

Summary Report for
Cooperative Agreement No. 07-FC-40-2633
Urban Conservation Opportunity Efficient Turf irrigation
Northern Colorado Water Conservancy District
Berthoud, CO
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Photograph of the study site at the Northern Colorado Water Conservancy District

Project Summary:

Studies indicate that in the Western United States., 50 to 70 percent of the water used in cities and towns is applied to irrigate landscapes. These studies also show that landscape irrigators (professionals and homeowners) are using up to twice as much water as the plants require. Translated, this means that potentially one-fourth to one-third of the water delivered from U.S. Bureau of Reclamation projects to cities and towns is wasted. In relation to agricultural water use, this amount of water is small, but the value of urban water is much higher. Urban water crises impact the lives of millions of individuals and can result in dire consequences. The Urban Conservation Opportunity Efficient Turf Irrigation project will evaluate a methodology to help define the seasonal water needs for a variety of turf grasses much like work that has been done for agricultural crops grown in the Western United States.

Project Methods:

Eight plots were established with different turf grass mixes in 2008 (Table 1) at the Conservation Gardens at Northern Water in Berthoud, CO. The official soil series at the Conservation Gardens is a Nunn clay loam, 0 to 1 percent slope, although soil tests indicated a silty clay soil texture.

Because the Conservation Gardens site is relatively new, many problem areas in the Conservation Gardens had not yet been discovered and fixed. In the initial stages of this project, severe drainage problems in the heavy silty clay soil postponed grass establishment and data collection. Timing of fund receipts also caused project delays. The valve boxes were excavated in 2008 and non-permeable membranes installed to alleviate concerns that standing water in the valve boxes might influence the soil moisture levels in each subplot. Dividers between the plots were also installed to prevent irrigation or precipitation runoff from each subplot. The valve boxes additionally were sealed from surface runoff in 2009. The encoders on each water meter were also replaced in 2009. The soil moisture sensor controlling irrigation was replaced in the Foothills Mix plot in 2009.

The project was considered fully operational in 2009. Each plot had a flow meter, three rain gauges, and two soil moisture sensors installed at the 5" depth. Irrigations were closely monitored in 2009 and no standing water was observed.

However, three plots (WSCS Mix, Carefree Mix, and Nature's Choice) were later discovered to not have the grass mix advertised and were reseeded in the Fall of 2009. Results from these plots are not presented.

Table 1

Turf Grass	Grasses in Mix				
Reveille Texas Bluegrass	100% Reveille				
Carefree Mix (reseeded) (AVS)*	35% Chewings Fescue	30% Creeping Red Fescue	25% Hard Fescue	10% Blue Fescue	
Canada blue fescue (AVS)	25% Blue Fescue	25% Creeping Red Fescue	25% Hard Fescue	15% Reubens Canada Bluegrass	10% Chewings fescue
Forever Green (PVC)	50% Perennial Ryegrass	30% Tufted Hairgrass	20% Kentucky Bluegrass		
WSC S Mix (reseeded)	50% Blue Grama	50% Streambank Wheatgrass			
Low Grow Mix (PVC)	25% Creeping Red Fescue	25% Kentucky Bluegrass	20% Perennial Ryegrass	20% Hard Fescue	10% Chewings fescue
Natures Choice (reseeded) (AVS)	70% Ephraim Crested Wheatgrass	15% Sheep Fescue	10% Perennial Ryegrass	5% Kentucky Bluegrass	
Foothills Mix (PVC)	30% Dwarf Type Tall Fescue	20% Hard Fescue	30% Perennial Ryegrass	10% Annual Ryegrass	10% Kentucky Bluegrass

*Seed sources: AVS = Arkansas Valley Seed, PVC = Poudre Valley Coop

. Project Results:

A soil water balance was calculated for each grass mix, assuming no runoff. Soil moisture data indicated that field capacity of the soil was never attained, so conditions of zero drainage were assumed. Because this soil is very heavy and somewhat restrictive, it was assumed that these relatively fine-rooted grasses had the preponderance of their roots in the top 8 inches. Turf evapotranspiration (ET) on a daily basis was calculated as the residual of the soil water balance, using effective precipitation and irrigation (precipitation or irrigation $\geq 0.2 \cdot ETo$, Allen et al. 1998) in the soil water balance. ETo was the Standardized Grass Reference ET (ASCE-EWRI, 2004). Preliminary results show that the Low Grow Mix used the most water at 27.5 inches between May 1 and Oct 31, 2009 (Table 2).

