Sustainable Real Estate: An Empirical Study of the Behavioral Response of Developers and Investors to the LEED Rating System[1]

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The interest in sustainable development in general –and LEED certification in particular-- has dramatically increased over the past several years. Indeed, a number of papers have been published that report LEED certified projects have benefited from tangible operational savings and have traded at significant premiums compared to other projects. While such research has been met with much interest, little attention has been focused on the underlying drivers of such projects and how behavioral responses of developers and investors have changed over time. The objective of this paper is to compare how the market pursued the initial set of LEED standards and how the market responses have changed over time. The empirical analysis will include a systematic analysis of the attributes that were used to achieve various levels of certification, as well as the pattern of point distributions around the various breakpoints. We use detailed point composition data of projects certified before and after this change to examine whether developers and investors have tended to chase certification rather than "doing the right thing", by looking at the building aspects that have been addressed to achieve credits for certification.

The empirical analysis of the LEED certification levels and point accumulation will be complemented by an analysis of several contemporaneous surveys of various real estate professionals. These surveys will provide insights into how the market approached sustainability and LEED certification in the early stages of growth, as well as how those responses have changed over time as the market matured. Finally, the impact of changing LEED certification requirements will be explored by extending the new system to project certified under the initial system.

Background

Over the past decade, interest in "sustainable real estate" has experienced tremendous growth. Despite this interest, there is little consensus as to what the term actually means. Thus, before delving into the major research question addressed in the article, it is useful to begin with some preliminary comments. Briefly, there are two critical dimensions of real estate that should be considered in any discussion of sustainability: space time and money time. That is, real estate has a temporal dimension that affects its spatial side, as well as its "capital" or money side. Since real estate improvements --both to a site and on a site in the form of buildings-- are resource intensive, the deployment of such resources must be compensated. Since this compensation will come from the market or from public sources, the decision to use real estate must provide an adequate return to justify the investment of resources. On the public side, this "return" may be intangible, or may come as part of the government's responsibility to provide amenities needed to serve residents or, in many cases, taxpayers who have a vested interest in how public funds are deployed. On the private side, this return can have some "intangible elements" as in the case of pride of ownership, but ultimately must still have sufficient "tangible" or economic benefits to provide an adequate return on investment of capital.

[1] This research is an extension of an earlier unpublished paper by the lead author entitled, "A Holistic Approach to Sustainable Real Estate: A Market-based Perspective, presented at the 25th ARES National Conference, April 3rd, 2009, Monterey CA

Graaskamp had a very high social consciousness, one that stemmed from his personal beliefs and from the Wisconsin tradition he embraced. This tradition was pointed out by Ratcliff who stated:

> I am inclined to believe that the area of the social sciences concerned with urban economics and urban land will respond to the merging nature of urban problems. After all, social scientific effort would be pointless if it did not serve in solving social problems and in the advance of social well-being… I am sure that you share with me a constant exposure to writings on the urban crisis, ad infinitum, ad nauseum. Since most people now live in cities, the urban crisis is essentially co-extensive with the social crisis…[2]

Graaskamp, provided a foundation for sustainable real estate by trying to sensitize his students and professional audiences to the need to approach real estate decisions as resource management issues. He summarized his sense of social commitment regarding real estate rather elegantly in a television interview he granted toward the end of his career:

> Man is the only animal that builds his terrarium about him as he goes and real estate is the business of building that terrarium. So we have a tremendous ethical content, tremendous social purpose. The student is looking for a field in which entrepreneurship and a way of life can be integrated into social purpose. We like to argue that the entrepreneur of tomorrow is going to be the individual who can inventively implement social policy.[3]

Graaskamp recognized that real estate decisions should satisfy a high ethical standard in terms of future generations. He contended that real estate activities and projects could be treated as cash cycle operations that link the spatial and economic dimensions over time. This insight was one of the driving forces behind the development of discounted cash flow analysis that he pioneered. It also explained the emphasis that he placed on developing a better understanding of the economic assumptions of the respective parties about future operations and market conditions. He argued for a responsible approach to real estate development, which if followed, would have helped the market avoid much of the real estate crisis that surfaced in the latter 80s and is occurring once again in the current market. He stated that:

> ...the best risk-management device for the producer group, which is usually the lead group in the initiation of a project, is thorough research so the development product fits as closely as possible the needs of the tenant or purchaser, the values of the politically active collective consumer, and the land use ethic of the society.[4]

In retrospect, he was arguing for "sustainable use," but added the notion of cash solvency to create some renaissance real estate types as the "Triple Bottom Line" of people, planet and profit. The profit dimension embedded in this definition takes on a longitudinal perspective. That is, the true test of sustainability is the ability to satisfy this proposition over time; to provide a durable solution that is appropriate for use decisions which constitute an "irretrievable commitment" of scarce resources. This

[2] Ratcliff, Richard U., Valuation for Real Estate Decisions, Santa Cruz: Democratic Press, 1972: p. 7.

[3] Jarchow, Stephen P., editor, Graaskamp on Real Estate, The Urban Land Institute, 1991. P68.

[4] Graaskamp, James A. Strategic Planning Approach to Major Real Estate Decisions, unpublished essay reprinted in Stephen P. Jarchow, editor, Graaskamp on Real Estate, Washington, DC: The Urban Land Institute, 1991, 378-83.

temporal nature operates on both the spatial (i.e., supply/demand for product) front as well as on the capital (i.e., supply demand for investments) front. Thus, on the spatial side, to create a project with sustainable demand, it is critical that the developer produce a project for which there is "effective" demand for the particular real estate offering over the full life cycle of the property. This long-term perspective is particularly important due to the "durable" nature of real estate which mandates that the true test of sustainability is determined over time and is reflected in continued market demand, both now and in the future. With this added criterion, a working definition of sustainability on the spatial front is:

> The use of scarce real estate in an efficient, economic, equitable and socially responsible manner that provides an acceptable –if not optimal– fit between users of space and the space that is produced that has an existing and enduring effective demand and balances the needs of current and future generations.[5]

Since these spatial benefits focus on space users and space produces, it is useful to review some of the drivers the attracted some of the early adopters to the "diffusion of innovation" process related to green buildings when the trend was first emerging. Based on a series of surveys of corporate users, developers and investors between 2006 and 2008, some of the benefits included:

- Competitive Advantage
  - First mover advantage in reputation and brand
  - Potential to create a better work environment and enhance productivity
  - Deliver positive marketing and goodwill as customers demand green practices
- Spatial Impacts
  - Improved performance and operations of investments and facilities
  - Produce more comfortable building for tenants and more efficient operation lowing costs
- Environmental Benefits
  - Deliver positive environmental, ecological and sustainable effects
  - Reduce use of nonrenewable resources; improved energy savings
  - Contribute to carbon reduction, waste reduction

In addition to this primary research, the literature is replete with articles discussing the benefits of green buildings at the spatial level. For example, Singh et al (2011) explored the costs and benefits from improved Indoor Environmental Quality (IEQ) in LEED certified buildings. Using case studies, he explored the requisite incremental hard and soft costs and estimated the resultant benefits to space users in terms of well-being and productivity. He collected well-being and productivity data from employees who occupied non-LEED offices and then followed up after their move into LEED offices. Applying a Life Cycle Cost model, he concluded that the gains of IEQ improvements offset the costs and were economically viable investments. On a similar note, Temmink (2010) that corporate users realized sustainability is a business imperative "…as a result of changing energy prices, anticipated carbon regulation, stricter future building codes, cost containment, limited natural resources, or increasing pressure from stakeholders, the question has clearly changed from whether sustainable design should be considered to why one would choose not to consider it.

