## DWR – CCUH at UC Davis
## Drought Conference – May 29th, 2015

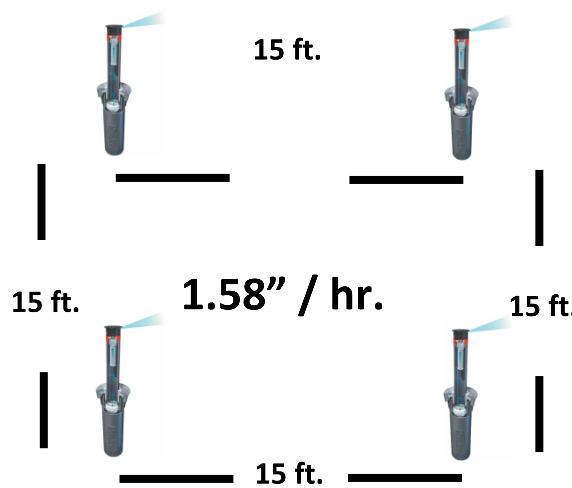
# Sprinkler precipitation rates – the key to controlling irrigation runoff

Spray nozzles have a high precipitation rate that frequently results in irrigation runoff. The precipitation rate will vary with pressure and spacing. At 30 psi and spaced in a square pattern the precipitation rate is 1.58" per hour. The triangular pattern has slightly higher precipitation rates due to the tighter row spacing of 13 ft. at 1.83"

**15 Series MPR**

30° Trajectory

| Nozzle | Pressure psi | Radius ft. | Flow GPM | ■ Precip In/h | ▲ Precip In/h |
|---|---|---|---|---|---|
| 15F | 15 | 11 | 2.60 | 2.07 | 2.39 |
| | 20 | 12 | 3.00 | 2.01 | 2.32 |
| | 25 | 14 | 3.30 | 1.62 | 1.87 |
| | 30 | 15 | 3.70 | 1.58 | 1.83 |
| 15H | 15 | 11 | 1.30 | 2.07 | 2.39 |
| | 20 | 12 | 1.50 | 2.01 | 2.32 |
| | 25 | 14 | 1.65 | 1.62 | 1.87 |
| | 30 | 15 | 1.85 | 1.58 | 1.83 |




Verify the working water pressure at the spray nozzle to be a minimum of 30 psi. In the case of the 15 Series nozzle, any pressure less than 30 psi requires a closer spacing than 15 ft. If the sprinklers are operating at 20 - 25 psi and spaced at 15 ft there will be serious coverage (uniformity) problems. Measure water pressure as the circuit operates at the first and last sprinkler on the circuit. Verify spacing to be no greater than the radius. Sprinklers should be spaced in a square or triangular pattern with consistent spacing between heads.

Test working water pressure at the first and last sprinkler with a pressure tee and gauge.

Verify spacing between heads with a tape measure. At 30 psi spray heads should be spaced at no greater than their series, i.e 15 series at 15 ft, 12 series at 12 ft, etc.

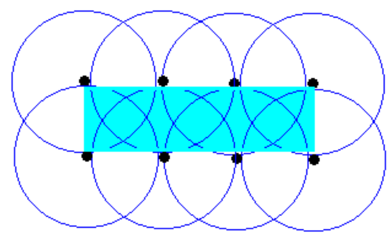
Rotor sprinklers rotate a single or multiple streams to achieve coverage. In general, the end of the stream from one sprinkler should hit right at the base of the adjacent sprinkler. The pressure requirement at the nozzle is dependent on the spacing and the nozzle installed in the sprinkler. Performance charts indicate a radius(spacing interval) that can be achieved with a particular nozzle at varying pressures. Generally, these sprinklers have a higher pressure requirement than spray nozzles. As a consequence low nozzle pressure is a common problem. Pressure, along with spacing must be verified in the field. Precipitation rate data may only be relied upon when pressure, nozzle, and spacing agree with nozzle performance data. These sprinklers have lower precipitation rates than sprays and therefore can be run for longer periods before runoff occurs.

**PGP Red Standard Nozzle Performance Data**

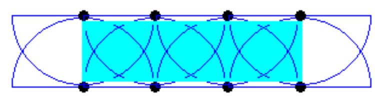
| Nozzle | Pressure PSI | Radius ft. | Flow GPM | Precip in/hr ■ | Precip in/hr ▲ |
|---|---|---|---|---|---|
| 1 | 30 | 28' | 0.5 | 0.12 | 0.14 |
| | 40 | 29' | 0.6 | 0.14 | 0.16 |
| | **50** | **29'** | **0.7** | **0.16** | **0.19** |
| | 60 | 30' | 0.8 | 0.17 | 0.20 |
| 2 | 30 | 29' | 0.7 | 0.16 | 0.19 |
| | 40 | 30' | 0.8 | 0.17 | 0.20 |
| | **50** | **30'** | **0.9** | **0.19** | **0.22** |
| | 60 | 31' | 1.0 | 0.20 | 0.23 |
| 3 | 30 | 30' | 0.9 | 0.19 | 0.22 |
| | 40 | 31' | 1.0 | 0.20 | 0.23 |
| | **50** | **31'** | **1.2** | **0.24** | **0.28** |
| | 60 | 32' | 1.3 | 0.24 | 0.28 |
| 4 | 30 | 32' | 1.2 | 0.23 | 0.26 |
| | 40 | 33' | 1.4 | 0.25 | 0.29 |
| | **50** | **34'** | **1.6** | **0.27** | **0.31** |
| | 60 | 34' | 1.8 | 0.30 | 0.35 |
| 5 | 30 | 34' | 1.6 | 0.27 | 0.31 |
| | 40 | 36' | 1.8 | 0.27 | 0.31 |
| | **50** | **38'** | **2.0** | **0.27** | **0.31** |
| | 60 | 38' | 2.2 | 0.29 | 0.34 |
| 6 | 30 | 34' | 2.0 | 0.33 | 0.38 |
| | 40 | 36' | 2.4 | 0.36 | 0.41 |
| | **50** | **38'** | **2.7** | **0.36** | **0.42** |
| | 60 | 38' | 2.9 | 0.39 | 0.45 |

These charts represent precipitation rates at half circle or 180 degree setting. For full circle operation divide the chart values by 2!

