Documenting Irrigation Systems Accurately
With Global Positioning

By Cory D. Metler, CLIA

Documenting irrigation systems through the use of the Global Positioning System (GPS) is fast becoming the standard means of site documentation. GPS technology is redefining the way irrigation system managers and irrigation designers collect and process data. GPS is the fastest, most cost-effective way to capture data on large turf irrigation systems, allowing for managers to make more informed decisions more quickly.

GPS is a satellite-based radio navigational system that provides 24-hour, three-dimensional information on position, velocity and time. It was developed and is operated by the U.S. Department of Defense and consists of a $12 billion constellation of military satellites. It is the only system available today capable of shooting your exact position on earth any time and in any weather.

The principle behind GPS is calculating distance measurements among the user and the satellites. Measurements from four satellites are needed when mapping in three dimensions.

GPS data is being used in many aspects of large irrigation documentation, among these are:

- base map development;
- precise irrigation auditing;
- accurate (submeter) irrigation record drawings; and
- producing maps for today's computerized irrigation central control systems.

Base Map Development

Several techniques are used for developing large turf irrigation system base maps. The most popular are traditional and modern surveying (tape measures, measuring wheels and total stations), aerial photography and GPS. All of these techniques have unique benefits, as well as limitations that limit their usefulness under certain conditions.

Traditional surveying of large turf areas using tape measures and measuring wheels can result in variations in a property's true layout and size. Mapping a property with traditional tools has been proven to be very inaccurate. Reproducing results with reasonable accuracy is nearly impossible.

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On the other hand, modern surveying methods that use total stations are very accurate. But there are disadvantages. Total stations rely on line of site to a benchmark location. This can be difficult at sites with dense vegetation or extreme terrain. Developing a base plan in this manner is often a two-person operation and is very time and labor intensive, and therefore expensive.

Aerial photography has been the most popular source of base map development. Date is an important issue with aerial photography. An outdated photo can lead to inaccuracies due to changes at the site since the photo was taken. Important site features, such as buildings and ponds, can be obstructed by tree cover at certain times of the year.

There is also the potential of error due to the size of the image. When an aerial photo is taken of a site that exceeds 3,000 feet in length in any direction, the curvature of the earth causes error in measurement. Errors in scale can result if photos aren't taken on a true horizontal axis. Digital orthophotos can alleviate distortion problems, but can

be expensive and impractical because of issues with vegetation.

GPS data collection is the fastest and easiest means for base map development. Depending on the accuracy of the equipment gathering the data, centimeter and even millimeter accuracy is obtainable. Advantages of GPS for base map development include very high accuracy and cost savings from the speed and ease of data collection. Data collected is directly imported as a digital format and each feature collected has a geographic coordinate and structured attribute.

A comparison of the architect's master plan and the actual site documented by GPS revealed significant differences in size and location of major course features.

Following are two different scenarios of base map development.

Scenario One: An irrigation system design was developed using a course map owned by a golf course. This course layout was the architect's master plan, which was used to develop the base map for the irrigation. As the design process continued, the design drawing and course layout had several discrepancies resulting in a drastic change in the number of rotors needed to properly irrigation the golf course.

Changes to the plan resulted in additional man-hours in the field for staking and installation, in addition to the extra rotors and materials caused by the inaccuracy of the map. Throughout construction there were several material change orders for the irrigation contractor. A comparison of the architect's plan and the actual site revealed significant differences in size and location. To resolve these differences, the entire golf course and the irrigation system were documented using GPS.

Scenario Two: An irrigation system design was developed using an aerial photograph supplied by a golf course. This aerial photograph was taken a few years prior to the development of the proposed irrigation system. Any features not represented via the photo were site located on the base map by the golf course superintendent. After numerous man hours in the development of the irrigation system design, materials take-off and bid documents, there were several discrepancies found among the three contractors bidding the project because each determined a different scale from the original aerial. These discrepancies varied from the total materials estimate for the job and not only impacted pipe and wire sizing, but ultimately requirements for the pump station.

