Village of Key Biscayne
Village Green Renovation
Agronomy Report by
Dr. Phil Busey, CCA, CPAg[1]

December 27, 2015[2]

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On December 9, 13, and 27, I observed conditions at Village Green fields, with emphasis on the bare area (Fig. 1) in the west central part of the north field, took photographs, and measured soil moisture. Present conditions and reassessment are that fields are fundamentally dry, sandy, young, and unstable. Fields are currently closed and recovering from traffic that caused deterioration as well as the recovery of the bare area that appears to be irrigation related. Bermudagrass may be trying to break through the original sod and soil layer and slicing has temporarily lessened the luxuriance, with the intention of improving rooting, so fields looked worse on December 27 than on December 9.

1. **Soil moisture varies due to the expected effect of irregular irrigation coverage.**
   A Spectrum FieldScout TDR 300 Soil Moisture Meter (Fig. 2) was used to measure volumetric soil moisture in the north field, using 4.8-inch rods, georeferenced with a Garmin GPS 72H, across a diagonal transect from a sprinkler head in the northwest to a sprinkler head in the southeast that span the bare area in the west central part of the north field. Paired values at 2-foot spacing were averaged, and values presented as a moving average of three adjacent pairs. A second transect was measured in a north-south transect across the entire north field (Fig. 3).

   The variation of soil moisture across the diagonal transect across the bare area (Fig. 4) shows that there is more water available nearest the sprinkler heads and there is a dip in coverage near the bare area in the center, but the driest area is offset southeast of the center. The offset is probably due to the effects of wind direction. While this observation does not prove irrigation non-uniformity caused the bare area, and does not prove that other factors such as soil are not involved, it is convincing evidence that this area is too dry and is consistent with the problem of inadequate low pressure at the heads due to using the wrong (too large) nozzle size, in combination with added heads on the same zone, that cover where the gazebo was located.

   The variation of soil moisture in the south-to-north transect across the north field (Fig. 5) shows that there is way too much water available in the south side of the field where there is a zone of half-circle sprinkler heads that should be set to one half the run time to adjust for the double overlap. So if full-circle zones are set for 24 minutes, half-circle zones should be set for 12 minutes. There is also a small potential for runoff in this area, and there is the shade of mahogany trees that may be involved. Regardless, this area is too wet due to not adjusting irrigation run times, and also there is weed activity due to too much irrigation.

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[1] Certified Crop Adviser and Certified Professional Agronomist and member of Brookside Society of Professional Consultants. Information in this report is a guidance and general recommendation, and is not supervisory.
[2] Report prepared December 28, 2015.

2. **General observations.**
On December 27, 2015, the condition of the Celebration bermudagrass in both the north and south field, planted between July 27, 2015 and August 1, 2015, was weakened due to slicing (Fig. 6) which was done to provide beneficial deep rooting.

In the north field, except for the deterioration due to play in the northeast corner (Fig. 7), Celebration bermudagrass was showing improvement since November 21, 2015, although it was in worse condition than it had been on December 9, 2015. There was continued movement of stolons into the bare areas and emergence of sprigs from burial. The south field continued to show severe effects of excessive wear in the northeast quadrant.

Rectangular strips of the four-foot width of the original sod rolls continued to show strong definition in color, especially in the south field (Fig. 8), probably due to variations in original sod thickness or condition. Sod had been planted in the southwest corner of the north field (Fig. 9) to repair equipment malfunction but had not rooted. There was some overseeded ryegrass in the shade area at the south end of the north field.

While the results of slicing have worsened the verdure that was seen on December 9, 2015 (Fig. 10) it should ultimately be beneficial.

3. **Recommendations.**

(a) There is sufficient regrowth of sprigs and stolons that bermudagrass recovery is occurring and full recovery is possible. However, play must still be restricted in these young, unstable fields or else wear deterioration will increase as weather is cool and bermudagrass is growing slowly. Slicing, to encourage deeper rooting, has set the fields back and they are temporarily more unstable, so play must not be intense.

(b) Rolling should be done to compact the top layer and improve stability.

(c) Slicing and other cultural practices should be suspended until warm weather in March.

(d) Bare areas should continue to be fertilized by hand with Milorganite (Fig. 11).

(e) When play resumes, there should be regular rotation of intense play areas so that the grass is not allowed to get worn out. Probably a three-week recovery time is appropriate, however, grass must never be allowed to be so worn that bare soil shows.

(f) While there may have been some progress in correcting the bad irrigation distribution, soil moisture measurements show that there is variation in soil moisture that is consistent with bad irrigation and bare areas. Nozzle sizes were too large and apparently caused excessive friction loss, high loss of dynamic pressure (when sprinklers are running), low pressure at the nozzles, and poor coverage.

(g) The only meaningful irrigation pressure measurement must be done at the sprinkler nozzles when irrigation head is running. Any other measurement will not capture the effect of friction loss which is the main reason that irrigation coverage is poor.

Fig. 1. Bare area in the west central part of Village Green north field, looking south, December 27, 2015, which is in the center of four sprinkler heads on zones 17 and 18 that provided only 35 psi pressure which is inadequate based on the minimum 50 psi required for these heads.

