Recycled Water for Landscapes

in the Middle East

by

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Abstract. Recycled water (treated sewage effluent) is in common use throughout the Middle East. This paper focuses on observations made in 2006 as the authors became involved in a rapid assessment of the City of Jeddah's current and future use of recycled water for landscapes. The City irrigates streetscapes, parks, and large open spaces with recycled water.

Observations were made during a site visit conducted at the request of the municipality and insights were obtained as to historic practices, maintenance concerns, operational issues, automation, and equipment selection. The use of recycled water is likely to continue in this water short region and future systems can be improved even considering the local constraints that are prevalent.

Pumps, filtration, automation, and other equipment will be described as well as design, hydraulics, and maintenance practices. Design, construction, and maintenance all play an important role in the future system expansion and upgrades if they are to be successful.

Introduction

The City of Jeddah, with a population of approximately 2.5 million people, is located in the western part of Saudi Arabia on the Red Sea. Generally speaking, the climate is quite hot and humid in the summer months and mild and humid in the winter.

The City of Jeddah enjoys an extensive network of roadways and streets. Roadways tend to be boulevards with landscaped medians and often landscape and plantings can be found on the sides as well.

Landscape plant materials tend to thrive when properly irrigated. Many planted areas have been established 10 or more years ago and mature palms or deciduous trees are well established

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along roadways. In addition to street plantings, there are numerous gardens. Gardens are actively used by the public and typically consist of turf areas, trees and shrubs, playground equipment and benches or picnic tables.

The City of Jeddah in Saudi Arabia is not unique in the Middle East with the prevalent use of recycled water for landscape irrigation. The overall operational concept is not difficult to understand. Water from the Red Sea is desalinated, treated, and hauled by tanker truck to individual potable water tanks for each residence and business. Most often these potable water tanks are found on the roof of buildings and are quite notable as one looks around the community. No potable water is used to irrigate plants in the landscape. Potable water is used for culinary and sanitary needs.

Sewage is collected in subterranean tanks and then periodically pumped back into tanker trucks for trucking to sewage treatment plants outside of Jeddah proper. Treated sewage effluent or recycled water is then trucked back into the community and delivered to subterranean concrete tanks. Water is the pumped and filtered and used for landscape irrigation – parks, streetscapes, and large open spaces. Sprinkler and drip irrigation are fairly common but bubbler irrigation is most prevalent.

The result of many years of irrigation in this way has resulted in a wide disparity in implementation, equipment, maintenance practices, operational practices, repairs, and overall quality of the operating irrigation system. In December 2006, the authors were privileged to be asked to conduct a rapid assessment of the irrigation systems within the City of Jeddah, and this paper reports on many observations made during the project.

Recycled Water Storage, Pumping, and Filtration

After treatment at the sewage treatment plant, recycled water is hauled to subterranean storage tanks having a capacity of 100 cubic meters. There are more than 400 individual storage tanks spread throughout the City of Jeddah.

Centrifugal pumps with a foot valve on the intake are used to pressurize the system. Element filters are located downstream of the pump. In a few cases, a water meter is found downstream of the pump station.

See Figures 3, 4, 5, 11, and 15.

When filter elements become clogged, the landscape maintenance workers may remove the element and leave it out of the filter housing so that a greater flow and pressure can be attained. Irrigation equipment then is likely to become clogged and emission devices are then often removed by maintenance workers as a response. In many cases the irrigation lateral has become, in effect, a means of flood irrigating medians or other landscaped areas that are bordered by a curb which contains the water inside the landscaped areas.

The issue of one problem leading to another and hence another has a cascading effect. A root cause of these problems is water quality. If recycled water was of greater quality and a predictable quality, then some core maintenance issues could be resolved. Worker response can most likely be resolved by implementing training programs.

Irrigation Equipment

Examples of sprinkler, drip, and bubbler irrigation can all be found depending on the age of the irrigation system and who designed the system. Bubbler irrigation is most prevalent and this

would likely be related to the greater orifice sizes found in bubbler irrigation and therefore the greater reliability of bubbler irrigation systems. Most bubblers were not pressure compensating.

Figure 16 shows an example of maintenance worker response in the field. The bubblers have been removed and placed to the side so that a greater flow of water can be attained. These bubblers will likely be replaced after the median is sufficiently irrigated in the workers' view. This system is being controlled manually at the remote control valve. This is another example of cascading problems that can be corrected.

