Value Landscape Engineering: Determining Lifecycle Costs of Landscape Installation and Maintenance

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Abstract. *The US Bureau of Reclamation conceptualized a process to evaluate and compare long-term costs and benefits of various landscape strategies. The process called Value Landscape Engineering (VLE) addresses the complexities associated with landscapes by breaking them down into components for evaluation. The end product of the process is a cost analysis of each component and a life-cycle financial analysis of the total landscape.*

Central Utah Water Conservancy District (CUWCD) has expanded upon the VLE concept to provide landscape professionals and homeowners a tool to determine the life-cycle impacts of not only water use and costs, but fertilizers, pesticides, labor, equipment, and fuel/electricity/energy costs as well. Additional information such as hydrocarbon output/reduction, particulate matter output/reduction, and solar heating/cooling benefits/costs are also available to the end user.

Keywords. Value Engineering, landscape water use, spreadsheet, model, cost benefit, long-term, comparison, customize, hydrocarbon output, hardscape, fuel costs, maintenance, replacement, landscape choice

Introduction

Landscape water use is top-of-the-list as a factor in consideration of western urban water supplies. In Utah, landscape water use accounts for nearly 2/3 of potable water supplies, twice the amount used indoors. Utah and other western states have come under increasing criticism for their wasteful water use practices, but indoors, their water use is generally very close to national averages.

With water supplies remaining relatively constant but populations always growing, it is not surprising that landscape water use has come in for close scrutiny as water districts, municipalities, and other water purveyors seek ways to maximize their customer numbers while keeping capital outlays to a minimum—in short, to stretch their water supplies to cover the needs of an ever-increasing public.

For engineering-focused businesses, one frequently used process for evaluating costs and benefits for proposed projects is Value Engineering. Experts are assembled to examine features proposed, material costs, anticipated maintenance and replacement costs, and expected benefits. Many public entities even require the Value Engineering step before any project is deemed "shovel-ready." So what about landscaping? Do homeowners ever seriously consider what the long-term consequences of their landscaping choices may be? And how much they will cost, labor- and money-wise? Frustrated homeowners half-joke about paving over their troublesome lawns. As landscape professionals, can you counter that suggestion with facts about the real benefits of well-chosen live landscape features? And for us as water industry professionals, can we point to hard dollar benefits of water conservation beyond the touchy-feely and altruistic?

In answer to these questions, Central Utah Water Conservancy District has sought to apply the template of Value Engineering principles to landscaping in order to enable professional water and landscape managers, as well as homeowners, to make well-informed decisions about their outdoor surroundings.

The Team

As with any Value Engineering project, Value Landscape Engineering has required an array of varied talents and expertise. Fred Liljegren, landscape architect with the US Bureau of Reclamation and Dr. Larry Rupp of Utah State University first proposed the idea at a 1997 conference, and we have been most fortunate to have them both participate in this project. Dr. David Rosenberg, Assistant Professor of Civil and Environmental Engineering, has headed a Utah State team that includes turf, woody plants, and landscape management experts. We were able to tap into Brigham Young University's Grounds management, and the owner of one of Utah's largest landscaping maintenance businesses. And to translate the results into a user-friendly web-based interface, we relied on one of CUWCD's project managers and the consulting services of CRS Engineers.

Collecting (and Crunching) the Data

After determining the pertinent resources, usage rates, and costs, compilations were made as "back-matter" for a summary that allows a user to insert his own values and generate a customized response. Below are excerpts from three of the fourteen spreadsheets that are the foundation for landscape analysis. Defaults are built in to the summary, but changes can easily be made in the "backmatter" for a truly customized result.

One interesting note: the VLE team took advantage of available information to include not only water and fuel use, but pesticide and fertilizer use, and CO_2 and particulate emissions as well. Now there is hard data to quantify the contributions (and some of the impacts) of the landscape plants in our environment.