[5] DeLisle, James R., excerpted from presentation entitled, Sustainable Development: A Market-based Approach Benefits & Opportunities for Developers and Communities, Seattle WA, 2006.

As on the spatial side, on the capital side of the equation, sustainable investment must provide competitive risk-adjusted returns over the full investment cycle. In terms of investment analysis, the determination of whether this criterion is likely to be satisfied is typically based on some form of Net Present Value (NPV) or the Internal Rate of Return (IRR) generated through some type of Discounted Cash Flow (DCF) analysis. Both of these measures consider periodic cash flows and future sales proceeds.

Exhibit 1: Discounted Cash Flow Model

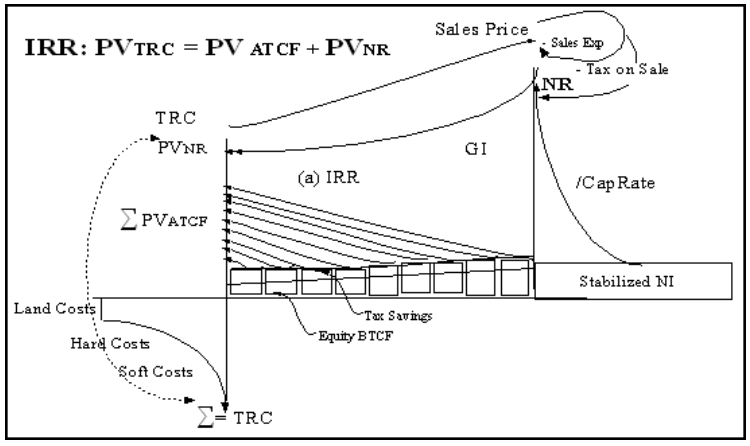


Exhibit 1 presents the life cycle of an investment. As noted, the NPV is the present value of the periodic cash flows plus the present value of the net sales proceeds at the end of the holding period at some specified discount rate (R).

$$NPV = [PV\ (ATCF_{1->n})_R + PV(NR_n)_R] - EQ_1$$

Referring back to the exhibit, the IRR is rate at which the present value of the benefits equals the present value of the outlay:

$$PV\ (ATCF_{n)} + PV(NR_n) = PV\ (EQ_1)$$

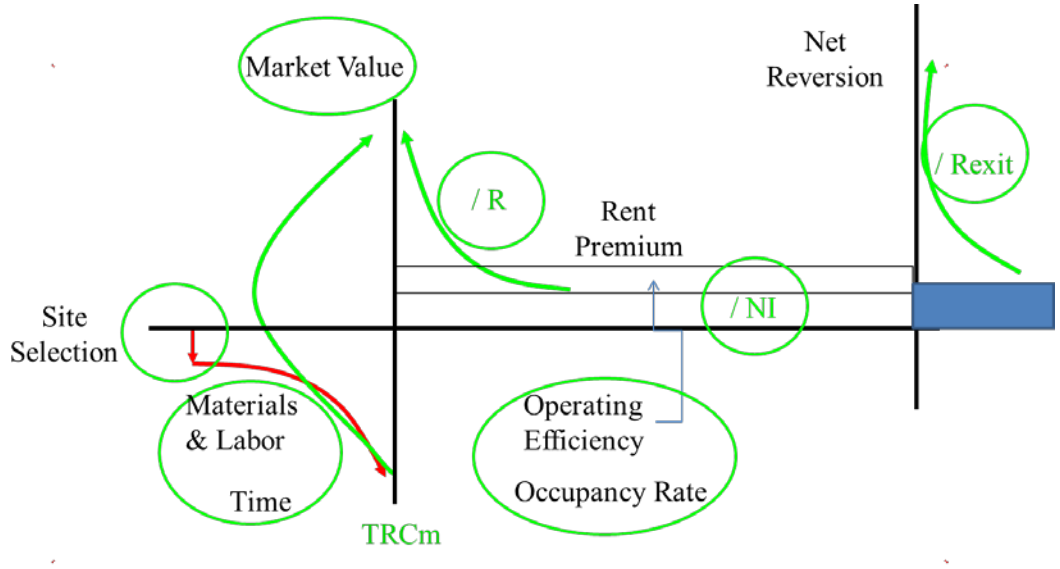
Where:

ATCF = After Tax Cash Flow/period 1-n periods
NR = Net Reversion After Tax
EQ_1 = Initial Equity Investment

At a simplistic level, the appropriate level of equity investment (EQ_1) can be estimated by applying a going-in cap rate (R) to the expected net income, while the Net Reversion can be estimated by applying an exit-cap rate to the stabilized net income expected at the time of sale. This relationship is reflected in Exhibit 2 which identifies some of the key areas in which sustainable properties can enhance property value. As noted, some of the impacts of developing sustainable properties have an adverse affect on on Total Replacement Cost (e.g., higher land costs, higher material costs, higher labor costs, greater time to market) which show up to the left of the Market Value/Cost y-axis. On the other hand, some elements

associated with sustainable buildings in theory, and partly reinforced by preliminary research, can enhance or increase market value (i.e., the present value of future benefits). As noted, some of these elements affect the Net Income that can be generated (e.g., rent premiums, lower operating costs, higher occupancy rates) while others affect the Net Reversion (e.g., exit cap rate, expected NI). Finally, if sustainable buildings have a durable value proposition, the may constitute lower risk which could translate to a lower yield requirement in terms of the discount rate applied in NPV analysis or the IRR hurdle rate, both of which would increase the present value of benefits (i.e., Market Value). On the other hand, if these benefits are not realized or are not stable, the value proposition would not be durable subjecting a property to a "correction" when the market recognizes the risks or uncertainty.

Exhibit 2: Sustainable Value Proposition



In summary, from an investment perspective, sustainability hinges on the levels of net income and the required rates of return for a project which are related to the relative risk or uncertainty of an investment and the commensurate hurdle rates of return the market will demand to compensate for risk. Thus, if LEED (Leadership in Energy and Environmental Design) designations are expected to increase net cash flows, reduce risk and/or attract capital with lower return requirements they can add to the market value of a property and lead to premium pricing over otherwise comparable but non-designated properties. If these benefits are not maintained over time, this premium can be quickly eroded which translates to a lack of "sustainable" pricing/performance.

