DESERT WATER HARVESTING INITIATIVE: RAINWATER AND STORMWATER HARVESTING, GREEN INFRASTRUCTURE AND LOW IMPACT DEVELOPMENT FOR IMPROVED SUSTAINABILITY AND ADAPTION TO CLIMATE CHANGE

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In the Desert Southwest, population growth and development are challenging water utilities to obtain supplemental water supplies, construct additional infrastructure, and consistently deliver sufficient fresh, high-quality water. In addition, the Southwest has been characterized as "ground zero" for climate change impacts in North America. Climate change models generally agree that temperature will increase, precipitation patterns may change, and annual precipitation may even decrease. Projected climate change will mean utilities must meet peak seasonal demand in conditions likely to be hotter and drier than in the past. They may be managing stormwater from more intense rainfall events, and facing floods exceeding historic levels. In addition, federal stormwater quality regulations will continue to require mechanisms to reduce the contaminant load of urban stormwater reaching waterways.

All these challenges entail costs to the community. The bulk of these costs will be related to capital investments in new or expanded infrastructure. Traditionally, communities have invested millions of dollars in large scale stormwater infrastructure to eject rainfall runoff as quickly as possible from the urban environment. Harvesting rain and stormwater instead produces many potential benefits.

A suite of techniques known today as Green Infrastructure (GI) and Low Impact Development (LID) collect and manage rainwater/stormwater in ways that capture those benefits. Unlike traditional approaches to stormwater management, these techniques mimic natural predevelopment systems and enhance them so as to direct water where it can be used and away from where it is a nuisance. A multitude of benefits can accrue including potable water savings, cost savings, reduced flood peaks, reduced flooding, stormwater water quality management, erosion control, habitat enhancement and reduction of urban heat island effects (see Figure 1).

For many years, the Tucson region has been at the forefront of efforts to incorporate water harvesting into water supply and stormwater management practices. In 2010, Tucson became the first city in the nation to implement a commercial water harvesting ordinance. The ordinance requires developers of commercial properties to meet at least 50 percent of their landscape irrigation needs through the use of water harvesting. The development standards written in consultation with developers encouraged its acceptance. To promote residential water harvesting, the City's water utility provides a rebate program that reimburses a portion of the costs residents incur for implementing water harvesting at their homes. The program requires that applicants attend a three-hour training session helping to ensure proper implementation of these residential systems. Tucson's transportation department is currently working with local entities to develop new policies to incorporate GI/LID infrastructure into new road construction and major road re-construction (see Figure 2).

The argument is often heard that water harvesting will not work in desert communities because there is not enough rain. But experience in Tucson contradicts that claim. The Ed Pastor Kino Environmental Restoration Project (KERP), a joint effort by the U.S. Army Corps of Engineers and Pima County, reconstructed a regional flood control detention basin, incorporating urban stormwater harvesting. The 125-acre KERP facility detains and can use up to 1880 AF of stormwater for irrigating ball fields and the facility's hydro-riparian native vegetation, saving the complex hundreds of thousands of dollars in water costs and providing environmental habitat and community recreation opportunities (see Figure 3).

Green Streets programs for neighborhood improvement led by Watershed Management Group, a nonprofit organization in Tucson, are demonstrating that appropriately designed and installed curb cuts, microbasins and bump outs in the right-of-way can radically reduce flooding while enhancing a neighborhood's natural amenities. Pima County Flood Control District studies show that water harvesting potential is greatest at the residential scale. In Tucson, water harvested from roofs and other impermeable surfaces can replace

Figure 1

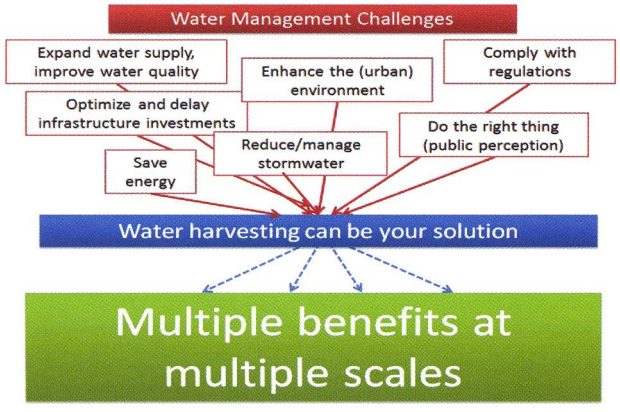

Figure 2 – Google Earth image shows contrast of traditional landscaping (right) with water harvesting (left) at the multifamily residential scale. Established vegetation at Sonora Cohousing site at left uses very little supplemental irrigation.

