

Investigation of LEED School Projects in Ohio

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As a leading state in public green school projects, Ohio, through the Ohio Facilities Construction Commission (OFCC), has administered more than 300 LEED (Leadership in Energy and Environmental Design) certified or registered K-12 and vocational schools. Its rich experience in the LEED program can be a valuable asset to other public agencies or private sectors in their implementation of LEED projects. The purpose of this study is to track points earned by OFCC-funded green school projects and identify patterns and variations in the credits attempted and/or earned. In addition, this study carefully analyzed the Green Building Certification Institute's review comments for 75 K-12 school projects, all certified under the LEED for Schools 2007 rating system. Findings concluded that Enhanced Commissioning, Recycled Content, Regional Materials, Maximize Open Space, Water Use Reduction, and LEFE (Low-Emitting and Fuel-Efficient) Vehicles Parking were the top 6 LEED credits among those awarded for the projects studied. The results included in this paper are helpful for school administrators and AEC (architecture, engineering and construction) industry practitioners in green school planning, design, and construction.

Key Words: LEED for Schools, Green Schools, LEED Certification, US Green Building Council (USGBC)

Introduction

Since the inception of the LEED (Leadership in Energy and Environmental Design) green building rating system, the number of public projects pursuing LEED has grown substantially. The same trend appears in the design and construction of educational facilities. In such facilities, an increased focus on sustainability, such as reduced environmental impact and facility operation costs, has intersected with a desire to integrate design principles like daylighting and optimal indoor environmental quality, which are intended to facilitate an enhanced learning environment for students. To public agencies that are responsible for public school project planning and administration, the LEED for Schools third-party rating system is considered a guideline for them to integrate the best sustainable practices as well as an opportunity to strengthen the accountability of project design, construction and operation.

Nationwide, the number of green school projects that are LEED certified or registered (in the midst of completing the LEED certification process) has increased tremendously in recent years. According to the information provided by the Green Building Information Gateway (www.gbig.org), by the end of October 2013, there were 527 LEED certified K-12 school facilities in the US, with another 612 LEED registered projects. These figures have been constantly updated as more projects are registered and existing projects achieve their LEED certification. With so many LEED school projects available in the practical world, it is important to take a close look at how these LEED projects were performed and certified so that the best practices for future LEED green school project development can be identified.

The purpose of this research is to explore how LEED certification is pursued within one of the nation's leading green schools programs, the Ohio LEED Schools program, which consists of over 300 LEED certified and registered projects. This program also offers a unique research opportunity as the vast majority of K-12 school construction in Ohio is funded by a single public entity, the Ohio Facilities Construction Commission (OFCC), formerly known as the Ohio School Facilities Commission (OSFC). All projects administered by OFCC are designed and constructed according to the Ohio School Design Manual (OSDM), which establishes standards for

facility sizing, budget, and materials selection and reduces the variability from project to project. This makes it practical to compare how individual project teams implement LEED in their school projects.

This research demonstrated the degree of difficulty in integrating individual LEED credits into the scope of a typical Ohio K-12 school project and calculated the rates at which individual LEED credits were successfully documented and subsequently achieved by project teams. The research also discovered what obstacles and factors, including costs, owner buy-in, maintenance considerations, etc., influenced the decisions of project stakeholders in pursuing individual credits. In the hope that other states may investigate the adoption of a formal LEED green school program to improve the sustainability of their public school systems, this research offered valuable information that will hopefully allow policymakers to make informed decisions on which LEED credits are most reasonable for them to pursue in their respective jurisdictions and can possibly be achieved after meeting their project requirements and resource/budget constraints.

Literature Review

History of LEED/Green Schools

The advocacy and implementation of green schools have caught increasing attention in the past decade. It also seems that transitioning from conventional to green school buildings is becoming the common way of the future. To many K-12 school administrators, green school buildings meet their expectations from both the perspectives of providing better quality facilities and learning environments/experiences for children (Baker, 2006). According to Baker (2006), students and other young people, making up about one quarter of our population, spend a significant portion of their time in K-12 school buildings around the country. So it is important to provide better indoor and outdoor environments for them. As pointed out by Olson and Kellum (2003), sustainable schools, also referred to as green or high performance schools, benefit from enhanced outdoor and indoor environments and provide a conducive atmosphere for both learning and teaching. Recent vigorous statistical studies, involving 21,000 students in three states, revealed that students perform better in daylit classrooms in addition to other health benefits (Plymton et al., 2000). Green schools also use less energy and utilize more renewable energy than conventionally designed schools. From a fiscal perspective, the construction of green schools is more practical and has lower risk than continuously building unhealthy, insufficient conventional schools (Norton, 2005; Kats, 2006).