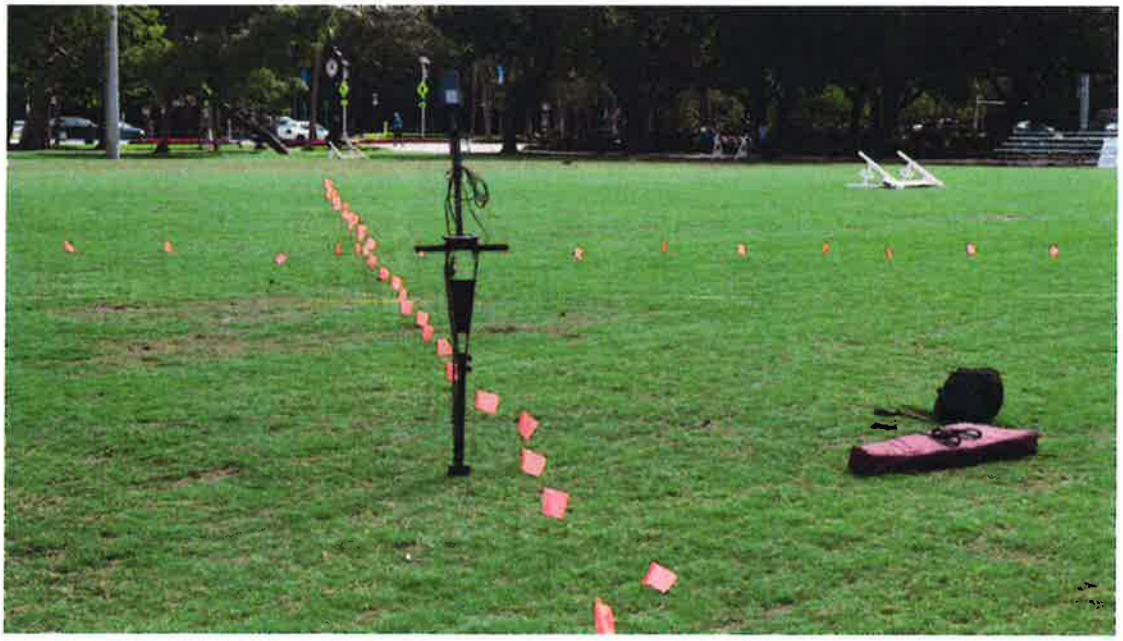


Fig. 2. Bare area in the west central part of Village Green north field, looking southeast, December 27, 2015, showing that it is in the exact criss-cross center of diagonal transects from surrounding sprinkler heads

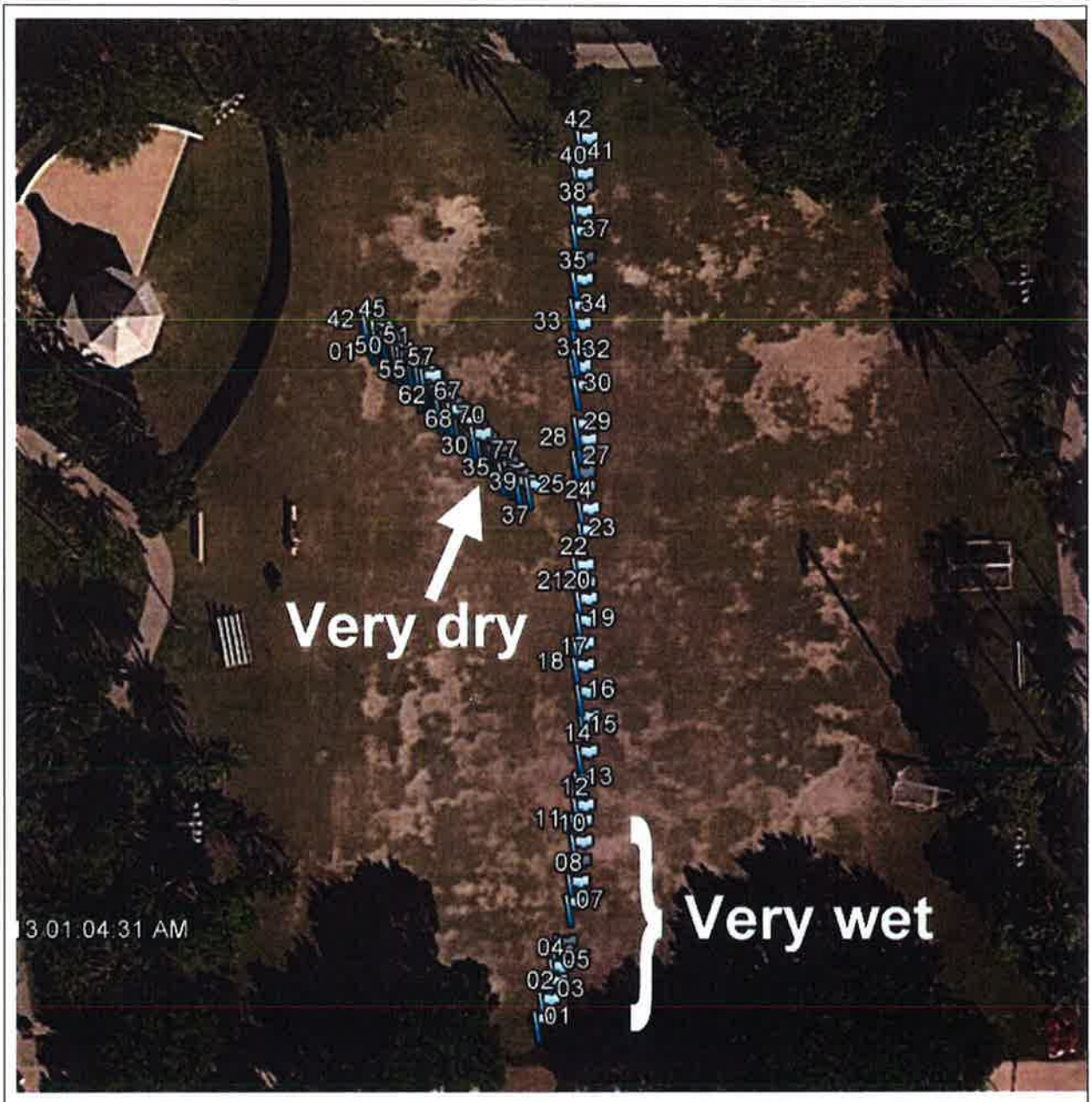


Fig. 3. Village Green north field with north at the top showing diagonal and south-north soil moisture transects layered on Google Earth imager from 2013. The diagonal soil moisture transect in the west central area of the north field spans the bare area. The "Very dry" area is placed based on soil moisture measurements and is slightly southeast of the bare area, probably due to wind direction. The surrounding heads in zones 18 and 19 had been measured with pressure around 35 psi, below the minimum required for the heads and nozzle sizes. The south-north transect across the entire field is labeled with a "Very wet" area in the south where there is excessive irrigation due to half-circle heads that need to have their run times reduced to adjust for double coverage from half-circle coverages.

