2014 WATER-ENERGY GRANT PROGRAM GRANT APPLICATION

SACRAMENTO STATE TURF AND IRRIGATION REPLACEMENT

ATTACHMENT 2

WATER AND ENERGY SAVINGS AND GHG CALCULATIONS

CALCULATION BACK-UP

Water Savings

Because the Sacramento State campus does not have a way to accurately measure the water being used for each irrigation zone, we will use the state of California Model Water Efficient Landscape Ordinance methodology to calculate water savings that we can expect to experience in the renovated turf sites. As part of the methodology, we will use plant factors for the Water Use Classifications of Landscape Species (WUCOLS) from the University of California Cooperative Extension and the State of California Department of Water Resources. Website links for each are:

http://ucanr.edu/sites/WUCOLS/Download_WUCOLS_IV_List/
http://www.water.ca.gov/wateruseefficiency/landscapeordinance/

Estimated total water usage (ETWU) = [(ETo)(0.62)(PF)(HA)]/IE = GAL/YEAR

ETo	=	Reference Evapotranspiration in Sacramento (inches) - 51.9 inch/yr
PF	=	Plant Factor from WUCOLS
HA	=	Hydrozone Area (square feet)
0.62	=	Conversion Factor
IE	=	Irrigation Efficiency

In the existing turf-based landscape and irrigation system, the estimated total water usage (ETWU) for 350,000 square feet of mowed lawn (PF=0.8) with a traditional spray irrigation system (IE=0.63) is approximately 14.3 MG/year.

[(51.9)(0.62)(0.8)(350,000)]/0.63 = 14,301,333 gal/year

In the renovated landscape and irrigation system, the estimated total water usage (ETWU) for 350,000 square feet of low-water-use plant material (PF=0.2) with high efficiency irrigation (IE=0.8) is approximately 2.8 MG/year.

[(51.9)(0.62)(0.2)(350,000)]/0.80 = 2,815,575 gal/year

Total water savings resulting from the project would be 11,485,758 gallons per year (rounded down to 11.4 MG/year).

For the proposal worksheet, the volume of water delivered after the project is completed is the current amount of irrigation water use minus the anticipated savings.

92.5 -11.4 = 81.1 MG/yr

Based on these calculations, the reduction in water use in the turf sites being renovated in this project would be about 80 percent, which represents about 12 percent of the total campus irrigation demand.

Pumping Electricity Savings

The existing campus irrigation wells do not have electrical meters. Consequently, the energy intensity must be calculated as shown below. The water depth in the wells and pipe pressure are typical current values.

Energy required to pump irrigation water	
9.25E+07	gal/yr of irrigation water (2013 data)
7.48	gal/ft^3
1.24E+07	ft^3/yr water volume per year
62.4	lb/ft^3
7.72E+08	lb/yr water weight per year
35	ft average static lift for the campus wells
60	psi pressure in the current pipe system (typ.) (Friction losses assumed to be small)
173	ft total head
1.34E+11	ft-lb per year to move water
0.55	assumed overall plant efficiency (pump + motor) Sources: www.edrgroup.com/pdf/pumptest.pdf (Table 3) and www.ext.colostate.edu/pubs/crops/04712.pdf (Data for Sacramento State campus pumps are not available.)
2.43E+11	ft-lb per year electrical energy required
3.77E-07	kwh/ft-lb conversion factor
91,652	kwh per yr electricity requirement
991	kwh/MG

Energy Savings from Cessation of Mowing

The energy savings from reduced use of mechanized maintenance equipment, mainly mowers, is calculated in this section. The amount of fuel used per acre of turf on campus is not known, so a calculation based on published values is used. After the fuel savings are calculated, an energy production efficiency factor is used to calculate the electrical energy that could be produced from this amount of fuel. This results in a number that is equivalent to the pump electrical demand value for insertion in the worksheet.

Estimate of fuel saved by reduced mowing			
A	1.2	gal/ac	based on golf course uses (http://archive.lib.msu.edu/tic/holen/article/2010apr7.pdf).
B	1.25		Assumed factor to account for the relative inefficiency of mowing small areas on a college campus compared to a golf course.
C	38	Mowings/yr	Current practice
D	57	gal/ac/yr	from multiplying A*B*C
E	8.03	acres	turf to be replaced
F	458	gal/yr	from D*E
Estimate of equivalent electrical energy from fuel saved			
G	124,000	BTU/gal	Energy content of gasoline Source: http://www.engineeringtoolbox.com/energy-content-d_868.html
H	10,991	BTU/kwh	Electrical energy production efficiency for petroleum fuels Source: http://www.eia.gov/electricity/annual/html/epa_08_01.html
I	5164	kwh/yr	from F*G/H

Project Life

Assigning a useful project life to landscaping is difficult. The large shade trees that will be planted can live for 100+ years. The current campus irrigation system is more than 40 years old and needs to be upgraded. This is the basis for choosing 40 years as the project life.