



Keesen Water Management
Design ~ Consultation ~ Evaluations



Irrigation System Evaluation Report for Conservatory Metropolitan District

September 9, 2013

PROJECT DESCRIPTION

The Conservatory Metropolitan District is located along South Conservatory Parkway, South Jericho Way, and the North side of Hampden Avenue in Aurora, Colorado. This site is primarily streetscape and common landscaped areas that are irrigated. This irrigation system was installed in 2003 & 2004 with the first full season of irrigation in 2005.

SCOPE OF INVESTIGATION

The purpose of the irrigation system investigation was to evaluate the design, installation, and overall performance of the irrigation system for the Conservatory Metropolitan District during July and August 2013. Every water tap, irrigation controller and zone with heads were operated and reviewed for the existing irrigation system. I have reviewed the irrigation plans, water invoices, information provided by Summit Services Inc., and data provided by Dick Dailey.

IRRIGATION SYSTEM WATER SUPPLY

CONSERVATORY WATER TAPS

ACCT.#	SIZE	ADDRESS	TAP#	ORIGINAL DESIGN PSI	06/11/13 TAP PSI
141760	3"	2384 S CONSERVATORY PKWY	8	69	110
140594	2"	2886 S CONSERVATORY PKWY	6	69	94
142878	2"	3156 S KIRK WAY at DOANE PL.	5	70	108
142838	3"	3232 S CONSERVATORY PKWY	4	65	115
138382	3"	21208 E HAMPDEN AVE	3	56	54
141434	3/4"	20655 E GIRARD PL	11	74	60
138832	3/4"	20297 E DOANE DR	10	77	69

Connections include shutoff valves, manual drain valves, and reduced pressure backflow preventers. Current static pressure at the source is listed above at the downstream side of the backflow preventer.

EXISTING IRRIGATION EQUIPMENT

Mainlines and Electric Zone Control Valves: Mainline from the backflow preventer to the zone control valves are 3", 4" & 6" PVC pipe except in tract "NN" which is 1¼".

The zone control valves are Rain Bird plastic 24-volt electrically actuated valves installed in molded plastic valve boxes. Some valves tend to be slow closing which results in two zones on at the same time for a minute or so.

Irrigation Controllers: 14 controllers manage the system for this site. Controllers are Rain Bird models ESP-40 SAT, ESP-32 SAT, ESP-12 SAT and ESP-24 MC with Rain Bird ET Managers. All controllers have metal locking cabinets. These controllers are in good condition.

Pop-up Spray Heads: Heads have an 8' to 15' radius and a 4-inch pop-up height. Most heads were installed too low, resulting in blockage of spray and poor coverage resulting in dry areas and wasted water. Some heads are tilted, resulting in uneven and poor coverage. Heads are Rain Bird 1804 series with plastic nozzles. Pop-up spray heads do not have pressure control or check valves as specified in the original drawings.

Rotary Heads: Rotor heads are Hunter I-20 & I-25 gear drive type heads. Many heads were installed to low and/or tilted resulting in poor coverage.

Drip Irrigation: Up until June 25, 2013 the drip system was not operating because the controller wasn't programmed for any watering days. Management was notified and the drip is now operating.

Best management practices for Landscape Irrigation System:

- The ideal operating pressure for pop-up spray heads is 30 psi +/- 10% at the head, and 40 to 60 psi for rotor heads. Spray head pressure for this site varied from 32 PSI to **87 PSI**. Rotor head pressure varied from **20 PSI** to over **100 PSI**. Site elevation changes and lack of pressure control are the primary reason for pressure variations. Pressures in **red** are below or above manufacturers recommended operating pressure.
- When water pressure at the sprinkler head is either too high or too low, both water pressure situations cause a distortion of the spray pattern resulting in poor uniformity of coverage. When water exits the nozzle of the irrigation head it explodes into droplets of water. Low operating pressure causes the water to explode into larger droplets, which produces soil compaction and also reduces the effective radius of coverage. High water pressure results in small droplets that drift away and a reduced radius of coverage.
- Low head drainage occurs after each cycle, creating puddles in some areas and water hammer in lateral lines when zones are turned on, resulting in reduced life expectancy of the system. Check valves prevent this problem.
- Efficiency rates vary for different types of heads. Typical efficiency for spray heads is 60%. Rotor heads are usually 75% and the newer rotator heads at 85%. With a weekly turf water

requirement of 1-inch and an efficiency of 60%, a head would have to apply 1.67- inches of water and a rotor head at 75% efficiency would have to apply 1.33-inches of water. Likewise the rotator head with pressure control would require 1.18-inches applied for a 1-inch water requirement.