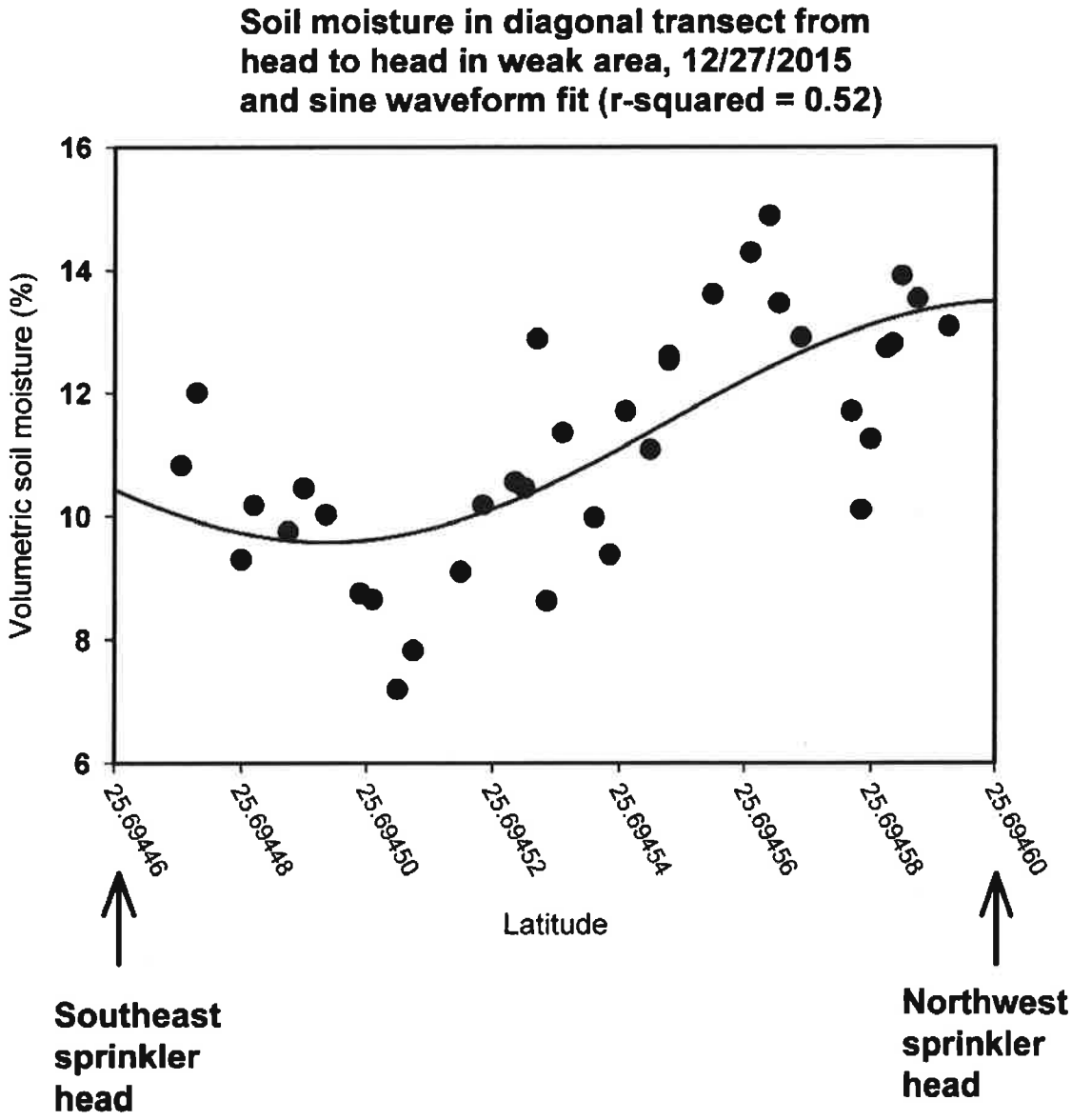


Fig. 4. Variation in volumetric soil moisture in Village Green north field in the diagonal transect from the southeast sprinkler head to the northwest sprinkler head spanning the bare area, moving means of 6 paired values, the irrigation measurements at paired locations 2 feet away from the nearest pair. There is a dry area nearer the southeast corner of the coverage area between four sprinkler heads, near the bare area.

