Managing the Irrigation Controller in a Drought

The amount of irrigation water applied to the landscape varies with the type of plant material and the precipitation rate of the sprinklers. The environmental factors that drive plant water use are temperature, wind, solar radiation, humidity, and ground temperature and collectively they generate a number known as Evapotranspiration (ET). These factors are nearly impossible for the landscape manager to evaluate in the field. The State of California manages a network of computerized weather stations linked to a free website in a program known as CIMIS (California Irrigation Management Information System). There are nearly 200 of these stations throughout the state. They provide the landscape manager with a number that represents the inches of water plants generally need in a month, week, or day. The number available from the local weather station is known as ET_O or reference ET. There are many regions of the state that lack a local weather station. In these instances tables are available providing monthly averages in the Water Efficient Landscape Ordinance (WELO) which is also available on line.

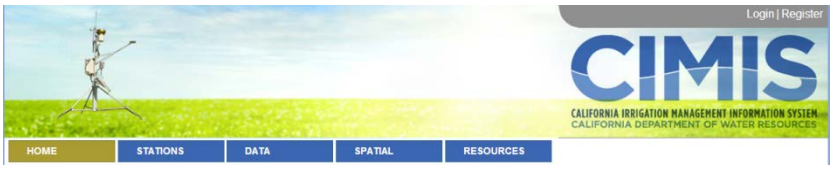
CIMIS Monthly Average ETo Report

Rendered in ENGLISH Units.
Printed on Thursday, March 12, 2015

Average ETo Values by Station

Stn Id	Stn Name	CIMIS Region	Jan (in)	Feb (in)	Mar (in)	Apr (in)	May (in)	Jun (in)	Jul (in)	Aug (in)	Sep (in)	Oct (in)	Nov (in)	Dec (in)	Total (in)
131	Fair Oaks	SAV	1.14	1.76	3.28	4.51	6.46	7.44	7.91	7.02	5.13	3.33	1.59	1.02	50.59

http://wwwcimis.water.ca.gov/



http://ucanr.edu/sites/WUCOLS/

Water Efficient Landscape Ordinance (WELO)
http://www.water.ca.gov/wateruseefficiency/landscapeordinance/

Every plant has a different water requirement relative to ET_O based upon the landscape coefficient or K_L. The primary factor that drives that landscape coefficient is the species factor. Our biggest concern in the drought is the water requirement for turfgrass as it consumes the bulk of the landscape water. The plant water requirement ET_L is obtained for any period by multiplying the ET_O x K_L. In a traditional year cool season turfgrass such as fescue, Kentucky Bluegrass, or rye have a species factor of 70 percent or 0.70. In a drought we reduce this species factor and in turn the landscape coefficient (K_L) to 60 percent or 0.60. This follows guidelines developed by turfgrass experts at the University of California at Davis and Riverside.

July ET_L in a traditional year – ET_O (7.91") x K_L (0.70 for cs turf) = 5.54" / month

July ET_L in a drought year – ET_O (7.91") x K_L (0.60 for cs turf) = 4.75" / month

The water savings associated with this recommendation will save 0.79" in the peak month of July which is a 14% reduction in water use!

The development of an irrigation schedule is based on the average daily ET_L (plant water requirement) In the month of July, in Sacramento, we have an ET_L of 4.75". The objective is to establish an average daily ET_L which in this case is 0.153" per day (4.75" / 31 = 0.153"). The replacement for every 4th day watering for turf in a typical July is 0.61 inches (4 x 0.153). If we were watering on a flat clay surface the infiltration rate or maximum intake rate of the soil is 0.08 inches per hour. It would be necessary to have 8 cycles or start times (8 x 0.08 = 0.64). Since most programs have only 4 start times, it will be necessary to utilize two programs (A & B) to have an adequate number of start times on this watering day to avoid runoff.

