Redwood City - Water Budget Methodology

Introduction:

This document represents the current methodology for calculating water budgets for landscape irrigation and residential water utility accounts in Redwood City. This methodology is subject to change due to changes in water supply, drought, state regulation, or local policy.

Background:

Redwood City water budgets are based on the Landscape Coefficient Method that is the standard of the Green Industry. It is endorsed by the Irrigation Association, California Landscape Contractors Association, California Urban Water Conservation Council, and over 300 water agencies as the best methodology for identifying and maximizing landscape irrigation efficiency. Water Budgets are calculated daily for the previous day utilizing weather data retrieved from external web services. At the end of a consumption period the water budgets calculated for each day in the period are added to provide a sum total water budget used by the billing system.

Water Budget Definitions & Variables:

Variable	Definition	Redwood City Value
BUDGET =	Volume of water budgeted for a given hydrozone area for a given period. The overall water use budget for a site is the sum of budgets over all hydrozones.	
AREA =	Landscape area irrigated in hydrozone (square feet).	A_T or A_N or A_W
A_T	Turfgrass area in square feet	site measurement
A_N	Non-Turf area in square feet	site measurement
A_W	Water Feature area in square feet	site measurement
K_S =	Species or plant factor relating a specific plant type's water requirements as a fraction of ETo.	K_{ST} or K_{SN} or K_{SW}
K_{ST} =	Turfgrass water requirement default value	0.8
K_{SN} =	Non-Turf water requirement default value	0.4
K_{SW} =	Water Feature water requirement default value	1.2
ETo =	Reference evapotranspiration (inches) equals the depth of water evaporated and transpired from a reference crop (4 to 7 inch tall fescue grass) with an abundant water supply. ETo is the "standard" measure of water needs from which other plant types are compared via K_S. Redwood City uses ETo from CIMIS weather stations. CIMIS weather data is accessed through the CIMIS Web API and REST Services more information is available at http://et.water.ca.gov/	by CIMIS (period aggregate)
ERain =	Effective rainfall (inches) equals the depth of rain effective in offsetting ETo for each hydrozone. Effective rainfall varies	by WeatherUnderground

	widely with rainfall frequency, magnitude, time of year, and root zone depth. Redwood City uses rainfall data from Weather Underground (WU). WU data is accessed through the WU API more information is available at http://www.wunderground.com/weather/api	(period aggregate)
NIR	Net Irrigation Requirement: The amount of water required in a hydrozone that is not provided by rainfall. NIR is calculated for each day, based on weather data downloaded from specified weather websites. NIR is calculated for both turf and non-turf surfaces, since these surfaces have different water storage characteristics, and thus differing requirements for irrigation. NIR is a function of daily precipitation and daily reference evapotranspiration.	Function >= 0
IE =	Irrigation Efficiency measures the percent of applied water that is beneficially used by plants. All irrigation systems have some inefficiencies as water is lost as runoff, overspray, or percolates past the root zone.	IE_T or IE_N
IE_T =	Irrigation Efficiency for Turf (value determined and inputted by Redwood City)	i.e. 0.5 to 0.65
IE_N =	Irrigation Efficiency for Turf default value	0.8
C_1 =	Conversion factor putting the water budget into gallons.	0.623
C_2 =	Conversion factor putting the water budget in into hundred cubic feet (ccf).	748
R =	Number of fulltime residents (default = 2, provided by customer and validated by City)	2
R_W	Volume of water allocated to 1 resident per day	57.6
DPP =	Days per period is the total days in a billing period/consumption cycle (when calculating a budget for a single day DPP = 1)	calculated
SN=	Special Needs in gallons per day	

Net Irrigation Requirement Function:

NIR_T is calculated for turfgrass using the logic below and the max soil constant for turf.
NIR_N is calculated for non-Turf using the logic below and the max soil constant for non-turf

NIR(d) = ETo(d) - ERain(d) - SoilStorage(d-1) *minimized to 0, where*
ERain(d) = Min(Precip(d), (MaxSoilConstant + ETo(d) - SoilStorage(d-1)))
SoilStorage(d) = Min(MaxSoilConstant, (Precip(d) - ETo(d) + SoilStorage(d-1))) *minimized to 0*
Precip(d) = *Rainfall for day d, measured using tipping bucket rain gauges*
MaxSoilConstant (turf) = 0.45 inches
MaxSoilConstant (non-turf) = 0.90 inches

Irrigation Only Budget Formula:

$$BUDGET = [TURF + NON\_TURF + WATER\_FEATURE] / C_2$$

$$TURF = A_T * \left(\frac{K_T * NIR_T}{IE_T} \right) * C_1$$

$$NON\_TURF = A_N * \left(\frac{K_N * NIR_N}{IE_N} \right) * C_1$$

$$WATER\_FEATURE = A_W * \left(K_W * NIR_N \right) * C_1$$

Residential Budget Formula:

$$BUDGET = [INDOOR + TURF + NON\_TURF + WATER\_FEATURE + SPECIAL\_NEEDS] / C_2$$

$$INDOOR = R * R_W * DPP$$

$$TURF = A_T * \left(\frac{K_T * NIR_T}{IE_T} \right) * C_1$$

$$NON\_TURF = A_N * \left(\frac{K_N * NIR_N}{IE_N} \right) * C_1$$

$$WATER\_FEATURE = A_W * \left(K_W * NIR_N \right) * C_1$$

$$SPECIAL\_NEEDS = SP * DPP$$