Nationwide, there are numerous locations where green schools have been blooming vigorously. For example, in 2004, Bolingbrook High School became the first high school in Illinois to receive a LEED rating. Thereafter, more LEED schools have been built in that state. Also, in December 2011, the US Green Building Council (USGBC), the organization that developed the LEED program, recognized Ohio as the state award winner for Best in Schools, leading the nation in green school projects. Today, green construction is already prominent in the education sector, and it will continue to grow in the coming years. Contractors that seek to be competitive in this market are also capitalizing on their green expertise as well as demonstrating that they can build in a sustainable way (Bernstein & Laquidara-Carr, 2013).

LEED for Schools Rating System

The USGBC's LEED certification process is very useful in grading a building's levels of sustainability or energy efficiency (Langdon, 2004). The LEED for Schools rating system is an adaptation of the LEED for New Construction and Major Renovation rating system (LEED-NC), but more specific to K-12 facilities. In particular, LEED for Schools adds credits and prerequisites, such as classroom acoustics and mold prevention, to the baseline structure of LEED-NC that can apply to all types of facilities where such traits receive less emphasis. LEED for Schools v2.2, also known as the 2007 version, was the first to be adopted by the USGBC. It embodies 9 prerequisites and 79 elective credits, grouped into six sustainable categories: 1) Sustainable Sites (SS), 2) Water Efficiency (WE), 3) Energy & Atmosphere (EA), 4) Materials & Resources (MR), 5) Indoor Environmental Quality (IEQ) and 6) Innovation & Design Process (ID).

A subsequent version, LEED for Schools v3 (2009), was released by the USGBC in an effort to update their rating systems. In this version, Regional Priority (RP) credits were added as bonus points and can be awarded to projects that have addressed regional/local environmental challenges. LEED for Schools will be updated again in

conjunction with the impending release of LEED v4 later this year. While the USGBC focuses on the development and improvement of existing rating systems, the LEED project certification is handled by the Green Building Certification Institute (GBCI).

Progress of LEED/Green Schools in the US

Ohio's Green Schools program was officially launched on September 27, 2007, when OSFC Resolution 07-124 was approved by commission leaders. The mandate states that commission-funded projects from that point on would strive to achieve a certification level of Silver under the LEED for Schools rating system. The resolution also states that each project would also have a "preferred investment in attaining LEED points" in the Energy & Atmosphere category, which refers to the EAc1: Optimize Energy Performance credit. The resolution also outlined measures for the OSFC to address funding topics by charging the Executive Director of the OSFC to pay GBCI registration and review fees, supplement project budgets with additional funds to pursue LEED certification, and to work with other parts of executive branch of Ohio's state government to develop alternative financing. Finally, the Executive Director and other associates were directed to report on the LEED certification incorporation, process improvement, OSDM updates, and the possibility of raising the target certification level to Gold.

In the five and a half years since the resolution was passed, over 300 Ohio K-12 projects have been registered under either the LEED for Schools 2007 (v2.2) or LEED for Schools 2009 (v3) rating system. As of this writing, 98 of those projects have attained LEED certification. This represents approximately 10% of the LEED certified schools nationwide. These figures are fluid, and are subject to frequent updates as more and more projects, both in Ohio and the rest of the country, are registered and certified.

Research Methodology

This study set out to analyze trends in 75 LEED certified projects, specifically, the rate at which individual LEED credits were pursued and also the rate at which individual credits were awarded. Analyzing the credit pursuit rates can help identify the common strategies project teams utilize to attain their project's LEED goals. As the 75 sample projects are fundamentally similar in their design and construction, the research team hypothesized that each project's approach to LEED certification would also be fundamentally similar. Beyond the standard project goal of LEED Silver, analysis could be performed on the credit trends in the projects achieving LEED Gold and LEED Platinum as well. By investigating the percentages of credits awarded, combined with the GBCI reviewer comments from each project, the research team was able to gain insight into what could be considered best practices for several components of a project. These include documenting each LEED credit and prerequisite, as well as the degree of difficulty each project team faced in documenting and incorporating required elements into the scope of their work. Finally, researchers identified what appeared to be inconsistencies among GBCI reviewer comments for the same credits from project to project. All of these objectives aid in addressing one question with many answers: "What can we learn from the Ohio green schools program?" Due to space limitations of this paper, the inconsistencies identified among GBCI reviewer comments are not included and will be presented in a separate paper.