**38 ft. square spacing**



**#5 noz. - 2.0 gpm @ 50 psi at 360 deg**
**precipitation rate = 0.135" / hr**



**#5 noz - 2.0 gpm @50 psi at 180 deg (half circle)**
**precipitation rate = 0.27" / hr.**

The pitot tube and pressure gauge are used to measure nozzle pressure which is evaluated against nozzle performance charts

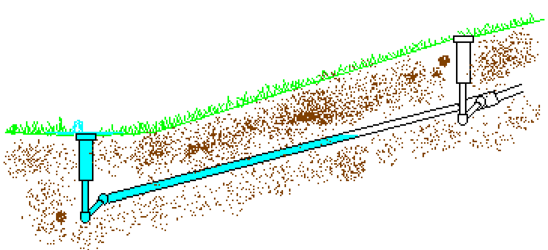
**Suggested maximum run times on clay soil before runoff occurs**
**(on flat surfaces)**
**infiltration rate - 0.10" / hr**

| spray | spray | spray | rotors | rotors | rotors | rotors | rotor |
|---|---|---|---|---|---|---|---|
| 1.6" / hr | 1.8" / hr | 2" / hr | 0.25"/hr | 0.35" / hr | 0.45"/hr | 0.55"/hr | 0.65"/hr |
| 4 min | 4 min | 4 min | 24 min | 17 min | 13 min | 11 min | 9 min |

**Suggested maximum run times on clay loam soil before runoff occurs**
**(on flat surfaces)**
**infiltration rate - 0.16" / hr**

| spray | spray | spray | rotors | rotors | rotors | rotors | rotor |
|---|---|---|---|---|---|---|---|
| 1.6" / hr | 1.8" / hr | 2" / hr | 0.25"/hr | 0.35" / hr | 0.45"/hr | 0.55"/hr | 0.65"/hr |
| 6 min | 5 min | 4 min | 38 min | 27 min | 21 min | 17 min | 14 min |

Low head drainage occurs in lateral sprinkler piping after the irrigation valve has shut down. When heavy clay soils are being irrigated, multiple cycles (usually 6-8) must occur every day that irrigation takes place. This necessary cycling process introduces the problem of low head drainage. This problem may be resolved with addition of check valves which may be retrofitted into the base of spray head bodies.



It is not unusual to find irrigation valves with spray and rotor type sprinklers plumbed together. This is never acceptable and should be corrected because of the different precipitation rates of the two types!

While low pressure at spray nozzles is frequently encountered, it is not unusual to find spray systems with excessive pressure. When pressure exceeds 45 psi, the sprinkler body should have a pressure regulating feature. This feature, like the anti-drain check valve, may be retrofitted into an existing spray body without digging up the sprinkler When sprinkler inlet pressures exceed 75 psi a regulator must be installed at the valve or backflow prevention device location.

Spray heads operating at 90 psi. This problem was corrected with the addition of a regulator feature on the valve.

Internal pressure regulating device is designed for inlet pressures between 45 and 75 psi

Same circuit operating at 30 psi!

# 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 more than 150 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.

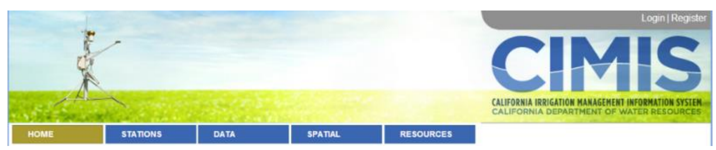
## Monthly Average ETo Report

California Irrigation Management Information System (CIMIS)
Rendered in ENGLISH Units.
Printed on Wednesday, May 27, 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | Manteca | SJV | 1.11 | 1.92 | 3.53 | 5.05 | 6.78 | 7.71 | 7.96 | 7.03 | 5.15 | 3.37 | 1.67 | 1.01 | 52.29 |

**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 – $ET_O$ (7.96”) x $K_L$ (0.70 for cs turf) = 5.57” / month (Manteca #70)

July $ET_L$ in a drought year – $ET_O$ (7.96”) x $K_L$ (0.60 for cs turf) = 4.78” / 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 Stockton, we have an $ET_L$ of 4.78”. The objective is to establish an average daily $ET_L$ which in this case is 0.154” per day (4.78” / 31 = 0.154”). The replacement for every 4th day watering for turf in a typical July is 0.62 inches (4 x 0.154”). 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) to avoid runoff. Apply 0.08”, let it soak in and do this for 8 cycles, regardless of sprinkler type!

| Daily $ET_L$ | Sun 0.154 | Mon 0.154 | Tue 0.154 | Wed 0.154 | Thur 0.154 | Fri 0.154 | Sat 0.154 |
|---|---|---|---|---|---|---|---|
| **JULY $ET_L$** | | | **Water Tues a.m. & p.m. replace 0.462" (3 days)** | | | | **Water Friday a.m. & p.m. replace 0.62" (4 days)** |

On Friday the water requirement is 0.62””. 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 on Friday is 8 (0.62 /0.08 = 8).

| | | 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 | 9:30 p.m. | 2:30 a.m. | |
| | 2 | 11:00 p.m. | 4:00 a.m. | |
| | 3 | 12:30 a.m. | 5:30 a.m. | |
| | 4 | 1:00 a.m. | 7:00 a.m. | |
| STATION | LOCATION | STATION RUN TIME | STATION RUN TIME | STATION RUN TIME |
| 1 | *Front Lawn - Sprays* | | | |

The next step in scheduling is to determine the run time in minutes required for Friday. 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 Friday $ET_L$ so the run time is as follows $ET_L$ (0.62) / PR (1.58) x 60 = 23.54 minutes. We’ve previously determined that 8 cycles are necessary to avoid runoff. We simply divide the 24 minute run time by 8 which means eight, 3 minute cycles. . On Program A we’ll water 3 minutes per cycle x 8 starts = 24 minutes. Two programs, A and B, are necessary to obtain 8 cycles.

(plant water requirement)

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

(constant)

(precipitation rate)

| | | 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 | 9:30 p.m. | 2:30 a.m. | |
| | 2 | 11:00 p.m. | 4:00 a.m. | |
| | 3 | 12:30 a.m. | 5:30 a.m. | |
| | 4 | 1:00 a.m. | 7:00 a.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)* | |

We've completed the schedule for station 1 for the spray heads on the turf for Friday. The irrigation water that we had to apply (0.62") and requires 8 repeats to avoid illegal runoff

The water requirement for Tuesday replaces 3 days of turf water use or 0.462 inches of water. Since the water requirement is different on Tuesday, 0.462", as opposed to 0.62" on Friday, we'll have a different run time so a different program is required. We'll utilize program C, for station 1 on Tuesday. The amount of water required on Tuesday replaces turf water use of 0.462". The run time for program C (Tuesday) is RT = $ET_L$ / PR x 60 (0.462 / 1.58 x 60) = 17.54 min. Since 17 or 18 minutes cannot be divided by 4 starts we must select a 16 or a 20 minute run time Since there are only 4 start times left we'll be forced to increase run time to four minutes. The run time for Tuesday is four, 4 minute cycles for a total of 16 minutes. We're doing this because a 20 minute run time would result in four, five minute cycles which might cause runoff! We're stretching the programming capabilities of this controller to the max due t the severe programming requirements of two days per week!