Conservatory Tap #3 located at 21208 E HAMPDEN AVE

Tap #3 has a 3" water tap and meter; 3" Reduced Pressure Backflow Preventer with a protective metal enclosure and a repaired and now functioning booster pump. The original static pressure when the system was designed in 2002 was 55 PSI. The water pressure as of June 2013 was 54 PSI. This area requires a booster pump. The peak flow demand as designed is 160 gpm.

Tap #3 has one Rain Bird model ESP-40 SAT controller with 40 stations used and marked as controller "F", one Rain Bird model ESP-40 SAT controller with 39 stations used and marked as controller "C", and one Rain Bird model ESP-32 SAT controller with 30 stations used and marked as controller "D". Controller "F" covers the area from E. Greenwood Pl. South to E. Hampden Ave. and West to the Aurora Green Belt just past the booster pump. Controller "D" covers the area from Aurora Green Belt West along E. Hampden Ave. and past Killarney Ct. to controller "C", all along the North side of Hampden Ave. Controller "C" covers the area west of controller "C" to S. Jericho Way along north side of E. Hampden Ave. and then north on S. Jericho Way to E. Girard Dr.

Controller "F"

Operating pressure ranged from 36 PSI to 68 PSI.

NOTE: All listed "F" controller/valve numbers (i. e. F3) are as listed on the irrigation plans.

F1 Find or install two missing heads along curb.

F2a Heads in planting bed not operating.

F4 Add a full circle spray head in area at northeast end of zone.

F10 Find or install missing head along curb west of control valve.

F12b Change 4" popups to 12" in planting bed. May need to add heads for better coverage.

F21 Zone wouldn't operate. Check for operation.

F25a Four heads at the north end of zone are watering dirt. Consider capping these heads.

F25b Repair leak in planting bed.

F35 Remove juniper branches overhanging rotor head at west end of zone.

F37 & F38 These stations have time on both A & B programs. Delete the time from program B.

Rotor heads at top of slope need to run longer then heads in middle of slope and heads at bottom of slope should run the least amount of time.

Controller "D"

Operating pressure ranged from 42 PSI to 72 PSI.

D7 Repair leak at quarter head at S.E. corner of flower bed on east side of Killarney Ct..

D7 The spray from several heads is blocked by flowers and other plants. Move heads to prevent blockage.

D7 Control valve needs repair to improve closure time.

D15 Straighten badly tilted head along walk.

Controller "C"

Operating pressure ranged from 45 PSI to 84 PSI.

C3 Slow closing valve.

C5 & C6 These two stations may be operating the same zone. Please check.

C9 Broken head along curb at the south end of zone and on the east side of S. Jericho Way.

C28 Missing rotor head along E. Hampden Ave. & west of S. Jericho Way on south side of walk/2nd head from west end.

C28 Broken head on same zone just east of head listed above.

Conservatory Tap #4 located at 3232 S CONSERVATORY PKWY

Tap #4 has a 3" water tap and meter; 3" Reduced Pressure Backflow Preventer with a protective metal enclosure and a nonfunctioning booster pump. The original static pressure when the system was designed in 2002 was 65 PSI. The water pressure as of June 2013 was 115 PSI. This area no longer requires a booster pump and the pump could be removed. The peak flow demand as designed is 160 gpm.

Tap #4 has one Rain Bird model ESP-40 SAT controller with 28 stations used and marked as controller "G" and one Rain Bird model ESP-40 SAT controller with 25 stations used and marked as controller "H". Controller "G" covers the area from E. Eastman Ave. south to E. Greenwood Pl. on the west side of S. Conservatory Pkwy. Controller "H" covers the area from E. Eastman Ave. to E. Hampden Ave. on the east side of S. Conservatory Pkwy.

Controller "G"

Operating pressure ranged from 32 PSI to over 100 PSI.

Zone:

G3 Change half nozzle to a quarter nozzle at southwest corner of zone.

G7 Plants are growing over several heads (blocking spray) and should be cut back to allow head to spray properly.

G15 Refer to plan sheet "Conservatory I-3.pdf" and change the arc on three heads in the center of the area to 270 degrees. This should diminish some of the dry areas.

Controller "H"

Operating pressure ranged from 34 PSI to 95 PSI.

Zone:

H1 Turfgrass and planting bed are on the same zone. Result is overwatering the planting bed.

H2 Clean clogged head north of wall.

H13 Rotor head blown off lateral.

Plants are growing over several heads (blocking spray).

Conservatory Tap #5 located at 3156 KIRK WAY (Actual tap location is on CONSERVATORY & DOANE PL.)

