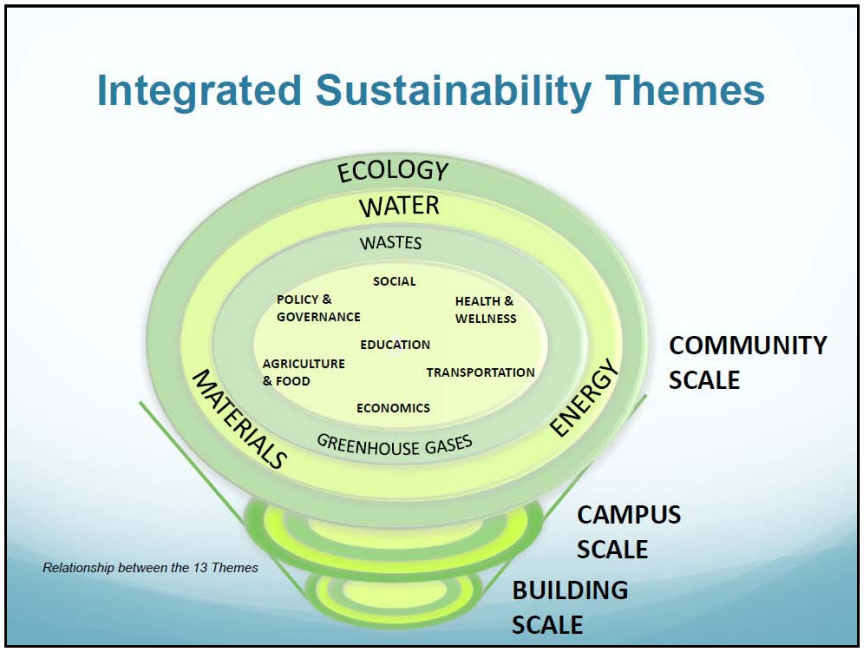

Figure 6. Sustainability can occur at all levels, from a single building to a community or entire region.

Finally, South East False Creek in Vancouver, Canada, is a mixed-use development designed for 16,000 people that was only the second in the world to achieve the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED™) Neighborhood Development Platinum certification. This project uses rainwater capture, large-scale sewer heat extraction, extensive green roofs, ecological regeneration, and the highest standards of energy performance, including passive heating and cooling, advanced glazing, and in-suite energy use monitors (www.thechallengeseries.ca).

Mr. Lucey said that it is all about waste management and wise resource use, “We need to go for broke. What is needed to achieve the essential break-through in urban infrastructure design for cities of the future is a ‘moon shoot’ approach analogous to that initiated by President John F. Kennedy in ‘putting a man on the moon within the decade.’ Model it, design it, and build it; and if you build it and it’s functional, they will come.”

Sustainable Infrastructure

Edward A. Clerico, P.E. , LEED AP, president, Alliance Environmental, LLC, spoke about the importance of water reuse and the tremendous benefits it can provide in the effort to improve water resource management.

“We’re supposed to take what we need, use it carefully, and put it back when we’re done so that somebody can use it again. But in today’s world – because of specialization – that’s so hard to do,” Mr. Clerico said in his presentation, *Achieving Sustainable Infrastructure*. In terms of integration, water cannot be discussed alone because everything is connected, and success will require innovations in systems, technologies, and delivery mechanisms, he added. In addition, these projects will need incentives for implementation, financing, and the best delivery mechanisms possible.

He illustrated the linear thinking of our current water management system with the fact that Americans use drinking-water quality water to flush their toilets and drains, wash their laundry, and transport their waste out into the environment. In the current model, a resource is used, contaminated with pollutants and other materials, cleaned as required by regulation, and then disposed of into the environment. Tremendous amounts of energy are used at each step in this process, which depletes resources and creates pollution, Mr. Clerico explained, “That’s not a model that we can sustain.”

Integrated systems, however, reduce and reuse; use less energy at each step and extract energy through post-consumer reuse; use less natural resources on production

or supply side; and release fewer contaminants to the environment on the post-consumer side.

Mr. Clerico explained that direct water reuse is one beneficial and innovative approach in which wastewater and stormwater are treated and reused for multiple non-potable purposes such as toilet flushing, cooling tower make-up, laundry, and landscape irrigation. Increasingly, decentralized water reuse alternatives are being integrated with decentralized renewable energy and bio-fuel projects in modernized, sustainable urban living.