Daily	Sun	Mon	Tue	Wed	Thur	Fri.	Sat
ET_L	0.153	0.153	0.153	0.153	0.153	0.153	0.153
JULY ET_L			Water Tues. replace 0.46" (3 days)				Water Sat.. replace 0.61" (4 days)

On Saturday, the turf water requirement is 0.61". Regardless of the type of sprinkler, the soil infiltration or intake rate of 0.08" for clay (in this case) dictates the maximum amount of water applied to be 0.08" before runoff. Some sprinklers such as rotors and drip apply water more slowly and can have longer run times. Spray type sprinklers have a much higher precipitation rate so their run times to reach runoff are shorter. The sprinkler does not dictate the number of repeats rather it is the soil type! So the number of cycles required is 8 (0.61 /0.08 = 7.6 so we round up to 8). We will have to use 2 programs here because of the limitations of start times available per program on most controllers at four. If the irrigation controller does not have adequate starts or a cycle soak feature you'll have to upgrade to a smart controller with these

		PROGRAM A	PROGRAM B	PROGRAM C
DAY OF THE WEEK		MO TU WE TH FR SA SU	MO TU WE TH FR SA SU	MO TU WE TH FR SA SU
INTERVAL (Choose 1 to 31 days)				
PROGRAM START TIMES	1	12:15 a.m.	4:15 a.m.	
	2	1:15 a.m.	5:15 a.m.	
	3	2:15 a.m.	6:15 a.m.	
	4	3:15 a.m.	11:15 p.m.	
STATION	LOCATION	STATION RUN TIME	STATION RUN TIME	STATION RUN TIME
1				
2				

The next step in scheduling is to determine the run time in minutes required for Saturday. We use a simple run time formula RT = ET_L (turf water requirement) / PR (precipitation rate) x 60 (constant). In this example the sprinkler is a 15 ft spray spaced square at 30 psi with a precipitation rate of 1.58" / hr. Recall the Saturday ET_L so the run time is as follows ET_L (0.61) / PR (1.58) x 60 = 23 minutes. The problem is that the number is not divisible by 8 cycles, so we'll round up to a number that can be divided by 8 which is 24. On Program A we'll water 3 minutes per cycle x 4 starts = 12 minutes. On B we'll water 3 min. / cycle x 4 starts

		PROGRAM A	PROGRAM B	PROGRAM C
DAY OF THE WEEK		MO TU WE TH FR SA SU	MO TU WE TH FR SA SU	MO TU WE TH FR SA SU
INTERVAL (Choose 1 to 31 days)				
PROGRAM START TIMES	1	12:15 a.m.	4:15 a.m.	
	2	1:15 a.m.	5:15 a.m.	
	3	2:15 a.m.	6:15 a.m.	
	4	3:15 a.m.	11:15 p.m.	
STATION	LOCATION	STATION RUN TIME	STATION RUN TIME	STATION RUN TIME
1	*Front Lawn - Sprays*	*3 min.*	*3 min.*	
2				
		(4 x 3 min = 12 minutes)	*(4 x 3 min = 12 minutes)*	

(plant water requirement)

$$RT = \frac{ET_L}{PR} \times 60$$

(constant)

(precipitation rate)

We've completed the schedule for station 1 for the spray heads on the turf for Saturday. The irrigation water that we had to apply (0.61") requires 8 repeats and utilized the capabilities of both the A and B programs using all eight available starts.
The water requirement for Tuesday morning replaces 3 days of turf water use or 0.46 inches of water. Since the water requirement is different on Tuesday,0.46", as opposed to 0.61" on Saturday, we'll have a different run time so a different program is required. We'll use the final program, program C, for station 1 on Tuesday. The amount of water required on Tuesday replaces turf water use of 0.46". The run time for program C (Tuesday) is RT = ET_L / PR x 60 (0.46 / 1.58 x 60) = 17 min. It is not possible to divide this into even cycles as 17 is not divisible into equal parts. We only have 4 cycle starts left so we'll program four 4 minute cycles for a total of 16 minutes. If we chose to run the next increment divisible by 4, it would be 20 minutes requiring four 5 minute cycles resulting in runoff. Clearly, this three program controller with four starts per program is falling short due to the stringent requirements of the 2 day per week restriction! It is probably time for a controller upgrade!

Since we utilized programs A, B, and C and 12 start times for the turf stations, the drip and shrub stations will have to water on the same days and start times as the lawns. Under such extreme programming requirements it makes sense to replace the controller with a smart controller that has "cycle/soak" capabilities.

