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GREEN BUILDING WATER EFFICIENCY STRATEGIES: AN ANALYSIS OF LEED NC2.2 PROJECT DATA

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Abstract

This report describes some aspects of project compliance paths for projects earning water efficiency credits under LEED for New Construction v2.2. A stratified random sample was taken of all non-confidential certified projects earning these credits under this version of the rating system, and compliance forms for Water Efficiency credits 1, 2, and 3 were analyzed. Usage rates for water efficient landscaping, non-potable water sources, on-site wastewater treatment, and selection of plumbing fixtures and tap fittings were calculated. It was found that for WEc1: Water Efficient Landscaping, projects most often avoid permanent irrigation altogether. Rainwater was the most common non-potable water source for those that selected that compliance path. Wastewater reduction was selected over on-site treatment, and high efficiency toilets and non-water urinals were most often used to meet the high reduction necessary to earn the WEc2: Innovative Wastewater credit. Dual flush and high efficiency urinals were most often selected for lower (20+% or 30+%) water use reduction needs for WEc3: Water Use Reduction.

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Introduction

Water use in the built environment is a very important aspect of human civilization. Public supply and domestic use accounts for about 12% of all fresh water withdrawals in the US (Barber 2009). The energy alone used to run the drinking water and wastewater plants in the US costs about $4 billion each year (Energy Star. 2012). Societally, this water use affects municipal water supply and treatment facility loads. Economically, it affects utility bills and municipal spending. Environmentally, it affects fresh water sources both in terms of volume extracted and pollution added. Because of these impacts, it is beneficial to reduce building water usage rates. There are many different facets of this issue, and many ways of addressing it in buildings, including water efficient fixtures and fittings such as toilets and sinks, collection of non-potable water sources such as rain, and treatment and reuse of wastewater.

The Energy Policy Act of 1992 (EPAct) took a step towards reducing the impacts of building water use by imposing flow restrictions on bathroom fixtures. Since then, many technological advances have been made which can further reduce water impacts while delivering the same level of service expected by building occupants. As a leader in the movement to create built environments that meet the needs of people and life on Earth without sacrificing the long term viability of either, the U.S. Green Building Council has sought to promote these technologies by including their use in the Leadership in Energy and Environmental Design (LEED) rating system for built environments.

In order to achieve certification, applicants must earn credits for inclusion of features in their building that achieve the goals of the rating system. LEED devotes an entire category of credits to efficient water use, covering several aspects of water efficiency. This report aims to describe how projects achieved credits for this category in LEED for New Construction v2.2 through an analysis of compliance paths and choices. Factors investigated include water efficient landscaping, non-potable water sources, on-site wastewater treatment, and flush fixture and tap fitting selection.

Methodology

Sample

The research team began with the public LEED project directory from the USGBC website, and a list of all non-confidential projects earning Water Efficiency (WE) 1, 2, and 3 credits under LEED NC v2.2. Non-US and confidential projects were not included in the sample. Owner types were obtained from the public database and statistics were generated to describe their distribution. A stratified random sample was then taken of the WE credit-earning projects based on owner type. The result was a sample of 448 projects earning at least one of WE credits 1, 2, and 3. Credits 1 and 3 were earned much more frequently than credit 2 (Figure 1).

