DEMONSTRATING WATER SAVINGS THROUGH SUBSURFACE TURF IRRIGATION

HENDERSON, NEVADA

A joint project between the Conservation District of Southern Nevada and the Clark County School District with funding assistance from the Bureau of Reclamation.

Summary

The purpose of this project was to test the Environmental Passive Integrated Chamber (EPIC) irrigation system as a water-saving irrigation method in Southern Nevada. In spring of 2005, the Clark County School District (CCSD) approached the Conservation District of Southern Nevada (CDSN) about seeking funding to demonstrate an emerging subsurface turf irrigation system at David Cox Elementary School in Henderson, Nevada. The EPIC System is a product of Rehbein Environmental Solutions. The system's designer Jonas Z. Sipaila merged his company Evaporative Cooling Systems, Inc. with Rehbein Environmental Solutions after a successful partnership at a Cambria, CA elementary school. He now works as the company's Director of Innovation. The Conservation District received a grant from the Bureau of Reclamation to fund the project, with a substantial amount of matching funds provided by the CCSD.

The School District installed the system in February of 2006. The demonstration consisted of two watering systems installed on a 2.25-acre activity field at the school. The field was split into two test groups, one installed with a traditional sprinkler system, the other with the new subsurface system. Water usage was monitored through September of 2007. School District staff encountered many problems with the subsurface irrigation field. Leaks and improper maintenance resulted in water use similar to, and sometimes exceeding that recorded for the traditional irrigation system. The CCSD contacted Jonas Sipaila who inspected the project and advised School District maintenance staff on the proper watering technique with the system. This helped to solve performance problems associated with human error (e.g. over-watering), but did not fix leaks in the system, which were later attributed to the gypsum soil base of the field. Microscopic leaks in the system liner resulted in small amounts of water that washed away fine gypsum soils under the system, causing havoc with the system's self regulation. Large volumes of water accumulated under the system, depriving the turf's roots system of irrigation. The problem resulted in large expenditures of staff time to repair the liner and reestablish the turf.

Despite the project's inability to document water savings with the subsurface system, it is interesting to note that overall water usage at the school was no different for the monitored year as compared to the previous year when the system was not in use. Furthermore, in spite of problems experienced with the EPIC system, Alan Paulson, Coordinator III for CCSD Landscaping and Grounds, still feels that the system has merit

for Southern Nevada and will continue working with it at Cox Elementary. He stated he would easily recommend the system to someone who had time to be on site every day and catch problems as they erupt. Jonas Sipaila recommended modifications to the system installation that would counteract the negative effect of gypsum soils. A fuller discussion of problems encountered and suggested solutions is included in the "Recommendations for Future Use" section of this report. The EPIC system has been successfully operated in a number of cities in the arid Southwest and its use in Southern Nevada is advised. Ideally, a second site should be selected in Clark County to demonstrate the system and record what water savings are possible.

Background

Landscape Water Use in the Clark County School District

The Clark County School District manages the most turf-covered properties in Clark County. The School District currently maintains 1500 acres of turf, for a total annual water usage on turf alone of 6,750 acre feet of water. The CCSD is the sixth fastest growing school district in the country with 12 new schools built per year. Elementary schools typically contain 2-2.5 acres of turf, middle schools maintain 3-4 acres of turf and high schools maintain 12-15 acres of turf. All of this adds up to considerable draws on limited water supplies.

Using conventional sprinkler irrigation, it takes an average of 4.5 acre-feet of water per year to maintain one acre of turf. Water savings of 50-80% over traditional sprinkler systems have been documented with the EPIC system. CDSN and the School District were hoping to demonstrate a more conservative 25-30% water savings.

Traditional above ground sprinkler systems lose large quantities of water by evaporation and runoff. Not only is water waste an issue, but damage to water quality from herbicides, pesticides, fertilizers and soil erosion can be a problem.