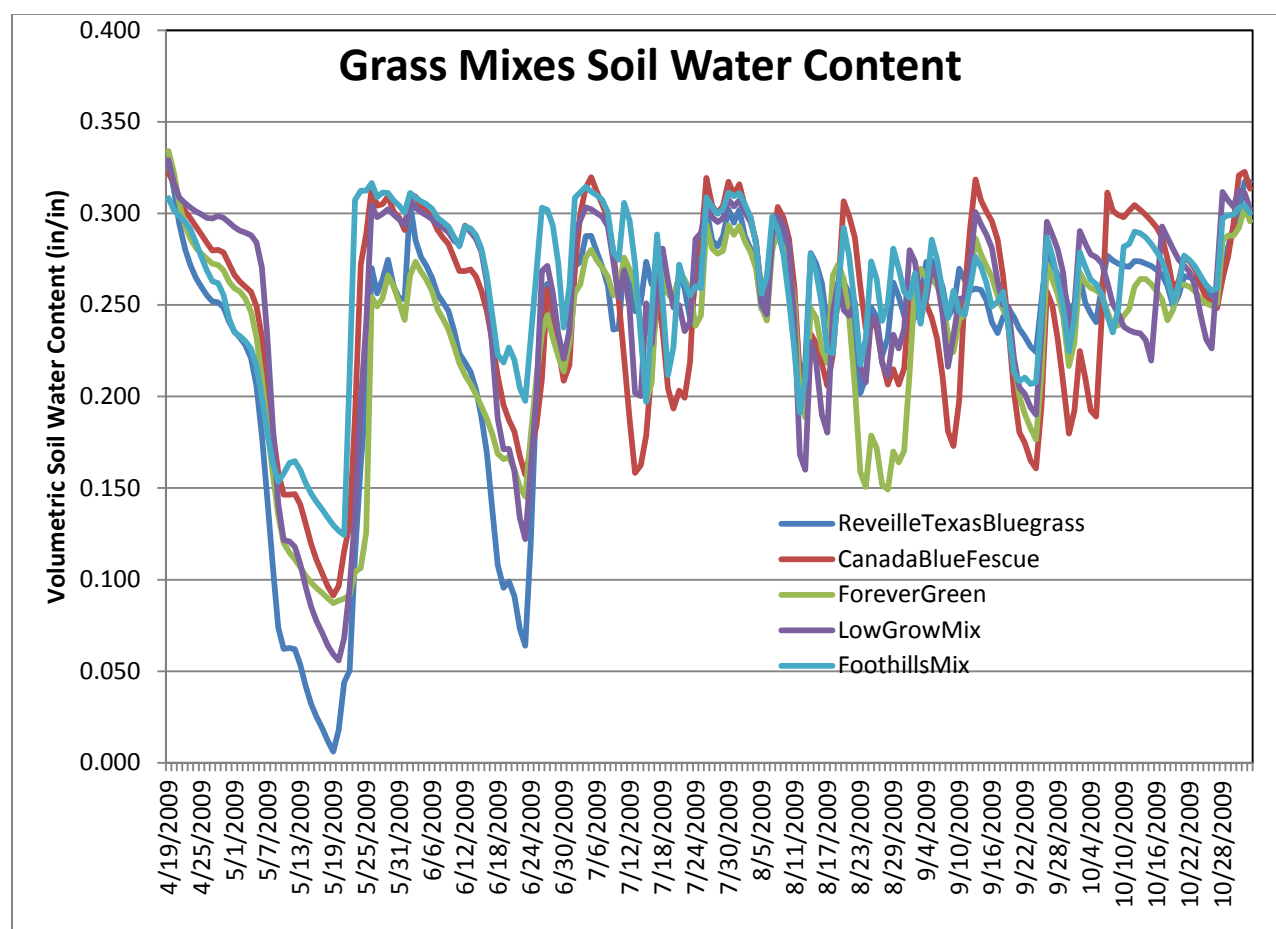
ETo from May 1 to Oct 31, 2009, was 28.94 inches. Seasonal crop coefficients ranged from 0.95 for the Low Grow Mix to 0.74 for the Foothills Mix. Reveille Texas Hybrid Bluegrass, the only single variety in the project, is a relatively new hybrid bluegrass that has good heat tolerance and lower water use requirements than Kentucky Bluegrass. The seasonal Kc for this hybrid bluegrass was 0.81.