A number of articles, research reports and white papers have emerged which tout the positive value premiums associated with LEED designations. For example, in an early study of the investment benefits that received significant attention, Miller et al concluded that LEED certified projects, and Energy Star projects commanded higher rents and traded at premiums relative to other investments. While these preliminary results are interesting, there is some concern whether they are "sustainable." That is, in many cases, the early pricing for LEED projects was based on an expectation that they would provide superior performance rather than on the basis of empirical research. The results of the Miller study received

significant attention, including an article by Muldavin in 2008, which provided an in-depth critique of the research.

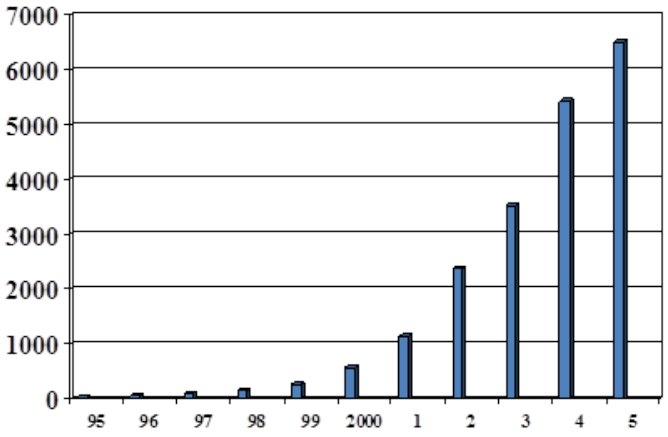
In a more recent paper, Fuerst (2009) noted, used hedonic models to calculate a sale price premium for Energy Star and LEED labeled office buildings of 18% and 25%, respectively. For properties that carried both designations, the sale price premium for dual certification was estimated at 28–29%. Jackson (2009) reported even more startling results. He applied Monte Carlo simulation analysis to estimate the expected return and risk associated with LEED and ENERGY STAR ratings. With respect to the LEED designation, he isolated an average IRR of 126% with only a 10% probability of achieving an IRR of 50% or less. With respect to ENERGY STAR certifications, he estimated an average IRR of 140% with only a 1.6% chance of an IRR that was less than 50%.

In a white paper targeted to institutional investors, Nelson (2007) noted the green buildings were altering real estate market dynamics with respect to "the nature of product demanded by tenants, constructed by developers, required by governments and favored by capital providers. The upshot will be a redefinition of what constitutes Class A properties and even institutional-quality real estate." He went on to argue that "…property owners will need to adapt quickly – or risk the consequences of sharply shrinking demand for property that, over time, becomes increasingly obsolete." In an article directed toward appraisers, Pitts & Jackson (2008) recognized the growing pressure that appraisers should consider the effects of green building in valuing properties. Despite the popular appeal of such a movement, they properly noted that that such valuation practices must be based on market evidence of the enhanced value attributable to sustainable components. While they recognized that there is a growing body of anecdotal evidence that such benefits are real, the noted the degree to which they impact value will vary by property type, location, and local market conditions. This debate is likely to heat up even more as the commercial real estate market continues to recover from the financial and economic crisis affecting investors across the globe.

Problem Statement

To this point, the bulk of published research has focused on the positive sides of green buildings in general and LEED designations in particular. While much of this research has been rigorous and subject to academic and industry scrutiny, the reality is that the LEED is only now emerging from the rapid growth stage of the "diffusion of innovation" process. This stage of evolution is punctuated by the dramatic growth in the membership in the United States Green Building Council (USGBC) membership between 1995 and 2005.

Exhibit 3: Growth in Membership in USGBC



The dramatic growth in membership was associated with a significant increase in the number of projects that received LEED designations. Exhibit 3 compares the growth of LEED projects by type of project and by level of designation between 2007 and 2009. As noted, the bulk of most LEED projects fell in the New Construction (NC) category in both periods, while the number NC projects increased more than two-fold. This growth rate was lower than the other types of projects although due to the higher concentration of NC (81% of all 876 projects in 2007) the category remained the most dominant.

Exhibit 3: LEED Growth: 2007-2009 by Type by Level

Projects as of 2007	**Level**					
Type	Certified /	Silver	Gold	Platinum	Total	Share
Commercial Interiors	31	0	35	5	71	8%
Core & Shell	2	14	17	2	35	4%
Existing Buildings	19	13	20	8	60	7%
New Construction	270	219	187	34	710	81%
Total	322	246	259	49	876	100%
Share by Level	37%	28%	30%	6%	100%	

Projects as of 2009	**Level**					
Type	Certified /	Silver	Gold	Platinum	Total	Share
Commercial Interiors	123	157	181	22	483	21%
Core & Shell	21	68	54	7	150	6%
Existing Buildings	32	45	48	17	142	6%
New Construction	503	514	442	84	1543	67%
Total	679	784	725	130	2318	100%
Share by Level	29%	34%	31%	6%	100%	

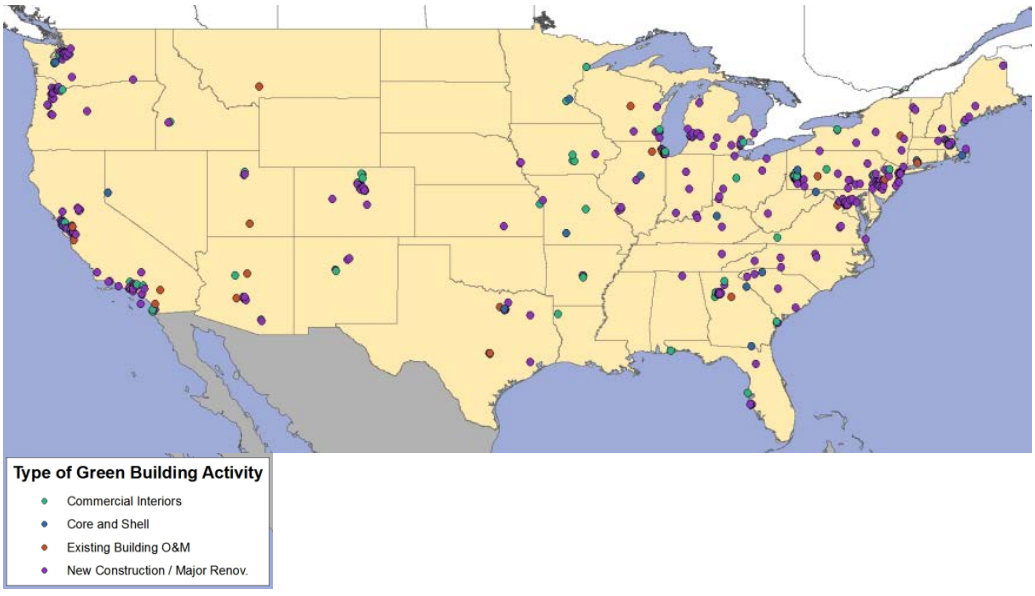
Change	**Level**				
Type	Certified /	Silver	Gold	Platinum	Total
Commercial Interiors	4.0		5.2	4.4	6.8
Core & Shell	10.5	4.9	3.2	3.5	4.3
Existing Buildings	1.7	3.5	2.4	2.1	2.4
New Construction	1.9	2.3	2.4	2.5	2.2