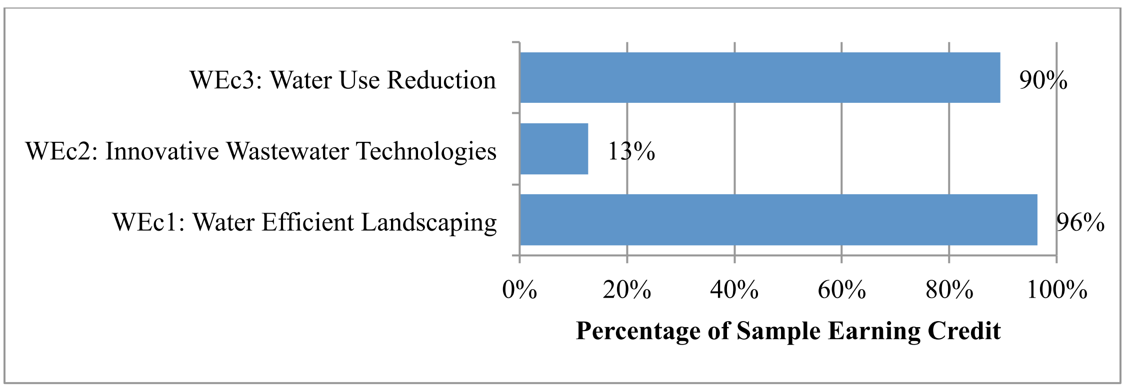

Figure 1: Counts of projects earning WEc 1, 2, and 3 in sample

For data validity, credit earning and owner type mentions were analyzed. The percentages of projects earning each credit are approximately equal in the population and the sample. Project teams specified one or more owner types as part of project documentation, and this selection was the basis for owner type classification (Figure 2). This stratified random sampling meant that the percentages of projects mentioning each owner type were equal in the population and the sample.

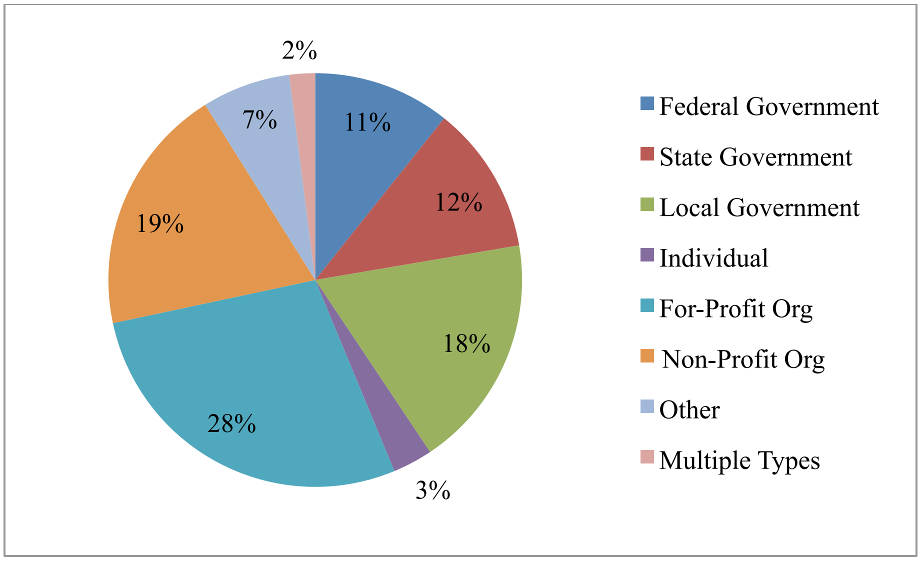

Figure 2: Percentages of projects mentioning each owner type

Measures

The data used in this study were drawn from LEED credit submittal forms and from the USGBC list of non-confidential certified projects. LEED credit submittal forms accept input in three different ways: radio buttons, check boxes, and text input fields. Each was treated and displayed differently.

Radio buttons allow a user to select only one of several options. These are presented in this report as pie charts, with data as percentages of projects earning that credit making each selection. This type is used for compliance paths for WEc1 and WEc2.

Check boxes allow a user to select more than one option. Because they are not mutually exclusive, these results are presented as bar charts, with data as percentages of projects with the ability to make a choice selecting each option. This type is used for non-potable water sources in WEc1.

Text field form entry is used to describe and specify flush fixtures and tap fittings in WEc2 and WEc3. Text fields allow manual entry of a description. These are by nature not standardized. The research team generated a list of all unique values, and assigned a standardized value to each. These standardized values are normalized and presented in this report in bar charts, with data as percentages of projects using the flush class of fixtures that used that particular type of fixture, or percentages of tap fittings using a particular flow rate.