Table 2

Grass Mix	Seasonal ET (in)	% Difference from Low Grow Mix	Seasonal Turf ET/ETo (Kc—seasonal basis)
Low Grow Mix	27.5		0.95
Canada Blue Fescue	26.2	-4	0.91
Forever Green	25.2	-8	0.87
Reveille	23.5	-14	0.81
Foothills	21.4	-22	0.74

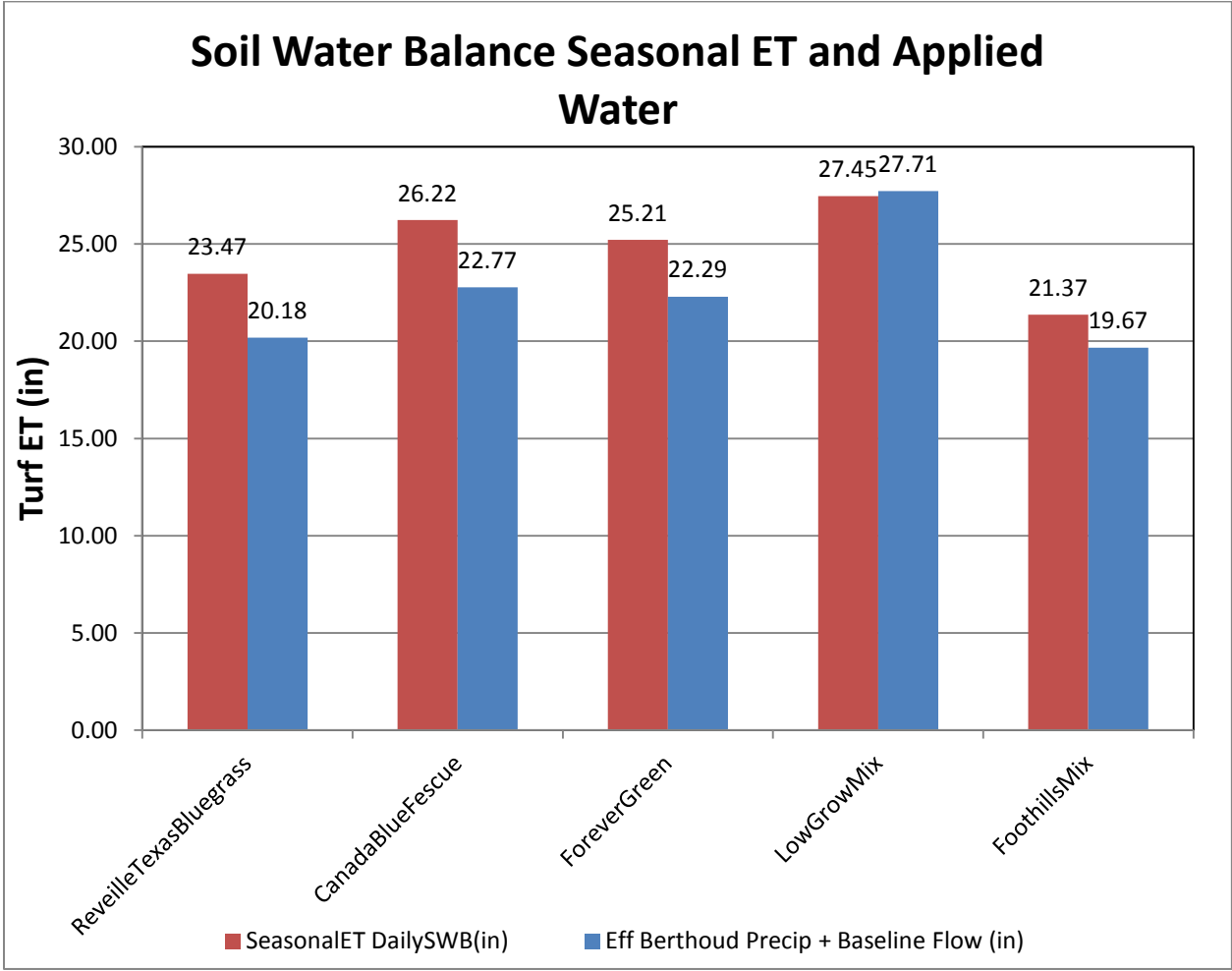
Soil water content for these five varieties is shown in Figure 1. Early in the season, soil water content was high, but dropped over a period of about four weeks to extremely dry for all five grass mixes. Rainfall and/or irrigation refilled the soil profile. Very low soil moisture occurred again for the Foothills Mix in late June. Subsequent rainfalls and irrigations maintained higher soil moisture.