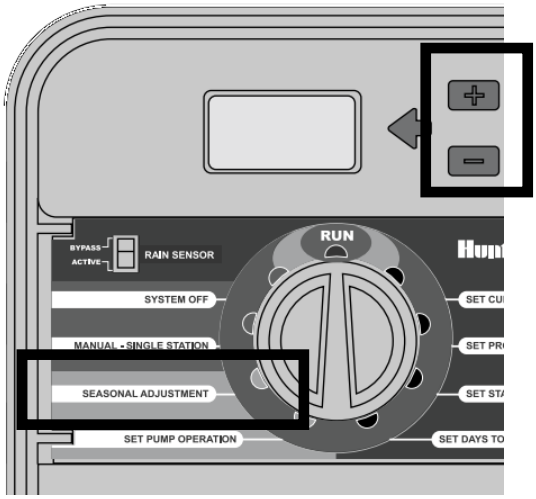
		PROGRAM A							PROGRAM B							PROGRAM C						
DAY OF THE WEEK		MO	TU	WE	TH	FR	SA	SU	MO	TU	WE	TH	FR	SA	SU	MO	TU	WE	TH	FR	SA	SU
INTERVAL (Choose 1 to 31 days)																						
PROGRAM START TIMES	1	12:15 a.m.							4:15 a.m.							10:15 p.m.						
	2	1:15 a.m.							5:15 a.m.							12:15 a.m.						
	3	2:15 a.m.							6:15 a.m.							2:15 a.m.						
	4	3:15 a.m.							11:15 p.m.							4:15 a.m.						
STATION	LOCATION	STATION RUN TIME							STATION RUN TIME							STATION RUN TIME						
1	*Front Lawn - Sprays*	*3 min.*							*3 min.*							*4 min.*						
2																						
		(4 x 3 min = 12 minutes)							*(4 x 3 min = 12 minutes)*							*(4 x 4 min = 16 minutes)*						

The previous special program addresses the water needs of the plant material on the designated day schedule of two days per week which is the 2015 guideline for the Sacramento Area. Some water purveyor's may already have landscape water conservation programs in place that allow watering three times per week which would require a controller with fewer start times.

The previous schedule is what is known as a "lower boundary" of watering time which does not reflect typical spray irrigation systems which have problems with uniform coverage and have poor distribution uniformitv

A landscape water audit would reveal the distribution uniformity DU_{LQ} (quality of sprinkler coverage) of the system and once this is known we can develop a scheduling or system multiplier. The spray system we audited for this example had a DU_{LQ} of 56 percent or 0.56. A scheduling or run time multiplier indicates how much we will have to increase the lower boundary run times to deliver adequate water to the drier parts of the irrigation circuit. The run time or scheduling multiplier for 56 percent is 1.36. The Saturday run time on the lower boundary was 24 minutes or eight 3 minute cycles. (Recall, that we bumped the 23 minutes up to 24!) The 23 minute run time would be increased 1.36 times to compensate for poor uniformity which is 32 minutes. The upper boundary of run time for Saturday is 8 cycles of 4 minutes.

One important feature of more modern controllers is the percentage or seasonal adjust key or +/- key. It allows adjustment of an entire program by percentages. Heavy clay soils and spray heads render this a meaningless feature. Imagine that there is a 3 minute run time that needs a 10% reduction. The controller times in 1 minute increments so the % key only works for 33% changes (3 minutes reduced to 2 minutes is a 33% change). The only options we have with these short run times is to eliminate a start time or decrease a run time. This is exactly why rotors, with their lower precipitation rates, and longer run times are a better option than sprays. If the rotor station was set for four 10 minute cycles a 90% adjust would reduce the run time to 9 minutes!



Ultimately we need to be very creative in dealing with drought conditions where reduced watering days may be imposed by cities or water agencies. There are many limitations to controller programming when this occurs and they are acutely felt during a drought. Another serious limitation in the more arid regions of the state is the limitation of the water meter to apply water in three days that would normally be applied in 4 to 7 days per

Irrigation Schedule — Roseville, CA

(Schedule based on CIMIS station 131 - Fair Oaks, CA)

