Evaluating the Efficiency of a Large Commercial Site with Multiple Systems

Abstract: The intent of this paper is to provide a comprehensive understanding on resolving the issues that arose during the process of proposing and conducting an evaluation of existing irrigation systems on a 70 acre corporate campus site with municipal water supplying 8 separate irrigation systems, controlling over 115 zones that service a perpetually changing landscape containing plant materials with a wide range of watering requirements with the purpose of providing to the owner, an inventory of irrigation system components and furnishing general recommendations for improving irrigation system efficiency.

Drafting the proposal

A preliminary meeting with clients' representatives (Director of Facilities and Director of Operations and Engineering) and the landscape/irrigation contractor who currently maintains the irrigation systems determined that the goals for performing an audit and evaluation of the irrigation systems were two fold:

- Provide an inventory of components of the systems currently in operation along with an evaluation of their performance in terms of irrigation efficiencies.
- Furnish general recommendations to help guide the client in all decisions regarding future modifications or redesign of the irrigation systems.

The inventory and evaluation included a review of all of the components which make up the existing irrigation systems including sprinklers, valves, controllers, sensors and point-of-connection components. This was necessary due to the absence of an existing 'as-built' landscape irrigation plan. There have been many changes to the landscape since it was originally installed over 15 years ago. Changes to the landscape resulted from construction of new buildings, roads, parking lots whereas lawn and bed areas were modified to accommodate new walkways and fences. . The site comprises 13 buildings on 70 acres and receives vehicle and pedestrian traffic 24 hours a day, 7 days a week. New construction was currently taking place on the site and one of the systems to be evaluated was only partially in operation.

On-site conditions that influenced projecting time required to perform the audit were:

- high security facility that required sign-in/sign-out procedures, security escorts into buildings to access controllers and view points of connection
- no remote control options available to manually operate controllers from outside the building due to radio interference from on-site communication satellite dishes and radio towers
- absence of as-built design and lack of knowledge on the part of the contractor and facilities staff as to the location and condition of valve boxes out in the field

- limited time frames in which to activate systems without affecting pedestrian traffic flow and other on-campus activities
- absence of separate irrigation water meter readings from that of water used for cooling tower use and other facility needs inhibited establishing a priority list of areas within the landscape receiving excessive amounts of irrigation water as well as inhibiting preparation of monthly and yearly water use/cost comparisons

Based on our preliminary on-site meeting with the clients we developed a proposal to provide an Evaluation/Water Audit Report that included:

- Obtain, familiarize and study existing irrigation systems without the aid of as-built plans
- Evaluate existing system hardware, i.e.: sprinklers, valves, control systems, pipe, fittings, pumps, drip-system components and controls
- Meet and obtain input from maintenance personal as to present operational programs, system maintenance and repair records
- Based on existing landscape, prepare submit a statement of estimated monthly and yearly water use/cost to be compared to future utility records
- Submit written report of observations and recommendations pertaining to #1 - #4 above plus evaluation obtained through the following:
    - methods of water and energy conservation
    - control system options
    - system distribution of uniformity
    - sprinkler precipitation rates vs soil percolation (infiltration) rates
    - evaluation of existing system in light of today's technology
- Attend one (1) review meeting to discuss evaluation report

Included in the proposal was a separate quote to provide a GPS mapping of the irrigation system using AutoCAD Map 2010 software on an accompanying new landscape design plan being provided by a landscape architect firm.

A Time Worksheet in Excel format was used to determine the dollar amount in labor costs and reimbursable expenses based on a projected number of site visits to perform a minimum two (2) catch can tests on each of the 9 controllers throughout the site which included a manual test cycles of a minimum 5 minutes per zone for each of the 9 systems to evaluate valve and sprinkler head performance. The test cycles would help determine which zones were most suitable for catch can tests whereby having the fewest performance issues caused by poor head spacing, spray deflection, broken equipment and pedestrian traffic flow.

Conducting the Audits

System Overview:
The clients existing irrigation systems were separated into eight systems, each with a separate point of connection to the local municipal water supply. Points of connection

were contained in mechanical rooms that also housed points of connection for domestic potable water supply, fire sprinkler system and HVAC service. Each system is controlled by a single automatic controller with the exception of one system that had two controllers. Most of the systems irrigate landscaped areas that have undergone design and construction changes since the system was initially installed. As a result, the original irrigation systems have been modified to accommodate the addition of new plant materials, fence or paved surfaces. In most cases, this has compromised the efficiency of the irrigation systems and in some cases may require a complete re-design and installation of a new irrigation systems, improving on the quality of the turf and reducing water consumption. Most of the bed areas contain mature plants and as a result, the drip irrigation systems installed in the bed areas are not currently on the active irrigation schedule.