Gillette Stadium, located in Foxborough, Massachusetts, and the surrounding commercial development is served by a water reuse system that provides treatment of all wastewater that is produced from within its service area. The project, which also serves an area along Route 1 that was zoned for redevelopment, helped to revitalize the area, said Mr. Clerico.

New York City has been a leader in water reuse because of a sustainable urban development model implemented by the Battery Park City Authority in the late 1990s. Initially, the project was designed to meet environmental objectives; now, however, rising costs for city sewer and water services have made economics equally important. (More details on these projects, along with additional case studies, can be found at www.werf.org/distributedwater.)

Recognizing the benefits of water reuse, the New York City Department of Environmental Protection implemented a Comprehensive Water Reuse Incentive Program that provides a 25% reduction in water and sewer rates for buildings that achieve at least a 25% level of water reuse. Payback periods range from 5 to 10 years depending on project size and specifics. Currently, eight high-rise buildings in New York City include reuse systems.

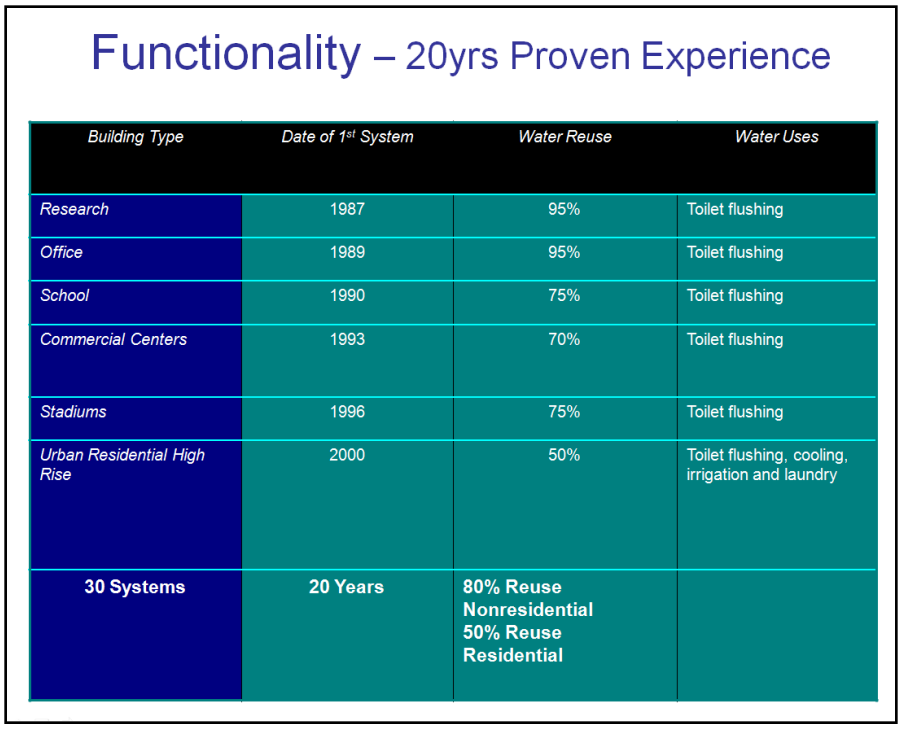

Figure 7. Opportunties for water reuse are growing and can be found in offices, schools, buildings, and more.

Mr. Clerico mentioned simple technologies that are readily available and can be implemented today with appropriate service delivery mechanisms. Such technologies include heat pumps, combined heat and power plants, biogas, and combining green waste and biosolids from wastewater systems in anaerobic treatment systems. “It’s not that complicated,” he said. “It’s challenging because the delivery mechanisms are not in place, but not complicated from a technology perspective.”

In urban areas, the goal is to determine how to repurpose the existing urban infrastructure to extract and expand its capabilities, reduce production of pollutants, and reduce demand on other resources while allowing sustainable urban development. For more than 20 years, Mr. Clerico has been involved in 30 water reuse projects using various technologies that have resulted in average water reuse of 80% in nonresidential buildings and 50% in residential buildings for water flushing, laundry, irrigation, and cooling.

