Test case of

The flow lab is one of four physical locations in the City of Tempe, Ariz., environmental sampling campus that enables senior staff members to train their successors and transfer institutional knowledge. Richard Dalton

The City of Tempe, Ariz., created an environmental sampling campus to train its staff and ensure the transfer of institutional knowledge

Richard Dalton and Michael Golden

For water and wastewater utilities, one of the primary challenges to maintaining functional and performance integrity entails preserving and transferring critical information, processes, and techniques from one generation of employees to the next. In 2013, 25 employees having more than 850 years of cumulative institutional knowledge were eligible to retire from the Tempe (Ariz.) Water Utilities Division before the end of 2017. To address this challenge head-on, the division's Environmental Services Section constructed an environmental sampling campus to enable senior staff to train their successors and transfer institutional knowledge to them.

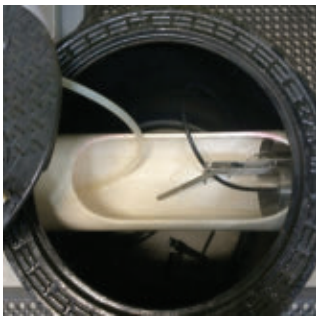
Located at the South Tempe Water Treatment Plant, the sample training campus comprises four physical sites: a flow lab, drinking water well, groundwater monitoring well, and surface water impoundment. The flow lab is situated in the basement of the water treatment facility, because it afforded the only location with adequate space for a permanent installation. The drinking water well, groundwater monitoring well, and surface water impoundment are located within the grounds of the water treatment facility.

Completed in 2014, the project has provided the dynamic

Palmer–Bowlus


Parshall flume


V-Notch weir


Simulated manhole


Avalanche sampler


Rain gauge


Assembly test station


Assembly repair station


Drinking water W\well


Monitoring well


Impoundment pond

equipment needed to enable experienced staff to transfer their knowledge to newer employees, diminishing the negative effects of attrition. The training campus provides a controlled, relaxed setting in which successes and failures may be examined; lessons may be learned; and mistakes may be reproduced, dissected, and discussed. The training campus also offers a means by which staff may test and master new technologies and equipment before having to rely on them to conduct compliance monitoring.

Filling the training gap

Faced with a pending wave of retirements from Tempe's Water Utilities Division, five employees of the division's Environmental Services Section brainstormed ideas to avoid the loss of existing institutional knowledge regarding the technical and situational aspects of environmental sampling and monitoring. The employees also recognized the need for less-experienced staff to learn how to keep pace with the dynamic regulatory and technological paradigm shifts that continuously occur within the environmental monitoring and sampling industry.

Unfortunately, regulatory professionals and treatment system staff often do not receive sufficient training to keep up with the agile, dynamic environment in which drinking water and wastewater utilities operate. Although training curricula specific to particular analytical techniques, lab methods, and proper quality assurance and quality control exist, training on the installation and use of specific water and wastewater monitoring equipment often proves difficult to find. Frequently, the training that does occur is provided by the vendor that sold a particular piece of equipment, and such training rarely, if ever, covers situational aspects such as access, weather conditions, or any other issue that falls outside the scope of the specific item provided. At the same time, available adequate training often carries a high cost and requires travel out of state. The current economy demands that public agencies do more with less, while workflow demands often preclude an effective regimen of on-the-job training.

These trends resulted in a devolution of knowledge in which newer staff were less comfortable and proficient with the equipment and processes. As a result, these staff members had to rely on senior employees in a manner that did not promote the acquisition of the skills they needed to succeed. Essentially,

a loss of confidence was occurring from the bottom up, and the Environmental Services Section faced the challenge of finding a way to reverse the devolutionary cycle, ensure the transfer of institutional and technical knowledge, reestablish staff confidence, and adapt to the dynamic work environment of the 21st century.

The City of Tempe decided to identify common sampling needs and build an environment conducive to training, situation reproduction under controlled conditions, and equipment troubleshooting. The team chosen to lead this effort began by designing a loop system consisting of approximately 15 m (50 ft) of 150-mm-diameter (6-in.-diameter), clear, polyvinyl chloride piping. The 40-m^2 (432-ft^2) system was outfitted with two flumes, a V-notch weir, a sewer manhole, a double-sweep cleanout, a magnetic flowmeter, a rain gauge, and backflow assembly devices commonly used in water distribution systems, as shown in Figure 1 (below). Because of spatial limitations, the piping diameter ultimately was reduced to 100 mm (4 in.).

As construction progressed, the team determined that the facility's onsite drinking water well, groundwater pump, and impoundment ponds also could be used in a training capacity. Thus, the City of Tempe's environmental sampling campus was born.