Figure 1



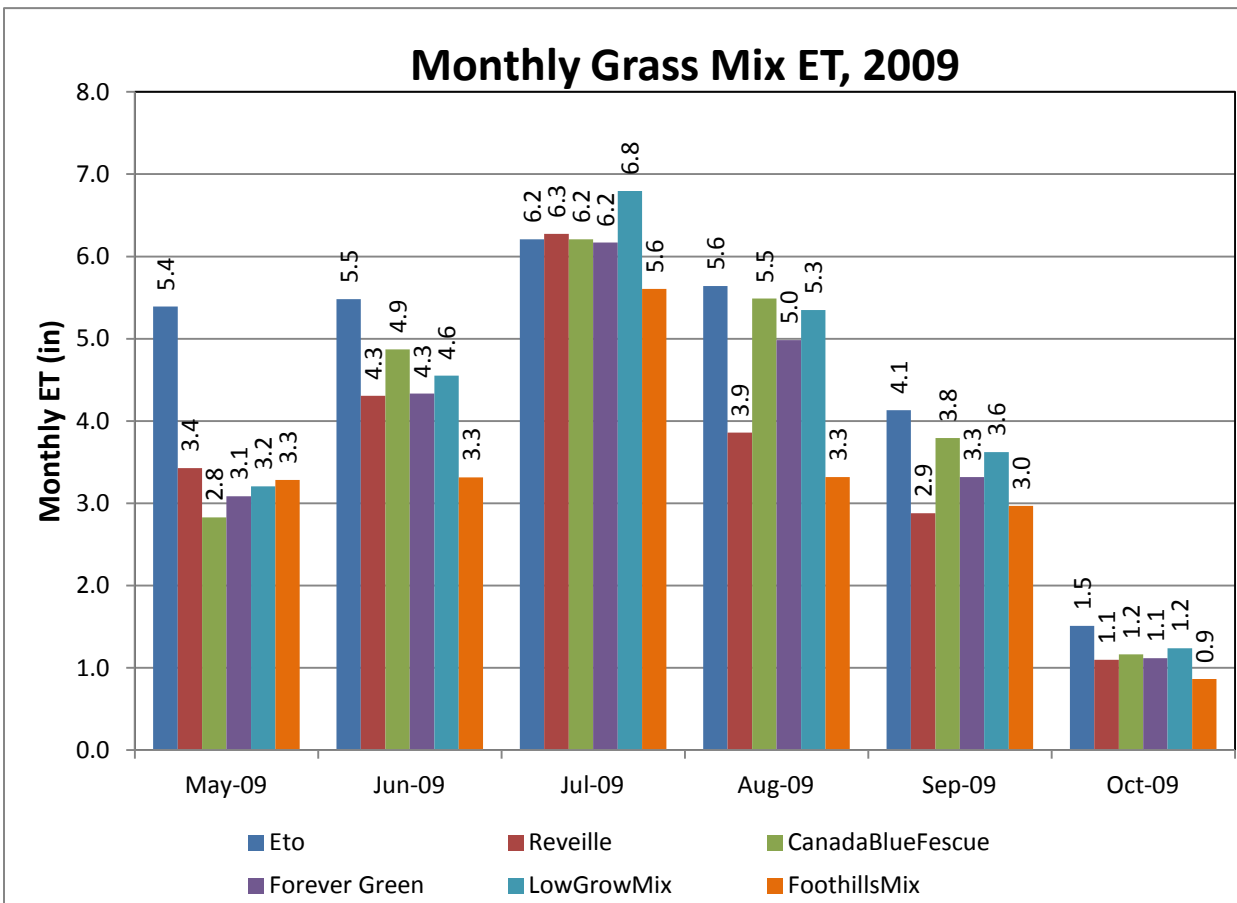
Total applied water (from flow meter data plus effective Berthoud precipitation) indicated that metered applications tracked closely with the seasonal soil water balance ET calculations (Figure 2). While the absolute numbers are slightly to somewhat different, the ranking of the total turf ET among the grass mixes remained the same as in Table 2. Future analysis will investigate these discrepancies and try to account for them in the soil water balance.