Pop Up Spray Heads / Cool Season Turf

Cool Season Turf with a K_T species factor (maximum stress) 0.60

DU_{LQ}	0.56	
PR Rate	1.58	inches / hr.
RTM	1.36	

		Fair Oaks ET_O Avg Monthly	Fair Oaks ET_O Avg. daily	Fair Oaks CS Turf Req't daily	Every 4th day watering: Lower Bndry. Run Time min.	Every 4th day watering: Upper Bndry. Run Time min.	Every 3rd day watering: Lower Bndry. Run Time min.	Every 3rd day watering: Upper Bndry. Run Time min.
31	Mar	3.28	0.1058	0.0635	10	13	7	10
30	Apr	4.51	0.1503	0.0902	14	19	10	14
31	May	6.46	0.2084	0.1250	19	26	14	19
30	Jun	7.44	0.2480	0.1488	23	31	17	23
31	Jul	7.91	0.2552	0.1531	23	32	17	24
31	Aug	7.02	0.2265	0.1359	21	28	15	21
30	Sep	5.13	0.1710	0.1026	16	21	12	16
31	Oct	3.33	0.1074	0.0645	10	13	7	10
		45.08						

MP Rotators / Cool Season Turf

Cool Season Turf with a K_T species factor (maximum stress) 0.60

DU_{LQ}	0.72	
PR Rate	0.43	inches / hr.
RTM	1.20	

		Fair Oaks ET_O Avg Monthly	Fair Oaks ET_O Avg. daily	Fair Oaks CS Turf Req't daily	Every 4th day watering: Lower Bndry. Run Time min.	Every 4th day watering: Upper Bndry. Run Time min.	Every 3rd day watering: Lower Bndry. Run Time min.	Every 3rd day watering: Upper Bndry. Run Time min.
31	Mar	3.28	0.1058	0.0635	35	43	27	32
30	Apr	4.51	0.1503	0.0902	50	61	38	45
31	May	6.46	0.2084	0.1250	70	84	52	63
30	Jun	7.44	0.2480	0.1488	83	100	62	75
31	Jul	7.91	0.2552	0.1531	85	103	64	77
31	Aug	7.02	0.2265	0.1359	76	91	57	68
30	Sep	5.13	0.1710	0.1026	57	69	43	52
31	Oct	3.33	0.1074	0.0645	36	43	27	32

MAXIMUM CYCLE LENGTH (IN MINUTES) TO AVOID RUNOFF ON CLAY SOILS		
SPRAYS	4 MINUTES	(15 FT SQUARE SPACING)
ROTORS	14 MINUTES	(0.43" / HR PRECIP RATE)
LINE SOURCE DRIP	4 MINUTES	(0.9 GPH - 12" X 12" SPACING)

Rain Bird HE-VAN High-Efficiency Nozzles

Irrigation Schedule

(Schedule based on CIMIS station 131 - Fair Oaks, CA)

HE-VAN Nozzles / Cool Season Turf

Cool Season Turf with a Kt species factor (maximum stress) 0.6

DU(lq) 0.72

PR Rate 1.66 inches/hr (*Average of 8', 10', 12', and 15' HE-VAN PR Rates)

RTM 1.39

					Every 4th day watering			**Every 3rd day watering**	
		2014 Fair Oaks ETo Avg Monthly	2014 Fair Oaks ETo Avg Daily	2014 Fair Oaks CS Turf Req't Daily	Lower Bndry. Run Time min.	Upper Bndry. Run Time min.		Lower Bndry. Run Time min.	Upper Bndry. Run Time min.
31	Mar	3.37	0.1087	0.0652	9	13		7	10
30	Apr	4.7	0.1567	0.0940	14	19		10	14
31	May	6.88	0.2219	0.1332	19	27		14	20
30	Jun	7.77	0.2590	0.1554	22	31		17	23
31	Jul	6.85	0.2210	0.1326	19	27		14	20
31	Aug	6.34	0.2045	0.1227	18	25		13	18
30	Sep	4.82	0.1607	0.0964	14	19		10	15
31	Oct	3.31	0.1068	0.0641	9	13		7	10

Definitions

Run-time in minutes = (60*D*Eto*Kc)/(PR*IE)

60 = constant for conversion of area, flow, in/hr, in/day

D = watering frequency in days

Eto = reference evapotranspiration rate, in inches per day

Kc = crop coefficient

PR = precipitation rate in in/hr

IE = application efficiency of the system

RTM = run-time multiplier. Also means scheduling coefficient (SC)