Mr. Clerico also discussed several other urban projects. A building in New York City, One Bryant Park, used the gravitational energy in captured rainwater and greywater to pressurize the reuse systems for units on lower floors of the building. Another project, in Anaheim, California, is using existing dual-plumbing in a municipal building to reuse

water for toilet flushing, cooling, and irrigation. Mr. Clerico stressed that these water reuse projects ultimately can save money as the cost of water and wastewater services is increasing, particularly in urban areas where aging infrastructure is inadequate to accommodate growth or suffers from deteriorated conditions.

Savings occur from reduced operating costs and in avoided capital investment that would have been used to expand centralized water supply and wastewater services. The end result of water reuse is less resources demand, economic savings, and reduced effects on the water resource environment.

FEDERAL AGENCY PERSPECTIVES

The second part of the meeting focused on discussing the role of the federal government in providing leadership and current strategies being implemented by various agencies for integrated water resource management. The three presentations by federal representatives were supplemented by commentary provided by employees from various agencies who were present in the audience. Some additional comments were provided by attendees via email to Jeff Moeller, WERF, after the meeting, some of which are summarized here.

In general, it was agreed that the federal government could be doing more to provide leadership in improving sustainability, particularly as it applies to water management, in the United States. Speakers and audience participants pointed to several barriers to this expanded role, including a lack of funding for initiatives at the local, state, and federal levels; minimal cooperation and coordination among federal agencies; limited specific "how-to" guidance in existing regulations; lack of basic information for benchmarking; and a resistance to take risks and try new things.

Peter Silva, U.S. EPA Assistant Administrator for Water, said in his presentation that the U.S. EPA needs to start thinking differently and provided some ideas on how this can be accomplished, including:

(1) Sustainability – has to be a key factor in how U.S. EPA looks at communities and how the department invests its money. The U.S. EPA may need to provide more direction to help states use money provided through the State Revolving Fund (SRF) in a way that is more focused on achieving sustainability objectives.
(2) Water conservation – the Water Sense program for water conservation needs to be expanded to commercial applications and should tie into water conservation effort nationwide.
(3) Water recycling –every effort should be made to include wastewater recycling as part of water resource efforts; it's not just a West Coast issue anymore.
(4) Energy conservation – because 3-5% of energy used in the United States goes toward water conveyance and treatment, both wastewater and water systems need to become more efficient.
(5) Green infrastructure – stormwater can be thought of and treated as an asset and not a liability. Trying to shift thinking toward considering some products a resource rather than a problem.

Funding issues also were discussed. Several participants pointed out that most water management projects are implemented at the local level, while funds are provided at the state level through the SRF. They questioned whether funds could go directly to cities and towns instead. Mr. Silva advised that the existing process was unlikely to change, but agreed that changes in water management approaches are most critical at the local level. Others suggested a private-sector financing model for projects.

Federal water infrastructure funding (focusing first on SRF) should be changed to focus on funding truly "green" and innovative projects, suggested Katherine Baer, American Rivers, in an e-mail communication. This focus would allow for better leveraging of limited federal water funds for development of more integrated infrastructure, she wrote. Ms. Baer also suggested funding and promoting U.S. EPA's Water Sense program to make water efficiency an integral part of water resources management.

Mr. Silva and other presenters, including audience members, talked about the need to overcome the silo effect in the federal government, which was hampering efforts to implement an integrated water management approach.

John Simpson, U.S. General Services Administration (GSA) Office of Federal High Performance Green Buildings, said that one of the roles his department plays is coordinating and collaborating with other federal agencies such as the Department of Energy, U.S. EPA, Department of Defense, and the Department of Transportation. The GSA is responsible for 9,624 buildings comprising 361.5 million sq. ft. of rentable office space across the United States. These statistics place GSA among the Fortune100 companies and mean that it has massive buying power. Their activities include:

- Coordinating and collaborating with other federal agencies
- Identifying relevant green building committees and standards
- Establishing green practices and training programs
- Demonstrating best practices in green building
- Reporting to Congress

“[The] GSA’s mission is to assist other federal agencies in making greater strides in sustainability, excel at greening initiatives, and increase federal building performance,” Mr. Simpson explained.

In his presentation, Mr. Simpson said that, unfortunately, federal guidebooks that are meant to provide guidance in implementing conservation initiatives in buildings are “behind the curve” and do not include specific guidance on integrated water management. He did say, however, that the right polices are in place but that more leadership was needed from the federal level.