The discrepancies were the direct result of the aerial photograph used for developing the base plan. Even though the irrigation system designer used an aerial photograph which accurately illustrated the golf course layout, the field measurements were only verified with measurements from one hole. Without measurements from multiple golf holes, the error in the aerial photograph was not evident until the system was staked. These errors were a result of the aerial photograph not being taken while the plane was on a true horizontal axis. Distance errors ranged from 50 to 400 feet across the property. This was not evident until GPS was used to map out several holes across the property as a control measure.

Irrigation Audits

GPS is also being used for auditing existing irrigation system performance. Catch can tests can be performed on various areas of the site. A single leg profile can be generated and entered into a computer to instantly tabulate a geographical representations of system uniformity. This allows a graphical representation for calculating the desired application, required application, and effect on wettest area per golf hole feature.

As before, here is a real-life scenario to help explain the usefulness of GPS:

A golf club is in the process of evaluating the efficiency of its existing single-row irrigation system. The system has deteriorated to a state that the pop-up rotors around the greens are no longer used for

greens irrigation. The superintendent has opted to hand water the greens daily. The single-row fairway system is also not delivering adequate coverage into the rough where it is needed to establish the thick, healthy stand of turfgrass required for tournament conditions. Consequently, portions of the rough are also being hand watered. An audit was recommended to quantify the performance of the 25-year-old system to help justify the expense of installing a new multi-row system.

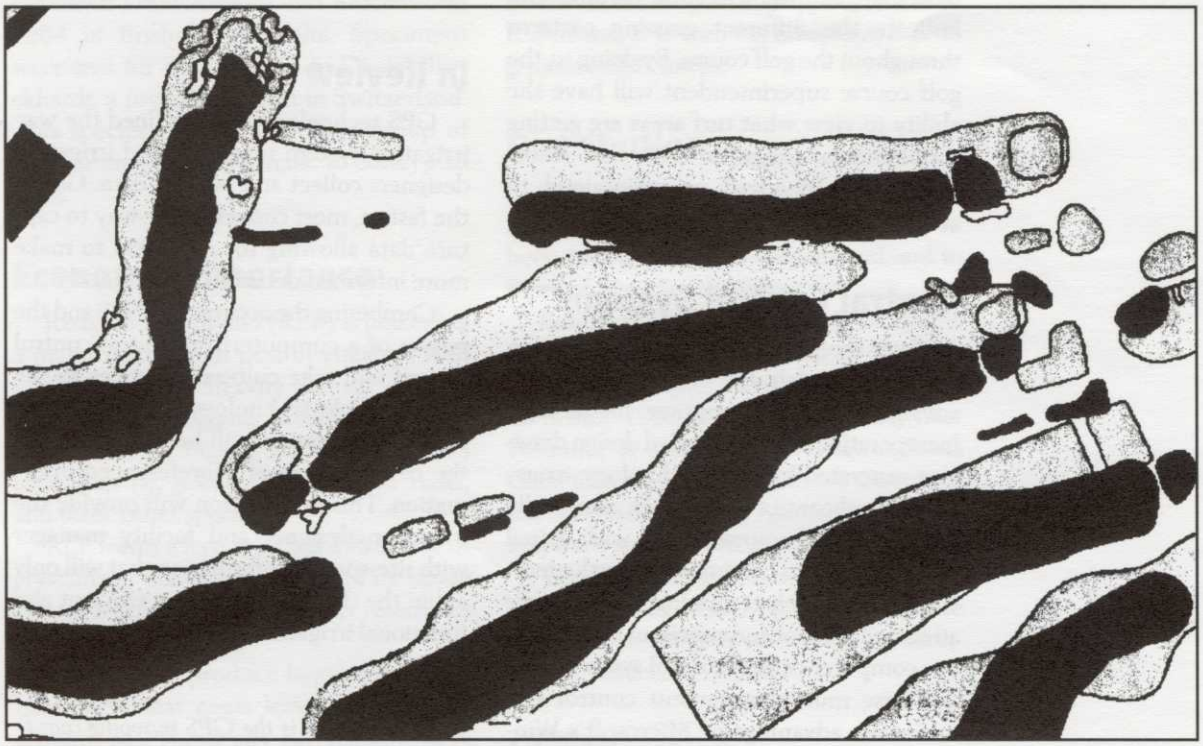
After performing catch-can tests, the data was entered into a computer software package and single-leg profiles were created for all areas tested. The results were entered into the GPS base map and a coverage map was produced to demonstrate the effective coverage of the sprinkler heads and to calculate the distribution uniformity (DU) of the irrigation system.