A recent solution to combat water waste has been the use of artificial turf at school stadiums and play fields. Made out of synthetic materials, artificial turf has been touted as the answer for effective, drought tolerant landscapes. However, artificial turf has its own unique set of problems. Reaching surface temperatures of 170 degrees Fahrenheit, the turf must be cooled down with water prior to use to avoid serious burns. Maintaining a sanitary playing field is another concern with artificial turf. A study published in the journal for *Clinical Infectious Disease,* November 15, 2004 issue, sited a high occurrence of skin infections found among high school students playing football on synthetic turf fields. Of the 100 students tested, 10 were infected with a drug-resistant bacterium called methicillin-resistant *Staphylococcus aureus*. Two of the students suffered from serious infections that required hospitalization. While the use of artificial turf may be recommended for certain situations, it is not the answer to all of Southern Nevada's water conservation needs.

The need for turf on school campuses will always exist. Turf provides safe areas for sports and play activities that are part of every child's school experience. Therefore,

identifying, testing and incorporating sustainable turf irrigation systems are important measures in conserving Southern Nevada's limited water resources

The EPIC System

The EPIC irrigation system was demonstrated on a 2.25-acre activity field at David Cox Elementary School in Henderson, Nevada. The demonstration consisted of two watering systems installed at the site. The field was split into two groups, one installed with a traditional sprinkler system, the other with the new subsurface system. Water use on both fields was monitored for a period of 1.5 years. Initially, monitoring was to be conducted for 6 months but because of leakage problems at the site monitoring was extended over the span of two summers to attempt to demonstrate water savings.

The EPIC irrigation system is a product of Rehbein Environmental Solutions. The irrigation system is based on the surprisingly simple concept of collecting all water and storing it safely below the ground. A blanket of 4x4 foot plastic cells, connected by piping, is installed across the length of the field. This is covered by 10-12 inches of sand with turf laid on top. Pipes supply the plastic cells with a constant reservoir of water. Any runoff water from rain gutters and drains is funneled to this storage reservoir. The picture at left is the EPIC chamber shown with its accompanying pan.

The EPIC system consists of three distinct elements that are combined to work together, namely the liner pan, the EPIC chamber, and the sand fill that covers and surrounds the first two components. The only moving part in the system is water that is controlled by gravity and capillary physics to travel throughout the system in a predetermined order.

The 10-12 inch area between the saturated reservoir and the grass blades serves as a capillary zone, providing an ideal matrix for root growth. A water film is constantly available around the sand grains, with the remaining void space occupied by air (oxygen). Root hairs during the growth phase prefer this environment to initiate water and nutrient absorption, and soil microorganisms prefer this aerobic environment for eventual decomposition of dead organic matter. The idea of watering "upside down" is not a new one. The Hopi Indians utilized dry riverbeds to grow corn, while the roots would draw from the water in aquifers beneath the surface. The movement of water molecules as they rise upward through the sand to the root zone is called capillary rise.

A transition zone exists from the tip of the deepest root in the capillary zone to the top of the highest leaf tip of the growing turf. This zone is the active pumping system within the plant that not only delivers water and nutrients to all plant tissue during the growth phase, but also regulates plant health by adapting turgor pressure and temperature within the leaf

through evaporation. The rate of transpiration is directly proportional to the surface area and growth rate of the plant, the ambient temperature, wind velocity, and humidity in the growing environment. As such, the turf itself determines the water needs for sustained growth and a reliable water irrigation reservoir and capillary zone are available at all times below the ground. The end result is an extremely efficient system of irrigation. Water levels in the saturation chamber are monitored not by a valve, but by a simple float ball like that found in a common toilet. When saturation levels dip and the float lowers, a sensor tells the pipes to open and water rushes into the cells until the float is returned to its normal resting level. As such, no electricity is needed to run control valves. The 700-800 hours of electricity typically spent to irrigate a turf field for one year is saved.