Tap #5 has a 2" water tap and meter; 2" Reduced Pressure Backflow Preventer without a protective metal enclosure; and a nonfunctioning booster pump. The original static pressure when the system was designed in 2002 was 70 PSI. The water pressure as of June 2013 was 108 PSI. The peak flow demand as designed is 80 gpm. This area no longer requires a booster pump and the pump could be removed.

Tap #5 has one Rain Bird model ESP-40 SAT controller with 40 stations used and marked as controller "K" and one Rain Bird ESP-24 MC controller with 9 stations used and marked as controller "K1". These controllers cover the area from E. Dartmouth Drive to S. Jericho Way on S.

Conservatory Pkwy and then south on S. Jericho to E. Dartmouth Drive on both sides of S. Jericho Way.

Operating pressure ranged from 36 PSI to 63 PSI.

Controller "K"

Leak was found at the base of backflow preventer where someone tried to remove it. Install a protective metal backflow preventer enclosure to help prevent theft.

Controller "K1"

Zone:

K 1-3 Repair leak under 12" popup by property line.

Conservatory Tap #6 located at 2886 S CONSERVATORY PKWY

Tap #6 has a 2" water tap and meter; 2" Reduced Pressure Backflow Preventer with a protective metal enclosure; and a nonfunctioning booster pump. The original static pressure when the system was designed in 2002 was 69 PSI. The water pressure as of June 2013 was 94 PSI.

This 2" water tap doesn't have the capacity to run both controllers simultaneously at flows up to 100 gpm. The peak flow demand as designed is 80 gpm. One solution is to sequence zones on both controllers so that no more than 80 gpm is required at any time when controllers operate simultaneously. Controller "L" has 10 zones requiring more than 40 gpm and controller "M" has 8 zones. Controller "L" has 31 spray and rotor zones and Controller "M" has 25 spray and rotor zones. The other solution would be to repair the existing booster pump which will allow both controllers to operate simultaneously.

Tap #6 has one Rain Bird model ESP-40 SAT controller with 36 stations used and marked as controller "L" and one Rain Bird model ESP-40 SAT controller with 31 stations used and marked as controller "M". Controller "L" covers the area from S. Lisbon Way South to E. Dartmouth Dr. on the East side of S. Conservatory Pkwy. Controller "M" covers the area from S. Ireland Way to E. Columbia Pl. on the West side of S. Conservatory Pkwy.

Controller "L"

Operating pressure ranged from 57 PSI to 84 PSI.

Zone:

L18 Slow closing valve.

L25 Slow closing valve.

L32 & L33 Both stations on the controller are wired to the same valve. Please check.

L34 Slow closing valve.

L35 Slow closing valve. Controller run time shows 5 minutes & should be 20 minutes for rotors.

L36 Controller run time shows 7 minutes & should be 20 minutes for rotors.

Controller "M"

Operating pressure ranged from 50 PSI to 94 PSI.

Zone:

M2 Slow closing valve. Junipers are growing over several heads (blocking spray) and should be cut back to edge of turf. One head has turf growing over it and not operating.

M14 Slow closing valve.

Conservatory Tap #8 located at 2384 S CONSERVATORY PKWY

Tap #8 has a 3" water tap and meter; 3" Reduced Pressure Backflow Preventer with a protective metal enclosure; and a nonfunctioning booster pump. The original static pressure when the system was designed in 2002 was 69 PSI. The water pressure as of June 2013 was 110 PSI. This area no longer requires a booster pump and the pump could be removed. The peak flow demand as designed is 160 gpm.

Tap #8 has one Rain Bird model ESP-40 SAT controller with 36 stations used and marked as controller "O" and one Rain Bird ESP-24 MC controller with 24 stations used and marked as controller "O1". These controllers cover the area from north end of site to E. LaSalle Place on the north and east of S. Conservatory Pkwy., and on the south and west side of conservatory Pkwy. to S. Lisbon Way.

Controller "O"

Operating pressure ranged from 40 PSI to 104 PSI.

Zone:

O7 Clean plugged spray head nozzle.

Conservatory Tap #10 located at 20297 E DOANE DR

Tap #10 has a 3/4" water tap and meter; 3/4" Reduced Pressure Backflow Preventer without a protective metal enclosure; and no booster pump. The original static pressure when the system was designed in 2002 was 77 PSI. The water pressure as of June 2013 was 69 PSI. The peak flow demand as designed is 15 gpm.

Tap #10 has one Rain Bird model ESP-12 SAT controller with 4 stations used and marked as controller "U". This controller covers the area from E. Dartmouth Dr. to E. Doane Dr. on Tract NN.