Exhibit 4: LEED Classifications

- LEED CI: Commercial Interiors
  - For high-performance green interiors (healthy, productive places to work, are less costly to operate and maintain, and reduce environmental footprint)
  - For tenants and designers, who do not control whole building operations
- LEED CS: Core & Shell
  - Covers base building elements (structure, envelope and building-level systems)
  - Recognizes division between landlord and tenant
- LEED EB: Existing Buildings
  - Performance-based benchmark for building owners and operators to measure operations, improvements and maintenance
  - Seeks operational efficiency while minimizing environmental impacts
- LEED NC: New Construction
  - New Construction and Major Renovation Green Rating System
  - Designed to guide and distinguish high-performance commercial and institutional projects, with a focus on office buildings

Exhibits 4 and 5 provide a breakdown of the LEED definitions and the geographic dispersion of projects by LEED classification. This paper focuses on the LEED New Construction category which is of interest since designations require the investment of additional resources upon which a positive economic return must be captured over the long term.[6]

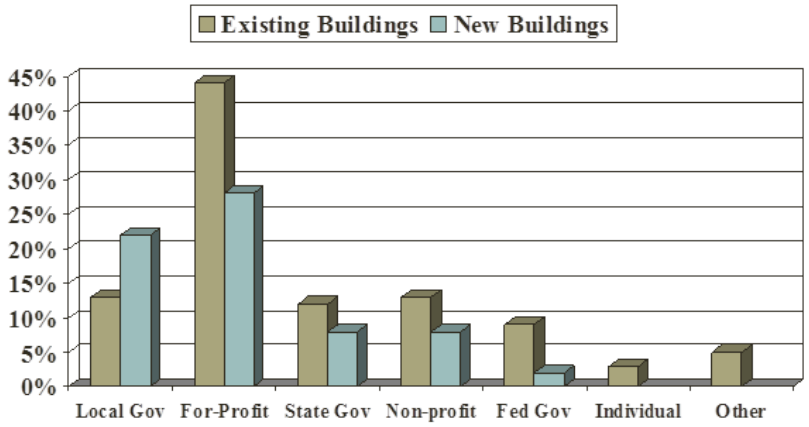
Exhibit 5: Geographic Dispersion of LEED Buildings



[6] It is recognized that some of the benefits of LEED certification may be non-economic or not easily quantified, but over the long term, to "sustain" the trend, these returns must be durable and supported by positive economics.

In addition to broad geographic dispersion, LEED EB and NC projects are fairly widely spread across ownership or sponsorship categories. While governmental agencies and non-profits were leaders in the adoption of LEED standards, the private for-profit segment which is of particular interest in terms of market value benefits were also active in the early LEED certifications. This paper focuses on that demographic and/or segment although the results are revealing for all types of owners and sponsors.

Exhibit 6: Market Share of LEED 2005 EB/NC by Ownership



Empirical Support for Durable Value Proposition

The dramatic growth in LEED projects that occurred up through2009 reveals the fact that the track record on such projects is relatively limited. As such, when compared to long-term analyses required by institutional investors and advisors who are held to a fiduciary standard, such results cannot be taken at face value, but as part of the exploratory phase of inquiry. This is especially true in light of the cyclical nature of the real estate market and the fact that such projects have not been tracked across cycles. While the results of individual studies may be valid (i.e., capture current value premiums) the relationships that have been reported cannot be accepted as reliable (i.e., enduring or holding over time). This caveat is exacerbated by the fact that the LEED designation standards are in something of a state of flux, with major revisions being introduced at relatively short intervals. The objective of this paper is to focus on this latter element; to determine the impact of changing standards on the levels of designations and by extension, any market value premiums that may have existed up to the time of the revisions.

From a public policy perspective, the continued evolution of LEED and/or other sustainability rating systems might appear to be a positive trend; a natural means of encouraging the advancement of professional practices and one that can lead to continuous "learning." This observation was extended to LEED by Lewis & Howard in 2003 when the acknowledged, "This is a time of massive and rapid change in the environmental practices of the U.S. building industry. Green buildings are a local point and a catalyst for these changes. Green technologies are evolving rapidly, leading to both improved cost effectiveness of green development strategies and increased acceptance of green building concepts in mainstream projects." They acknowledged the speed of evolution and argued that it called for increasing rigor and sophistication in green building rating systems, placing the emphasis on evolutionary change.

While continuous learning and advancement is both a desirable and necessary requirement for professionals operating in fields related to the dynamic and cyclical real estate, the lack of consistency in

building standards over time may have a deleterious impact on the "real estate value proposition." Indeed, due to the capital intensive, durable and long-term nature of real estate, from a strategic perspective, continuity and predictability are critical to the relatively smooth operation of the market. The underlying problem statement addressed in this paper focuses on this issue, namely:

- The absence of stability in LEED standards creates a degree of uncertainty which, by definition, increases the risk associated with real estate investment. To offset such risk, real estate investors will require higher returns. Referring back to the DCF models that are used to value real estate, an increase in required returns (i.e., hurdle rates) places downward pressure on market values. Such changes could be material and could more than wipe out any temporary or short-term gains attributable to LEED designations.
- The downward pressure on market values due to changes in LEED requirements is especially true if such changes result in a decline in designation levels for projects that were built to a now-obsolete standard. For example, assume an investor is willing to pay a premium for a building that has been designated as Gold, the 2nd highest category of designations.
    - If a new rating system is adopted, it is possible that the building might slip down to a Silver designation under the new rating system. If the premium price for Silver building is lower than for Gold or non-existent, any premium price that was paid at acquisition could be eroded.
    - Even if the investor might hold the property for the long-term, such changes would represent "unrealized losses" that would have to be reflected in the valuation of "mark-to-market" holdings which is often the case in real estate.
- Some might argue that the fact the existing designations are "grand-fathered" in and thus such value losses could be avoided. While intuitively appealing, such an argument does not hold up in the case of real estate:
    - Under professional appraisal standards, when valuing an existing building, an appraiser must deduct for depreciation. One form of depreciation is "functional obsolescence" or the failure of a building to meet modern standards. As such, changing LEED standards would constitute functional obsolescence which, depending on the magnitude of changes may be economically viable to correct.
    - Another form of "depreciation" which must be recognized in appraisal is physical obsolescence. This could occur where a system fails to deliver the desired results over time. While related to functional obsolescence, this criterion addresses the "efficacy" of systems and whether they do what they were purported to do. Assuming there are some compelling reasons to change LEED rating systems to improve "sustainability," by definition non-compliant buildings will perform to a lower standard.
- A final concern with changing rating or designation systems relates to the confusion that might be introduced into the market. Depending on the importance of designations to buyers, the creation of an array of designations which cannot be interpreted without looking at the vintage or year of designation and, by extension, the underlying rating standards which they satisfied. This complexity and the resultant uncertainty is amplified by the fact that there is a significant transition period within which a new building can opt for one standard or the other making it impossible to rely on the year of construction or completion to understand the standard of performance that might be expected from a designated building. While these issues are clear to real estate professionals, they are not as clear to policy makers and others not active in the real estate market. Consider the following comments or observations:

    - Window of Change. “Since NC-2.2 was available for registration until June 26, 2009, the deadline for submitting under that system would be June 25, 2015.”[7]
    - Certification Level. “"... but you might be able to achieve a higher certification level (such as Gold versus Silver) by staying with a pre-2009 system. Usually, the system under which a project is certified is not as important to the owner and the public as the certification level."
- In reviewing the implications of this research, it should be noted that LEED 2012 is out for the third round of public comments and will be introduced in Fall 2012.
    - The main differences between 2009 and 2012 are changes to “impact categories” or weights in the classification system. While the U.S. EPA‟s TRACI Impact Categories were adopted for 2009, in preparing the new system, a new set of impact categories was developed by USGBC to “more closely align with our mission and vision for ongoing LEED development.”[8]
    - The new Impact Categories include: reduction in the contribution to global climate change; enhancement of individual human health, well-being, and vitality; protection of and restoration of water resources; protection, enhancement, and restoration of biodiversit and ecosystem services; promotion of sustainable and regenerative material resource cycles; creation of a greener economy; and enhancement of community: social equity, environmental justice, and quality of life.

Research Design

A multi-tiered approach was adopted to explore the stability of LEED rating systems during the transition from the 2005 standard to the now-current 2009 standards.[9]

- The first stage was to explore the two systems and develop a comparison which could be used to map old 2005 designed projects to the new 2009 standard.
- The second stage was secondary data collection which consisted of extracting building-by-building point awards for some 800 LEED NC (New Construction) projects.
    - While such data might have been available in an electronic version from USGBC, to avoid introducing sponsor bias and/or limiting the use of the results, the data were keyed in by hand which covered some 84 individual attributes contained in 6 major categories.
    - In addition to the point awards, data were extracted for the name, location, owner, type of project, and other descriptive data.
    - During data development and scrubbing, the potential 800 or so projects were reduced to 589 usable projects.
    - The behavioral responses of developers to the rating system were analyzed by compiling some basic statistics to compare the actual earned points/category to the break points or hurdle points between designations.

[7] This comment was extracted from a LEEDuser.com blog: http://www.leeduser.com/compare#resources-tab

[8] For more discussion, visit www.usgbc.org and http://www.usgbc.org/ShowFile.aspx?DocumentID=9828

[9] The 2005 standard had several iterations including V2.1, V2.2. It should also be noted that a new 2012 standard is being readied for rollout in Fall 2012; this new system will include even more dramatic changes than did the 2005-2009 revisions which are the subject of this paper.

- The third stage involved the conversion of 2005 points to 2009 equivalents. This was accomplished through several steps:
    - First, the 2005 point total on a category-by-category basis were adjusted by changing weights assigned to the 6 categories and the introduction of the new "Regional Priority" category.
    - Second, the resultant changes in Weighted Scores were adjusted to account for differences in scaling (i.e., the 2005 system had 69 total points; the 2009 system had 110 points)
    - Third, the changes in classification from the original 2005 vintage designations were calculated generating a "reclassification" matrix.

Empirical Analysis

Stage 1: Comparative Analysis of 2005 v. 2009 Systems

Once the data were scrubbed, attention turned toward analysis of the key topics of interest: the changes that occurred in LEED designations; and, the implicit impact of those changes on the classification of vintage (i.e., pre-2009) LEED buildings.

Exhibit 7: Categorical Comparison of 2005 v. 2009

	Points		Share	
Categories	2005	2009	2005	2009
Sustainable Sites	14	26	20.3%	23.6%
Water Efficiency	5	10	7.2%	9.1%
Energy & Atmosphere	17	35	24.6%	31.8%
Materials & Resources	13	14	18.8%	12.7%
Indoor Air Quality	15	15	21.7%	13.6%
Innovation & Design	5	6	7.2%	5.5%
Regional Priorities	0	4	0.0%	3.6%
Total	69	110	100%	100%

Exhibit 7 presents a summary of the changes in the LEED classification system for 2005 V2.2 and LEED 2009. As noted the 2005 system consisted of 69 points while the 2009 system included 110 points. In addition to changing the number of points, the relative contribution of the categories (i.e., weights) changed as well with the first three of the original six categories (i.e., sustainable sites, water efficiency, and energy & atmosphere) receiving added emphasis, and the latter three (i.e., materials & resources, indoor air quality, and innovation & design) receiving less emphasis. As such, it could be expected that vintage 2005 projects that had more points earned in the former areas would benefit while those with more points in the latter would lose ground. In addition to the "traditional six categories," 2009 saw the addition of a new category entitled Regional Priorities. The addition of this category was an obvious reaction to criticism that the earlier system did not differentiate among projects located in dramatically different climates where the appropriateness and/or importance of certain attributes (i.e., water retention in Seattle v. Phoenix; open ventilation in Chicago vs. Houston). Addendum 1 provides a much more detailed comparison of the two systems including the point assignments for individual attributes. It should

be noted that some attributes were required to achieve any points in a particular category, while others were optional and depending on degree of achievement could earn different points.

Stage 2: Secondary Data Collection and Exploration for Behavioral Responses

As noted earlier, a number of primary studies conducted by the authors from 2006 to 2010 regarding the underlying rational behind the early adoption of green building standards (i.e., LEED or Energy Star) included such motivators as a "first to market" strategy, and a desire to make a public statement about social responsibility. As such, a likely behavioral response by some early adopters would be a pursuit of a particular designation level which emphasized point acquisition rather than achievement of the underlying goals and objectives. This behavior would manifest itself in a series of leptokurtic curves (i.e., high concentrations) and narrow confidence intervals or bands that would be clustered just above the cut-off points. The strategy of slightly overshooting the target might be to provide some degrees of freedom in case a couple of points were lost along the way or turned out to be prohibitively costly.