We've utilized programs A, B, and C for the turf stations. The drip and shrub stations must be assigned to run on days that lawns water which is not a problem due to the long intervals between watering days

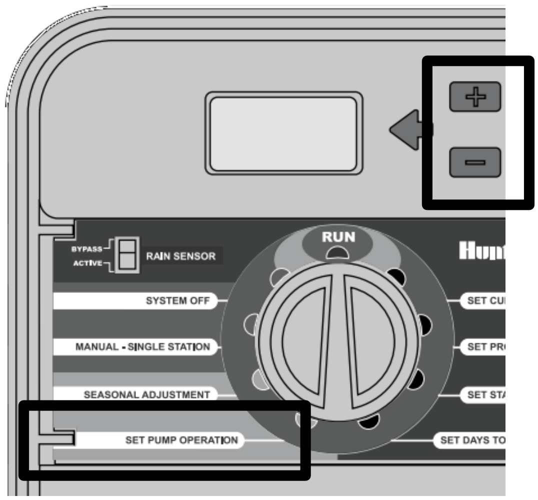
| | | PROGRAM A | PROGRAM B | PROGRAM C |
|---|---|---|---|---|
| DAY OF THE WEEK | | MO TU WE TH FR SA SU | MO TU WE TH FR SA SU | MO TU WE TH FR SA SU |
| INTERVAL (Choose 1 to 31 days) | | | | |
| PROGRAM START TIMES | 1 | 9:30 p.m. | 2:30 a.m. | 10:15 p.m. |
| | 2 | 11:00 p.m. | 4:00 a.m. | 12:15 a.m. |
| | 3 | 12:30 a.m. | 5:30 a.m. | 2:15 p.m. |
| | 4 | 1:00 a.m. | 7:00 a.m. | 4:15 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)* | *( 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 2015watering restriction for Stockton. Some water purveyor's may already have landscape water conservation programs in place that allow watering three times per week which would require a lesser degree of programming complexity.

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 uniformity

A landscape water audit would reveal the distribution uniformity $DU_{LQ}$ 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 $DU_{LO}$ 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 Tuesday run time on the lower boundary was 16 minutes or three, 3 minute cycles. The 16 minute run time would be increased 1.36 times to compensate for poor uniformity which is 22 minutes. The upper boundary of run time for Tuesday is 4 cycles of 6 minutes which would likely cause runoff! Consider changing to a controller that has more start times and programs or a cycle soak feature

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 three 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 two days that would normally be applied in 4 to 7 days per week!

EWING

# Irrigation Schedule — Stockton, CA

(Schedule based onb CIMIS station # 70 - Manteca, 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 | |

| | | Stockton $ET_O$ Avg Monthly | Stockton $ET_O$ Avg. daily | Stockton 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 | 3.53 | 0.1139 | 0.0683 | 10 | 14 | 8 | 11 |
| 30 | Apr | 5.05 | 0.1683 | 0.1010 | 15 | 21 | 12 | 16 |
| 31 | May | 6.78 | 0.2187 | 0.1312 | 20 | 27 | 15 | 20 |
| 30 | Jun | 7.71 | 0.2570 | 0.1542 | 23 | 32 | 18 | 24 |
| 31 | Jul | 7.96 | 0.2568 | 0.1541 | 23 | 32 | 18 | 24 |
| 31 | Aug | 7.03 | 0.2268 | 0.1361 | 21 | 28 | 16 | 21 |
| 30 | Sep | 5.15 | 0.1717 | 0.1030 | 16 | 21 | 12 | 16 |
| 31 | Oct | 3.37 | 0.1087 | 0.0652 | 10 | 13 | 7 | 10 |
| | | 46.58 | | | | | | |

## 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 | 1.2 | |

| | | Stockton $ET_O$ Avg Monthly | Stockton $ET_O$ Avg. daily | Stockton 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 | 3.53 | 0.1139 | 0.0683 | 38 | 46 | 29 | 34 |
| 30 | Apr | 5.05 | 0.1683 | 0.1010 | 56 | 68 | 42 | 51 |
| 31 | May | 6.78 | 0.2187 | 0.1312 | 73 | 88 | 55 | 66 |
| 30 | Jun | 7.71 | 0.2570 | 0.1542 | 86 | 103 | 65 | 77 |
| 31 | Jul | 7.96 | 0.2568 | 0.1541 | 86 | 103 | 64 | 77 |
| 31 | Aug | 7.03 | 0.2268 | 0.1361 | 76 | 91 | 57 | 68 |
| 30 | Sep | 5.15 | 0.1717 | 0.1030 | 57 | 69 | 43 | 52 |
| 31 | Oct | 3.37 | 0.1087 | 0.0652 | 36 | 44 | 27 | 33 |

**MAXIMUM CYCLE LENGTH (IN MINUTES) TO AVOID RUNOFF ON CLAY SOILS**

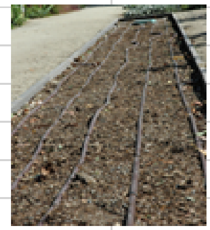
| | | |
|---|---|---|
| SPRAYS | 4 MINUTES | (15 FT SQUARE SPACING) |
| ROTORS | 14 MINUTES | (0.43" / HR PRECIP RATE) |
| LINE SOURCE DRIP | 4 MINUTES | (0.9 GPH - 12" X 12" SPACING) |

## 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 | |
| PR Rate | 1.42 | inches / hr. |
| RTM | 1.06 | |

| | | Stockton $ET_O$ Avg Monthly | Stockton $ET_O$ Avg. daily | Stockton Orn. Shrub 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 | 3.53 | 0.1139 | 0.0455 | 8 | 8 | 6 | 6 |
| 30 | Apr | 5.05 | 0.1683 | 0.0673 | 11 | 12 | 9 | 9 |
| 31 | May | 6.78 | 0.2187 | 0.0875 | 15 | 16 | 11 | 12 |
| 30 | Jun | 7.71 | 0.2570 | 0.1028 | 17 | 18 | 13 | 14 |
| 31 | Jul | 7.96 | 0.2568 | 0.1027 | 17 | 18 | 13 | 14 |
| 31 | Aug | 7.03 | 0.2268 | 0.0907 | 15 | 16 | 11 | 12 |
| 30 | Sep | 5.15 | 0.1717 | 0.0687 | 12 | 12 | 9 | 9 |
| 31 | Oct | 3.37 | 0.1087 | 0.0435 | 7 | 8 | 6 | 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 | |
| PR Rate | 0.25 | inches / hr. |
| RTM | 1.06 | |

| | | Stockton $ET_O$ Avg Monthly | Stockton $ET_O$ Avg. daily | Stockton Orn. Shrub 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 | 3.53 | 0.1139 | 0.0455 | 44 | 46 | 33 | 35 |
| 30 | Apr | 5.05 | 0.1683 | 0.0673 | 65 | 69 | 48 | 51 |
| 31 | May | 6.78 | 0.2187 | 0.0875 | 84 | 89 | 63 | 67 |
| 30 | Jun | 7.71 | 0.2570 | 0.1028 | 99 | 105 | 74 | 78 |
| 31 | Jul | 7.96 | 0.2568 | 0.1027 | 99 | 105 | 74 | 78 |
| 31 | Aug | 7.03 | 0.2268 | 0.0907 | 87 | 92 | 65 | 69 |
| 30 | Sep | 5.15 | 0.1717 | 0.0687 | 66 | 70 | 49 | 52 |
| 31 | Oct | 3.37 | 0.1087 | 0.0435 | 42 | 44 | 31 | 33 |