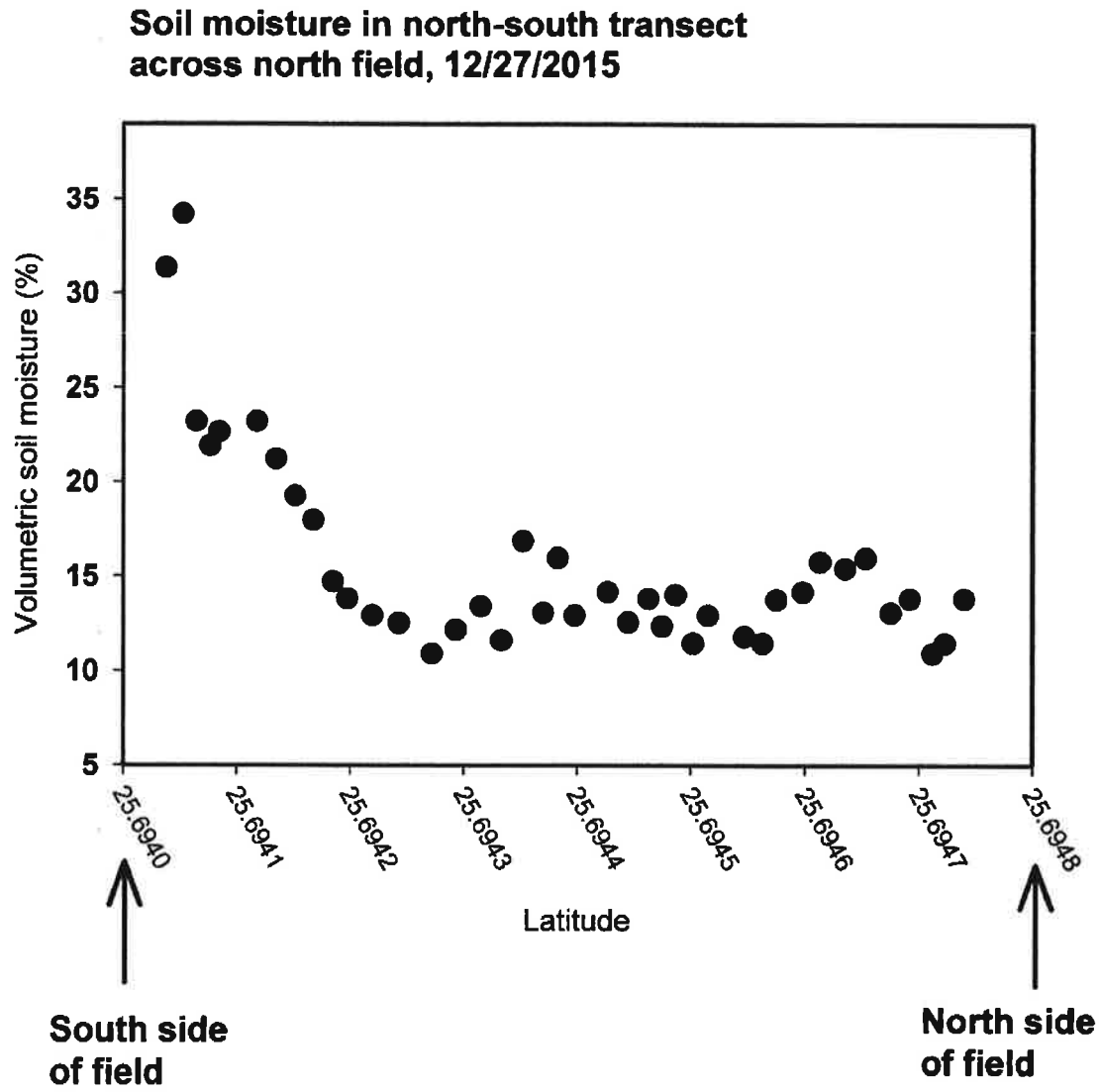


Fig. 5. Variation in volumetric soil moisture in Village Green north field in the south-north transect from the south side of the field to the north side of the field, individual measurements at about a 10-foot interval. The values shown are the moving means of three adjacent measurements. The very wet area on the left is due to using half-circle heads on the south side of the north field and failing to reduce irrigation run times to adjust for double coverage.

Fig. 6. December 27, 2015. Village Green north field, looking north, showing rills caused by slicing machine to help deep rooting of sod.

Fig. 7. December 27, 2015. Village Green north field, northeast quadrant looking south, showing worn area which had been used for intensive soccer practice.

Fig 8. December 27, 2015. Village Green south field, near south goal post,looking north by west, showing rills caused by slicing machine and four-foot-wide strips of different sod density.

Fig 9. December 27, 2015. Village Green north field, southwest corner, looking south, showing new sod installed to repair area caused by equipment malfunction, that has not adequately rooted.

Fig. 10. December 9, 2015. Village Green south field, looking south, showing luxuriant foliage prior to slicing.

Fig. 11. December 9, 2015, Village Green north field showing stolon growth in bare area which was fertilized by hand with Milorganite.

Irrigation Design Group

Mr. Todd Hofferberth, Director
Parks and Recreation Department
Village of Key Biscayne
10 Village Green Way
Key Biscayne, Florida 33149

Reference: Village of Key Biscayne – Irrigation Management Proposal

Dear Mr. Hofferberth:

Attached, please find a narrative with an accompanying cost estimate to provide the Village of Key Biscayne with a comprehensive proposal for the operation and management of the Village Green Park irrigation system. We have crafted a solution that meets the needs of your objectives, while making the implementation uncomplicated and affordable.

Our approach to management is straightforward:

- Listen to your objectives and desired outcomes
- Understand the physical construction of the irrigation system
- Document how the system is currently being operated and managed
- Coordinate with the person(s) responsible for the parks turf management and customize the water application, as required, to provide cohesive system management and achieve optimum performance throughout the year. With the benefit of evapotranspiration and the acquisition of daily site rainfall, regularly adjust station runtimes to achieve Management Allowed Depletion (MAD) the best method to achieve a Soil - Plant - Water balance.
- Suspend irrigation application so as not to conflict with any planned community activities.

Successful water management considers all the stakeholders in its formulation and makes every effort to address their individual needs. Precision water application coupled with heightened water management best practices will place the right amount of water, in the right place at a specific time, throughout the year. Improved scheduling will eliminate dry areas, reduce disease and create a more aesthetically appealing look to the park. Efficient water application will reduce consumption, increase fertilization effectiveness and guarantee optimum landscape performance. System oversight and real-time diagnostics will provide a layer of independent verification that the system is being properly maintained by the current service provider, at the correct interval, while identifying any system related failures within hours from the time that it occurs.

Our service will provide the maximum in flexibility, water conservation, system oversight though automated diagnostics and achieve the goal of efficient irrigation system management.

We believe that in equipping the park with this technology, the leadership of the Village of Key Biscayne will have gone a long way in effectively overseeing its water distribution system and establish that it is environmentally responsible in the sustainable management of its resources well into the future.