Drip / Line Source - 0.9 GPH - 12" x 12" spacing

Ornamental Shrubs with a species factor K_P (max stress) 0.40

	DU_{LQ}	0.9				Every 4th day			Every 3rd day	
	PR Rate	1.42	inches / hr.			watering			watering	
	RTM	1.06								
		Fair Oaks		Fair Oaks	Fair Oaks	Lower	Upper		Lower	Upper
		ET_O		ET_O	Orn. Shrub	Bndry.	Bndry.		Bndry.	Bndry.
		Avg		Avg.	Req't	Run Time	Run Time		Run Time	Run Time
		Monthly		daily	daily	min.	min.		min.	min.
31	Mar	3.28		0.1058	0.0423	7	8		5	6
30	Apr	4.51		0.1503	0.0601	10	11		8	8
31	May	6.46		0.2084	0.0834	14	15		11	11
30	Jun	7.44		0.2480	0.0992	17	18		13	13
31	Jul	7.91		0.2552	0.1021	17	18		13	14
31	Aug	7.02		0.2265	0.0906	15	16		11	12
30	Sep	5.13		0.1710	0.0684	12	12		9	9
31	Oct	3.33		0.1074	0.0430	7	8		5	6

Drip / Point Source - random spacing - 0.25" / hr. PR

Ornamental Shrubs with a species factor K_P (max stress) 0.40

	DU_{LQ}	0.9				Every 4th day			Every 3rd day	
	PR Rate	0.25	inches / hr.			watering			watering	
	RTM	1.06								
		Fair Oaks		Fair Oaks	Fair Oaks	Lower	Upper		Lower	Upper
		ET_O		ET_O	Orn. Shrub	Bndry.	Bndry.		Bndry.	Bndry.
		Avg		Avg.	Req't	Run Time	Run Time		Run Time	Run Time
		Monthly		daily	daily	min.	min.		min.	min.
31	Mar	3.28		0.1058	0.0423	41	43		30	32
30	Apr	4.51		0.1503	0.0601	58	61		43	46
31	May	6.46		0.2084	0.0834	80	85		60	64
30	Jun	7.44		0.2480	0.0992	95	101		71	76
31	Jul	7.91		0.2552	0.1021	98	104		73	78
31	Aug	7.02		0.2265	0.0906	87	93		65	69
30	Sep	5.13		0.1710	0.0684	66	70		49	52
31	Oct	3.33		0.1074	0.0430	41	44		31	33

EWING

345 Richards Blvd	Sacramento, CA 95811-0217	(916) 447-9530
5761 Florin Perkins Rd. #1	S. Sacramento, CA 95828-1033	(916) 383-2400
5050 Hillsdale Cir.	El Dorado Hills, CA 95762-5706	(916) 933-8822
500 Berry St. Unit B	Roseville, CA 95678-1342	(916) 784-0323
3267 Monier Cir.	Rancho Cordova, CA 95742	(916) 635-7850

* lower boundary represents a water time that assumes a high uniformity of application DU_{LQ}

* upper boundary increases run time to account for normal sprinkler uniformity deficiencies

Irrigation Schedule — Roseville, CA

(Schedule based on CIMIS station 131 - Fair Oaks, CA)

Pop Up Spray Heads / Warm Season Turf

Cool Season Turf with a K_T species factor (maximum stress) 0.40

DU_{LQ}	0.56	
PR Rate	1.58	inches / hr.
RTM	1.36	

		Fair Oaks ET_O Avg Monthly	Fair Oaks ET_O Avg. daily	Fair Oaks WS Turf Req't daily	Lower Bndry. Run Time min.	Upper Bndry. Run Time min.	Every 4th day watering: Lower Bndry. Run Time min.	Every 4th day watering: Upper Bndry. Run Time min.
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30	Jun	7.44	0.2480	0.0992	15	20	11	15
31	Jul	7.91	0.2552	0.1021	16	21	12	16
31	Aug	7.02	0.2265	0.0906	14	19	10	14
30	Sep	5.13	0.1710	0.0684	10	14	8	11
31	Oct	3.33	0.1074	0.0430	7	9	5	7
		45.08						

MP Rotators / Warm Season Turf

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RTM	1.20	

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31	Mar	3.28	0.1058	0.0423	24	28	18	21
30	Apr	4.51	0.1503	0.0601	34	40	25	30
31	May	6.46	0.2084	0.0834	47	56	35	42
30	Jun	7.44	0.2480	0.0992	55	67	42	50
31	Jul	7.91	0.2552	0.1021	57	68	43	51
31	Aug	7.02	0.2265	0.0906	51	61	38	46
30	Sep	5.13	0.1710	0.0684	38	46	29	34
31	Oct	3.33	0.1074	0.0430	24	29	18	22