EWING 1023 S. Pershing Ave Stockton, CA 95206-1177 (209) 948-6933

## Irrigation Schedule — Stockton, CA

(Schedule based onb CIMIS station # 70 - Manteca, CA)

### Pop Up Spray Heads / Warm Season Turf

Warm 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 | |

| | | Stockton $ET_O$ Avg Monthly | Stockton $ET_O$ Avg. daily | Stockton WS 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 | 3.53 | 0.1139 | 0.0455 | 7 | 9 | 5 | 7 |
| 30 | Apr | 5.05 | 0.1683 | 0.0673 | 10 | 14 | 8 | 10 |
| 31 | May | 6.78 | 0.2187 | 0.0875 | 13 | 18 | 10 | 14 |
| 30 | Jun | 7.71 | 0.2570 | 0.1028 | 16 | 21 | 12 | 16 |
| 31 | Jul | 7.96 | 0.2568 | 0.1027 | 16 | 21 | 12 | 16 |
| 31 | Aug | 7.03 | 0.2268 | 0.0907 | 14 | 19 | 10 | 14 |
| 30 | Sep | 5.15 | 0.1717 | 0.0687 | 10 | 14 | 8 | 11 |
| 31 | Oct | 3.37 | 0.1087 | 0.0435 | 7 | 9 | 5 | 7 |
| | | 46.58 | | | | | | |

### MP Rotators / Warm Season Turf

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

| | | |
|---|---|---|
| $DU_{LQ}$ | 0.72 | |
| PR Rate | 0.43 | inches / hr. |
| RTM | 1.2 | |

| | | Stockton $ET_O$ Avg Monthly | Stockton $ET_O$ Avg. daily | Stockton WS 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 | 3.53 | 0.1139 | 0.0455 | 25 | 31 | 19 | 23 |
| 30 | Apr | 5.05 | 0.1683 | 0.0673 | 38 | 45 | 28 | 34 |
| 31 | May | 6.78 | 0.2187 | 0.0875 | 49 | 59 | 37 | 44 |
| 30 | Jun | 7.71 | 0.2570 | 0.1028 | 57 | 69 | 43 | 52 |
| 31 | Jul | 7.96 | 0.2568 | 0.1027 | 57 | 69 | 43 | 52 |
| 31 | Aug | 7.03 | 0.2268 | 0.0907 | 51 | 61 | 38 | 46 |
| 30 | Sep | 5.15 | 0.1717 | 0.0687 | 38 | 46 | 29 | 34 |
| 31 | Oct | 3.37 | 0.1087 | 0.0435 | 24 | 29 | 18 | 22 |

**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) |

## Precipitation Rate Tables - Low Volume/Drip-Micro Irrigation

### Point Source Emiiters or Micro Spray

(METER FLOW)

AREA IN SQUARE FEET(CANOPY AREA)

| CFM | GPM | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.03 | 0.25 | 0.48 | 0.32 | 0.24 | 0.19 | 0.16 | 0.14 | 0.12 | 0.11 | 0.10 | 0.09 | 0.08 |
| 0.07 | 0.50 | 0.96 | 0.64 | 0.48 | 0.39 | 0.32 | 0.28 | 0.24 | 0.21 | 0.19 | 0.18 | 0.16 |
| 0.10 | 0.75 | 1.44 | 0.96 | 0.72 | 0.58 | 0.48 | 0.41 | 0.36 | 0.32 | 0.29 | 0.26 | 0.24 |
| 0.13 | 1.00 | 1.93 | 1.28 | 0.96 | 0.77 | 0.64 | 0.55 | 0.48 | 0.43 | 0.39 | 0.35 | 0.32 |
| 0.17 | 1.25 | 2.41 | 1.61 | 1.20 | 0.96 | 0.80 | 0.69 | 0.60 | 0.54 | 0.48 | 0.44 | 0.40 |
| 0.20 | 1.50 | 2.89 | 1.93 | 1.44 | 1.16 | 0.96 | 0.83 | 0.72 | 0.64 | 0.58 | 0.53 | 0.48 |
| 0.23 | 1.75 | 3.37 | 2.25 | 1.69 | 1.35 | 1.12 | 0.96 | 0.84 | 0.75 | 0.67 | 0.61 | 0.56 |
| 0.27 | 2.00 | 3.85 | 2.57 | 1.93 | 1.54 | 1.28 | 1.10 | 0.96 | 0.86 | 0.77 | 0.70 | 0.64 |
| 0.30 | 2.25 | 4.33 | 2.89 | 2.17 | 1.73 | 1.44 | 1.24 | 1.08 | 0.96 | 0.87 | 0.79 | 0.72 |
| 0.33 | 2.50 | 4.82 | 3.21 | 2.41 | 1.93 | 1.61 | 1.38 | 1.20 | 1.07 | 0.96 | 0.88 | 0.80 |
| 0.37 | 2.75 | 5.30 | 3.53 | 2.65 | 2.12 | 1.77 | 1.51 | 1.32 | 1.18 | 1.06 | 0.96 | 0.88 |
| 0.40 | 3.00 | 5.78 | 3.85 | 2.89 | 2.31 | 1.93 | 1.65 | 1.44 | 1.28 | 1.16 | 1.05 | 0.96 |
| 0.43 | 3.25 | 6.26 | 4.17 | 3.13 | 2.50 | 2.09 | 1.79 | 1.56 | 1.39 | 1.25 | 1.14 | 1.04 |
| 0.47 | 3.50 | 6.74 | 4.49 | 3.37 | 2.70 | 2.25 | 1.93 | 1.69 | 1.50 | 1.35 | 1.23 | 1.12 |
| 0.50 | 3.75 | 7.22 | 4.82 | 3.61 | 2.89 | 2.41 | 2.06 | 1.81 | 1.61 | 1.44 | 1.31 | 1.20 |
| 0.53 | 4.00 | 7.70 | 5.14 | 3.85 | 3.08 | 2.57 | 2.20 | 1.93 | 1.71 | 1.54 | 1.40 | 1.28 |
| 0.57 | 4.25 | 8.19 | 5.46 | 4.09 | 3.27 | 2.73 | 2.34 | 2.05 | 1.82 | 1.64 | 1.49 | 1.36 |
| 0.60 | 4.50 | 8.67 | 5.78 | 4.33 | 3.47 | 2.89 | 2.48 | 2.17 | 1.93 | 1.73 | 1.58 | 1.44 |
| 0.64 | 4.75 | 9.15 | 6.10 | 4.57 | 3.66 | 3.05 | 2.61 | 2.29 | 2.03 | 1.83 | 1.66 | 1.52 |
| 0.67 | 5.00 | 9.63 | 6.42 | 4.82 | 3.85 | 3.21 | 2.75 | 2.41 | 2.14 | 1.93 | 1.75 | 1.61 |