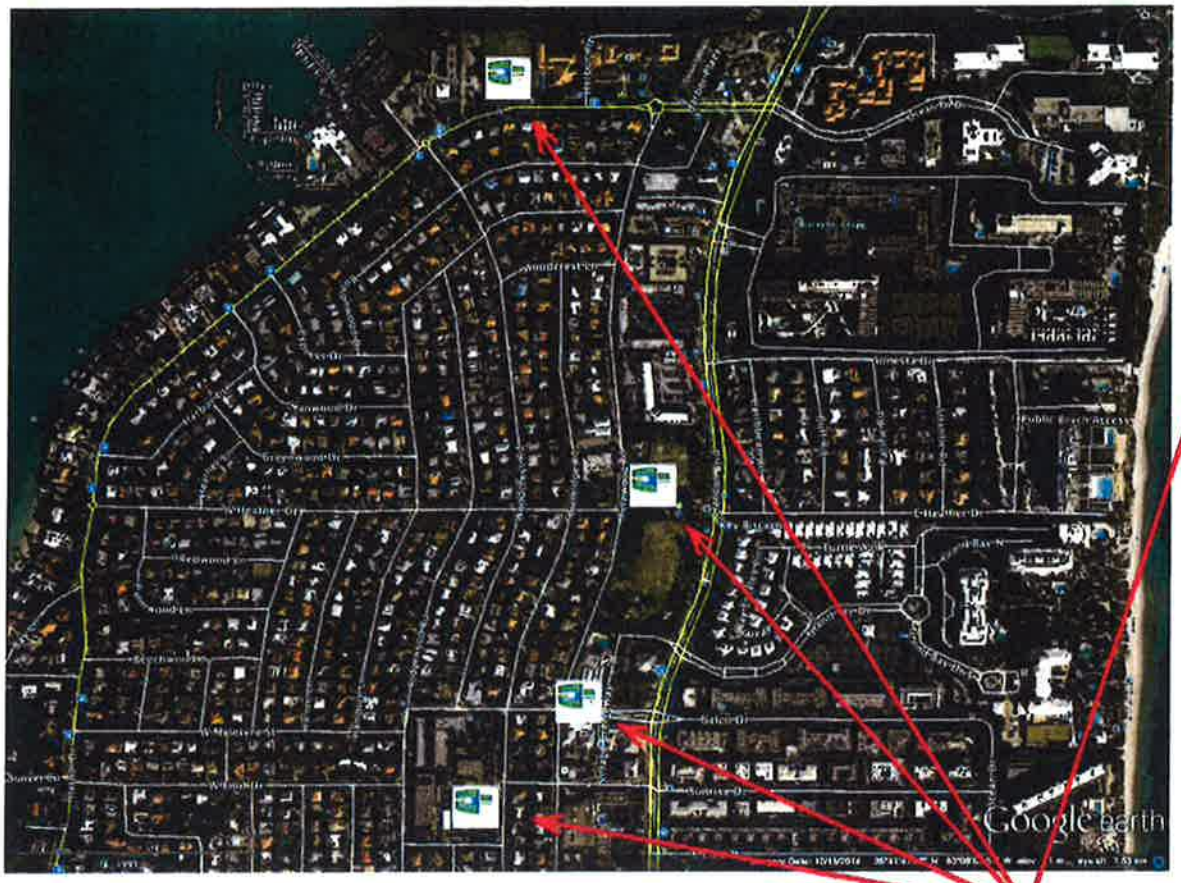
Respectfully Submitted,

Michael Perkins
Michael Perkins, CID, CLIA


Revolutionize Irrigation Management
iQ
Total System Management From our Desktop to Your Site
Remote Data Acquisition
Information Management
24 Hour a Day Monitoring

Irrigation Design Group

Irrigation System Management



- Central Control Systems make irrigation management a simple, accurate and labor efficient task
- You will achieve superior water management with precision system control & accurate water application
- Enjoy thriving landscapes, lower water use, faster response to schedule changes & streamline service implementation
- Have unprecedented system information knowing what happens at all times improving operation & service response
- Experience unparalleled coordination and complete integration between landscape, pest control, fertilization and property management.

By employing "smart irrigation technology" Irrigation Design Group offers a comprehensive irrigation management approach that delivers precise control and oversight over each site.

Benefits of Central Control

Irrigation Design Group offers a comprehensive irrigation management solution that delivers a positive return on investment through consistent system operation, water savings and improved landscape performance.

This Results in... Precise remote control of the irrigation system, watering based on the changing needs of the landscape, reduced run-off, healthier turf with a potential water savings of 20 to 45 percent.

- ✓ Irrigation Design Group will monitor the system 24/7 from our office
- ✓ Create water efficient schedules to maximize system performance
- ✓ Respond to any abnormal event automatically anytime day or night
- ✓ Provide verification that system maintenance is occurring
- ✓ Provide technical support to Service Provider to keep the system running

The Benefits

■ **Water Savings** – Through advanced climate based scheduling, our management will reduce system operation by 20% - 45% per year.

■ **Reduced Operation Costs** – System runs less so equipment lasts longer. Eliminates costly unscheduled service calls.

■ **Maximum Versatility** – Programmed to conform to needs of site conditions including wet areas, sunny dryer areas, varying sprinkler efficiency.

■ **Healthier Landscape** – Ensures the landscape receives the right amount of water, stretches fertilizer performance, reduces fungus and other diseases, increases root depth, develops more drought tolerant landscape.

■ **Precise Operation** – Precision daytime water of specific areas when needed, water high traffic areas during off hours to not interfere with people, schedule in advance for system shutdown of planned events or holidays.

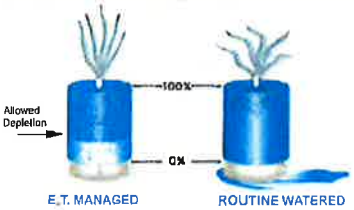
■ **Proactive Management** – System documents the day, time and duration the controller is operated manually, verifying maintenance is occurring. Monitors water flow & takes action to prevent washouts or flooding in the event of pipeline failures or stuck valves.

CENTRAL CONTROL

Basis of Operation
Water Management



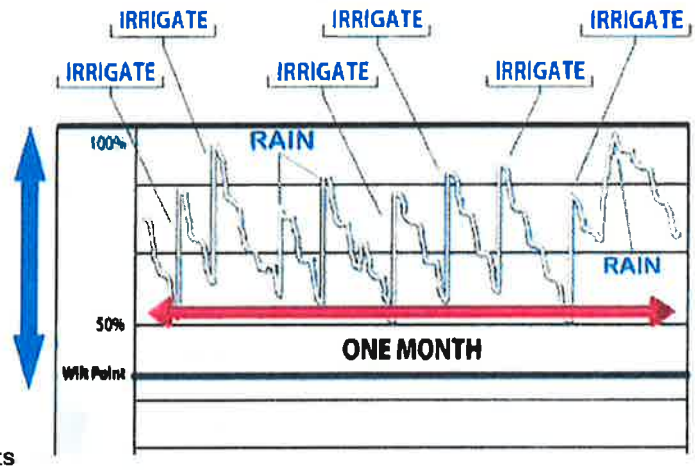
- The foundation of water management employs watering based on actual daily need verses a routine schedule. This means the sprinklers water only when the water in the soil requires it.
- IDG understands the relationship between soil and water and based on the daily loss from evapotranspiration (ET), calculates when the soil is ready to be replenished and then turns the sprinklers on.
- Conversely, routine schedule watering always waters the same time, the same day, week after week & does not take into consideration ET, site rainfall, soil or the landscapes actual daily need, which varies seasonally.



MONTHLY SUMMARY:

With Central Control - Water 6 times

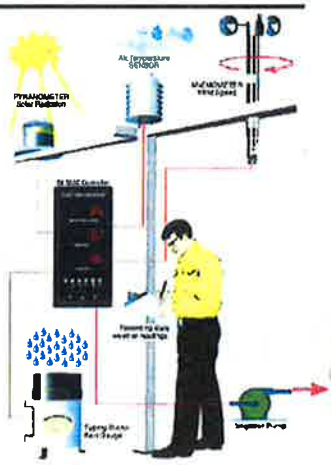
Without - Water 13 times



The example to the left illustrates in graphic form, what watering based entirely on the actual need of the landscape looks like.