Conservatory Tap #11 located at 20655 E GIRARD PL

Tap #11 has a 3/4" water tap and meter; 3/4" Reduced Pressure Backflow Preventer without a protective metal enclosure; and no booster pump. The original static pressure when the system was designed in 2002 was 74 PSI. The water pressure as of June 2013 was 60 PSI.

Tap #11 has one Rain Bird model ESP-12 SAT controller with 4 stations used and marked as controller "V". This controller covers the area from E. Hamilton Ave. and E. Girard Dr. on Tracts VV & WW.

The 20 to 24 psi operating pressure is too low for operating I-20 rotor heads. Pressure loss through 3/4" tap, service, meter and backflow preventer is the result of inadequate water pressure. The irrigation mainline has a continuous slow leak at an unknown location.

RECOMMENDATIONS for Tap #11:

The pressure loss in this tap is very high and can't support the use of I-20 rotor heads. Most of the pressure loss is in the backflow preventer and "K" copper water service lines. Install a small booster pump to increase the water pressure by 50 to 60 psi.

SYSTEM WATER CONSUMPTION:

Irrigation water consumption data based on meter readings for 2012 indicates a total annual irrigation usage of 23,966,000 gallons (73.5 acre feet). With a 15 percent allowance for drip irrigation, usage for turf is 19,173 or 40.6 inches per square foot. The Water use is up 22% over 2011. The annual water budget for this site should be 12,280,000 gallons or 26 inches per square foot plus 4,793,000 gallons for drip irrigation.

Turf water requirements for this type of streetscape and common areas should not exceed 22" on an annual basis. Irrigation system efficiencies should be between 75% and 85%. With an 80% efficiency annual consumption should not exceed 26.4". Improved system operation and upgrades to the irrigation equipment and repairs will help reduce irrigation water consumption by as much as 36% (6,893,000 gallons) or \$44,668.00 per year at 2013 budgeted water use rate.

RECOMMENDATIONS:

Popup Spray Heads:

1. Remove foliage that's growing over the heads (from planting beds) and blocking the spray pattern.
2. Adjust arcs and radii of coverage to some heads that overspray on streets, structures, native grass, etc.
3. The popup spray heads appear to have been installed below the turf level when the sod was installed. Some heads are tilted resulting in poor uniformity of coverage and dry areas.
4. The original plans specified that an integral part of the heads include pressure control (at 30 PSI) and check valves (to prevent low head drainage). High water pressure ranging from 40 to over 100 PSI occurs on most heads (see **Background Information** on page two). None of the spray heads have these features.
5. Replace all 4-inch popup heads (in turf areas) with Hunter PROS-04-PRS30-CV-MP2000 Series rotator heads. This type of head has the highest efficiency rate at approximately 85 %. Heads should be installed 1/8" below the flattened turf and compact the soil around the head to maintain stability. The cost to replace approximately 4,678 popup spray heads with MP rotator heads @ \$20.00 per head for a total of \$93,560.00. Investing in the head replacement project will bring the highest rate of return in terms of water savings.

RECOMMENDATIONS:

Rotor Heads:

1. The breakup and or adjusting pin that reduces the radius should not be inserted into the water stream (per manufacturer's recommendation for optimum coverage) unless the radius must be reduced to prevent overspray on streets or private property. Adjust these heads as necessary.
2. Many heads were installed too low resulting in grass blocking the spray pattern. A few heads are tilted resulting in poor uniformity of coverage and dry areas. Raise these heads and plum heads that are tilted. Heads should be installed 1/8" below the flattened turf and compact the soil around the head to maintain stability.
3. Adjust arcs and radius of coverage to rotor heads (not heads bordering areas) to the arc as indicated on plans or to water dry areas behind the heads. Example: a 180° arc is changed to a 270° arc.

4. When this work is completed, it will result in the 2nd highest rate of return in terms of water savings. It's difficult to quantify this type of work. It would be best if this effort could be done on a time and materials basis.

RECOMMENDATIONS:

ET Manager:

Rain Bird ET Manager is installed at every controller. ET Manager works to automatically control watering. This device retrieves information from local weather stations. The information is broadcast via a paging radio frequency to the ET Manager. The ET Manager requires a monthly fee to use the service.

Weather stations are site specific. The weather station location may be miles from your site. If you get rain and the weather station doesn't, then the irrigation system will run based on offsite weather station data. I would look at having a mini weather station on site or at each controller to gain better results and eliminate a potential monthly bill if using the ET Manager.