The flow lab and its loop

After completing the project design, the team received a budget to construct and equip the sampling campus. Except for some electrical reconfiguration, the flow loop was constructed entirely in-house by staff within the city's Water Utilities Division.

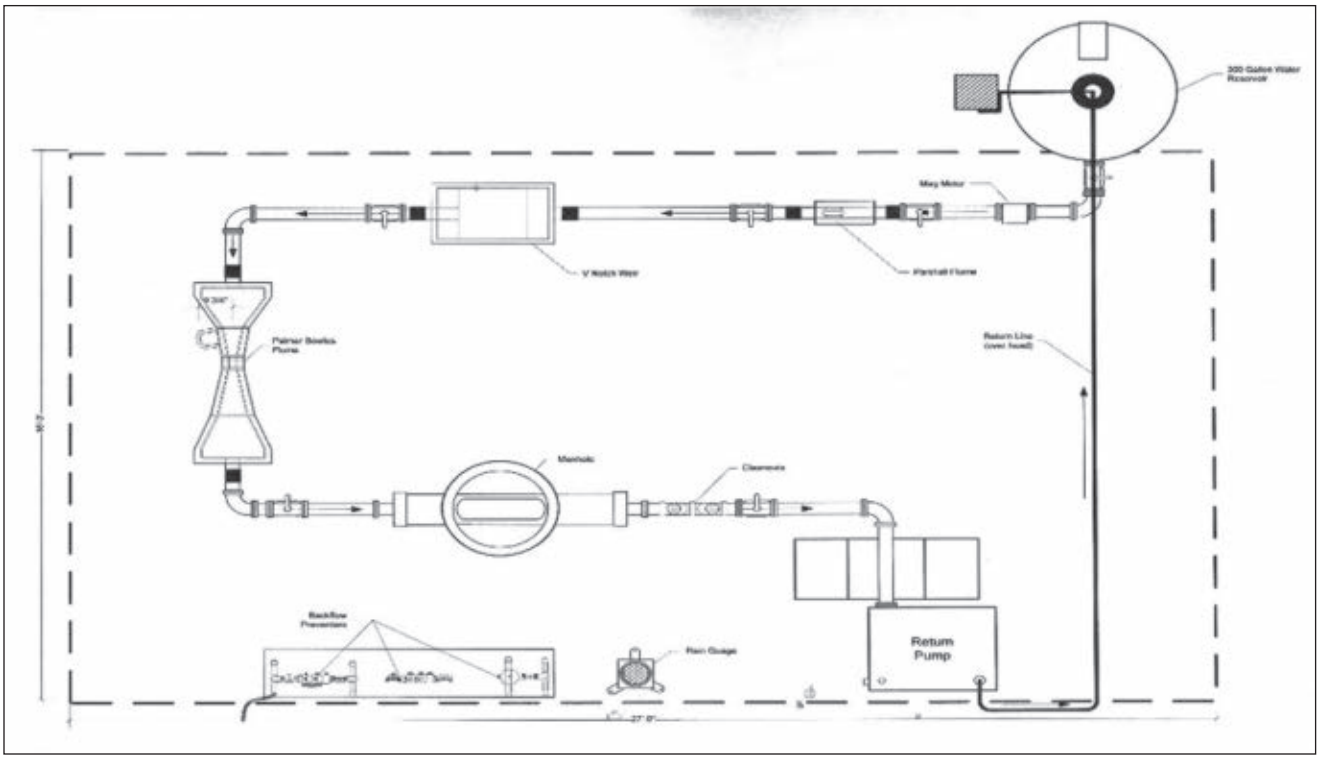
Flow into the system is generated gravimetrically from an elevated tank that drops water through a 100-mm-diameter (4-in.-diameter) electromagnetic flowmeter with transmitter (EMT). The water flows through series of primary devices typically used in wastewater monitoring: a 100-mm (4-in.) Palmer–Bowlus flume, a 22.5-degree V-notch weir, a 100-mm (4-in.) Parshall flume, a 200-mm-diameter (8-in.-diameter) simulated manhole, and a double-sweep clean out. The water then enters a return tank in which a submerged sump pump conveys the water back to the elevated tank.

A panel on the EMT displays real-time flow readings. Each flume station is equipped with a dedicated ultrasonic probe and ultrasonic flow module that interface with an autosampler to enable the collection of samples based on a defined flow volume in conditions similar to those of industrial users. Each of the three flow control devices feature removable union joints to facilitate removal and replacement should the need arise. Additionally, the union joints afford the flexibility to move devices around and simulate different upstream and downstream conditions.