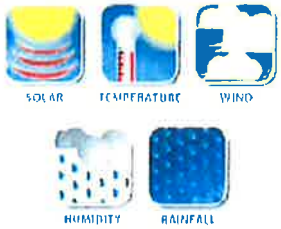
Only when the water in the root zone reaches the red line will the system turn on. If rainfall re-charges the soil, the system waits for the landscape to consume that water and drop to the red line before it turns sprinklers on.

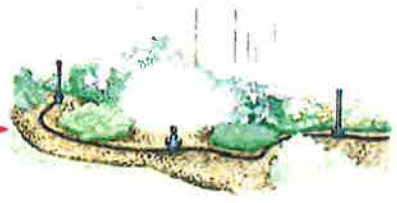
Local Weather Station



- Weather plays the ultimate role in the determination of water delivery to the soil and plant material.
- The weather factors that influence ET are Sunlight (solar radiation), Wind, Temperature, Humidity, and Rainfall.
- The system contacts a local weather station each day and downloads the actual daily ET, then calculates how much water to apply to the landscape.

Factors that affect ET



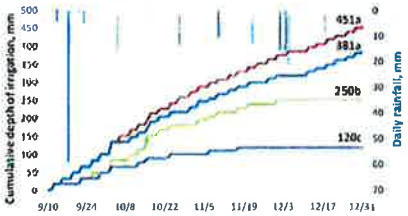


Basis of Operation Water Management

How A Climate Based Central Control System Works

Weather Station

ET Calculation Based on Weather



Daily ET Rate Sent to Central

Central Control Computer

Based on the Daily ET Rate, station run times of each zone are adjusted and sent to the controller(s)

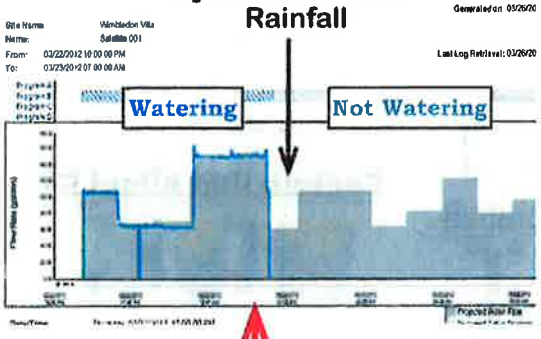
The controller runs the sprinklers and re-charges the root zone

System activity is reported back to the Water Manager. Manager knows exactly what ran, the time and length it ran and any system alarms or shutdowns that occurred. Manager facilities service, if required.

Water Manager

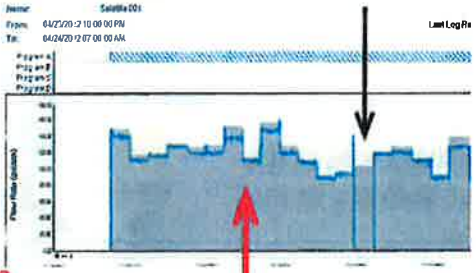
Flow Log Graph

System Shutdown Rainfall

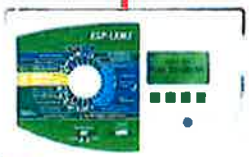


Flow Log Graph

Station Shutdown Excessive Flow



Rain Shutdown



Controller reacts immediately to equipment failure

Rainfall occurs at the project. Controller stops and will not start again until the landscape uses all of the rain water.

Rainfall Reported to Controller as it occurs

Central Control Project Management

How Irrigation Design Group Manages a Project

Geographic Map of Every Controller is Created
(If Mapping Option is Selected)

Satellite and Site Configuration Report

Site Name: Cap Juluca Resort

Name: Satellite B - West Controller (Recreation)

Description:

Controller Model:	Rain Bird - IQ Satellite	Water Supply Type:	Re-claimed Municipal Water
Controller Type:	Conventional 24 v/ac	Water Meter Size:	4" Sensus
Max Flow:	250.00 gal/min	Control Valve:	4" Dorot Pressure Regulating
Total Stations:	48	Static Range:	70 - 100 psi
Doublers:	Yes	Configuration:	Pressurized Main Line

Station Configuration

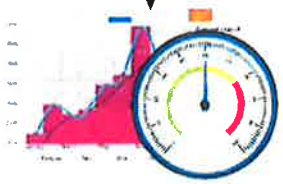
Notes

Module 1 - 12-Station Module					
#	Station Name	Flow Rate	Pressure	Valve Model	Zone Type
1	Station 001	151.40	48	Irritrol	Rotor
2	Station 002	148.20	55	Rain Bird	Spray
3	Station 003	145.10	42	Rain Bird	Mixed
4	Station 004	99.60	51	Hunter	Spray
5	Station 005	147.90	50	Rain Bird	Spray
6	Station 006	153.20	49	Rain Bird	Spray
7	Station 007	143.70	53	Irritrol	Spray
8	Station 008	108.80	52	Rain Bird	Mixed
9	Station 009	132.70	48	Rain Bird	Mixed
10	Station 010	145.40	49	Irritrol	Rotor
11	Station 011	131.40	53	Rain Bird	Spray
12	Station 012	155.00	54	Hunter	Spray

Comprehensive Site Database is Developed

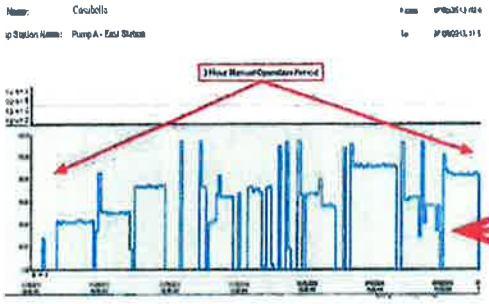
Key site personnel are kept abreast of all site activity & are alerted to system problems as they occur, including unauthorized tampering. Special schedule requests are immediately transmitted to the controller. Sprinklers can be turned on for anyone over the phone while they are at the site.