| CFM | GPM | 325 | 350 | 375 | 400 | 425 | 450 | 475 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 675 | 700 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.03 | 0.25 | | | | | | | | | | | | | | | | |
| 0.07 | 0.50 | 0.15 | 0.14 | 0.13 | 0.12 | 0.11 | 0.11 | 0.10 | 0.10 | 0.09 | 0.09 | 0.08 | | | | | |
| 0.10 | 0.75 | 0.22 | 0.21 | 0.19 | 0.18 | 0.17 | 0.16 | 0.15 | 0.14 | 0.14 | 0.13 | 0.13 | 0.12 | 0.12 | 0.11 | 0.11 | 0.10 |
| 0.13 | 1.00 | 0.30 | 0.28 | 0.26 | 0.24 | 0.23 | 0.21 | 0.20 | 0.19 | 0.18 | 0.18 | 0.17 | 0.16 | 0.15 | 0.15 | 0.14 | 0.14 |
| 0.17 | 1.25 | 0.37 | 0.34 | 0.32 | 0.30 | 0.28 | 0.27 | 0.25 | 0.24 | 0.23 | 0.22 | 0.21 | 0.20 | 0.19 | 0.19 | 0.18 | 0.17 |
| 0.20 | 1.50 | 0.44 | 0.41 | 0.39 | 0.36 | 0.34 | 0.32 | 0.30 | 0.29 | 0.28 | 0.26 | 0.25 | 0.24 | 0.23 | 0.22 | 0.21 | 0.21 |
| 0.23 | 1.75 | 0.52 | 0.48 | 0.45 | 0.42 | 0.40 | 0.37 | 0.35 | 0.34 | 0.32 | 0.31 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.24 |
| 0.27 | 2.00 | 0.59 | 0.55 | 0.51 | 0.48 | 0.45 | 0.43 | 0.41 | 0.39 | 0.37 | 0.35 | 0.33 | 0.32 | 0.31 | 0.30 | 0.29 | 0.28 |
| 0.30 | 2.25 | 0.67 | 0.62 | 0.58 | 0.54 | 0.51 | 0.48 | 0.46 | 0.43 | 0.41 | 0.39 | 0.38 | 0.36 | 0.35 | 0.33 | 0.32 | 0.31 |
| 0.33 | 2.50 | 0.74 | 0.69 | 0.64 | 0.60 | 0.57 | 0.54 | 0.51 | 0.48 | 0.46 | 0.44 | 0.42 | 0.40 | 0.39 | 0.37 | 0.36 | 0.34 |
| 0.37 | 2.75 | 0.81 | 0.76 | 0.71 | 0.66 | 0.62 | 0.59 | 0.56 | 0.53 | 0.50 | 0.48 | 0.46 | 0.44 | 0.42 | 0.41 | 0.39 | 0.38 |
| 0.40 | 3.00 | 0.89 | 0.83 | 0.77 | 0.72 | 0.68 | 0.64 | 0.61 | 0.58 | 0.55 | 0.53 | 0.50 | 0.48 | 0.46 | 0.44 | 0.43 | 0.41 |
| 0.43 | 3.25 | 0.96 | 0.89 | 0.83 | 0.78 | 0.74 | 0.70 | 0.66 | 0.63 | 0.60 | 0.57 | 0.54 | 0.52 | 0.50 | 0.48 | 0.46 | 0.45 |
| 0.47 | 3.50 | 1.04 | 0.96 | 0.90 | 0.84 | 0.79 | 0.75 | 0.71 | 0.67 | 0.64 | 0.61 | 0.59 | 0.56 | 0.54 | 0.52 | 0.50 | 0.48 |
| 0.50 | 3.75 | 1.11 | 1.03 | 0.96 | 0.90 | 0.85 | 0.80 | 0.76 | 0.72 | 0.69 | 0.66 | 0.63 | 0.60 | 0.58 | 0.56 | 0.54 | 0.52 |
| 0.53 | 4.00 | 1.19 | 1.10 | 1.03 | 0.96 | 0.91 | 0.86 | 0.81 | 0.77 | 0.73 | 0.70 | 0.67 | 0.64 | 0.62 | 0.59 | 0.57 | 0.55 |
| 0.57 | 4.25 | 1.26 | 1.17 | 1.09 | 1.02 | 0.96 | 0.91 | 0.86 | 0.82 | 0.78 | 0.74 | 0.71 | 0.68 | 0.65 | 0.63 | 0.61 | 0.58 |
| 0.60 | 4.50 | 1.33 | 1.24 | 1.16 | 1.08 | 1.02 | 0.96 | 0.91 | 0.87 | 0.83 | 0.79 | 0.75 | 0.72 | 0.69 | 0.67 | 0.64 | 0.62 |
| 0.64 | 4.75 | 1.41 | 1.31 | 1.22 | 1.14 | 1.08 | 1.02 | 0.96 | 0.91 | 0.87 | 0.83 | 0.80 | 0.76 | 0.73 | 0.70 | 0.68 | 0.65 |
| 0.67 | 5.00 | 1.48 | 1.38 | 1.28 | 1.20 | 1.13 | 1.07 | 1.01 | 0.96 | 0.92 | 0.88 | 0.84 | 0.80 | 0.77 | 0.74 | 0.71 | 0.69 |

** Obtain flow to the area by reading water meter.  Calculate canopy area using Ewing's "16 point" measuring system for irregularly shaped areas.*

## In-Line Drip Tubing Flow Precipitation Rates (Netafim)

| GENERAL GUIDELINES | TURF | | | | | | | | | | | | SHRUB & GROUNDCOVER | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CLAY SOIL | | | LOAM SOIL | | | SANDY SOIL | | | COARSE SOIL | | | CLAY SOIL | | | LOAM SOIL | | | SANDY SOIL | | | COARSE SOIL | | |
| EMITTER FLOW | 0.26 GPH | | | 0.4 GPH | | | 0.6 GPH | | | 0.9 GPH | | | 0.26 GPH | | | 0.4 GPH | | | 0.6 GPH | | | 0.9 GPH | | |
| EMITTER SPACING | 18" | | | 12" | | | 12" | | | 12" | | | 18" | | | 18" | | | 12" | | | 12" | | |
| LATERAL (ROW) SPACING | 18" | 20" | 22" | 18" | 20" | 22" | 12" | 14" | 16" | 12" | 14" | 16" | 18" | 21" | 24" | 18" | 21" | 24" | 16" | 18" | 20" | 16" | 18" | 20" |
| BURIAL DEPTH | Bury evenly throughout the zone from 4" to 6" | | | | | | | | | | | | On-surface or bury evenly throughout the zone to a maximum of 6" | | | | | | | | | | | |
| APPLICATION RATE (INCHES/HOUR) | 0.19 | 0.17 | 0.15 | 0.45 | 0.41 | 0.37 | 0.96 | 0.83 | 0.72 | 1.44 | 1.24 | 1.08 | 0.19 | 0.16 | 0.14 | 0.29 | 0.24 | 0.21 | 0.72 | 0.64 | 0.58 | 1.08 | 0.96 | 0.87 |
| TIME TO APPLY ¼" OF WATER (MINUTES) | 81 | 90 | 99 | 33 | 37 | 41 | 16 | 18 | 21 | 10 | 12 | 14 | 81 | 94 | 108 | 53 | 61 | 70 | 21 | 23 | 26 | 14 | 16 | 17 |