Table 1. Water Use Analysis (Example of Backmatter)

Landscaping				UNIT	YEAR 1 WATER USE (GAL/UNIT)	YEAR 2 WATER USE (GAL/UNIT)	YEAR 3 & UP WATER USE (GAL/UNIT)
1	Trees						
		Drought tolerant		EA	168	144	0
		Drought intolerant					
			Slow growing	EA	216	168	0
			Fast growing	EA	216	168	0
			Fruit	EA	216	168	0
		Conifers		EA	216	168	0
2	Shrubs						
		Drought tolerant		EA	48	42	42
		Drought intolerant		EA			
			Hedged	EA	60	54	54
			Fast growing flowering	EA	60	54	54
			Non pruned	EA	60	54	54
3	Ground cover						
		Drought tolerant		SQ FT	13	3	3
		Drought intolerant		SQ FT	26	12	12
4	Perennials						
		Drought tolerant		SQ FT	12	3	3
		Drought intolerant		SQ FT	26	12	12
5	Annuals			SQ FT	48	48	48
6	Vegetable garden			SQ FT	48	48	48
7	Turf grass						
		Cool season		SQ FT	23	23	23
		Warm season		SQ FT	18	14	14
		Total Lifecycle Plant Water Required (gallons)					

Table 2. Replacement Costs (Example of Backmatter)

Landscaping					NUMBER OF TIMES TO REPLACE
1	Trees				
		Drought tolerant			0
		Drought intolerant			
			Slow growing		0
			Fast growing		0
			Fruit		0
			Conifers		0
2	Shrubs				
		Drought tolerant			0
		Drought intolerant			
			Hedged		0
			Fast growing flowering		0
			Non pruned		0
3	Ground cover				
		Drought tolerant			1
		Drought intolerant			1
4	Perennials				
		Drought tolerant			1
		Drought intolerant			1
5	Annuals				14
6	Vegetable garden				14
7	Turf grass				
		Cool season			0
		Warm season			0
8	Mulches				
		Organic			4
		Inorganic (around sparse shrubs)			0
9	Paving				0

Table 3. Pesticide Requirements (Example of Backmatter)

Landscaping					Insecticide (lbs Active Ingredient/UNIT/YEAR)	UNIT
1	Trees					
		Drought tolerant			0	EA
		Drought intolerant				
			Slow growing		0	EA
			Fast growing		0	EA
			Fruit		0.1132	EA
			Conifers		0	EA
8	Shrubs					
		Drought tolerant			0	EA
		Drought intolerant				
			Hedged		0	EA
			Fast growing flowering		0	EA
			Non pruned		0	EA
9	Ground cover					
		Drought tolerant			0	SQ FT
		Drought intolerant			0	SQ FT
10	Perennials					
		Drought tolerant			0.00009	SQ FT
		Drought intolerant			0.00009	SQ FT
11	Annuals				0.00009	SQ FT
12	Vegetable garden				0.00009	SQ FT
13	Turfgrass					
		Cool season			2.1875E-06	SQ FT
		Warm season			2.1875E-06	SQ FT

How Well Does It Work?

The true test of any model is how accurate it is in projecting and predicting what will actually happen. In the case of Value Landscape Engineering, the Utah State team was able to use data from a unique source: the nine-year-old Conservation Garden Park at Jordan Valley Water Conservancy District in the Salt Lake Valley. The Garden Park has been expanded dramatically over the last couple years, but the original garden was built around a neighborhood theme, with model landscapes demonstrating a variety of irrigation and planting strategies. Irrigation for each landscape is metered separately, and maintenance and planting records are also isolated for each unit. Using records from the “traditional,” “perennial,” and “woodland” themed yards, the Utah State team tested and verified their formulas and cost projections.

Table 4. Sample of Compared Landscapes, Jordan Valley Water Conservancy District

II.	PLANT COVERAGE and CONFIGURATION					JVWCD Traditional Landscape	JVWCD Perennial Landscape	JVWCD Woodland Landscape
					UNIT			
1	Total Landscaped Area				SQ FT	4,850	4,655	4,870
2	Hardscape							
		Paved or stone			% of TOTAL AREA	15%	20%	20%
		Landscape rocks			% of TOTAL AREA			
		Decking			% of TOTAL AREA			
3	Turfgrass							
		Cool season (percent of total landscaped area)			% of TOTAL AREA	45%	5%	
		Warm season (percent of total landscaped area)			% of TOTAL AREA			
4	Shrub beds							
		Drought tolerant			% of TOTAL AREA	15%		60%
		Drought intolerant						
			Hedged		% of TOTAL AREA			
			Fast growing flowering		% of TOTAL AREA			
			Non pruned		% of TOTAL AREA			
5	Perennial beds							
		Drought tolerant			% of TOTAL AREA	13%	52%	20%
		Drought intolerant			% of TOTAL AREA	8%	20%	
6	Annual beds				% of TOTAL AREA			
7	Vegetable garden				% of TOTAL AREA			
8	Ground cover							
		Drought tolerant			% of TOTAL AREA	5%	3%	
		Drought intolerant			% of TOTAL AREA			

