List of measures WMI recommended during an irrigation audit in Southern Nevada:

1) **Remove existing non-functional turf grass areas and install xeriscape plantings with a drip or subsurface irrigation distribution system.**

   The drip irrigation system proposed often includes subsurface irrigation and is watered based upon actual weather or soil moisture conditions.

2) **Change existing nozzles in gear driven rotors to ensure matched precipitation rates are achieved in each irrigation zone.**

   When maintenance workers replace a broken or malfunctioning rotor they most often choose a gear driven rotor with a factory installed nozzle. As a result the precipitation rates in the zones are not matched, and the Distribution Uniformity (DU) is well below the acceptable industry standard of 75%. Auditing all of the rotors in a system and correcting the nozzles is one of the most effective water saving measures one could implement. It will improve the DU significantly and as per IA Irrigation Association) guidelines when DU's are low the runtimes need to be increased to make up for the under watered areas. One of the main reasons for the turf vitality looking poor is due to the lower than industry standard DU values.

3) **Replace existing spray heads and nozzles with MP-Rotator nozzles with 40 PSI pressure regulation spray bodies.**

   The MP Rotator's multi – trajectory, revolving streams apply water much more slowly and uniformly than conventional sprays. Independent audits have shown that water usage can be reduced by up to nearly one-third of current levels than what conventional sprays are replaced with MP Rotator sprinklers. Additional water saving advantages includes better wind-resistance, less misting, and the ability to handle reclaimed water. The application rate is approximately 1.5 to 2.5 inches per hour. Because soils are very compacted in most areas, run off of water starts to occur within 5 to 10 minutes after cycle starts. The rotating nozzle applies water at a rate of .5 inches per hour and works more effectively at lower pressures, resulting in increased distribution uniformity. Also the narrow streams of water are much more wind resistant. The MP-Rotator nozzle works more effectively at lower pressures than a gear driven rotor and the distribution uniformity improves if spaced appropriately.

4) Install Check Valve Rotors and Spray Heads in areas of noted low head drainage.

There are several areas that are on slopes and hillsides that have quite a bit of low head drainage. Check valve rotors and spray heads installed in these areas would prevent this continuous drainage of pipes and water loss.

5) Irrigation Central Controller Programming

The irrigation central control system requires initial programming input from the irrigation manager then continued monitoring to ensure all zones are operating properly. What was identified in the field was not what was programmed in the central control systems software. Several stations were not programmed to operate at the central computer location, but had a valve and heads at the site controller location. In these cases it's challenging to manage the water because some of the fields are extremely saturated and others are really dry, or not getting any water at all. The water manager informs the maintenance man the system operated at his site, but he doesn't know the site controller has 12 stations and the programming only has 11 stations in use, unless the irrigation tech alerts him to this fact. Water Management tested the distribution uniformity and the precipitation rates of several fields and determined the programming in the central control system did not match the actual field conditions at the site.

6) Retro-Fit existing stand alone irrigation controllers to central control system.

Upgrading these controllers to a weather based clock would be beneficial to water conservation. When it gets really hot outside it is simply a response of most people to add two or three different start times and increase the irrigation time dramatically to zones. In the spray zones of several of the schools the precipitation rates were close to 1.5 inches per hour and some of these zones are running for 30 minutes three times a day. So they are applying more water than needed for an irrigation cycle and a majority of the water becomes run-off.

7) Install digital hydro-meter which combines flow sensing, pressure regulation, and master control valve.

Globe HydroMeter

In order to evaluate the effectiveness of the outdoor water conservation measures, it is imperative to determine the amount of water consumed through each irrigation point of connection. Most of the irrigation systems do not have an effective water meter or flow sensor to accurately read and record the water consumption for the system. WMI recommends installing a hydro-meter on each irrigation point of connection which will allow the irrigation manager the ability to measure the water consumption at each site as well as regulate the pressure to the desired amount, and shut down the system if a catastrophic break occurs. Hydrometers provide superior hydraulic performance and reliable flow measuring. A single unit-combination of water meter and hydraulic valve saves space and installation costs.

8) Replace broken and old Agrifim emitters with Salco emitters in xeriscape planting zones.