Once the research objectives were identified, the research team began forming a sample of Ohio K-12 projects. The projects were incorporated from a sample of a previous research project (known as the Green Schools Compendium) carried out by the Central Ohio Chapter of the USGBC. The goal of the previous study was to investigate cost premiums of LEED school projects. Only projects that were included in previous research were included in this study. This was done to preserve the possibility of investigating a correlation between projects. The research team deemed it important that all of the projects in the sample must be LEED certified to ensure that the research results would be completely accurate. Once a project accepts LEED certification, no further changes or appeals can be made and the process is final. At the early stage of this research, less than 60 projects had completed the LEED certification process, while the target sample size was to include 75 projects for a thorough probe. As additional projects achieved certification, they were incorporated into the sample until 75 projects were included (by July 2013). To maintain the consistency of the sample, all of the projects were certified under the LEED for Schools 2007 rating system. All levels of certification were included to maintain diversity within the sample and also to allow for future analysis of patterns within the distinct levels, such as LEED credit trends for projects at Certified, Silver, Gold, and Platinum levels.

To gather data, the research team was granted access to LEED Online by Lisa Laney, the OFCC official leading the administration of the state's green schools program, a leader of an adjacent research program, the Green Schools Compendium, and a board member of the USGBC Central Ohio chapter. LEED Online is the web-based system used to manage the certification process for both the project teams and GBCI reviewers. Access to LEED Online allowed the research team to develop final scorecards and pull GBCI reviewer comments. Once the scorecards were created and the reviewer comments collected and reviewed, the research team built two distinct spreadsheets, one to track all the credits each project had attempted, and another to track the credits each project was awarded. These spreadsheets can be made available upon request.

The distinct attempt and award rates were calculated using a simple equation, formulated as *(Applicable Number of Projects/Total Number of Projects) x 100%*, to determine a simple percentage. By determining these two distinct rates, the research team could delve further into the intricacies of the Ohio Green Schools program. When examining the rate of achievement for each LEED credit, the GBCI review comments were utilized to understand which credits were denied, and equally important, why they were denied. These comments provided insight into the nuances of each credit's documentation requirements and what kind of common issues project teams encountered. By analyzing these comments, lessons can be learned by LEED New Construction project teams, specifically LEED for Schools project teams, in areas such as reducing documentation errors and omissions.

Results and Discussions

LEED Credit Pursuit

The research team hypothesized early on that there would be several credits that collectively form the core of most projects' achieved LEED points and inversely that several credits would be much more challenging to earn and document and would only be included on a handful of projects. The findings were consistent with that belief, with 15 distinct LEED credits pursued on at least 90% of the sample of projects. Figure 1 illustrates the 12 most frequently attempted LEED credits and also tracks eventually how many projects achieved each of those credits.