Another interesting opportunity for testing the VLE model was on a home bought by Provo City as a redevelopment project. As is unfortunately typical for many home construction projects, no plans were made for the landscaping, even though the intention was to showcase energy and water efficiency in the remodeled home. As an afterthought, Central Utah Water was contacted to ask if their irrigation grant program could be a resource; the landscaping was ultimately funded in large part by the District, with assistance and in-kind contributions from a number of contractor partners. Two separate landscaping plans were drawn up, and their features were plugged into the VLE spreadsheets, with very interesting results.

Table 5. Excerpt from comparison of two possible Provo Redevelopment House landscapes

			Artistic Landscape	Simple Landscape
VI.	**REPLACEMENT COSTS**			
	Total Replacement Costs		$42,968	$31,468
	Present Value of Replacement Costs		$37,152	$27,214
VII.	**INVESTMENT ANALYSIS**			
	Year 1 Capital, Material, Purchase, Contingencies, Site Preparation, and Installation Costs		$29,222	$21,407
	Present Value of Future Costs		$42,735	$31,951
	Total Present Value of All Costs		$71,957	$53,358
VIII.	**LIFECYCLE ANALYSIS**			
	Total lifecycle financial cost	($)	$71,957	$53,358
	Total lifecycle water use	(1000 gallons)	1,485	2,476
	Total lifecycle energy	(kW-hr)	0	0
	Total lifecycle fertilizer use	(lbs N)	151	255
	Total lifecycle pesticide use	(lbs)	8	5
	Total lifecycle owner labor	(hrs)	3,834	3,222
	Total lifecycle hired labor	(hrs)	0	0
	Total lifecycle fuel	(gallons)	111	232
	Total lifecycle particulate matter	(lbs)	1	2
	Total lifecycle hydrocarbon output	(tons CO_2)	-1.4	-1.6

Findings

The Value Landscape Engineering model highlights a number of findings that can inform choices of landscape practices and composition. Among them are:

1. Landscapes require significant money, time, water, fertilizers, and other inputs over the long period that people may own a residential or commercial property.
2. Replacing cool-season turfgrass with warm-season turfgrass can substantially reduce total and annual costs, water, labor, and fertilizer use over a wide range of water and turf seed prices.
3. Replacing cool-season turf with drought-tolerant shrubs or perennials or hardscaping can significantly decrease water use and net CO_2 emissions.
4. Intensively managing a landscape can significantly increase all costs, required inputs, and impacts, but property owners can realize large savings if they follow recommended maintenance practices.[1]

[1] Rosenberg et al. (2011)

One Final Step

In order to make the VLE model most useable for the average homeowner, CRS Engineers developed a web-based version that can be readily accessed online. Visitors to the website can insert their property dimensions, the number of trees and shrubs, the dimensions of planting beds and turf, the areas of hardscape, and end up with a useful projection of what that landscape will cost in energy, water, and labor over a twenty year lifetime. They can then go back and play "what if?": what if they plant more or fewer trees?; what if they add a patio?; what if they irrigate with drip instead of pop-ups?; what if they use less turf and more hardscape?; what if they only plan to stay in the home 5 years? The potential of this tool as an aid to more thoughtful and purposeful landscape choices is great.