Projects typically use more than one type of fixture and fitting. For instance, a building might have different types of urinals in different bathrooms. Tap fittings and flush fixtures were categorized by classes and types, as many different brands and flow rates were mentioned. The water closet class included dual flush, high efficiency, compressed air, and composting toilet types. High efficiency toilets are defined as water closets that use a maximum of 1.28 gallons per flush (GPF), which is 20% less water than the current U.S. maximum of 1.6 GPF. Urinal class fixtures were placed in one of two major types: High efficiency and non-water. High efficiency urinals are those that use no more than 0.5 GPF, half of the current U.S. maximum of 1 GPF. Non-water urinals have no flush. Tap fittings include sinks and showers. These are categorized by type and flow rate. Flow comparisons for water use reduction towards credit compliance are based on EPAct standards.

Results

WEc1: Water Efficient Landscaping

This credit covered landscaping water use. 401 out of 448 projects (89.5%) in the sample earned this credit. There were four paths to compliance (Figure 3), by some combination of reduced irrigation and non-potable water sources, or by removing permanent irrigation altogether. The most commonly selected option was no permanent irrigation. Reduced irrigation consumption is part of options 1 and 3, and between them the technique almost rivaled the lack of permanent irrigation in popularity.

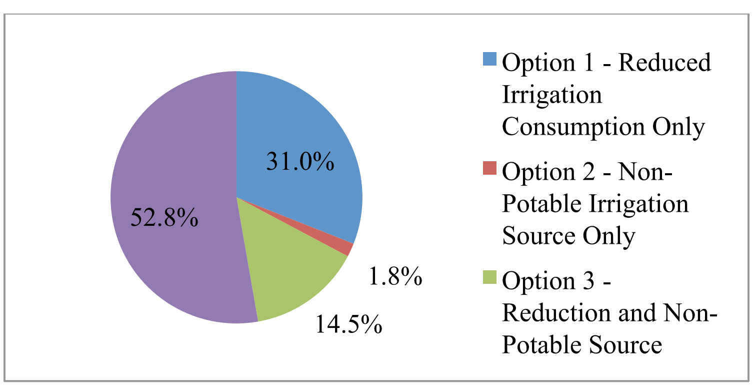

Figure 3: WEc1 Compliance path for sample

For those projects selecting option 2 or 3, at least one non-potable water source was listed. Of the 401 projects earning WEc1 in the sample, 65 made this choice. The categories on the forms were rainwater, greywater, wastewater, and publicly supplied non-potable water (reclaimed municipal wastewater that has been treated, but not up to drinking standards), also known as purple pipe. Some projects used more than one source. Rainwater was the most popular choice, followed by public sources (Figure 4).

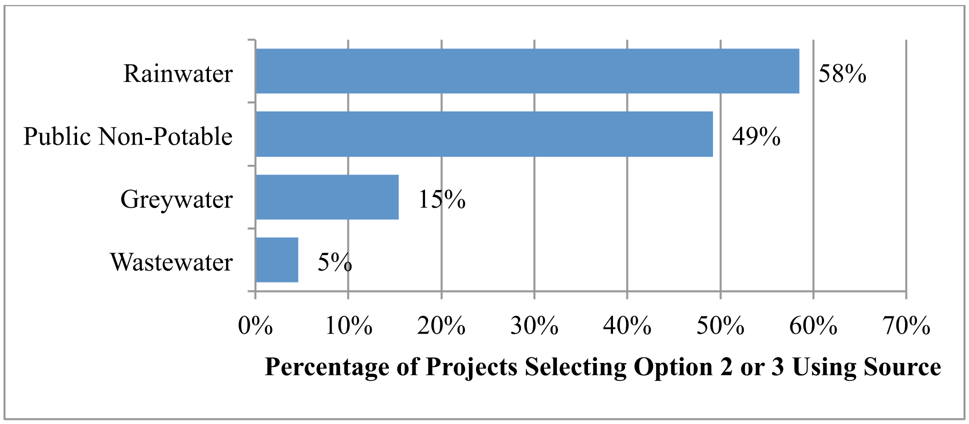

Figure 4: WEc1 Non-potable water source for projects selecting option 2 or 3

WEc2: Innovative Wastewater Technologies

This credit addresses generation and treatment of wastewater, and can be achieved either through on-site wastewater treatment or a sewage conveyance water savings of at least 50%, both of which reduce the demand placed on public wastewater treatment facilities by a project. This 50% reduction can be achieved with the use of efficient water closets and urinals. Of the 57 (12.7%) projects in the sample that achieved this credit, most projects selected reduced sewage conveyance based on water savings calculation for their compliance path (Figure 5).