IDG manages site remotely with precision system control



Flow of each zone is measured and used for comparison to actual flow that is recorded as the system runs

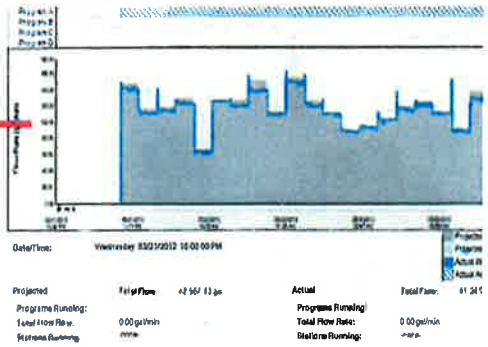
Maintenance Flow Log Graph



IDG reports any service related issues within 24 hours of occurrence. Shuts down station or entire system when required. Maintenance graphs are monitored to verify that maintenance is occurring as per the service agreement.

Facilitates maintenance

Flow Log Graph



Previous nights operation is checked each day and any issues are reported

Central Control Project Management



VILLAGE GREEN PARK
Pump Station Controller

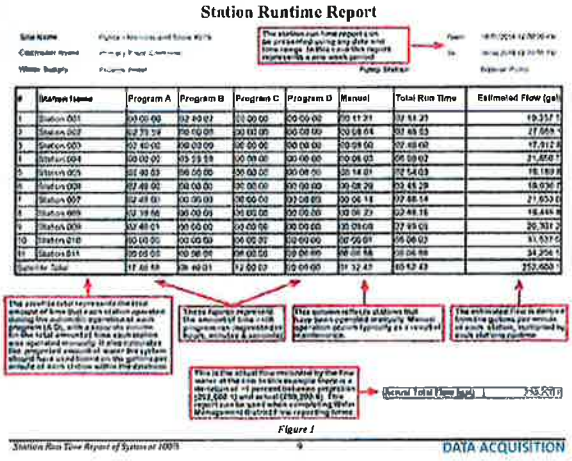
The controller at the park execute its programs, specific to the area it is intended to irrigate, utilizing the Hoover pump station the controller is connected to.

Sprinkler System Pump

The flow meter records the actual flow entering the system

System Flow Sensors

The Rain Bird IQ control system records the total time of every program that runs, the total time each station was operated manually and the total amount of water delivered to the system in a given period of time.


Station Runtime Report

Refer to Figure #1 on Following Page

Station Runtime Report

Site Name: Publix - Marco Island Store #275

Controller Name: Primary Plaza Controller

Water Supply: Potable Water

The station run time report can be presented using any date and time range. In this case this report represents a 7 day period.

From: 08/01/2014 12:00:00 PM

To: 08/08/2014 12:00:00 PM

Pump Station: Booster Pump

#	Station Name	Program A	Program B	Program C	Program D	Manual	Total Run Time	Estimated Flow (gal)
1	Station 001	00:00:00	02:40:02	00:00:00	00:00:00	00:11:21	02:51:23	19,357.5
2	Station 002	02:39:59	00:00:00	00:00:00	00:00:00	00:08:04	02:48:03	27,058.1
3	Station 003	02:40:00	00:00:00	00:00:00	00:00:00	00:08:00	02:48:00	17,912.8
4	Station 004	00:00:00	05:59:59	00:00:00	00:00:00	00:08:03	06:08:02	21,850.7
5	Station 005	02:40:02	00:00:00	00:00:00	00:00:00	00:14:01	02:54:03	19,189.8
6	Station 006	02:40:00	00:00:00	00:00:00	00:00:00	00:08:29	02:48:29	18,036.7
7	Station 007	02:40:00	00:00:00	00:00:00	00:00:00	00:06:14	02:46:14	21,653.0
8	Station 008	02:39:56	00:00:00	00:00:00	00:00:00	00:06:23	02:46:19	19,446.8
9	Station 009	02:40:01	00:00:00	00:00:00	00:00:00	00:09:08	02:49:09	20,301.2
10	Station 010	00:00:00	00:00:00	06:00:02	00:00:00	00:06:01	06:06:03	33,537.0
11	Station 011	00:00:00	00:00:00	06:00:00	00:00:00	00:06:58	06:06:58	34,256.5
Satellite Total		17:40:58	08:40:01	12:00:02	00:00:00	01:32:42	40:52:43	252,600.1

The satellite total represents the following:

- The total amount of time that each station operated during the automatic operation of each of the four programs (A-D)
- The total amount of time each station was operated manually.
- The projected amount of water the system "should" have used based on the gallons per minute of each station within the database.

These four columns represent the amount of time each program ran (A-D) (expressed in hours, minutes & seconds)

This column reflects the amount of time the stations that have been operated manually. Manual operation occurs typically as a result of maintenance to the system or when IDG operates the system remotely to verify operation.

The estimated flow is derived from the gallons per minute of each station in the database, multiplied by each stations runtime. This is what IQ expected the system will use based on run time.

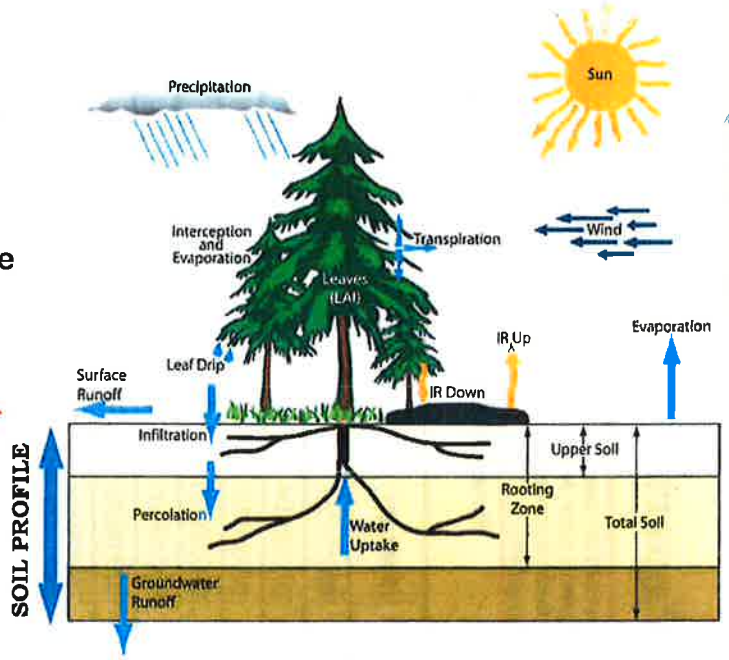
This is the actual flow recorded by the flow meter at the site. In this example there is a deviation of ~1 percent between projection (252,600.1) and actual (250,200.6). This report can be used when completing Water Management District Flow reporting forms.