Figure 2



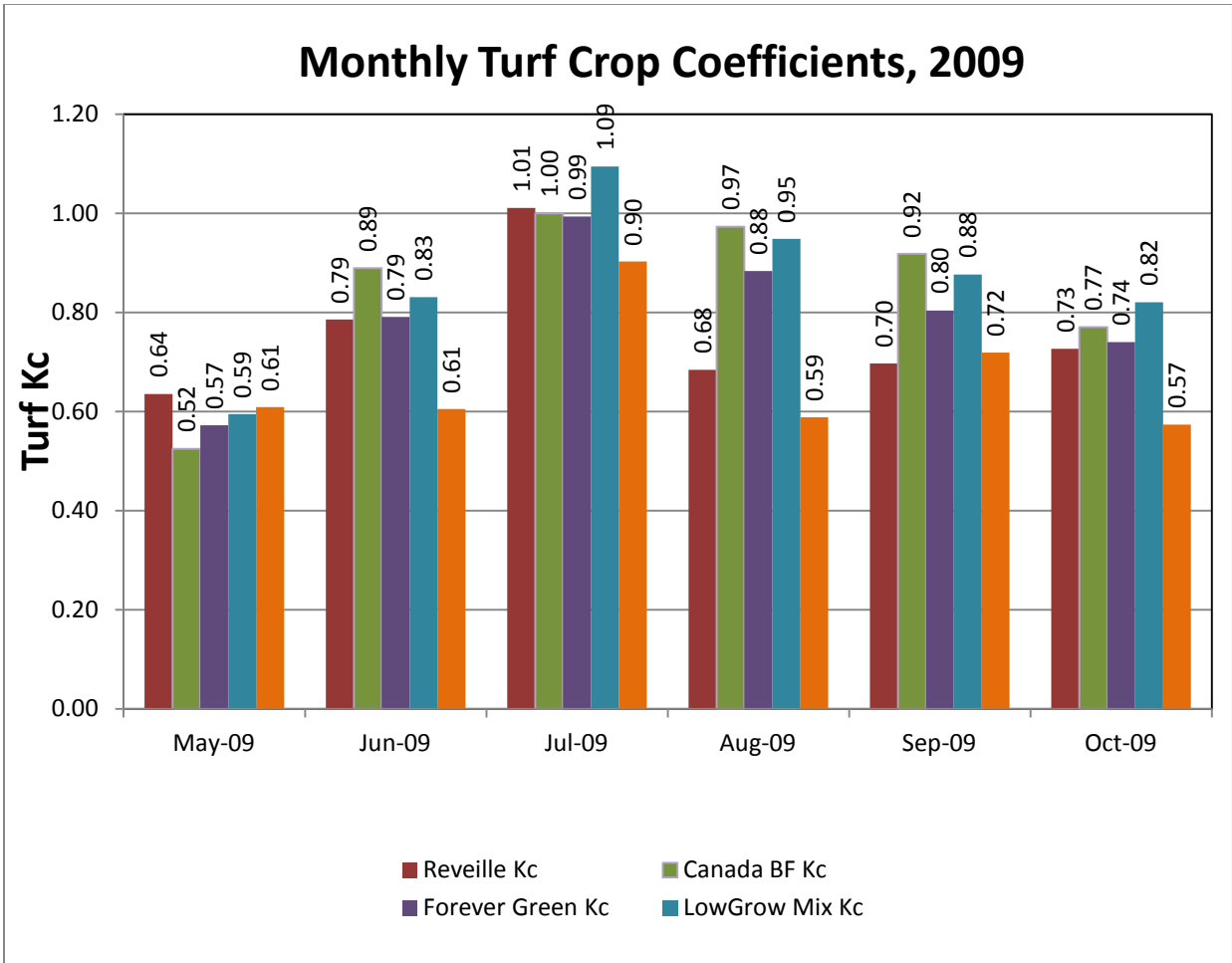
Monthly soil water balance ET and ETo are shown in Figure 3. All grass plots showed substantially lower ET compared to ETo in May, 2009. This is consistent with grass green-up and the lower soil moisture levels in May. In July, the grass mixes ET ranged from 5.6 to 6.2 inches. ETo was 6.2 inches. In the peak ET month, grass ET for four of the mixes was at or exceeded ETo, with the Foothills Mix about 10 percent less than ETo. Reveille and Foothills Mix ET dropped sharply in August to 68 and 59 percent of ETo, respectively. Low Grow Mix, Canada Blue Fescue, and Forever Green ET remained 88 to 97 percent of ETo. Clearly there are marked differences in water use patterns as well as total ET. These differences can be exploited to lower overall irrigation applied and use the monthly turf ET patterns to apply less water when the turf water requirements ease.