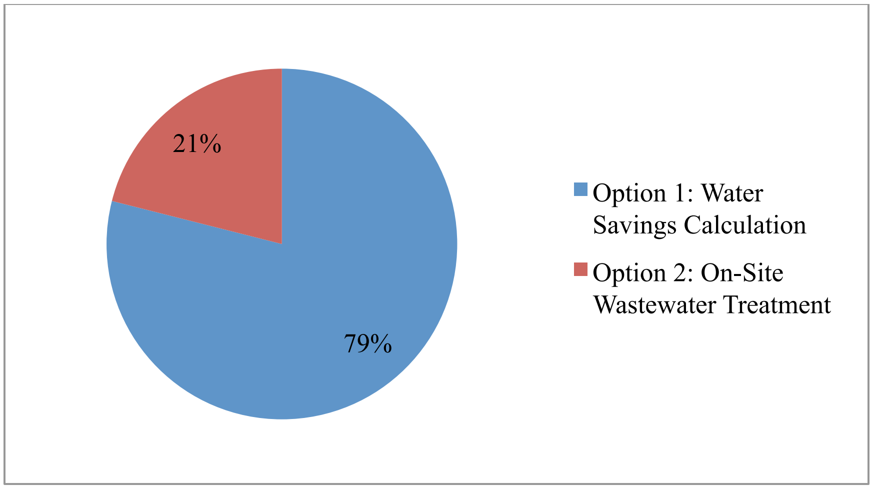

Figure 5: WEc2 Compliance path for sample

Although only the projects pursuing the water savings compliance path were required to specify flush fixture types, 54 of 57 (95%) projects achieving the credit provided a description of flush fixtures for the project. Therefore, flush fixtures are given as a percentage of these 54 projects that described flush types (Figure 6). Among these, high efficiency toilets and non-water urinals were the most common.

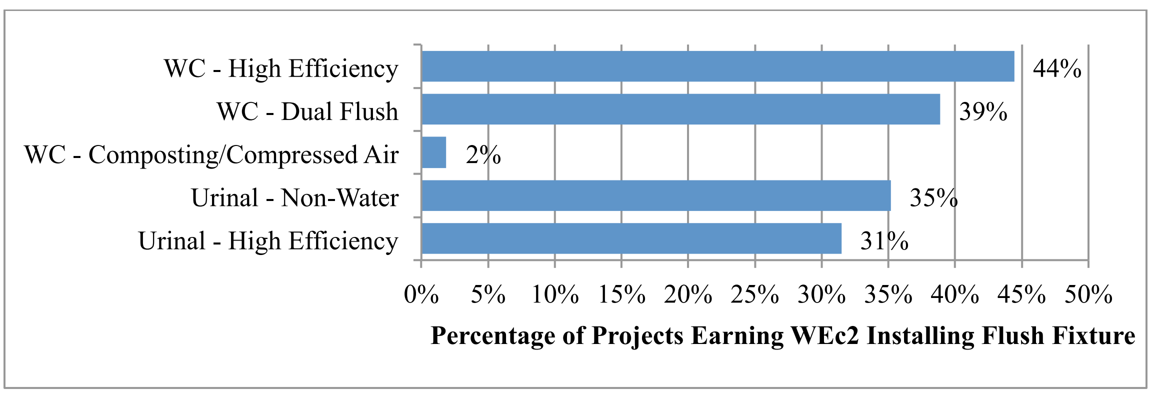

Figure 6: WEc2 Flush fixture type usage

WEc3: Water Use Reduction

Water efficiency credit 3 can be earned by reducing water use through efficient tap fittings and flush fixtures to reduce water use in the building by at least 20% for one credit or at least 30% for two credits. These classes are limited to water closets, urinals, lavatory faucets, showers, and kitchen, classroom, lab, or janitor sinks. Projects used some or all of these classes, and some used more than one type within a class. Flush fixture use is given as a percentage of the projects earning WEc3 that used each fixture type for compliance (Figure 7). Dual-Flush was the most common type of water closet used, and high efficiency urinals were more commonly used than non-water.