RECOMMENDATIONS:

Maintenance:

1. I recommend operational checks once every two weeks or half the site one week and the other half the following week.
2. Have the controller remote connection repaired for controllers "F" & "K".
3. Sequence zones at the controller according to the order listed on irrigation plans to improve system checks and location of zones.
4. Use the remote when checking the system to save time and allow for minor adjustments and testing.
5. These maintenance recommendations are necessary for proper system maintenance.

At present, the irrigation system is wasting water due to low and tilted heads, low head drainage, and some leakage. Significant water and maintenance savings, plus a better-looking property can result if the above recommendations are implemented.

Disclaimer of cost estimates:

Cost estimates are very difficult to define do to the nature of the work. These estimates are based on my best guess and on past experience. Keesen Water Management, Inc. cannot be held responsible if the estimates are not accurate.

Keesen Water Management, Inc.



Larry Keesen, CID, CLIM, CLIA
President

WATER USE & SITE PHOTOGRAPHS

Keesen Water Management, Inc.
Conservatory Metropolitan District

Water Use Analysis:

9/6/2013

*Figures are in thousand gallons

METER LOCATION:	Entire Site, All Meters			
METER SIZE:	3/4", 2" & 3"			
YEAR:	2010	2011	2012	Average
TOTAL USE	23,526	19,715	23,966	22,402
LESS DRIP IRRIG: 15%	4705	3943	4793	4480
TOTAL TURF WATER USE:	18,821	15,772	19,173	17,922
AREA IN SQ. FT.: 757,633				
Acres: 17.39				
ANNUAL INCHES/SQ.FT.	39.85	33.39	40.60	37.95
TURF WATER REQUIREMENT*:	26.00	26.00	26.00	
EXCESS USE/INCHES	13.85	7.39	14.60	11.95
EXCESS USE/M GALLONS	6541	3492	6893	
POTENTIAL SAVINGS @: \$ 6.48			\$44,668	
POTENTIAL SAVINGS @: \$ 7.13			\$49,149	

***TURF WATER REQUIREMENTS ARE DEPENDENT
ON IMPLANTATION OF RECOMMENDED UPGRADES
AND IMPROVED SYSTEM EFFICIENCY.**

TAPS #5/CONT. "K" & #8/CONT. "O" ARE BASED ON MY SQ. FT. TAKEOFFS FROM THE PLANS AND INCLUDE WALKS WHERE TURF IS ON BOTH SIDES OF WALK

CONTROLLER "K"				
METER LOCATION: Tap #5 / 3156 KIRK WAY				
METER SIZE:	2"			
YEAR:	2010	2011	2012	Average
TOTAL USE	2,132	2,123	2,455	2,237
LESS DRIP IRRIG: 15%	320	318	368	
TOTALTURF WATER USE:	1,812	1,805	2,087	1,901
AREA IN SQ. FT.: 94,319				
Acres: 2.17				
ANNUAL INCHES/SQ.FT.	30.82	30.69	35.49	32.33
TURF WATER REQUIREMENT*:	26.00	26.00	26.00	
EXCESS USE/INCHES	4.82	4.69	9.49	6.33
EXCESS USE/M GALLONS	284	276	558	
POTENTIAL SAVINGS @: \$ 6.48			\$3,616	
POTENTIAL SAVINGS @: \$ 7.13			\$3,979	

CONTROLLER "O"				
METER LOCATION: Tap #8 / 2384 S CONSERVATORY PKWY				
METER SIZE:	3"			
YEAR:	2010	2011	2012	Average
TOTAL USE	3,865	2,431	3,923	3,406
LESS DRIP IRRIG: 15%	580	365	588	
TOTALTURF WATER USE:	3,285	2,066	3,335	2,895
AREA IN SQ. FT.: 69,720				
Acres: 1.60				
ANNUAL INCHES/SQ.FT.	75.59	47.54	76.72	66.62
TURF WATER REQUIREMENT*:	26.00	26.00	26.00	
EXCESS USE/INCHES	49.59	21.54	50.72	40.62
EXCESS USE/M GALLONS	2155	936	2205	
POTENTIAL SAVINGS @: \$ 6.48			\$14,285	
POTENTIAL SAVINGS @: \$ 7.13			\$15,718	

CONTROLLER "O" AREA SQ. FT. MAY NOT BE ACCURATE AS THIS TAP PROVIDES WATER FOR THE AREA SERVED BY CONTROLLER "N" TOO



System checks can reduce water loss



Vandals ???



Low head and grass blocking spray



Tilted popup spray head



Low rotor head and uneven coverage



Junipers growing over turf and heads



High pressure misting and droplets drifting away



12" popup in the middle of the plant



Plugged nozzle on head



Arc needs adjusting to water turf



Heads in this planter are smothered in plants



Drip irrigation would save water