During the audit process it was noted at least one emitter or several emitters were broken on each of the xeriscape landscape irrigation zones. WMI witnessed cracked or broken emitters flowing at a rate of 2 to 8 gallons per minute per cycle. If these zones were repaired or retrofitted, water savings would be achieved.

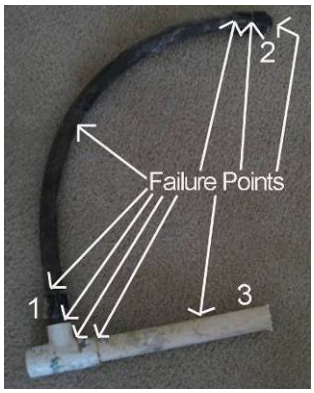
9) Cap all emitters not irrigating specific plants.

There are several thousands of emitters in the thirty schools that needed to be capped due to the plants dying soon after installation because of overwatering, under watering or the valve being turned off due to a break and never turned back on again. All of the emitters can be capped and water savings will be achieved.

10) Install hand held remote on all clocks that are remote capable.

The Irrigation managers and Rovers typically would not notice a broken emitter or head because a fence or large plant prevents them from witnessing the break due to the distance away from the control unit. If the irrigation technician had a hand held remote control device, this would allow him/her to inspect the zone at the distribution area and determine the actual flow, pressure and distribution uniformity. The remote would allow the technician to immediately identify breaks, inefficiencies, and poor distribution uniformities.

11) Install subsurface irrigation systems in existing xeriscape planting areas.



In some of the xeric zones most of the plant material has died due to the existing irrigation distribution systems ineffective watering. It would be cost effective in the short run if the emitters were capped. However under the current system the emitters that have been capped begin to leak at a number of potential failure points seen at the right. A cap is put on at #2 in the picture and then over time #1 connection area begins to leak or over the winter time #3 gets cracked because trucks drive over the grounds and the next season CCSD has a broken lateral to fix. Installing subsurface irrigation in these areas would be a better alternative to the existing set up. In some of the popup spray zones with high precipitation rates, and for zones with high slopes areas where a lot of runoff happens, sub surface irrigation is an efficient alternative.

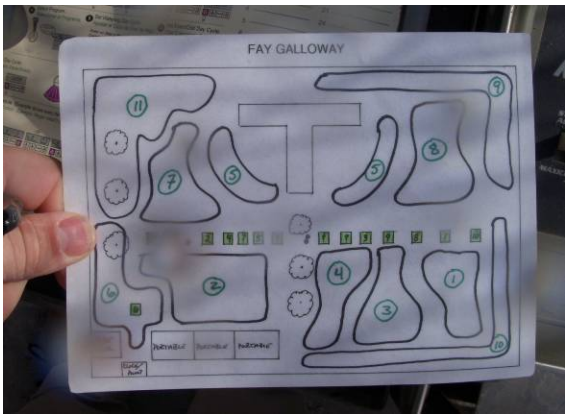
12) Install subsurface irrigation system in functional turf grass area.

Subsurface irrigation involves the application of water to plants or turf via pipes with emitters and installed totally underground. This process has several features which provide significant benefits over conventional above ground irrigation. Recent Advances in the subsurface industry suggest that sports fields can be irrigated using less than 3/8" of water per week in Southern Nevada whereas the conventional over head rotor system will require upwards of 1.5" of water per week. The subsurface system is designed to supply water directly to the root zone at a rate that suits the soil type. Applying the water to the root zone forces the roots to go deeper creating a healthier drought tolerant plant. WMI is installing this new technology (KISSS) on ½ of the sports field (soccer) at Sierra Vista High School and within the next few months will report our findings.

Damage to Laughlin High School track due to hard water buildup from over spray by irrigation system would also be eliminated. The cost of replacing the track is expensive and would be eliminated. In the photo it shows the track in Laughlin being sprayed and the past staining of irrigation water.

13) Aerial mapping of all zones per clock and associate records for easy field checking.

When a new irrigation technician tries to remember the location of all the irrigation zones, without updated as-builds, they tend not to be familiar with the areas of coverage. If accurate GPS mapping of the heads and zones are provided to them in electronic format, it will allow them to become familiar with their system. This would prevent the water loss due to unfamiliarity with the system.