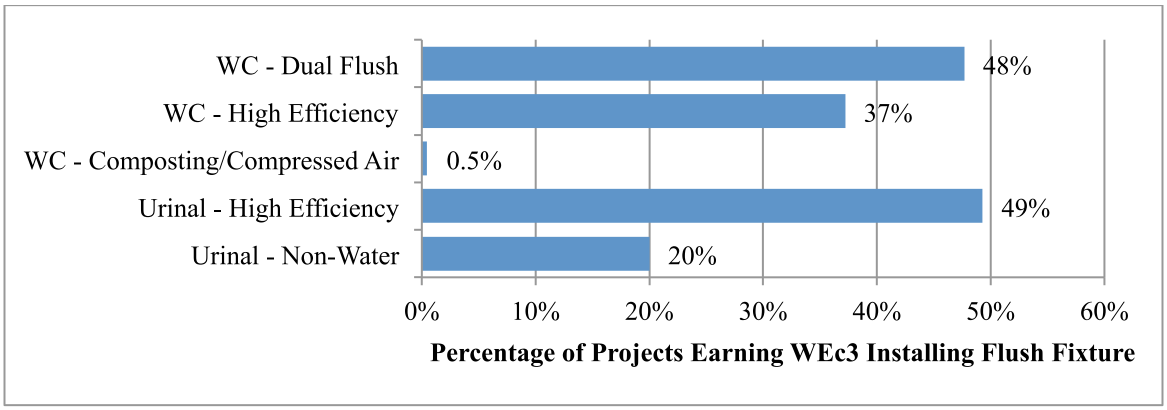

Figure 7: WEc3 Flush fixture type usage

Tap fittings described on forms include showers and several classes of sinks. Projects may have multiple taps, so results are presented by type. Use is given as the five most common design flow rates for each fitting type, as a percentage of the type. The average reduction of flow rate from EPAct baseline to design is also given (Table 1). The greatest average reduction was in lavatory sinks, at about twice that of the other types.

Table 1: WEc3 Tap fitting average flow reductions

Tap Fitting Type	Number of Fittings Examined	Average Percent Flow Reduction
Shower	249	35%
Sink - Lavatory	474	73%
Sink - Kitchen	322	35%
Sink - Janitor	48	34%
Sink - Class/Lab	19	43%

Tap fitting types were analyzed to find the most common flow rates for each. Projects may have multiple taps, so results are presented by type. Each fitting type had a different distribution of commonly used flow rates (Table 2). The most pronounced preference was for 0.5 GPM faucets in lavatory sinks.

Table 2: WEc3 Most utilized flow rates for each tap fitting type

Tap Fitting Type	Fitting Examined	Most Common Flow Rates (GPM)	Percent of Fittings Using Flow Rate
Shower	249	1.5	43%
		2	15%
		1.8	12%
		1.75	10%
		Other	21%
Sink - Lavatory	474	0.5	78%
		1.5	8%
		1	3%
		2.2	2%
		Other	8%
Sink - Kitchen	322	2.2	32%
		1.5	26%
		0.5	14%
		1.8	8%
		Other	20%
Sink - Janitor	48	2	29%
		2.2	23%
		1.5	17%
		0.5	13%
		Other	19%
Sink - Class/Lab	19	1.5	32%
		0.5	21%
		2.2	16%
		1.6	11%
		Other	21%

Results were compiled for all sink fittings, and 0.5 GPM faucets were the most commonly used (Figure 8).