MAXIMUM CYCLE LENGTH (IN MINUTES) TO AVOID RUNOFF ON CLAY SOILS		
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Rain Bird R-VAN and Rotary High-Efficiency Nozzles

Irrigation Schedule

(Schedule based on CIMIS station 131 - Fair Oaks, CA)

Rain Bird R-VAN and Rotary Nozzles / Cool Season Turf

Cool Season Turf with a Kt species factor (maximum stress) 0.6

DU(lq) 0.72

PR Rate 0.64 inches/hr

RTM 1.39

					Every 4th day watering			Every 3rd day watering	
		2014 Fair Oaks ETo Avg Monthly	2014 Fair Oaks ETo Avg Daily	2014 Fair Oaks CS Turf Req't Daily	Lower Bndry. Run Time min.	Upper Bndry. Run Time min.		Lower Bndry. Run Time min.	Upper Bndry. Run Time min.
31	Mar	3.37	0.1087	0.0652	24	34		18	25
30	Apr	4.7	0.1567	0.0940	35	49		26	37
31	May	6.88	0.2219	0.1332	50	69		37	52
30	Jun	7.77	0.2590	0.1554	58	81		44	61
31	Jul	6.85	0.2210	0.1326	50	69		37	52
31	Aug	6.34	0.2045	0.1227	46	64		35	48
30	Sep	4.82	0.1607	0.0964	36	50		27	38
31	Oct	3.31	0.1068	0.0641	24	33		18	25

Definitions

Run-time in minutes = (60*D*Eto*Kc)/(PR*IE)

60 = constant for conversion of area, flow, in/hr, in/day

D = watering frequency in days

Eto = reference evapotranspiration rate, in inches per day

Kc = crop coefficient

PR = precipitation rate in in/hr

IE = application efficiency of the system

RTM = run-time multiplier. Also means scheduling coefficient (SC)

					Coarse - Moderately Coarse Soils			Medium/Moderately Fine Soils				Fine Soils	
Color	Manufacturer	Series	Spacing	Precipitation Rate	Sand/Fine Sand	Loamy Sand	Sandy Loam	Loam	Silt	Clay Loam	Sandy Clay	Silty Clay	Clay
Red	Rain Bird MPR - fixed arc	5 ft	Square	1.58	6	8	13	19	15	6	5	4	3
Red	Rain Bird MPR - fixed arc	5 ft	Triangular	1.83	5	7	11	16	13	5	5	3	2
Green	Rain Bird MPR - fixed arc	8 ft	Square	1.56	6	8	13	19	15	6	5	4	3
Green	Rain Bird MPR - fixed arc	8 ft	Triangular	1.81	5	7	11	17	13	5	5	3	2
Blue	Rain Bird MPR - fixed arc	10 ft	Square	1.52	6	8	13	20	16	6	6	4	3
Blue	Rain Bird MPR - fixed arc	10 ft	Triangular	1.75	5	7	11	17	14	5	5	3	3
Brown	Rain Bird MPR - fixed arc	12 ft	Square	1.74	5	7	11	17	14	6	5	3	3
Brown	Rain Bird MPR - fixed arc	12 ft	Triangular	2.01	4	6	10	15	12	5	4	3	2
Black	Rain Bird MPR - fixed arc	15 ft	Square	1.58	6	8	13	19	15	6	5	4	3
Black	Rain Bird MPR - fixed arc	15 ft	Triangular	1.83	5	7	11	16	13	5	5	3	2
Blue	Hunter - Pro Spray-fixed ar	5 ft	Square	1.8	5	7	11	17	13	5	5	3	3
Blue	Hunter - Pro Spray-fixed ar	5 ft	Triangular	2.08	4	6	10	14	12	5	4	3	2
Brown	Hunter - Pro Spray-fixed ar	8 ft	Square	1.41	6	9	14	21	17	7	6	4	3
Brown	Hunter - Pro Spray-fixed ar	8 ft	Triangular	1.63	6	8	12	18	15	6	5	4	3
Red	Hunter - Pro Spray-fixed ar	10 ft	Square	1.69	5	7	12	18	14	6	5	4	3
Red	Hunter - Pro Spray-fixed ar	10 ft	Triangular	1.95	5	6	10	15	12	5	4	3	2
Green	Hunter - Pro Spray-fixed ar	12 ft	Square	1.74	5	7	11	17	14	6	5	3	3
Green	Hunter - Pro Spray-fixed ar	12 ft	Triangular	2.01	4	6	10	15	12	5	4	3	2
Black	Hunter - Pro Spray-fixed ar	15 ft	Square	1.59	6	8	12	19	15	6	5	4	3
Black	Hunter - Pro Spray-fixed ar	15 ft	Triangular	1.84	5	7	11	16	13	5	5	3	2