The results of this test helped illustrate not only to the golf course staff, but to the golf course membership, where the weak areas were and what needed to be considered in the design of a new multi-row irrigation system. These results also aided in the management of the existing system while the design process evolved.

Accurate Record Drawing

One of the most obvious advantages to GPS is the development of an accurate "Record Drawing" for system management and system documentation. A record drawing is a very valuable tool. It identifies any individual attribute (sprinkler head, isolation valve, wire splice) with submeter accuracy. System managers no longer have to hunt for system components with a metal detector. Instead, they can locate these important components quickly and accurately.

Record drawings are often created while out in the field and they consist of several pages. Even though these pages can be very accurate, the scale can be lost when several pages are combined onto one sheet. With the aid of GPS and a CAD viewing software package, system managers can have an irrigation record drawing in front of them at



A comparison of the architect's master plan (gray above) and the actual site documented by GPS (dark) revealed significant differences in size and location of major course features.

any time and view any attribute. Since CAD drawings are built in layers, you can turn on or off layers according to need.

Buried components can be found by measuring from two known, visible components. The computer can calculate the distances for you.

Scenario One: A local golf course that utilizes a spreadsheet-based central control system is in the preliminary stages of evaluating the efficiency of their existing irrigation system. The system is multirow and was designed to furnish enough coverage to allow the new construction project to fully grow-in.

Now that the course is established, several native areas do not need supplemental irrigation. Since the irrigation system was installed during construction of the course, no turf areas are delineated on the record drawing. This restricts the superintendent's ability to visualize where the rotors are and what turf areas they cover.

The main intent is to develop a GPS base map, add the irrigation features and indicate the different grassing patterns throughout the golf course. By doing so, the golf course superintendent will have the ability to view what turf areas are getting supplemental irrigation and what rotors need to be changed or maintained to achieve better water distribution.

Central Control Systems

Over the past few years, the irrigation industry has felt the direct benefits of advancements in computer technology. Incorporating computer-aided design drawings generated by GPS technology, irrigation central control systems can graphically recreate a golf course layout with actual irrigation system layouts down to the individual rotors. This technology allows more advanced control and precision over previous computer central control systems.

These multimanagement control systems take advantage of Microsoft's Windows Operating System with true 32-bit graphics. The end-user can turn on and off desired GPS map layers and zoom in an out to monitor every detail of the course. Users are no longer restricted to long repetitious spreadsheets. This Windows environment eliminates tedious keystrokes and layers of spreadsheets, replacing them with point and click simplicity.

Using a GPS map with an advanced irrigation central control system results in a very flexible, accurate and powerful management tool. As technology advances, more design information will be available through the development of georeferenced information. Georeferenced information will help provide more site-specific information for every aspect of facility management. Having the ability to use georeferenced information and to import it directly into an irrigation central control system can only aid in the development of highly efficient and functional irrigation systems.

Users will have the ability to look at several different watering scenarios, treat site-specific microclimates, soil characteristics and problem areas with the attention that they deserve.

In Review

GPS technology has redefined the way irrigation system managers and irrigation designers collect and process data. GPS is the fastest, most cost-effective way to capture data allowing for managers to make more informed decisions more quickly.

Combining the accuracy of GPS and the power of a computerized central control system will take cultural practices to the next level. As technology advances, more design information will be available with the development of georeferenced information. This information will provide the irrigation designer and facility manager with site-specific information that will only aid in the development of an efficient and functional irrigation system.

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