According to Rehbein Environmental Solutions "the inherent problem with well drained sand based turf is that irrigation water applied at the surface just kept going and a high water demand ensued to keep the sand moist for grass to grow. The purpose of the liner pan provided by EPIC is to simply provide a barrier to catch and retain water. Polyethylene and EPDM liners have been successfully used for over 30 years as pond liners and as groundwater protection barriers in hazardous waste dumps," (www.rehbeinsolutions.com).

A number of successful irrigation projects have been documented by Rehbein Environmental Solutions and can be found at http://www.rehbeinsolutions.com/news/white_papers.html.

Results

Both the traditionally irrigated field and field irrigated by the EPIC system were monitored daily for 1.5 years by an electromechanical flow monitor. Contrary to our intent, the monitoring revealed that the EPIC system used more water than the standard irrigation system. Two factors were believed to have contributed significantly to the poor results. The first was attributed to the learning curve of CCSD maintenance staff as they figured out how to use the system. Initially, staff treated the subsurface field like a traditional sprinkler system in effect flooding the turf. There were times early in the project when over-watering resulted in a soggy field. EPIC designer Jonas Sipaila advised staff on how to better manage the system and this problem was overcome.

The more serious problem that created the largest water waste was undetected leaks in the liner. The liner itself is constructed of highly durable polyethylene and should be able to withstand normal wear and tear nicely. Unfortunately, a fall carnival was held at the elementary school and, unbeknownst to maintenance staff, trucks were driven on the field and tent spikes were hammered into the ground. It is believed that this trauma perforated the liners and lead to leakage. Even with such small leaks, a stable soil base would have been able to absorb the water. The site has a base of gypsum soil, which unbeknownst to the school district or product manufacturer, presented new problems to the system. As water leaked from the liner, water pooled underneath one of the water pans and melted away the gypsum soil forming a cavern. With the soil washed away, the water pan sunk lower. Because the system operates similar to the floating mechanism on a toilet bulb,

sensors read this lower seating as a decrease in water and continued to pump water into the pan resulting in a constant bathtub of water underneath the system. Because landscape maintenance staff is on site only one day per week, the problem went unnoticed for a longer than normal period of time and the leaks were not identified until the turf began to suffer. The pictures below show the heavily gypsum soils and turf damage because of the leaks.

Despite using more water than needed during the summer of 2006, water use on the field averaged normal for previous July-August months. Because even with a leak, the subsurface system did not use more water than the standard sprinkler system we hoped that we could document water savings and received permission from the Bureau of Reclamation to continue monitoring for an additional year. CDSN and the CCSD continued working with the system and the CCSD continued experiencing leakage problems and increased maintenance costs. At the end of the project monitoring, overall water use at the school was about the same as in previous years when both fields were

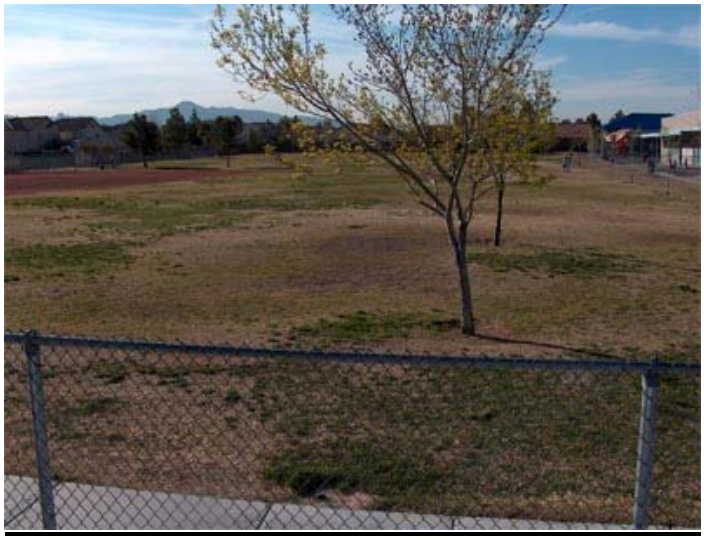
watered with the sprinkler system. We would like to infer from this measurement that the EPIC system was indeed saving water when functioning properly, but are not able to make this claim as fact.