					Coarse - Moderately Coarse Soils			Medium/Moderately Fine Soils			Fine Soils		
Color	Manufacturer	Series	Spacing	Precipitation Rate	Sand/Fine Sand	Loamy Sand	Sandy Loam	Loam	Silt	Clay Loam	Sandy Clay	Silty Clay	Clay
Red	Toro MPR Plus - fixed arc	5 ft	Square	1.47	6	9	13	20	16	7	6	4	3
Red	Toro MPR Plus - fixed arc	5 ft	Triangular	1.7	5	7	12	18	14	6	5	4	3
Green	Toro MPR Plus - fixed arc	8 ft	Square	1.51	6	8	13	20	16	6	6	4	3
Green	Toro MPR Plus - fixed arc	8 ft	Triangular	1.75	5	7	11	17	14	5	5	3	3
Blue	Toro MPR Plus - fixed arc	10 ft	Square	1.38	7	9	14	22	17	7	6	4	3
Blue	Toro MPR Plus - fixed arc	10 ft	Triangular	1.59	6	8	12	19	15	6	5	4	3
Brown	Toro MPR Plus - fixed arc	12 ft	Square	1.47	6	9	13	20	16	7	6	4	3
Brown	Toro MPR Plus - fixed arc	12 ft	Triangular	1.69	5	7	12	18	14	6	5	4	3
Black	Toro MPR Plus - fixed arc	15 ft	Square	1.44	6	9	14	21	17	7	6	4	3
Black	Toro MPR Plus - fixed arc	15 ft	Triangular	1.66	5	8	12	18	14	6	5	4	3
Red	Toro - Precision Spray-fixe	5 ft	Square	1	9	13	20	30	24	10	8	6	5
Red	Toro - Precision Spray-fixe	5 ft	Triangular	1.15	8	11	17	26	21	8	7	5	4
Green	Toro - Precision Spray-fixe	8 ft	Square	1	9	13	20	30	24	10	8	6	5
Green	Toro - Precision Spray-fixe	8 ft	Triangular	1.1	8	11	18	27	22	9	8	5	4
Blue	Toro - Precision Spray-fixe	10 ft	Square	1	9	13	20	30	24	10	8	6	5
Blue	Toro - Precision Spray-fixe	10 ft	Triangular	1.1	8	11	18	27	22	9	8	5	4
Brown	Toro - Precision Spray-fixe	12 ft	Square	1	9	13	20	30	24	10	8	6	5
Brown	Toro - Precision Spray-fixe	12 ft	Triangular	1.1	8	11	18	27	22	9	8	5	4
Black	Toro - Precision Spray-fixe	15 ft	Square	1	9	13	20	30	24	10	8	6	5
Black	Toro - Precision Spray-fixe	15 ft	Triangular	1.2	8	11	17	25	20	8	7	5	4
ALL NOZZLE DATA BASED ON 180 DEGREE ARC AT 30 PSI													
	MAXIMUM RUN TIME IS DUE TO WATER LOSS THROUGH DEEP PERCOLATION WHEN AMOUNT APPLIED EXCEEDS ALLOWABLE DEPLETION												

Controller Water Requirement Workshe					Month				Year								
Sta	sprinkler type	plant material	Area - ft^2	Cubic ft per min.	Gallons (cubic ft x 7.48)		Run time Progr. A	# cycle starts	min. total		Run time Progr. B	# cycle starts	min. total		Run time Progr.C	# cycle starts	min. total	TOTAL GALLONS
1																		
2																		
3																		
4																		
5																		
6																		
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