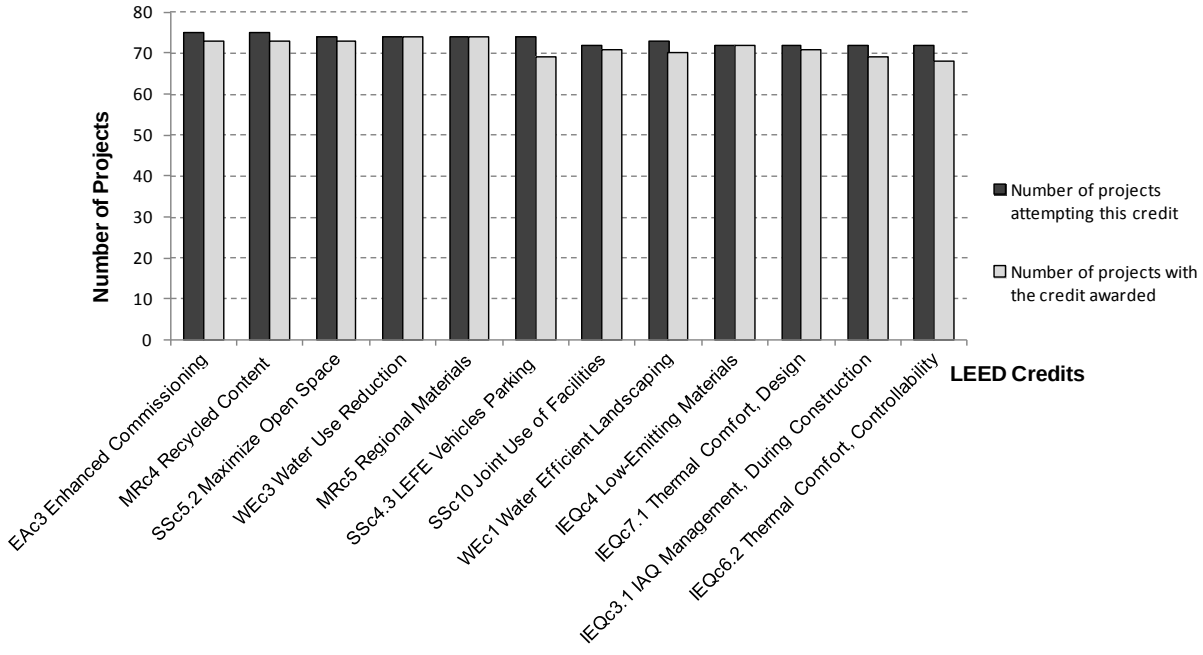

Figure 1: The most frequently attempted and awarded LEED credits.

It is noteworthy that this figure does not include LEED prerequisites or Optimize Energy Performance (EAc1), as compliance with those requirements is mandatory. Mandatory elements are excluded from this aspect of the research because their inclusion circumvents factors such as stakeholder buy-in and cost considerations that pertain

to the other optional LEED credits. However, analysis of the GBCI review comments for prerequisites and EAc1 is included because it is consistent with this project's stated goal of informing LEED practitioners of documentation best practices and lessons learned. What factors lead to widespread adoption of individual LEED credits? Several different considerations were encountered throughout this study, all of which contribute to the adoption in different ways.

As shown in Figure 1, the Enhanced Commissioning (EAc3) credit is pursued on every project because of OFCC's emphasis on project quality control. To ensure that school districts and the state protect the millions of dollars they invest in every project, the commissioning process is incorporated into the contractual language of each individual project. Commissioning is intended to ensure that each project has building systems (e.g., mechanical, electrical, and plumbing) designed and installed according to the owner's project requirements. The synchronization of the commissioning requirements of the OSDM, the Fundamental Commissioning prerequisite (EAp1) and the Enhanced Commissioning credit results in every applicable project pursuing EAc3.

Another credit that is frequently attempted (72 out of 75, or 96% of the projects in the sample), and worth discussion, is SSc10: Joint Use of Facilities. The Joint Use Facilities credit pertains to allowing the public use of facility spaces such as cafeterias, gymnasiums, classrooms, playing fields, and others with the goal of reducing the need for additional facilities within a community. This widespread adoption has less to do with intended benefits of the LEED credit and more to do with policies that already exist in many of Ohio's school districts. Integrating this credit into a project's LEED scorecard and documenting it during the certification process often consists primarily of identifying the relevant section of the school board's policy and demonstrating to the GBCI that the policy is communicated to the public. Frequently this results in very little, if any, cost to the owner and as a result is pursued on approximately 96% of projects statewide.

Other credits are frequently attempted due to a variety of factors. These include: developments in the construction materials marketplace (MRc4: Recycled Content), Ohio's proximity to material extraction and manufacturing locations (MRc5: Regional Materials), reductions in operational costs (WEc3: Water Use Reduction), low-cost of credit compliance (SSc4.3: LEFE Vehicles Parking), best practices of project management and indoor environmental quality (IEQc3.1: Construction IAQ and IEQc4: Low-Emitting Materials), and utilizing native or adapted plants in landscaping (WEc1). While Ohio may have some geographical advantages, many of these factors can also be found in other states and readily incorporated into the green schools programs of other jurisdictions.

Figure 2 shows the 12 least attempted LEED credits and the number of projects that eventually earned these credits. The factors that cause many LEED credits to be rarely pursued are very diverse. The types of frequently encountered considerations include project scope as it relates to renovations versus new construction, materials selection and the scale necessary to meet credit requirements, and required credit elements that are disruptive to building operations, such as the dishwasher exclusion required by WEc4: Process Water Use Reduction.