Water Supply and Controller evaluation:
Each point of connection to the municipal water supply was reviewed and the following data was recorded on Worksheet #2 of the Irrigation Associations' Rotor and Spray Audit Worksheets, June 2010 edition:

- type of piping and it's size throughout the mainline system, from connection to potable water supply to connection to irrigation mainline outside the building
- meter size and model
- backflow manufacturer, model number, size and date of latest inspection
- dynamic and static pressure and time of day at which tests were conducted
- pressure regulator make and model
- isolation valves
- components for winterizing the system
- controller make and model, programming features and current operating schedule

The components for each point of connection were uniform in size and manufacturer with the exception of one system that was comprised of only 4 zones. Our final report included evaluations of each water supply and control system with recommendations to improve flow monitoring capabilities by upgrading the controllers to newer "Smart" controllers with moisture and flow sensing features and remote capabilities. Even though each point of connection had a water meter separate from the potable water supply for each building, it wasn't until we made our final presentation to the Facilities Department that we learned that irrigation water had also been diverted for cooling tower use during the summer months and thereby making historical water billing statements irrelevant for projecting water savings based on system upgrades.

Field Audits
Catch can test were performed on selected turf areas or zones on each of the 8 systems on the campus. Determining which areas were to be tested was based on which zones had the fewest problems observed during a 5 minute manual test cycle run for each program as well as areas deemed by the facilities management team as a priority to maintain for marketing events held on campus. Tune-ups were performed to correct head and valve issues but many zones had severe design issues and were deemed impractical for testing.

Those zones or areas that performed best after tune-up procedures and would appear to have the highest efficiency rates were selected to have catch can tests performed. Linking information from one zone and applying to others was utilized. At least one spray zone and one rotor zone was chosen from each system and these zones were also representative of the other zones on the same system in terms of soil type and microclimate conditions. All but one system had twelve or more zones and all had conventional wiring to the controller to the valve.
Since most controller locations were deep within building structures that inhibited hand-held remote access and required security guard escort to access to mechanical rooms, most of the catch can tests required manual activation from the remote control valve in the field. Many of these valves required the use of a wire tracking device to locate and identify the correct valve.

The catch can tests were conducted according to the guidelines developed by the Irrigation Association and Cal Poly catchment devices with 16.5 square inch surface area were used to collect data. Pressure tests were conducted at the sprinkler head prior to as well as during the tests if there was a sprinkler on the zone that was not in the area being tested.
Site conditions that influenced audit procedures were:

- Wind conditions varied over the two week period in which tests were performed but on most days there were wind gusts between 5 to 10 mph between buildings. Tests were frequently interrupted and then restarted during calm conditions.
- Pedestrian traffic and scheduled events on some of the lawns required conducting tests either on weekends or early morning.
- Lack of remote access to controllers

There were a total of 18 catch can tests performed throughout the campus and 3 of the areas tested had overlapping zones and the results of two runtimes were combined to provide accurate performance data for an area. Test results were recorded on IA Worksheets and a site map was drawn for each area showing head location, catch can location, distance between heads and catch cans.

Catch Can Test Results:
Even though areas tested has similar microclimate and soil conditions as well as having minor or no observed problems with equipment, the DU and PR rates varied greatly between areas. DU rates ranged from 16% to 67% on spray zones and 23% to 51% on rotor zones. The lowest rates were a result primarily from design issues such as poor head spacing and insufficient head counts to provide head-to-head coverage.
Knowing that most of the tests were going to produce results well below the industry efficiency standards for both rotor and spray head zones, the results helped us prioritize zones that were in most need of renovation. Priority was also given to areas where marketing events were hosted and taped for promotional purposes. These priority areas were determined in a preliminary meeting with the owners representative and the current landscape maintenance contractor prior to testing.

Summary:

Upon completion of the catch can tests conducted throughout the campus, we conducted a GPS mapping of all eight existing systems locating all heads, valves, controllers and points of connection along with estimated pipe and wire runs to provide an As-Built irrigation plan. A Landscape Architect firm provided a new AutoCAD landscape plan for us to use AutoCAD Map and add the irrigation.
A final presentation with the Facilities Management staff included:

- Audit worksheets with documents explaining test results and included a glossary of terms
- Estimated Annual Water Use data for each irrigation system that included projected water use in gallons for each day, week and month from April through October which incorporated historical rainfall and ET data, specific plant watering requirements and system efficiency rating. Quattro Pro X3 software was used to compile data.
- Recommendations for controller field units that have flow sensing, moisture sensing, remote capabilities and potential for central control upgrade. The recommendations were non-proprietary and our report is intended to provide the client with necessary information on control system features and use as a reference when researching different product lines.
- Re-design irrigation system for areas with lowest DU rates and have high profile status.
- Establish a Base Irrigation Watering Schedule to be monitored and altered throughout the irrigation season to accommodate changing demands upon the irrigation system relating to weather conditions and activity schedules

References:

Irrigation Association, March 1996 Second Edition. Landscape Irrigation Auditor Training Manual

Irrigation Association, September 2009. Recommended Audit Guidelines.