14) Install or exchange existing pumping system to appropriate pressure and flow rates.

The water pressure at some of the schools is too low for the irrigation system to operate efficiently and a booster pump will be required to ensure adequate water pressure. In several schools it was determined that the pump was sized to provide a higher than required pressure which contributes to excessive water loss due to vaporization and excessive flow. Making sure these pumps are matched to the hydraulic calculation is vital to ensuring the proper pressure and flow per the original design intent. Having a pump that is too large can also cause the system to have too low a pressure. The pump pulls water from the mainline faster than it is provided and this causes the pressure problems to occur elsewhere in the system but also causes the pump to cavitate and the pump propellers to wear out prematurely.

15) Plant trees around the perimeter of the field with associated subsurface irrigation system and put in slats on all field fences where possible to further prevent water loss due to wind drift and evaporation.

A parameter not usually looked at but one that is noted and an important one to review is wind and it's affect on water loss. The lowest wind speed normally happens at 8 am in the morning. All large rotors if possible would perform better if re - sequenced to irrigate at the end of the irrigation cycle to have them run at the time of historically lowest wind speed. Several studies have been conducted to determine water loss from wind drift and evaporation.

On some of the baseball fields, slats have been installed in the chain link fence. This enhancement makes the irrigation systems perform better with less wind distortion and water loss. Slats need to be installed on all field fences where possible.

The elementary school and high school in Laughlin, NV need the baseball slats and trees/ shrubs screens to stop some of the continuous wind. Water is lost in the irrigation system as a result of evaporation and wind drift. The water loss is high in these locations. Installing several layers of trees as well as more oleander bushes with associated subsurface irrigation would be beneficial to conserving water.

16) Removal of Plants which require extensive labor to repair irrigation systems.

A shrub planted in the landscape known by common name Centennial Broom grows quickly and makes a branching pattern close to the ground creating a difficult situation for repairing broken irrigation systems below the plant. The shrub is small when installed in the landscape but after only a short time a few of these shrubs grow together and create one large dense mass planting. Broken emitters can leak for several months without any detection. Future landscape specification for school landscapes should prohibit plants that are hard for the irrigation technicians to repair the irrigation system.

Common Name	Centennial Broom	Desert Carpet or Prostrate Acacia
Amount of Water Needed	Low	Low
Planting Exposure	Full Sun	Full Sun
Rate of Growth	Fast	Moderate
Season of Bloom	Winter/ Spring	Spring
Type of Plant	Shrubs	Groundcovers
Foliage Type	Evergreen	Evergreen
Bloom Color	White	Yellow
Foliage Color	Green	Green-Gray
Mature Height in Feet	3	1 to 6
Mature Width in Feet	5	10 to 15
Family	Asteraceae	Fabaceae
Genus	Baccharis	Acacia
Species	X Centennial	redolens

Prostrate Acacia

Centennial Broom

This Centennial Broom shrub creates additional work for the irrigation technicians, time to remove the plant to get to the broken irrigation component. In a number of situations, this problem has occurred and the repair is not done due to time constraints.

An alternative plant to use would be the Desert Carpet or Prostrate Acacia, which has a larger footprint at maturity but a less dense branching pattern and is easier to repair broken irrigation components. In the 30 schools, 28 Centennial Broom dense shrubberies were found with broken irrigation components beneath and a virtually impossible way to get at the break and fix it. WMI estimates a total of 500,000 gallons of water is lost per year due to broken components beneath these shrubs that goes undetected. The system could be modified to subsurface where it would have less chance of breaking.

17) Maintenance contract for control irrigation system water management.

Our project managers are field trained to provide contract administration services to ensure the installation of the irrigation system meets the intent of the design documents.

Our irrigation management services can allow for the irrigation system to be monitored and adjusted remotely from our main office. We provide direct connection to the irrigation control unit from a phone or ethernet communication line and observe and report on the operating condition of the system. Our managers can troubleshoot fault conditions, and make adjustments per actual soil moisture or weather conditions.
A performance based solution contract could be established so if water consumption is not maintained below a specified threshold, agreed upon by all parties then WMI will pay for the shortfall.