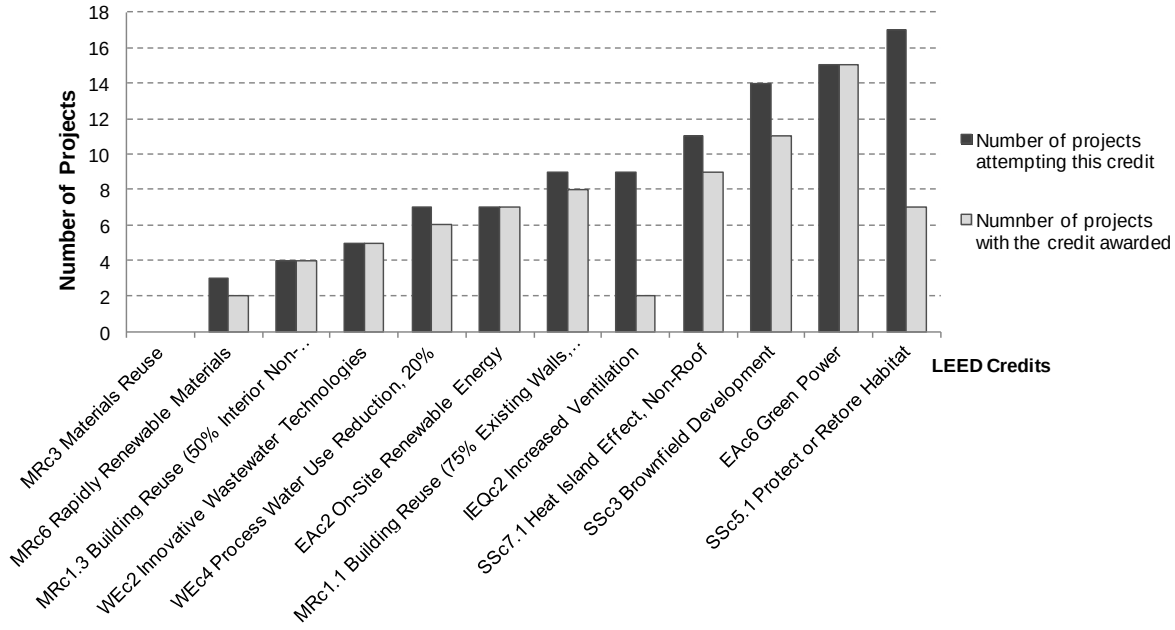

Figure 2: The least attempted vs. awarded credits.

There are also examples of LEED credits that apply specifically to renovation projects, such as the Building Reuse credits (MRc1.1 and MRc1.3). In the research sample, 14 of the 75 projects (18.67%) were major renovations, including those with additions. The number of projects that pursued the Building Reuse credits is considered significant: 4 projects for MRc1.3 (Non-Structural) and 9 projects for MRc1.1 (Structural). This represents 28.5% and 64.3% of the applicable renovation projects, respectively. However, these make up only 5.33% and 12% of the total projects in the sample. The Interior Non-Structural version of the Building Reuse credit is likely pursued less frequently because of the work dictated by the scope of the project. Consider building elements like an existing suspended acoustical panel ceiling. Typically, the replacement of such a ceiling would be included in the major renovation scope of the work. Floor finishes are another element that are frequently demolished and replaced. These types of aspects quickly subtract from the applicable square footage that must remain to demonstrate credit compliance. The structural components of an existing facility, such as the bearing walls, roof deck, slab-on-grade, etc. are much easier to leave in place, resulting in a higher pursuit rate for the MRc1.1 credit. As more projects, both new construction and renovations, complete the LEED certification process, further research should be conducted to track both the pursuit and award rates for these credits.

This research found that the thresholds outlined in the credit requirements for Materials Reuse (MRc3) and Rapidly Renewable Materials (MRc6) make credit compliance very difficult for most OFCC projects. This is demonstrated easily by relatively simple calculations. Let us use an example of a $10 million new elementary school project. If the LEED-provided 45% default value for materials cost were used to calculate compliance with MR credits 3 through 6, this would represent a sum of $4.5 million for the cost of all materials used on the project. To earn 1 LEED point in MRc3, the project would be required to spend 5% of this $4.5 million, $225,000, on credit-compliant materials. In the case of MRc6: Rapidly Renewable Materials, the project is required to purchase 2.5% of the materials cost, or $112,500. This is further complicated by the fact that all materials purchased with OFCC funding must also comply with the guidelines of the OSDM. As a result of these challenges, few project teams pursued these two credits. In the case of MRc3: Materials Reuse, none of the projects in the sample pursued this credit.

As a general observation, the additional cost required to comply with particular LEED credits is the main factor that causes projects not to pursue them. All of the funding that comprises the budgets for these projects comes from public coffers, and often does not allow for scope items that can be value engineered out of a project to reduce construction costs.