Control

Independent irrigation controllers are in use although some are set in the "off" position and the system is operated manually by the landscape maintenance workers assigned to that site.

Other sites are centrally controlled and the storage tank water surface elevation is monitored. See Figure 13. A weather station is integrated with the central control.

Operation and Maintenance

Imagine 400 sites supplied by water by tanker trucks. Imagine 400 parks and streetscapes spread throughout any large city and the demands of mowing, pruning, planting, trash removal, irrigation operations, and irrigation repairs. Imagine 400 individual and independent irrigation systems. The magnitude of the effort is enormous and demanding and never ending.

Workers are supplied by landscape contractors. Maintenance practices and results vary widely throughout the City.

The Future

The City of Jeddah is in the process of studying the benefits and costs of implementing piped deliveries of recycled water to the 400 landscaped sites in the community. This approach is recommended in the future to improve delivery consistency, improve monitoring of water quality, and decrease delivery costs.

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Figure 1. Tanker trucks are filled at the sewage treatment plant and recycled water is hauled to subterranean tanks throughout the community. Water is used for landscape irrigation.

Figure 2. Some landscapes are surface or flood irrigated directly from tanker trucks as shown here.

Figure 3. Some pump enclosures were also used for storage of other landscape maintenance equipment as well as personal items of workers.

Figure 4. Pumps and filters are housed in expanded metal enclosures with a metal roof. The concrete tank holding 100 cubic meters of recycled water can be seen in the foreground. This site is centrally controlled and the antenna for the control system is set in the concrete block seen in the foreground.

Figure 5. Filter elements are often removed by workers to increase flow and pressure downstream of the pump station. This, of course, aggravates plugging of emitters and orifices in other water emission equipment.

Figure 6. Pressures were measured to document dynamic pressures in the irrigation system. Low pressures were sometimes due to multiple laterals opened manually and simultaneously, thereby causing the pump to run out on the pump curve and produce inadequate pressures.

Figure 7. Bubbler irrigation is prevalent. Some bubblers are imported from the U.S. but bubblers are also manufactured in the Middle East.

Figure 8. This operating sprinkler is clearly operating well below minimum acceptable pressures.

Figure 9. Roundabout landscapes are often quite colorful and a significant contribution to the beauty of the City of Jeddah.

Figure 10. Palm trees in roadway medians dominate the landscape but often with an understory of groundcover or flowers.

Figure11. The pump, filter, and control system housed in this enclosure are exemplary of the newest construction.

Figure 12. Workers shown here are installing bubblers that will be used to irrigation trees as well as understory groundcover.

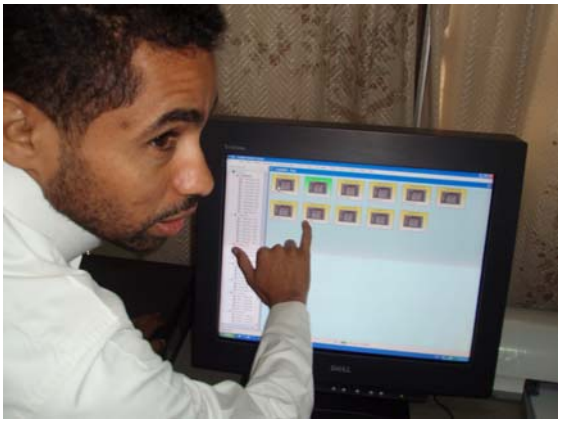

Figure 13. A portion of the landscape irrigation systems in the City of Jeddah are controlled using a central control system tied directly with a local weather station to monitor day-to-day evapotranspiration rates.

Figure 14. This irrigation controller is an independent controller not compatible with the central control system. Only a small portion of the 400 landscape irrigation sites are on the central system.

Figure 15. In the photo on the left above, the filters were disassembled to show that no filter elements were installed at the time of this site visit. In the photo on the right, the clogged filter element can be seen. This filter element was sitting off to the side -- uncleaned and unused.

Figure 16. The “fountains” in the median are the result of the maintenance crew removing the bubblers from the risers during sprinkler operation. The bubblers are the black caps to the left of the fountains. It is assumed that the caps are then replaced at the end of the irrigation cycle, although several areas were observed with missing bubblers. This adapted approach to bubbler irrigation is the result of “cascading” operation and maintenance issues.