Exhibit 8: Behavioral Response in Terms of Breakpoints, Average Earned Points

Categories and Profiles	Original 2005 LEED		
	Cut-off	Average	Std. Dev.
Unclassified			
Certified	26	27.6	2.2
Gold	33	34.2	1.4
Silver	39	40.8	2.7
Platinum	52	54.6	2.8
Grand Total	69	34.0	7.2

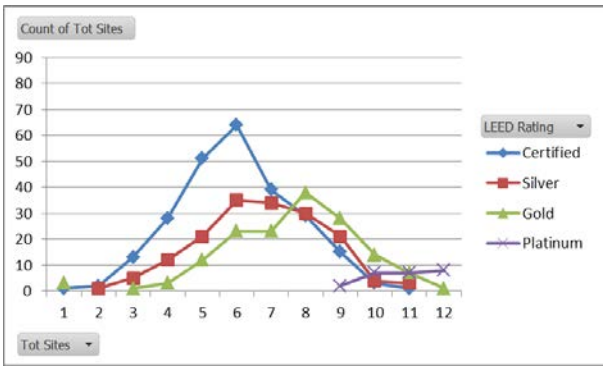
Exhibit 8 presents some of the summary statistics regarding the relative concentration/dispersion of earned points by category. As noted and as hypothesized, the average points earned for the four targeted designations for the 589 projects were indeed fairly tightly clustered slightly above the breakpoints or hurdle levels for each of the respective categories. Exhibit 9 provides a summary of the classification of the 589 projects by LEED designation. As noted, the bulk of the projects fell into the "certified" category while Platinum, the highest level had relatively few projects.

Exhibit 9: Distribution of 2005 Classification

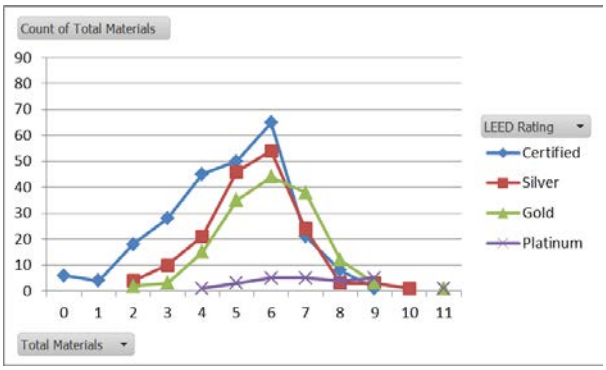
Categories	Original 2005 LEED		Cut-offs	
	Number	Share	Points	Share of total
Unclassified		0%		
Certified	246	42%	26	38%
Silver	166	28%	33	48%
Gold	153	26%	39	57%
Platinum	24	4%	52	75%
Grand Total	589	100%	69	100%

Exhibit 10: LEED 2005 Points by Category

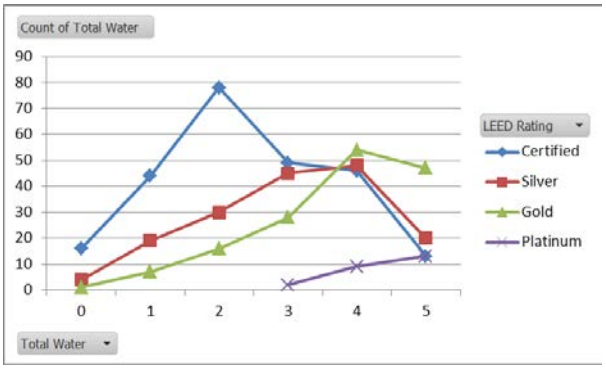
Sustainable Sites



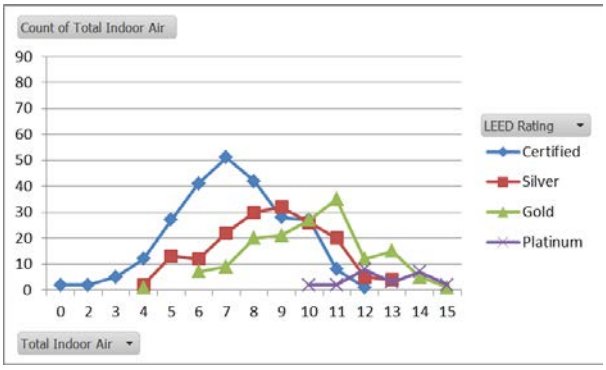
Materials & Resources



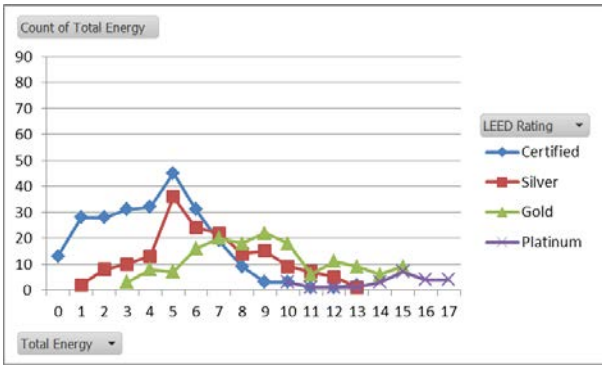
Water Efficiency



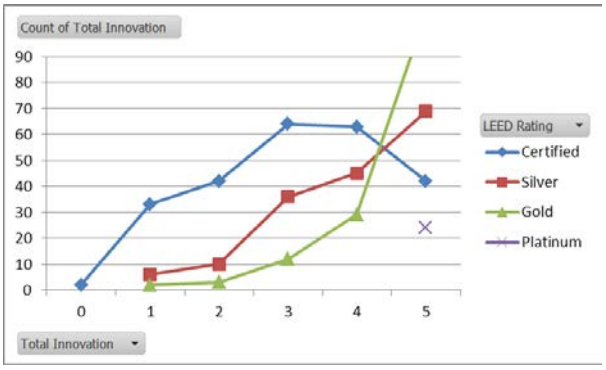
Indoor Air Quality



Energy & Atmosphere



Innovation & Design



To provide additional insights into the distribution of point among categories, frequency distributions were generated for each of the categories and each of the original 2005 classifications. As noted in Exhibit 10 there were significant and interesting differences in point distributions by classification for each of the categories. In some cases, the distributions were normal while in others they were skewed. It should also be noted that in some cases the points were higher in the first three categories which received additional emphasis in the 2009 system, while others were higher in categories that were de-emphasized. Given the narrow "cushion" above the cut-offs, these patterns might translate to significant changes in classification.

Stage 3: Conversion of 2005 to 2009 Systems and Re-classification

Once the nature of the empirical point-data for the 589 projects were understood, the next stage of analysis involved the conversion of 2005 vintage projects to the new 2009 LEED system. This conversion involved several steps.