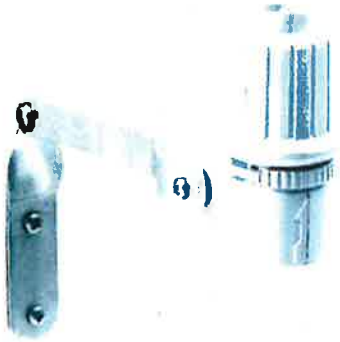
Actual Total Flow (gal)	250,200.6

Figure 1

How Irrigation Design Group Manages Rainfall

Rainfall is characterized by its amount, intensity and total distribution over time. It is important to consider that not all rainfall will be used by the landscape. As a result, some of the water is lost to surface run-off and some will percolate deep beneath the surface (ground runoff), out of the reach of the root zone. Only the water that remains within the root zone will benefit the landscape and is referred to as effective rainfall.





Each controller must be equipped with one of these devices, which are only relied upon for immediate rainfall shutdown.

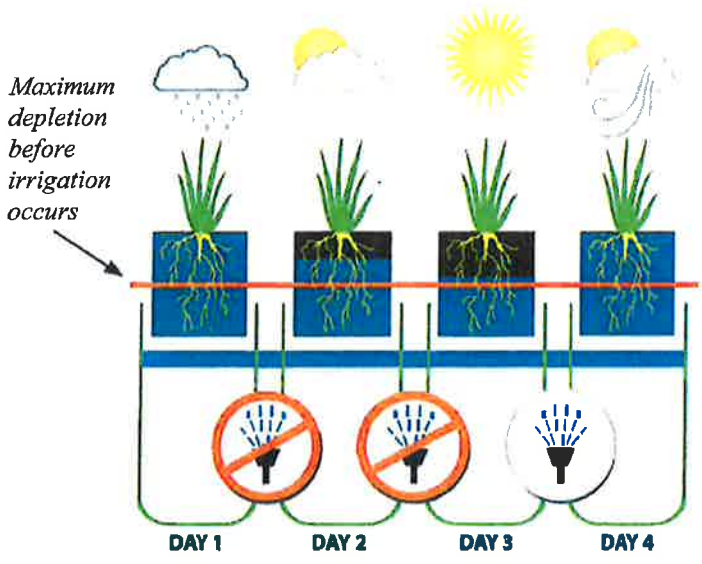
The typical rain shutoff device is not a precision instrument but rather a simple switch designed to immediately suspend watering during rain periods. Simple rain sensors cannot perform any of the calculations required to determine effective rainfall and therefore are not precise in their ability to manage soil moisture content.

IDG shall install one independent site rain station (with a single soil moisture probe) at a central location on the property. The electronic rain collector will measure the exact amount of rainfall that occurs within each 24 hour period. The soil sensor will measure volumetric water content by percent. Our management includes the calculation of effective rainfall and the corresponding delay of irrigation.

Example of Actual Site Rainfall Calendar
September - 2014

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1 0.59 in/d Site Rainfall	2 No Irrigation Required	3 No Irrigation Required	4	5	6 0.47 in/d Site Rainfall
7 0.19 in/d Site Rainfall	8 1.79 in/d Site Rainfall	9 1.51 in/d Site Rainfall	10 No Irrigation Required	11 No Irrigation Required	12 1.34 in/d Site Rainfall	13 No Irrigation Required
14 No Irrigation Required	15 No Irrigation Required	16 No Irrigation Required	17 0.32 in/d Site Rainfall	18 0.76 in/d Site Rainfall	19 0.97 in/d Site Rainfall	20 0.28 in/d Site Rainfall
21 No Irrigation Required	22 0.41 in/d Site Rainfall	23 0.03 in/d Site Rainfall	24 No Irrigation Required	25 0.44 in/d Site Rainfall	26 0.18 in/d Site Rainfall	27 1.12 in/d Site Rainfall
28 0.31 in/d Site Rainfall	29 0.05 in/d Site Rainfall	30 No Irrigation Required				

In viewing the rainfall activity that occurred at this site for the month of September, you can see that a significant amount of rainfall occurred throughout the month. Our management service includes the daily monitoring of accumulated rainfall and the suspension of irrigation based on actual site precipitation. In this example, the system would have only operated for 2 of the 30 days. This cannot be accomplished with a simple rain shutoff device.



When the system is equipped with an IDG Rain Station, accurate site rainfall and soil moisture content is recorded and transmitted to our weather management computer 24 hours a day. In the rainfall example above, the soil is continually recharged before it reaches maximum depletion and therefore, the system would be shutdown for almost the entire month. In utilizing this valuable resource, IDG is able to provide a significant reduction in water consumption. Our management will save millions of gallons of water a year while reducing the accumulated ware and tare on the irrigation equipment, which in turn will extend its service life.

Central Control Cost Analysis



Cost of Installation of Hardware and Site Configuration

	Perform initial site setup of the controller (includes configuration of pump station, verification of rain shutoff, develop detailed database of site parameters and zone configuration, configure controller and verify correct communication).	$ 500.00
	Provide and install a more accurate rain shut off device (switch provided by the Village).	$ 85.00
	Retrofit existing Rain Bird ESP-LXME controller at the park to be flow sensor capable wiring the existing Rain Bird 350B flow sensor into the new flow module (provided by the Village). Calibrate, test and configure controller.	$ 961.00
	Provide and install one IDG Site Rain Collection Station to record hourly rainfall. Remains property of IDG (requires high voltage electrical connection and monthly cellular fee as listed below). Valued at $2,961.87.	$ N/C
	Install one GPRS modem (provided by the Village) in the controller and configure the cellular communication enabling communication between central computer and field equipment Rain Bird provided cellular service (IDG provides loaner modem N/C when needed).	$ N/C
	Inspect every zone and develop a detailed colored Zone Map. This service is optional and can be substituted using the as-built irrigation plan. It is used to quickly identify specific areas on the site and correlate that area to a station number on the controller.	$ 1,247.00

Cost of Monitoring and Management of the Project's Irrigation System

	Monitoring & System Management 24 hours a day 7 days a week. Provide unlimited communication/support with persons responsible for park management and the current irrigation service provider.	$ 190.00/Month*
	Cellular Fee to communicate to Site Rain Collection Station.	$ 20.00/Month

** requires a 3 year contract*