Figure 3



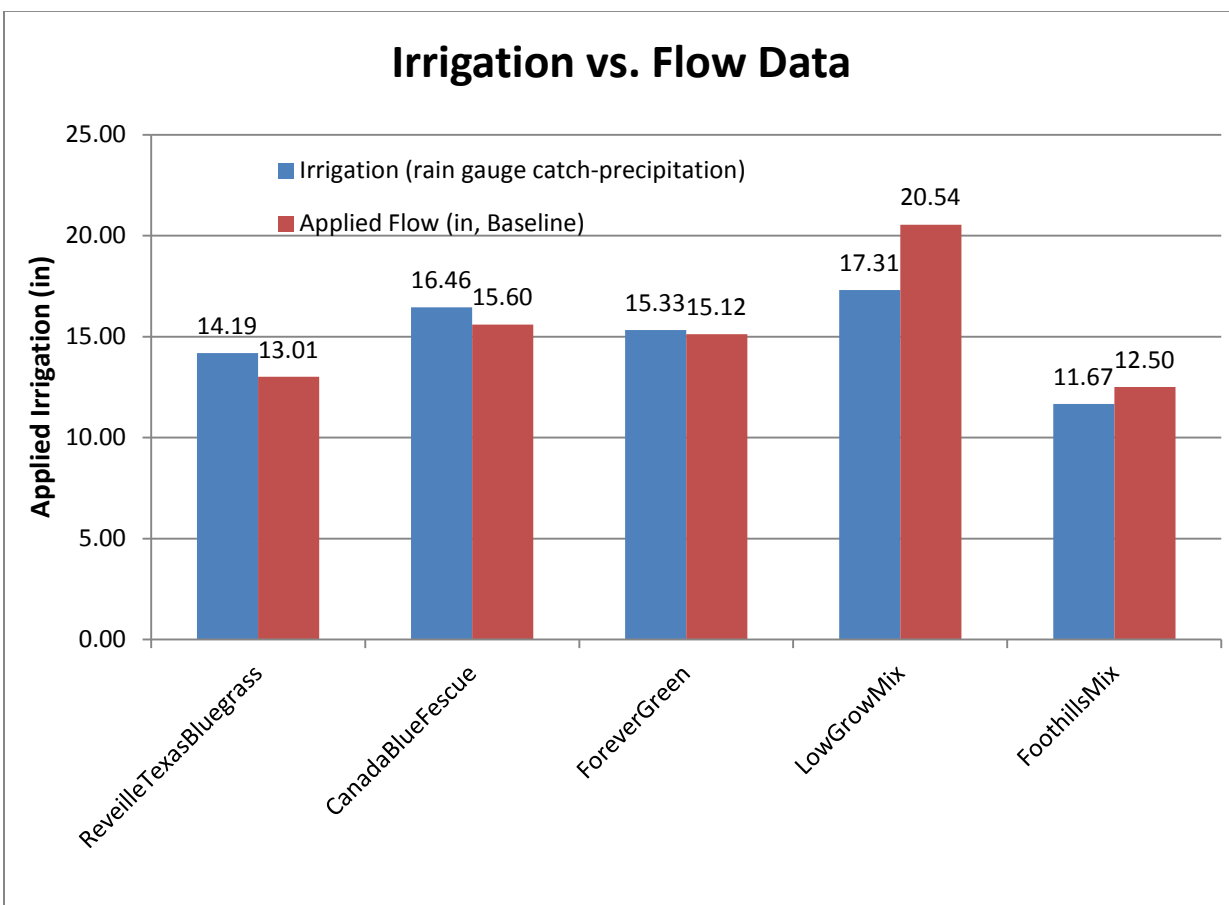
Monthly crop coefficients (Kc) were calculated for each turf variety (Figure 4). Kc values ranged from 0.52 (Canada Blue Fescue Mix) in May to 1.09 (Low Grow Mix) in July. Reveille Kc dropped off sharply in August, but increased somewhat in September. Ample rainfall in May and June made development of Kc values more challenging for shorter time intervals. Work will continue on this project in 2010. Closely monitoring irrigation scheduling and measurement of turf water conditions will facilitate better Kc curves in 2010. These Kc results are considered preliminary only and need some refinement. Methods will be explored to ascertain possible drainage out of the root zone, and root distribution data will be collected in 2010.