Metrics to Measure LEED Credit Achievement Rate

The research team tracked each project's LEED credit achievement utilizing two different metrics. The first metric sought to determine the percentage of projects which achieved the credit from the total number of projects that pursued them, i.e., submitting documentation for at least one round of GBCI review. The second metric determined the percentage of projects which achieved the credit from the number of projects that actually filed the related credit documentation for the final review and received either an "award" or "denied" decision. It was necessary to use two different metrics because the analysis of review comments uncovered a trend of project teams dropping attempted credits midway through the GBCI documentation review process. It was not uncommon for GBCI review comments to reveal that a given project may have submitted documentation for the purposes of demonstrating compliance, but the nature of the reviewer's issues with a particular strategy made it clear the project would not be able to earn a credit without substantial alterations to the project's strategy. As a result, the project's LEED administrator would unattempt the credit, so it would be dropped from the scorecard. The research team felt that these instances were relevant and should be included in its calculations, as they would provide an accurate picture of the success rate of any particular credit.

To further clarify this, if a project team judged on their own that they could not meet an individual credit's requirement prior to submitting documentation to GBCI, the information should not be included in research calculations for the actual success rate of a credit. For the first metric, every calculated instance of credit pursuit met a minimum threshold of being submitted to GBCI for review at least one time. An independent calculation was also made of the credits that did undergo a full review process and all of the instances included in the second metric were either officially denied or awarded. Table 1 shows a few credit examples that have a significant difference between these two metrics. The rates calculated based on the first metric are always lower than that calculated based on the second metric.

Table 1: Credit success rates based on two different metrics

LEED credits	Success rate based on the 1st metric	Success rate based on the 2nd metric	Difference
EAc5	36.36%	53.33%	16.97%
SSc4.1	79.31%	95.83%	16.52%
SSc3	78.57%	91.67%	13.10%
MRc7	27.27%	40%	12.73%
SSc4.2	81.13%	91.49%	10.36%

It can be seen that some of these credits have a very high success rate based on the second metric, e.g., 95.83% for SSc4.1: Public Access to Transportation. It would be interesting to learn why some project teams decided to unattempt this credit in the middle of the LEED review process. Also, this credit presents a great example of why separate calculations were important. The SSc4.1 credit was pursued on 29 of the 75 projects (38.67%) when factoring in the projects where credit consideration was withdrawn during the GBCI review process. However, it was only officially awarded or denied on 24 of the 75 projects (32%). Of those 24 projects, this credit was awarded 23 times, meaning an approximate success rate of 96%. If all projects were considered, including where the credit was unattempted and dropped in the middle of review, the actual rate of successfully documenting credit compliance would be 23 of 29 projects, or 79.31%. This would represent a difference of 16.52%, depending on which metric is chosen to measure credit success. In the interest of conducting thorough investigation and accounting for all pertinent factors, the research team included both calculations for each LEED credit.

Conclusion

The purpose of this study was to identify patterns and variations in LEED credits attempted and/or obtained by 75 K-12 school projects. The purpose was to provide insight into what credits can be deemed practical on a statewide scale. In addition to tracking credits attempted/earned by individual projects, the study carefully analyzed the review comments (mainly technical advice provided for the pursued credits) generated for each project during the LEED certification process. Findings concluded that Recycled Content, Enhanced Commissioning, Maximize Open Space, Water Use Reduction, and Regional Materials, and LEFE (Low-Emitting and Fuel-Efficient) Vehicles Parking were the top 6 LEED credits awarded for Ohio green school projects. Discussions disclosed some rationales on why some credits were most frequently or least frequently attempted by the project teams.

This study was only a first step in investigating the best practices and lessons learned in the implementation of the LEED green school program. Several future research directions can be pursued based on the conclusions of this study. Approximately half of the LEED for Schools 2007 projects registered in Ohio are included in this study as having achieved LEED certification. As more projects achieve certification, these results can be updated until the entire picture becomes clear. Additionally, the same research methods can be applied to the v3 projects; a vast majority of these have not been LEED certified at this time. There are a multitude of updated credit requirements, credit approaches, etc. that will certainly impact the findings. Consistencies and inconsistencies in the LEED review process can also be summarized in greater detail. The research team is also currently trying to establish a solid and reliable methodology to determine a correlation between cost premiums and individual credits. Research into green schools is a relatively new and unexplored topic with a great deal of fresh territory to explore.

Acknowledgement

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