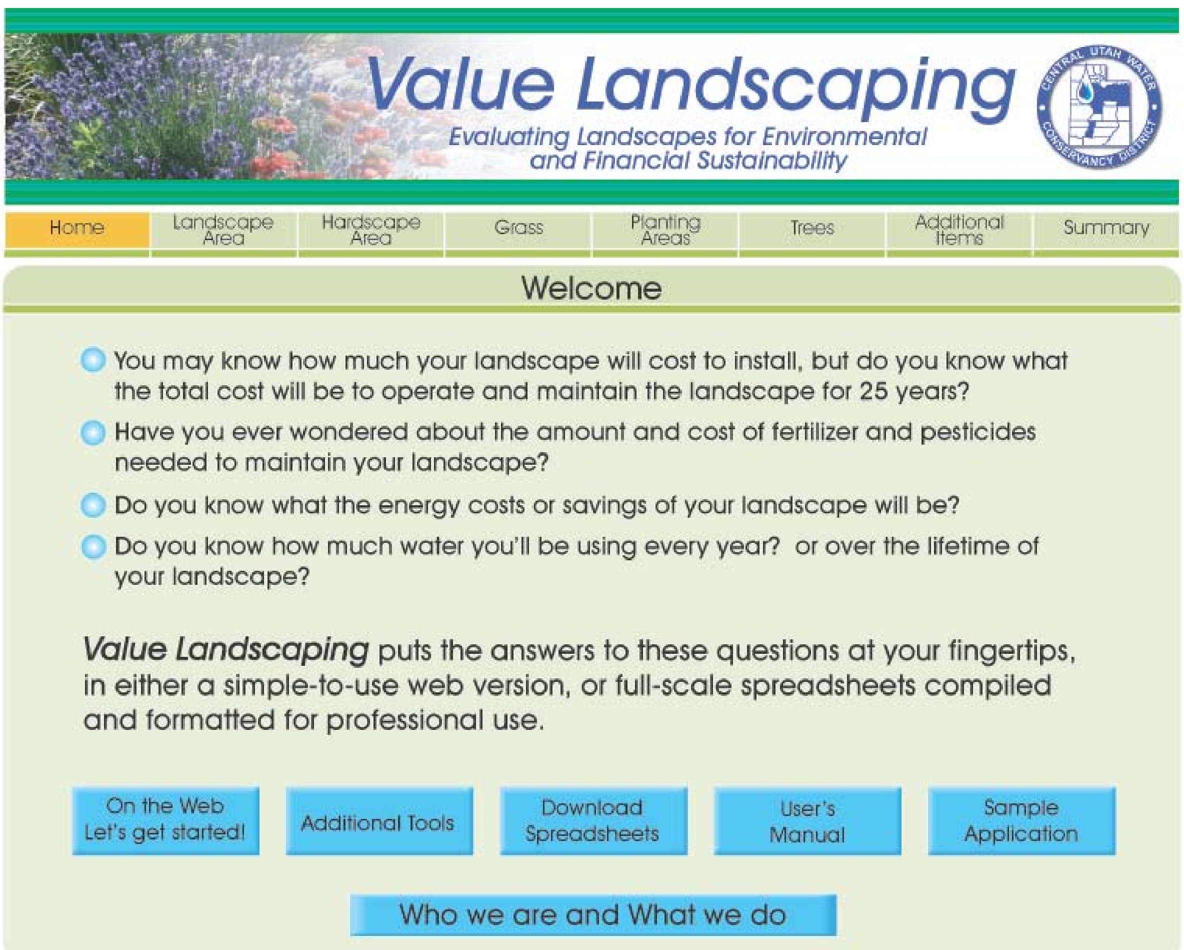

Figure 1. Welcome page for Value Landscape Engineering (Value Landscaping), accessed at vle.cuwcd.com

Figure 2. Sample input screen from vle.cuwcd.com

Expanding the Model

One of the largest landscape water users in Utah is the LDS Church. Their basic church plan calls for ___ acres of grounds plus parking lot. The Facilities Management Department of the Church has been very active in tailoring the model to different climate regions in the country and is currently testing VLE in depth in northern Utah near Utah State University. Their data and experience input to this process will be invaluable.

Conclusion

The USU team continues to collect and evaluate useful data for this project. The original spreadsheets were updated early this year and will be updated again as the need arises. Comparisons are being made with the findings of statewide landscape water audits and other research projects ongoing at Utah State University and at the State Botanical Center.

We encourage other professionals to contribute their expertise to this project as well. Homeowners, property managers, contractors, and vendors around the country are urged to review and use the model to help make decisions for their landscaping plans. The input of the real experts in the green industry will be essential to keeping this tool sharp and ready to use.

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References

Rosenberg, David E., Kelly Kopp, Heidi A. Kratsch, Larry Rupp, Paul Johnson, and Roger Kjelgren. 2011. Value Landscape Engineering: Identifying Costs, Water Use, Labor, and Impacts to Support Landscape Choice. *Journal of the American Water Resources Association* (JAWRA) 1-15, DOI: 10.1111/j.1752-1688.2011.00530.x

Additional references are included and quoted extensively in the above Journal article.