The School District will continue to maintain the EPIC system at David Cox Elementary. When the system is functioning properly, the turf appears healthier and children play almost exclusively on that side of the field. Trees along the EPIC field also appear healthier than along the control side. Alan Paulson stated that he likes and still does believe in the science behind the system. He would easily recommend the system to someone who had time to be on site everyday and catch any problems as they erupt. Time devoted to regular maintenance is key.

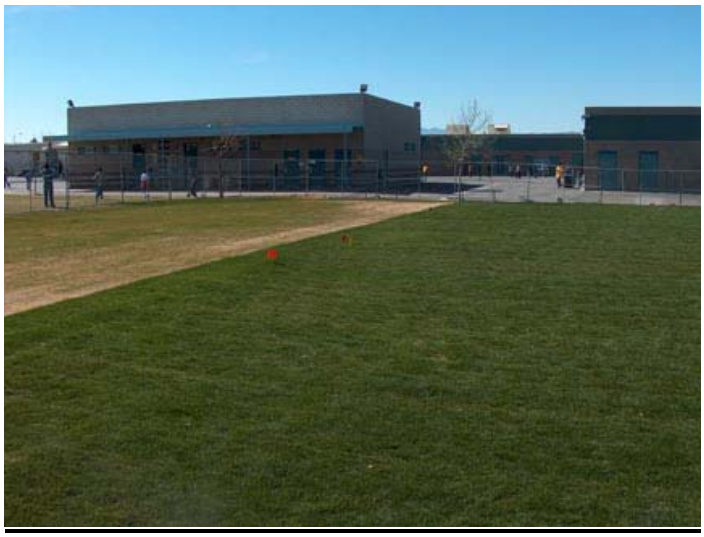
As hindsight is always 20/20, the chart below details the problems encountered with the EPIC system and suggests remedies for those problems. Beneath the chat are a series of photographs documenting installation of the system at Cox Elementary.

Problems Encountered With the EPIC System	Suggested Solutions
Human error resulting in poor management and over-irrigation.	In speaking with Alan Paulson from the CCSD and EPIC designer Jonas Sipaila, it is clear that good maintenance is key to the system's success. Persons responsible for maintaining the system must understand upfront that the EPIC system does not operate like a traditional sprinkler system. Much of the problems encountered early on were caused by staff, resulting in over-watering and mucky turf. Once these problems were remedied, constant maintenance was necessary to catch leaks before they posed the magnitude of problems they did. Overburdened CCSD staff was only onsite 1-2 times per week, which was clearly not often enough. Jonas also mentioned the importance of professional installation. CCSD staff installed the system themselves. Jonas feared that the lack of experience and specific equipment needed to prepare the site might have helped cause some of the leakage problems. For example, a mainline runs through the site. The liner was placed over the mainline, and Jonas felt that two liners should have been used, each one running up to and abutting the mainline to avoid friction.
Gypsum soil base.	The gypsum problem was one never before encountered with the EPIC system. Upon learning of the problem Jonas suggested that it could be avoided by depositing a clay base beneath the liner, which would absorb any water leaks before they reached the gypsum soil.

Tears in the liner.	In retrospect, small tears in the liner were attributed to two causes. Alan believes that a number of tears resulted from improper activities conducted on the field during a school festival, namely driving on the field and hammering tent stakes into the field. The stakes likely passed through the sand and punctured the liner. Jonas also attributed some of the leakage due to placement of the liner over a mainline that ran through the field.



The field prior to installation



Recommendations for Future Use

Both CDSN and the CCSD see merit in the EPIC system. It has a strong track record at numerous other sites, where they have documented water savings 50-80% higher than traditional sprinkler systems. Such water savings would obviously be a huge benefit here in Southern Nevada. Below is a series of photos submitted by Jonas Silaipas, which document a successful EPIC installation in Folsom, CA. The photos track installation of the system through growth of a seed-started turf field. The system obviously works and ideally, we would like to see this system demonstrated successfully in Clark County.