Will Lintner from the U.S. Department of Energy said that “energy has always been the poster child; the stepchild has always been water.” Energy legislation and executive orders have been in place since the 1970s, whereas water efficiency only began to be

considered in the 1990s, and quantifiable goals for water were not in place until 10 years ago. Mr. Lintner said that there was a long way to go before there would be any real integration in water approaches at the federal level.

Data and information challenges also were discussed. Mr. Simpson said that his agency is using "terrible water data" for benchmarking purposes, and the Department of Energy does not even track water use as part of their efforts to encourage increased efficiency. He also said that "terrible systems" make it difficult to coordinate the various agencies. Jim Loving from IBM said that information was critical and suggested a national information management structure for water similar to what is in place for electricity – a Smart Grid for water (www.oe.energy.gov/smartgrid.htm) – that would allow a comparison for how different regions use water.

Josh Johnson, Senate Energy and Natural Resources Committee, provided an example of the basic disconnects that are occurring in the federal government. He explained that although the Senate bathrooms use automatic faucets, the water temperature is extremely hot. In this case, tankless water heaters are using energy to provide unnecessarily hot water. Water is needed for energy and vice versa, he said, "We lose sight of how these two are connected."

"In the Senate, there are eight committees and thirteen subcommittees that address water … in the House there are nine committees and seventeen subcommittees," said Mr. Johnson. "When we start to focus … comprehensively and across agencies, as well as across committees, I know that we'll have a lot more success in what we do."

DISCUSSIONS

The final segment of the meeting consisted of a facilitated discussion between the audience and the panel of expert speakers. Although much of the commentary touched on the meeting's basic theme of the need for integration, discussions typically went beyond water management. Integration was discussed in terms of getting the right

people working together to solve these complex problems and considering the broader effects human use of resources is having on ecosystem services and climate change.

To begin, a series of questions was posed to the audience for consideration:

- What is your perspective on what "integrated water" means?
- What programs, activities, and issues on this topic are you engaged in or aware of?
- What role could the federal government play and what would federal leadership look like?
- What research and demonstration projects are needed to advance integration?

Paul Schwartz, Clean Water Action, spoke of the need for equitable pricing of water services, particularly for underpriveledged communities. He expressed concern for these groups if water was "priced right" and that water services may need to be subsidized for users who cannot afford it. Mr. Schwartz wondered who is at the table when decisions about water infrastructure investments are made and also stressed the need to ensure that communities are involved in discussions of any changes. Ernest Jolly, DC Water (formerly DC Water and Sewer Authority), echoed the need for community participation. He said that nationally, there is a huge communication problem in talking to the public about conservation, which needs to be addressed.

Several participants spoke about the importance of ecosystem services. Richard Pouyat, U.S. Forest Service, stressed the importance of maintaining ecosystem services and explained that we need to start looking at metropolitan areas as an ecosystem. To accomplish this, the ecological and engineering and design communities need to work more closely together. Mr. Pouyat said that the water, carbon, and nitrogen cycles need to be considered, including how these cycles are affected by fossil fuel use, fertilizers, and the "human behavior component".

In an email communication following the meeting, Mr. Pouyat and Kenneth Belt, USDA Forest Service, advocated organizing all activities based on a watershed approach. This approach would allow for measurement of inputs and outputs and effectiveness of

management efforts in a given area, is flexible enough for both large and small watersheds, and allows for integration of human, biological, and physical factors. They also wrote that it is important to take a long-term view of any effort because "environmental issues are long in coming and even longer in solving."

This approach was echoed at the meeting several times, including by Elly Best, U.S. EPA, who urged that all of these issues need to be looked at from a watershed-scale perspective, which needs to be part of the new integrated water management approach. Water should be usable for both humans and ecosystems, she stressed.

H. Kenneth Hudnell, Ph.D., of SolarBee Inc. and the University of North Carolina's Institute for the Environment, spoke about the need to manage individual waterbodies, which he termed "within waterbody management" (Hudnell, 2010). A combination of within waterbody and watershed management policies are needed to help form an integrated approach to water management, he said. Dr. Hudnell said such an approach is being developed by the Clean Water American Alliance, which was introduced by Ken Kirk, executive director of the National Association of Clean Water Agencies.