- The basic equation for the first step of adjusting for changes in weights consisted of:

  $WgtAdj_n = \sum (\beta_1\delta_1 + \beta_2\delta_2 + \beta_3\delta_3 + \beta_4\delta_4 + \beta_5\delta_5 + \beta_6\delta_6)$

  Where:

n	= 589 projects
$\beta_{1\text{-}6}$	$= {}_{2005}$ Ratings by Category 1-6
$\delta_{1\text{-}6}$	$= {}_{2009/2005}$ multipliers

- The second equation for adjusting for differences in scaling consisted of

  $WgtAdj_n * (LEED2_{pt}/LEED1_{pt}) + U_{rp}$

  Where:

LEED2	= Total Points for LEED 2009
LEED2	= Total Points for LEED 2005
U_{rp}	= Added Category for Regional Priority Points

Exhibit 11 provides a profile of the WgtAdj multipliers for the respective projects comparing the percent point composition in 2005 to that of 2009. This involved calculating the market share of the 69 v. 100 points and then calculating the appropriate multiplier. As noted, the first three categories were weighted upward as a result, while the latter three categories were weighted downward. The cumulative percent changed among the two clusters of categories was fairly pronounced with the first three gaining 12.4% and the latter three losing 16%. The net negative 3.6% difference is attributable to the addition of 4 points for the Regional Priority category.

Exhibit 11: Changes in Weighting

Categories	2005	2009	Multiplier	Change	Cum Change
Sustainable Sites	20.3%	23.6%	1.16	3.3%	
Water Efficiency	7.2%	9.1%	1.25	1.8%	
Energy & Atmosphere	24.6%	31.8%	1.29	7.2%	12.4%
Materials & Resources	18.8%	12.7%	0.68	-6.1%	
Indoor Air Quality	21.7%	13.6%	0.63	-8.1%	
Innovation & Design	7.2%	5.5%	0.75	-1.8%	-16.0%
Regional Priorities	0.0%	3.6%			
Total	100%	100%	5.77		-3.6%

Adjustment for Regional Priorities

To keep the analysis fairly simple, in the initial phase an automatic 4 points for Regional Priorities was added to the adjusted scores. This is being modified through a process of an automatic adjustment. In subsequent analysis but not included in this report, the adjustment for Regional Points includes:

$$\text{Total Score 2009} = SS * w_{ss} + WE * w_{we} + EA * w_{ea} + MR * w_{mr} + IEQ * w_{eq} + ID * w_{id} + RPC$$

Where:

SS is the vector of Sustainable Site attributes
WE is the vector of Water Efficiency attributes, and so on, and

RPC is the Regional Priority Credits, ranging from 0 through 4.

The summery statistics for the re-classification of the LEED 2006 project by applying the 2009 system are presented in Exhibit 12. As in the case of the original ratings, the behavioral response of clustering just above the breakpoints is fairly robust and not affected by the differences in scaling.

Exhibit 12: Change in Weighting & Scaling

Categories and Profiles	Original 2005 LEED			Re-Weighted & Re-Scaled		
	BP	Average	Std. Dev.	BP	Average	Std. Dev.
Unclassified					33.6	4.3
Certified	26	27.6	2.2	40	44.7	3.1
Gold	33	34.2	1.4	50	53.7	2.7
Silver	39	40.8	2.7	60	66.6	4.9
Platinum	52	54.6	2.8	80	42.2	10.4
Grand Total	69	34.0	7.2	110	42.2	10.4

Exhibits 12 and 13 provide a summary of the results of the reclassification of existing 2005 LEED vintage buildings under the new 2009 system. As noted the results are fairly dramatic. For example, of the 589 Certified or better project designations, 276 fall into the "Unclassified" category. At the other extreme, none of the previously classified Platinum projects would achieve that designation under the new system.

Exhibit 12: Changes in Classification 2005 Converted to 2009

Converted Wgtd Scaled	2005 Categories				
	Certified	Silver	Gold	Platinum	Grand Total
Unclassified	225	49	2		276
Certified	21	109	62		192
Silver		8	74		82
Gold			15	24	39
Platinum					
Grand Total	246	166	153	24	589

Exhibit 13: Summary of Changes in Classification

Number/Category

	Orig 2005	Re-weighted	Re-Wgtd-Scaled
Unclassified	0	408	276
Certified	246	84	191
Silver	165	80	82
Gold	153	17	38
Platinum	23	0	0
Total	587	589	587

Share/Category

	Orig 2005	Re-weighted	Re-Wgtd-Scaled
Unclassified	0%	69%	47%
Certified	42%	14%	33%
Silver	28%	14%	14%
Gold	26%	3%	6%
Platinum	4%	0%	0%
Total	100%	100%	100%

Conclusion

In this paper we explored the durability of "sustainable" value proposition by exploring the changes in classification of vintage LEED buildings if new standards are imposed. As noted, the results are both dramatic and more significant than expected. However, these results are not as surprising as they might seem since they reflect the fact that developers and other space producers opted to hedge slightly over the breakpoints for targeted classification levels. Due to the lack of degrees of freedom, when the system changed in terms of weights and scale, the net loss in relatively marginal points had a significantly negative impact on classification levels across the board. Whether the market will pick up on these differences and reflect them in future pricing will be the subject of future research that is already underway. In the meantime, the results suggest the importance of policy stability when dealing with durable, capital intensive real estate which constitutes an irretrievable commitment of scarce resources. In the face of another major adjustment in the LEED system, it is time to step back and look at the potential "unintended consequences" associated with continuous changes in the "rules of engagement" by which we fight for more sustainable real estate solutions.