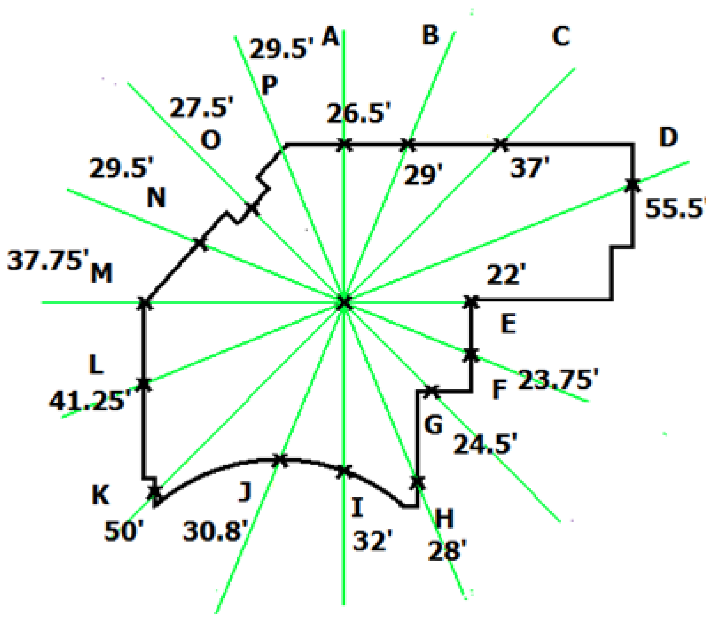
Following these maximum spacing guidelines, emitter flow selection can be increased if desired by the designer.
0.9 GPH flow rate available for areas requiring higher infiltration rates, such as coarse sandy soils.

Note: 0.4, 0.6 and 0.9 GPH are nominal flow rates. Actual flow rates used in the calculations are 0.42, 0.61 and 0.92 GPH.

## Measuring irregularly shaped drip zone canopy

When the geometry of an area is complex, the area can be measured by treating it as a circle. The formula for the area of a circle is Pi (3.14) x radius (squared) = A. We can determine the average radius of any shape by measuring the distance from near the center to the perimeter 16 times using a 100 foot tape. We then total these measurements and divide by 16 to obtain the average.

In the field use a fabricated 2 x 2 plywood sheet with a hole in the center for a screwdriver and place this sheet near the approximate center of the area to be measured. Create 16 permanent radii from the center at 22.5 degree increments on the plywood sheet. Use these as a guide and measure to the perimeter.




| | |
|---|---|
| A | 26.5' |
| B | 29' |
| C | 37' |
| D | 55.5' |
| E | 22' |
| F | 23.75' |
| G | 24.5' |
| H | 28' |
| I | 32' |
| J | 30.8' |
| K | 50' |
| L | 41.25' |
| M | 37.75' |
| N | 29.5' |
| O | 27.5' |
| P | 29.5' |

**524.55**

**524.55 /16 = 32.78**

**Figure 1- Measuring an irregularly shaped landscape area**

For simplicity of calculation inches are converted to a decimal equivalent. A conversion chart for inches to decimal equivalent may be found on the right side of the table on the reverse side of this page.

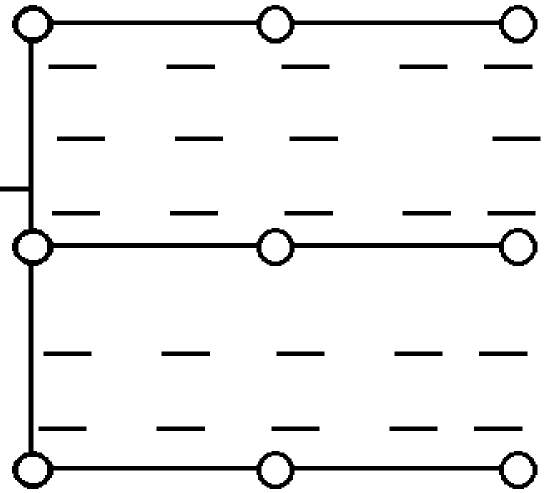
This shape has a total of 524.55 feet. The average radius is therefore 32.78 (524.5/16). Find the average radius on the reverse table. We have to interpolate to determine that the area is 3,346 sq. ft