Dr. Nelson said that in some cases, the solutions to create greater integration may be really quite simple. "Building at the neighborhood scale, I think we just need to get everyone involved in that building in the same room, and just get them rethinking what the services and the functions of those places are and really challenge them to integrate their work."

She cited an example in New York City in which an older building was being retrofitted for water reuse. Designers learned after talking with the fire department that they would be able to use the existing fire system for the needed dual plumbing. "It's as simple as making these segregated functional folks start looking for these synergies, and, when that happens, there's huge value that can emerge," Dr. Nelson said. "It's finding the way to get everyone in the same room really working to determine what an integrated

approach would be." She added that the federal government needs to find a way to encourage these collaborations.

SUMMARY AND FUTURE DIRECTIONS

Several themes emerged over the course of the day through the presentations and participant discussions, including the need for more collaboration among diverse groups, greater federal efforts, expanded or more creative funding, increased water reuse and recycling, and improved information and communication. Several attendees spoke of the importance of the concept of the watershed and the various water, nutrient, and other natural cycles within it.

The importance of bringing together diverse groups to come up with solutions to existing water challenges emerged repeatedly. We need a place to get the right people in the room sit down together and have the right discussions to encourage creative thinking, said Juli Beth Hinds, Tetra Tech, in her wrap up of the meeting. We need to change how we think about these issues and get away from "doing less bad" and go for some "moonshots" that really push us forward.

Many participants voiced frustration with the lack of progress by the federal government in encouraging and supporting integrated water management, both through leadership, guidance, and funding programs. Presentations and participants indicated that industry and the community of practice is far ahead of federal agencies in the effort to achieve an integrated water management approach, although most also agreed that everyone needs to do a better job of improving the way things are being done. There is definitely a groundswell of good intention to do much better, said Ms. Hinds, but there is a long way to go, particularly in federal efforts.

The overall challenges associated with funding innovative projects emerged several times, including the need to develop unique mechanisms such as private-public partnerships and making money available directly to localities. Several speakers and participants pointed out that there is not a lot of federal money available for water

projects. In tough economic times, more private-public sector initiatives that include all stakeholders – non-governmental organizations, federal and state agencies, cities, and other private and public groups – are needed, wrote attendee Jerry Stonebridge, Stonebridge Environmental, in an e-mail communication after the meeting.

Most agreed that the projects that are occurring are being driven at the local level – from cities and towns to smaller communities. Local governments are being asked to do a large share of the work, including integrating across departments, providing funding, and bringing together the “right people”, said Ms. Hinds. Local governments also are expected to engage community stakeholders and address equity issues. Unfortunately, however, the limited federal funding that is available for projects has to be funneled through the states via the SRF. Several participants suggested that direct funding for these local projects could result in greater innovation and connection.

The need to close the loop on resource use, particularly through water and product reuse, was a hot topic. It was recognized that water reuse is no longer a West Coast issue, but is an urban, rural, and East Coast issue as well. Speakers indicated that the problem with broader application of these technologies, however, is that standards governing reuse are not uniform. Concern was voiced that this lack of consistent standards for reuse could emerge as a major challenge in efforts toward an integrated water management approach.

Many participants spoke of the importance of having correct information, including data for characterizing and understanding water systems; measuring water use in buildings, communities, and regions; and assessing the value of ecosystem services. Sharing information with the public through accurate, inclusive communication was identified as a critical aspect of integration, and the importance of encouraging a new way of thinking also was discussed.

In addition, the right information is not always provided to aspiring engineers in colleges and universities in the United States. “We need to create smart, integrated thinkers that

can develop solutions and not just solve problems," said Dale Manty, U.S. EPA's Office of Research and Development. He challenged the engineering community to change from the traditional science and engineering approach and provide education that focuses on sustainability and innovation. This integrated future will require a different kind of engineer, who can think and design in a way that promotes sustainability, he said.

Future Directions

The Water Environment Research Foundation developed a dedicated web page for the meeting, which includes video highlights, speaker presentations, relevant reports, and other information, www.werf.org/integration. In addition, WERF will be kicking off a new research program area related to this topic, Next Generation Water Management. Details of this new research area will be worked out over the next six months and will include input from this meeting and other meetings WERF has conducted. Research is expected to begin in 2011.

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