Addendum 1: 2005 v. 2009 Detailed Categorical and Attribute Mapping

Part A: Sustainable Sites, Water Efficiency and Energy & Atmosphere

	NEW 2009 LEED		OLD 2008 LEED	
	Sustainable Sites	**26 Points**	**SustainableSite**	**14 Points**
Prereq 1	Construction Activity Pollution Prevention	Required	ErodSedControl	Y
Credit 1	Site Selection	1	SiteSelect	1
Credit 2	Development Density & Community Connectivity	5	UrbanRedev	1
Credit 3	Brownfield Redevelopment	1	BrownfieldRed	1
Credit 4.1	Alternative Transportation, Public Transportation Access	6	AltTranAccess	1
Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1	AltTranBike	1
Credit 4.3	Alternative Transportation, Low-Emitting & Fuel-Efficient Vehicles	3	AltTranAltFuelRefuelStat	1
Credit 4.4	Alternative Transportation, Parking Capacity	2	AltTranParkCap	1
Credit 5.1	Site Development, Protect or Restore Habitat	1	RedSiteDistOS	1
Credit 5.2	Site Development, Maximize Open Space	1	RedSiteDistFoot	1
Credit 6.1	Stormwater Design, Quantity Control	1	StrmWaterRateQ	1
Credit 6.2	Stormwater Design, Quality Control	1	StrmWaterTreat	1
Credit 7.1	Heat Island Effect, Non-Roof	1	HeatIslandNonRf	1
Credit 7.2	Heat Island Effect, Roof	1	HeatIslandRoof	1
Credit 8	Light Pollution Reduction	1	LightPollReduct	1
	Water Efficiency	**10 Points**	**WaterEfficiency**	**5 Points**
Prereq 1	Water Use Reduction, 20% Reduction	Required	WatEffLndsR50	1
Credit 1.1	Water Efficient Landscaping, Reduce by 50%	2	WatEffLndsNoW	1
Credit 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	2	InnWstWaterTech	1
Credit 2	Innovative Wastewater Technologies	2	WaterUseRed20	1
Credit 3.1	Water Use Reduction, 30% Reduction	2	WaterUseRed30	1
Credit 3.2	Water Use Reduction, 40% Reduction	2		
	Energy & Atmosphere	**35 Points**	**EnergyAtmosphere**	**17 Points**
Prereq 1	Fundamental Commissioning of the Building Energy Systems	Required	FundCommiss	Y
Prereq 2	Minimum Energy Performance: 10% New Bldgs or 5% Existing Bldg Renovations	Required	MinEnergyPerf	Y
Prereq 3	Fundamental Refrigerant Management	Required	CFCReduction	Y
Credit 1	Optimize Energy Performance	1 to 19		1 to 10
	12% New Buildings or 8% Existing Building Renovations	1	OptEnergyNE15_5	
	16% New Buildings or 12% Existing Building Renovations	3	OptEnergyNE20_10	
	20% New Buildings or 16% Existing Building Renovations	5	OptEnergyNE25_15	
	24% New Buildings or 20% Existing Building Renovations	7	OptEnergyNE30_20	
	28% New Buildings or 24% Existing Building Renovations	9	OptEnergyNE35_25	
	32% New Buildings or 28% Existing Building Renovations	11	OptEnergyNE40_30	
	36% New Buildings or 32% Existing Building Renovations	13	OptEnergyNE45_35	
	40% New Buildings or 36% Existing Building Renovations	15	OptEnergyNE50_40	
	44% New Buildings or 40% Existing Building Renovations	17	OptEnergyNE55_45	
	48% New Buildings or 44% Existing Building Renovations	19	OptEnergyNE60_50	10
Credit 2	On-Site Renewable Energy	1 to 7		1 to 3
	1% Renewable Energy	1		
	5% Renewable Energy	3	RenewEnergy_5	
	9% Renewable Energy	5	RenewEnergy10	
	13% Renewable Energy	7	RenewEnergy20	3
Credit 3	Enhanced Commissioning	2	AddlCommiss	1
Credit 4	Enhanced Refrigerant Management	2	OzoneDeplete	1
Credit 5	Measurement & Verification	3	MeasVerify	1
Credit 6	Green Power	2	GreenPower	1

Part B: Materials, Indoor Air, Innovation and Regional Priorities

	Materials & Resources	14 Points	MaterialsResources	13 Points
Prereq 1	Storage & Collection of Recyclables	Required	StoreCollRecyles	Y
Credit 1.1	Building Reuse, Maintain 75% of Existing Walls, Floors & Roof	2	BldgReuseMaint75	1
Credit 1.2	Building Reuse, Maintain 95% of Existing Walls, Floors & Roof	1	BldgReuseMaint100	1
Credit 1.3	Building Reuse, Maintain 50% of Interior Non-Structural Elements	1	BldgReuseMSNS100_50	1
Credit 2.1	Construction Waste Management, Divert 50% from Disposal	1	ConstWasteDivert50	1
Credit 2.2	Construction Waste Management, Divert 75% from Disposal	1	ConstWasteDivert75	1
Credit 3.1	Materials Reuse, 5%	1	ResourceReuse5	1
Credit 3.2	Materials Reuse, 10%	1	ResourceReuse10	1
Credit 4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	1	Recycled Content	1
Credit 4.2	Recycled Content, 20% (post-consumer + ½ pre-consumer)	1	Recycled Content	1
Credit 5.1	Regional Materials, 10% Extracted, Processed & Manufactured Regionally	1	Local/RegMat's20Locally	1
Credit 5.2	Regional Materials, 20% Extracted, Processed & Manufactured Regionally	1	Local/RegMat's20above50Local	1
Credit 6	Rapidly Renewable Materials	1	RapidlyRenewableMat	1
Credit 7	Certified Wood	1	Certified Wood	1
	Indoor Environmental Quality	**15 Points**	**IndoorAir**	**15 Points**
Prereq 1	Minimum IAQ Performance	Required	MinIAQPerf	Y
Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required	EnvTobaccoControl	Y
Credit 1	Outdoor Air Delivery Monitoring	1	CO2Monitor	1
Credit 2	Increased Ventilation	1	IncVentEffective	1
Credit 3.1	Construction IAQ Management Plan, During Construction	1	ConstIAQMgmtDurC	1
Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1	ConstIAQMgmtBOcc	1
Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1	LowEmitMatsAdhSeal	1
Credit 4.2	Low-Emitting Materials, Paints & Coatings	1	LowEmitMatPaint	1
Credit 4.3	Low-Emitting Materials, Flooring Systems	1	LowEmitMatCarpet	1
Credit 4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	1	LowEmitMatCWood	1
Credit 5	Indoor Chemical & Pollutant Source Control	1	IndChemPollControl	1
Credit 6.1	Controllability of Systems, Lighting	1	ControlSysPer	1
Credit 6.2	Controllability of Systems, Thermal Comfort	1	ControlSysNonP	1
Credit 7.1	Thermal Comfort, Design	1	ThermalComfComply	1
Credit 7.2	Thermal Comfort, Verification	1	ThermalComfPermMon	1
Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1	DaylightViewDay75	1
Credit 8.2	Daylight & Views, Views for 90% of Spaces	1	DaylightViewView90	1
	Innovation & Design Process	**6 Points**	**InnovationDesign**	**5 Points**
Credit 1.1	Innovation in Design: Provide Specific Title	1	InnDesSustEdProg	1
Credit 1.2	Innovation in Design: Provide Specific Title	1	InnDesExemptPerf	1
Credit 1.3	Innovation in Design: Provide Specific Title	1	InnDesGreenHskp	1
Credit 1.4	Innovation in Design: Provide Specific Title	1	InnDesMercRedLight	1
Credit 1.5	Innovation in Design: Provide Specific Title	1		
Credit 2	LEED® Accredited Professional	1	LEEDAccProf	1
	Regional Bonus Credits	**4 Points**		
Credit 1.1	Region Specific Environmental Priority: Region Defined	1		
Credit 1.2	Region Specific Environmental Priority: Region Defined	1		
Credit 1.3	Region Specific Environmental Priority: Region Defined	1		
Credit 1.4	Region Specific Environmental Priority: Region Defined	1		
	Project Totals	**110 Points**		**69 Points**
	Certified: 40-49 points **Silver:** 50-59 points **Gold:** 60-79 points **Platinum:** 80+ points	Cert 26, Silver 33, Gold 39, Platinum 52		

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