The manhole was created by cutting holes on two parallel sides of a circular irrigation box and inserting a 200-mm-long (8-in.-long) section of polyvinyl chloride pipe through the holes. Strategically cut so as to have had its top portion removed, the pipe was outfitted on either end with a 100-mm (4-in.) reduction union to enable the installation of a stainless steel sleeve containing an area velocity probe connected to an area velocity meter. This configuration enables flow-based sampling and monitoring conditions like those found in an actual sewer main. The simulated manhole also can be outfitted with ultrasonic or laser-based flow monitoring equipment.

The manhole also may be used to simulate monitoring within a municipal separate storm sewer system. To this end, the manhole includes a refrigerated sampler having an area velocity flowmeter, rain gauge, and interface unit, enabling the simulation of rain

Figure 1. Initial design of the City of Tempe, Ariz., environmental sampling campus



event sampling. During operation, rain is simulated, and when the sampler detects that preprogrammed trigger points have been met, it sends notification alarms similar to those sent during an actual storm. The municipal separate storm sewer system monitoring station will be equipped to look exactly as it does in the field, including the use of a wireless modem to transmit information online.

The flow lab also includes a pressure vacuum breaker, a double check valve, and a reduced pressure principle backflow assembly, though these items are not connected to the flow loop. The devices are used to train staff on the procedures for testing and certifying backflow assemblies. In addition, a 100-mm (4-in.) reduced pressure principle device facilitates training related to its assembly, reconstruction, and repair.

The drinking water well, dedicated groundwater monitoring well, and surface impoundment ponds are located at the south end of the facility.

A regional facility

Automatic sampling and flow monitoring equipment is used to support industrial pretreatment programs, water resource recovery facilities, and stormwater monitoring programs across the U.S. Industrial pretreatment programs and water resource recovery facilities must follow monitoring requirements that call for the use of specific equipment and techniques.

The environmental sampling campus is designed to facilitate the training of all drinking and wastewater sampling, groundwater monitoring, backflow assembly testing and device maintenance, and stormwater compliance monitoring. Additionally, the flow loop can be used to reproduce system conditions that will enable staff to identify and report the causes of equipment failure. What is more, such conditions as a sanitary sewer overflow and plumbing backup can be simulated by restricting flow at specific points in the loop, enabling staff to prepare safely for these situations before they occur in the field.

Originally, the City of Tempe intended to use the sample campus to educate and train city staff only. However, the city soon realized that other Arizona municipalities also needed such a facility. To help fill this void, the city began inviting partner agencies to use the facility, which quickly evolved into a regional training center. In fact, the facility has been used by other jurisdictions at the federal, state, and local levels.

Since its completion, the facility has hosted two statewide industrial sampling training classes and several custom training and equipment review sessions that involved more than a dozen government agencies and private sector groups. Agencies that have used the sample campus to date include the U.S. Environmental Protection Agency, the Arizona Department of Environmental Quality, the Arizona Game and Fish Department, Gateway Community College (Phoenix), and staff from more than a dozen pretreatment programs throughout Arizona.

In addition to training staff on the use of certain equipment, the sample campus also is equipped to test emerging technologies. Primary flow monitoring devices and benchtop analysis described in the *Standard Methods for the Examination of Water and Wastewater* and *ASTM Standards Related to Environmental Monitoring* comprise the current standard within the wastewater industry. Within the last decade, however, noncontact laser technology, and real-time in situ monitoring have begun being used in situations and scenarios in which existing technology has been found to have limitations in functional productivity. Along with training city staff and personnel from other agencies on the use of such technology, the sample campus may be used to test the limits of emerging solutions to determine when and where they can be used most effectively.

Moving forward

Armed with the knowledge and tools needed to perform their jobs effectively, future water and wastewater staff will be prepared to address all existing and emerging challenges that confront them. Proper preparation also will promote an environment of integrity, professionalism, and quality. These characteristics not only are required by the regulations that govern sampling and monitoring work, but they are expected by utility leaders, rate payers, and the public.

The sample campus will ensure that the future of sampling and monitoring within the Tempe utility, as well as any other willing utility in the State of Arizona and the U.S., will have the means – and the tool box – to preserve the knowledge of their professional forerunners. Additionally, sampling and monitoring staff trained at the campus will attain the confidence, ethics, and integrity that come with a solid educational foundation. At the same time, it is hoped that the trained staff inherit the desire to extend that knowledge before one day passing it on to the succeeding generation.

Richard Dalton *is the current environmental compliance supervisor and* ***Michael Golden*** *is the retired environmental compliance supervisor for the City of Tempe (Ariz.).*