| Conversion Chart - Average Radius to Square Feet (16 radii minimum) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Avergage Radius (feet) | Area (square feet) | Avergage Radius (feet) | Area (square feet) | Avergage Radius (feet) | Area (square feet) | Avergage Radius (feet) | Area (square feet) |
| 10.00 | 314 | 22.00 | 1,521 | 43.00 | 5,809 | 66.50 | 13,893 |
| 10.25 | 330 | 22.50 | 1,590 | 43.50 | 5,945 | 66.00 | 13,685 |
| 10.50 | 346 | 22.75 | 1,626 | 44.00 | 6,082 | 66.50 | 13,893 |
| 10.75 | 363 | 23.00 | 1,662 | 44.50 | 6,221 | 67.00 | 14,103 |
| 11.00 | 380 | 23.25 | 1,698 | 45.00 | 6,362 | 67.50 | 14,314 |
| 11.25 | 398 | 23.50 | 1,735 | 45.50 | 6,504 | 68.00 | 14,527 |
| 11.50 | 415 | 23.75 | 1,772 | 46.00 | 6,648 | 68.50 | 14,741 |
| 11.75 | 434 | 24.00 | 1,810 | 46.50 | 6,793 | 69.00 | 14,957 |
| 12.00 | 452 | 24.25 | 1,847 | 47.00 | 6,940 | 69.50 | 15,175 |
| 12.25 | 471 | 24.50 | 1,886 | 47.50 | 7,088 | 70.00 | 15,394 |
| 12.50 | 491 | 24.75 | 1,924 | 48.00 | 7,238 | 70.50 | 15,615 |
| 12.75 | 511 | 25.00 | 1,963 | 48.50 | 7,390 | 71.00 | 15,837 |
| 13.00 | 531 | 25.50 | 2,043 | 49.00 | 7,543 | 71.50 | 16,061 |
| 13.25 | 552 | 26.00 | 2,124 | 49.50 | 7,698 | 72.00 | 16,286 |
| 13.50 | 573 | 26.50 | 2,206 | 50.00 | 7,854 | 72.50 | 16,513 |
| 13.75 | 594 | 27.00 | 2,290 | 50.50 | 8,012 | 73.00 | 16,742 |
| 14.00 | 616 | 27.50 | 2,376 | 51.00 | 8,171 | 73.50 | 16,972 |
| 14.25 | 638 | 28.00 | 2,463 | 51.50 | 8,332 | 74.00 | 17,203 |
| 14.50 | 661 | 28.50 | 2,552 | 52.00 | 8,495 | 74.50 | 17,437 |
| 14.75 | 683 | 29.00 | 2,642 | 52.50 | 8,659 | 75.00 | 17,671 |
| 15.00 | 707 | 29.50 | 2,734 | 53.00 | 8,825 | 75.50 | 17,908 |
| 15.25 | 731 | 30.00 | 2,827 | 53.50 | 8,992 | 76.00 | 18,146 |
| 15.50 | 755 | 30.50 | 2,922 | 54.00 | 9,161 | 76.50 | 18,385 |
| 15.75 | 779 | 31.00 | 3,019 | 54.50 | 9,331 | 77.00 | 18,627 |
| 16.00 | 804 | 31.50 | 3,117 | 55.00 | 9,503 | 77.50 | 18,869 |
| 16.25 | 830 | 32.00 | 3,217 | 55.50 | 9,677 | 78.00 | 19,113 |
| 16.50 | 855 | 32.50 | 3,318 | 56.00 | 9,852 | 78.50 | 19,359 |
| 16.75 | 881 | 33.00 | 3,421 | 56.50 | 10,029 | 79.00 | 19,607 |
| 17.00 | 908 | 33.50 | 3,526 | 57.00 | 10,207 | 79.50 | 19,856 |
| 17.25 | 935 | 34.00 | 3,632 | 57.50 | 10,387 | 80.00 | 20,106 |
| 17.50 | 962 | 34.50 | 3,739 | 58.00 | 10,568 | | |
| 18.00 | 1,018 | 35.00 | 3,848 | 58.50 | 10,751 | Decimal Equival. | |
| 18.25 | 1,046 | 35.50 | 3,959 | 59.00 | 10,936 | inches | decimal |
| 18.50 | 1,075 | 36.00 | 4,072 | 59.50 | 11,122 | | |
| 18.75 | 1,104 | 36.50 | 4,185 | 60.00 | 11,310 | 1 | 0.08 |
| 19.00 | 1,134 | 37.00 | 4,301 | 60.50 | 11,499 | 2 | 0.17 |
| 19.25 | 1,164 | 37.50 | 4,418 | 61.00 | 11,690 | 3 | 0.25 |
| 19.50 | 1,195 | 38.00 | 4,536 | 61.50 | 11,882 | 4 | 0.33 |
| 19.75 | 1,225 | 38.50 | 4,657 | 62.00 | 12,076 | 5 | 0.42 |
| 20.00 | 1,257 | 39.00 | 4,778 | 62.50 | 12,272 | 6 | 0.50 |
| 20.25 | 1,288 | 39.50 | 4,902 | 63.00 | 12,469 | 7 | 0.58 |
| 20.50 | 1,320 | 40.00 | 5,027 | 63.50 | 12,668 | 8 | 0.67 |
| 20.75 | 1,353 | 40.50 | 5,153 | 64.00 | 12,868 | 9 | 0.75 |
| 21.00 | 1,385 | 41.00 | 5,281 | 64.50 | 13,070 | 10 | 0.83 |
| 21.25 | 1,419 | 41.50 | 5,411 | 65.00 | 13,273 | 11 | 0.92 |
| 21.50 | 1,452 | 42.00 | 5,542 | 65.50 | 13,478 | | |
| 21.75 | 1,486 | 42.50 | 5,675 | 66.00 | 13,685 | c. 2009 Ewing Irrigation Produ | |

Once the canopy area of a specific drip irrigation zone has been measured, the flow to the zone must be obtained by operating the zone from the irrigation controller. Proceed to the water meter and observe the flow to the zone as the station is running. Allow a couple of minutes for the tubing to fill and come to full pressure before reading flow at the meter. Proceed to the precipitation rate chart and derive the precipitation rate by matching area in square feet to meter flow in cubic feet per minute (CFM)

Also insure that there is adequate pressure to the last (and or highest) elevation emitter in the zone. Minimum psi for pressure compensating emitters is 10 psi and for drip line 15 psi.

## Spray Circuit - Audit Run Time (4 minutes)



psi: ____

gpm: ____

cfm: ____

Driest 6 catches: ____ ____ ____ ____ ____ ____

Total: ____

Avg. (total divided by 6): ____

psi: ____

Total of 24 catch readings: ____

avg.(total divided by 24): ____

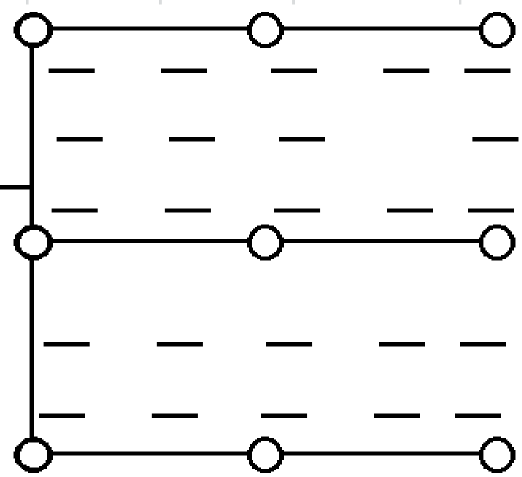
$DU_{LQ}$ = dry 6 / avg of 24: ____ / ____

$DU_{LQ}$: ____

PR $= \frac{3.66 \times V_{avg}}{t_r \times 16.5}$

PR: ____

## Rotating Stream Circuit - Audit Run Time (10 minutes)



psi: ____

gpm: ____

cfm: ____

Driest 6 catches: ____ ____ ____ ____ ____ ____

Total: ____

Avg. (total divided by 6): ____

psi: ____

Total of 24 catch readings: ____

avg.(total divided by 24): ____

$DU_{LQ}$ = dry 6 / avg of 24: ____ / ____

$DU_{LQ}$: ____

PR $= \frac{3.66 \times V_{avg}}{t_r \times 16.5}$

PR: ____

Estimating Irregularly shaped Areas

Measurement

| | |
|---|---|
| A | |
| B | |
| C | |
| D | |
| E | |
| F | |
| G | |
| H | |
| I | |
| J | |
| K | |
| L | |
| M | |
| N | |
| O | |
| P | |
| | |
| TOTAL | |
| AVG/16 | |
| SQ. FT | |
| | |
| METER | |
| FLOW | |
| CFM | |
| | |
| PR Rate | |


**EMITTER FLOW (TIME TO FILL 2" CAP)**

| EMITTER TYPE | GPH | FILL TIME |
|---|---|---|
| POINT SOURCE | 2.00 | 56 SECONDS |
| POINT SOURCE | 1.00 | 1 MIN 52 SECONDS |
| LINE SOURCE | 0.92 | 2 MIN 2 SECONDS |
| LINE SOURCE | 0.61 | 3 MIN 4 SECONDS |
| POINT SOURCE | 0.50 | 3 MIN 45 SECONDS |
| LINE SOURCE | 0.42 | 4 MIN 26 SECONDS |

The water meter is an important management tool during the drought. As a landscape professional you can provide a very important service for your customers by monitoring their water use. If you are performing landscape maintenance at a site, then you are visiting it on a weekly basis and it will take just a few minutes to provide this service. Your primary objective in this regard is to look for leaks. Open the valve meter box when you arrive for maintenance and watch the meter for a few moments. There is a low flow indicator on the meter. If the meter is not dedicated to the landscape there may be a flow of potable to the residence or building. Try to check for leaks when no one is present in the building. If the irrigation system is off and no one is home the low flow indicator should not be moving. Observe it for a few seconds to see if it is turning. It may not be turning, but there still may be a leak. Note the position of the needle and the reading on the total flow which looks like a car's odometer. Check this before you leave the site to see if there has been any flow during your maintenance period. <u>Calculate the flow of the leak per hour and multiply by 8,760 (hours per year to determine the amount of water loss per year</u>.