Figure 4



Rain gauge catch in the plots is sprinkler irrigation plus precipitation (P+I). Precipitation at the Berthoud weather station was subtracted from P + I to get Irrigation (I). Irrigation was compared to the calculated water applied from flow data (Figure 5). The values mostly compared favorably, ranging from 1 to 9 percent higher for three varieties, and 7 percent lower for Foothills Mix.. The Low Grow Mix flow data indicated about 16 percent more water applied than irrigation from rain gauge catch. This is another independent verification that most of the instrumentation was functioning correctly. The Low Grow Mix flow meter may require some testing and calibration; however, the rain gauge catch and soil moisture sensor data provide an independent means to calculate turf water use.

Figure 5



Summary and Conclusions:

Several grass mixes offer lower water use for turf installations. Grass mixes instead of single varieties can offer the best characteristics of each grass and may have an advantage in responding to different climate and irrigation conditions. Foothills Mix used 22 percent less water than the Low Grow Mix. Reveille Texas hybrid blue grass used 14 percent less water than the Low Grow Mix. Soil moisture values ranged from very dry to high, sometimes nearing field capacity (about 0.35 in/in). Soil water balance calculated ET and total applied water (flow meter data plus effective Berthoud precipitation) were in substantial agreement. The flow meter data were a valuable check for the soil water balance

calculation, providing instrumentation redundancy and confirmation that the calculation technique was valid. In July, monthly turf ET varied from 9 percent higher than ETo (Low Grow Mix), to about ETo for three varieties, and to 10 percent less than ETo for the Foothills Mix. ET of Reveille and Foothills Mix dropped markedly in August in comparison to the other three turf varieties.

This study showed that Reveille Texas Hybrid Bluegrass and Foothills Mix had substantially lower seasonal ET than Canada Blue Fescue, Forever Green Mix, and Low Grow Mix. Monthly ET patterns also showed Reveille and Foothills Mix ET declining more rapidly in late summer than the other three turf varieties. These differences can be exploited for landscape water conservation.

References

Allen, R. G., L. S. Pereira, D. Raes, and M. Smith. 1998. Crop evapotranspiration: Guidelines for computing crop water requirements. FAO Irrig. and Drain. Paper No. 56. Rome, Italy: United Nations FAO.

ASCE-EWRI. 2004. The ASCE standardized reference evapotranspiration equation. Standardization of Reference Evapotranspiration Task Committee Final Report. Reston, Va.: ASCE Environmental and Water Resources Institute.