Figure 3 – Detention basin on the University of Arizona Campus creates multiple benefits.

a large portion of landscape irrigation demand for potable water (see Figure 4).

As the benefits of water harvesting are recognized, the number and diversity of individuals and agencies exploring its potential has grown, yet most of the work has been performed in relative isolation with correspondingly little organized data and information sharing. In an effort to assist researchers and practitioners to share information and coordinate their activities, the Water Resources Research Center (WRRC) initiated the Desert Water Harvesting Initiative (DWHI), an umbrella program for research and information sharing activities. Research is ongoing into use of GIS to locate potential LID/GI sites and concerns about cistern water quality.

The idea for the DWHI was conceived in July 2011, when the WRRC hosted a round-table on water harvesting that brought together many of the individuals and organizations involved in developing and implementing water harvesting in the Tucson region. A major result of this initial round-table was formation of the Rainwater-Stormwater Professionals Networks (RSPN) that meets semi-annually at the WRRC. Its purpose is to keep members abreast of current and planned activities, resources, and data.

At their first round-table the RSPN identified the need for guidance on benefits and costs of implementing water harvesting. The RSPN focused attention on benefits that are not easily quantified. These unquantified benefits include, for example, the services provided by of urban forests supported by harvested rainwater, which produce energy savings from shading and mitigate urban heat island effects. Other benefits difficult to quantify include deferring infrastructure expansion, mitigating neighborhood flooding, and complying with stormwater quality regulation.

The traditional image of water harvesting as simply collecting rainwater in a tank needs to be expanded to include the broader range of techniques of Green Infrastructure and Low Impact Development. A suite of techniques such as bioswales, microbasins, and porous pavement keep stormwater on site where it can support vegetation and offset demand for potable supply. Soils and vegetation filter out and/or break down pollutants. The EPA has adopted Green Infrastructure and Low Impact Development in its regulatory process and encourages adoption of GI/LID practices in design of stormwater management permits. Meeting regulatory requirements may provide a strong incentive for incorporating these practices into stormwater management plans.

Although fairly well established in the humid eastern and northwestern U.S., relatively little is known about the use of such techniques in arid regions. In particular, there is a need to understand their effects on stormwater quality, urban hydrology, and the real costs and benefits to communities in the semi-arid and arid Southwest. The WRRC collaborated with conference organizers on a special workshop at the Arid LID Conference in Tucson in March 2012, to discuss a research agenda to address these issues. The participants highlighted a range of research needs relating to unique characteristics of regional soils, rain storms, land use patterns, laws and regulations, and public attitudes. The workshop report can be found at the DWHI web site (http://wrrc.arizona.edu/DWHI).

Recommendations of the RSPN provided impetus for a research project to develop guidance on the feasibility of water harvesting at multiple scales to capture multiple benefits in the southwestern region. The project, funded by the Bureau of Reclamation's WaterSMART program, is designing and testing guidance tools for use by water utilities, stormwater management agencies, flood control agencies, and other public departments that obtain, deliver, or otherwise manage potable water, rainwater and/or stormwater in the urban environment of the desert Southwest. Based on the specific conditions faced by a range of public utilities in the greater Tucson area, these guidance tools are imbedded in a process that involves the users in developing strategies uniquely appropriate to their communities. Ideally a cross-section of potential beneficiaries, from engineers to land use planners, would be represented in a joint meeting, but the toolbox includes tools to educate and build support within a community's management structure, if needed. An interactive presentation guides the group step-by-step through the analysis of water harvesting benefits, requirements, challenges and options. The presentation references a workbook for recording and tracking community-relevant information and on-line resources with additional guidance, data and references.

Among the project's tools is a new DWHI web site. The site is being populated with links to many useful resources, case studies, publications, and sources of expertise, most of which are focused on water harvesting in arid and semi-arid regions. The site is open to the public, but it is also intended to function as a reference source integral to the process described above for using water harvesting strategies to solve the unique challenges of individual communities. Numerous gaps in available data and information have been identified, but more resources are being developed every day as interest in the topic grows

Figure 4 – Green Streets programs capture urban runoff to reduce flooding and enhance natural amenities.

A ½ inch rainfall yields 28,000 gallons per linear mile of roadway