At each maintenance visit check the low flow indicator and the position of the needle and total flow to determine if there is a slow leak. Take a digital image with your phone camera to document any leaks as well as the meter number. This is a great low cost service that you can provide to your customers during the drought!

The water meter is usually located between the curb and the backflow prevention device. Most commercial sites have dedicated landscape meters but this is not always the case. Meters record water volume in gallons or cubic feet, but most water agencies provide meters that record in cubic feet. A cubic foot of water is 7.48 gallons and is a 12"x12"x12" cube. Customers are billed in what is known as ccf's or hundred cubic foot units of 748 gallons.


Each full revolution of the dial on commercial meters (1 ½" and larger) represents a flow of ten cubic feet or 74.8 gallons


Each full revolution of the dial on a residential meter (5/8", 3,4" and 1") represents a flow of one cubic foot or 7.48 gallons

The water meter limits the amount of water that can be delivered to the site. Most irrigation systems were designed with the expectation that they would apply water anywhere from three to seven days per week. Take the system that in non-drought years was able to water six days per week and nine hours per day in the month of July. This is a total watering time of 3,240 minutes (6 x 9 x 60). Let's assume this is a 2" meter providing 50 gallons per minute. Under these conditions the meter could provide up to 162,000 gallons per week. (This 50 gpm flow is an average as some stations such as drip have far less flow and others such as large turf rotors have more)

Now, transition to a drought where watering is allowed two days per week for a maximum of thirty hours per week. The amount of water that could be delivered to the site would be 90,000 gallons (1,800 minutes x 50 = 90,000. Given this shortfall it is likely the site manager will have to set priorities on landscape watering and it is possible that some areas of the landscape may not survive. Invest the landscape water in large trees and shrubs which have the greatest value in the landscape!

## Managing Landscape Water in the Drought of 2015 – Meeting your conservation goal

The State Water Resources Control Board has directed Water Suppliers throughout California to reduce their water use dramatically in 2015. Each district has been charged with a goal for reducing water use and it varies by district from 4 to 36%. The secret to achieving these reduction goals is to establish realistic expectations about what can be achieved in the landscape. In many cases significant areas of the landscape may have to be sacrificed to save higher value plant material such as trees.

Understand that the reductions in water use must take place immediately! Furthermore, the amount of landscape that can be irrigated in early spring will be far less than in the warmest month which is July. The $ET_L$ or plant water requirement for cool season turf is only 4.06" per month in May in Stockton. In July, the $ET_L$ is 4.78". Don't water any more square footage of landscape in May than you can keep alive in July. It is simply a waste of water!

In order to set meaningful goals you'll need the site water bills for 2013 and the square footage of the landscape. Let's work an example to help illustrate the process. Review the water bill for July 2013 and determine the CCF's or billing units of water used at the site. (A billing unit is 100 cubic feet or 748 gallons). Let's assume in this example the site water use is 40 units of water in July for this residential estate. You have been directed to reduce water use by 36%! Determine the water use goal for July 2015 and then we will determine how many square feet can be irrigated. We'll determine the new water use goals by factoring 64% against 40 units which is 25.6 units.(40 x 0.64 = 25.6) Twenty five point six (25.6) units of water is 19, 148 gallons. (25.6 x 748 = 19,148). Our 2013 use was 40 units or 29,920 gallons (40 x 748 = 29,920). The amount of water that must be saved is the difference between 2013 use 29,948 and 2015 goal of 19,148. **The amount of water that must be eliminated from July 2015 consumption is 10,771 gallons.**

All we have to understand now is how many gallons are required to keep one foot of either turf or ornamentals alive at marginal quality in July. We use the average $ET_O$ for the month of July from CIMIS station #70, Manteca. We reduce the requirement for the plant material to account for the landscape coefficient and then increase according to an average $DU_{LQ}$ (uniformity of coverage) for the sprinklers. We then convert inches to gallons per square foot.

| | | | | 56% $DU_{LQ}$ | 72% $DU_{LQ}$ | 90% $DU_{LQ}$ |
|---|---|---|---|---|---|---|
| Turf (cool season | 7.96 | 0.6 | 4.776 | 6.50<br>(4.536 x 1.36) | 5.73<br>(4.746" x 1.20) | |
| Ornamentals | 7.96 | 0.4 | 3.184 | | | 3.38<br>(3.024" x 1.06) |

| Gallons per square foot per month (inches x 0.6234) | | |
|---|---|---|
| $DU_{LQ}$ | | |
| Sprays at 56% | 4.05 | for cs turf |
| Rotating Stream at 72% | 3.57 | for cs turf |
| Drip at 90% | 2.10 | for ornamentals |

**Managing Landscape Water in the Drought of 2015 – Meeting your conservation goal!**

Let's assume that the entire site is sprays with the typical uniformity shown. The water requirement is 4.05 gallons per square foot and the amount to be saved is 10, 771 gallons. Simply divide the 10,771 by 4.05 which is 2,659 square feet of turf you'll have to eliminate from irrigation in 2015 starting now!

Another way to look at it is that you have an allocation of 19,148 gallons. How many square feet could be maintained with this water in July? The answer is 19,148 divided by 4.05 gal / sq. ft. which is **4,727 square feet.**

Now let's assume you upgrade to MP Rotators and improve the uniformity from 56% with sprays to 72%. You'll be able to keep more area alive. The 19,148 gallons would irrigate more area due to the higher uniformity for an area of **5,363 square feet!** (19,148 / 3.30 = 5,363 sq ft). Same amount of water, but a more efficient use of water due to the higher uniformity of this sprinkler type.

***One thing to keep in mind is that you should not turn off lawn in a wholesale fashion as there are often trees in these lawns, that when deprived of lawn water will die. In these cases turn off all the nozzles except those under the canopy of the trees***

Ultimately the accuracy of this technique relies on careful site measurement. Utilize web sites such as google maps or Go I Lawn to remotely measure or utilize Ewing's 16 point measurement method for irregular shapes.