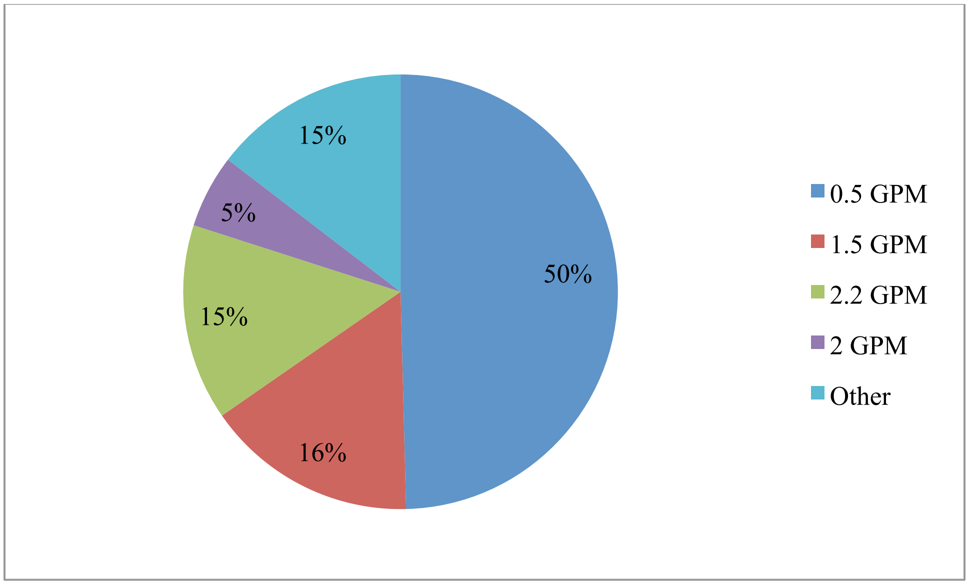

Figure 8: WEc3 Most common flow rates for sink fittings

Discussion

The analysis of WEc1: Water Efficient Landscaping forms showed that non-potable water sources were not used nearly as much as irrigation reduction or elimination. This might be related to the availability of municipal non-potable water, local restrictions on rain or grey water collection, or the simplicity of not having an installed irrigation system. A study of these choices by climate and municipal non-potable availability could be a useful future study. Of the sources mentioned, the heavy skew away from grey and wastewater also bears investigation, perhaps into local ordinance patterns.

With WEc2: Innovative Wastewater Technologies, on site wastewater treatment did not see much use, possibly because the other option of sewage conveyance reduction was partially already covered by flush fixtures used to earn WEc3: Water Use Reduction. This might have provided an easier path to compliance with WEc2 than installing water treatment on-site, as the sewage conveyance reduction was already mostly met for WEc3. There is a difference to be noted between the flush fixture selections, specifically that WEc2, which required a greater wastewater flow reduction, showed majorities for high efficiency water closets and non-water urinals. On the other hand, WEc3, with its lower requirements, tended towards dual-flush water closets and high efficiency urinals. This could indicate that non-water urinals and pure high efficiency water closets are less desirable than the other options when water use restrictions are not as high.

Conclusions

While it is true that projects employ many different techniques to earn each water efficiency credit, it is clear from the results of this study that some are much more common than others. WEc1 earners tended towards removing permanent irrigation altogether, and when non-potable water sources were used, they preferred rainwater and public non-potable sources. WEc2 earners tended to avoid on-site wastewater treatment in favor of conveyance reduction, and used non-water urinals and high efficiency water closets to that end. WEc3 earners selected high efficiency urinals over non-water urinals, and tended to select dual-flush water closets over high efficiency water closets. Efficient tap fittings were most commonly used in lavatory sinks, and typically used 0.5 GPM faucets.

As the use of water efficiency techniques in the built environment becomes more common, it becomes even more important to study how it is being achieved by projects. By doing so, practices can be analyzed and improved. This report provides a starting point for future research, pointing to the most commonly used techniques on LEED projects. In this way, research can be directed towards the most useful questions first. Why is rainwater the preferred non-potable water source? What makes projects select dual flush toilets over low-flow? Why are waterless urinals less used than low-flow? Answering these questions could make it easier for future builders to make selections of their own, and for more projects to include water efficient features.

References

Barber, N. L. (2009). *Summary of estimated water use in the United States in 2005*, U.S. Dept. of the Interior, U.S. Geological Survey.

Energy Star. (2012). "ENERGY STAR for Wastewater Plants and Drinking Water Systems." <http://www.energystar.gov/index.cfm?c=water.wastewater_drinking_water>. (January 29, 2013).