

Viridian Place



Growing a **Green** Building

A Case Study



OREGON OFFICE
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Viridian Place

Growing a **Green** Building *A Case Study*

By

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Photographs by Adam Bacher

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Viridian Place

Growing a Green Building: A Case Study

How do you grow a green building? It's a little like growing a vegetable garden. There's planning to ensure the right soil blend and seeds. Then comes the tilling, planting, and watering. All are completed according to Mother Nature's schedule. There are unforeseen problems: too much rain, slugs, you-name-it. And, of course, a garden needs continuing maintenance and care. It's not easy, but most gardeners will tell you that the outcome is worth the effort.

The same can be said about growing a green building. The key is in the planning — the research, meetings, decision-making, and scheduling. Problems — the wheatboard doors won't hold the glass inserts, the certified wood beams are too expensive — are there, too. The building requires on-going monitoring and maintenance. It is difficult. However, the result — an energy-efficient building that provides a more comfortable work environment and promotes water conservation and waste reduction — has a big payoff for the owners, tenants and society, too.

Viridian Place is a "pioneer" green building in the Pacific Northwest. In 1999, the owners had a vision, but soon discovered they were blazing a new trail. It was not a simple undertaking. This case study reviews the process and lessons learned in growing and maintaining Viridian Place, a "pioneer" green building.

We intend to update this case study as needed. For example, the building's energy use has not been as low as forecasted. Analysts are examining possible reasons and solutions. We will revise the case study when we have the results.

Introduction

There are nearly 5 million commercial buildings in the U.S. today. These buildings use a tremendous amount of energy each year — approximately one-third of all electricity produced. The average commercial building generates more than two pounds of solid waste per square foot of space while under construction. All of this has a great impact on our environment and natural resources.*

Consider, too, that buildings are a major source of air pollution — sulfur dioxide emissions, nitrous oxide emissions, carbon dioxide emissions and particulate emissions, all of which damage air quality and some which are blamed for climate change.



Viridian Place is visible from Interstate 5 south of Portland, Oregon.

* Statistics from the U.S. Department of Energy's Center of Excellence for Sustainable Development

Most commercial buildings are being built using traditional building practices. Their impact on our energy and resource use and on the amount of pollutants produced is likely to increase, and will continue for the life of the building.

Green building practices offer an alternative. Green buildings promote energy efficiency, water conservation, waste reduction and healthier, more comfortable and productive work environments. Business owners are beginning to realize that waste reduction, energy efficiency, and pollution prevention are more than ethical considerations. They make economic sense and are good business.

Oregon's Viridian Place is a 15,000-square-foot office building visible from Interstate 5 just south of Highway 217 outside Portland. The name literally means "green," although it's not painted green. It was built using green building practices and has received an official "green" building certification.

A Green Building Certification

In November 2001, the U.S. Green Building Council awarded Viridian Place a LEED™ certification for "green" buildings. It is a rigorous and difficult certification to achieve. LEED is an acronym for Leadership in Energy and Environmental Design and is only awarded to buildings that are energy efficient and friendly to the environment. Viridian Place has the distinction of being the first in the Pacific Northwest to achieve the LEED certification. At the time Viridian Place received certification, approximately 16 buildings nationwide had achieved LEED certification. The Ecotrust Natural Capital Center in Northwest Portland earned a gold LEED rating in December 2001 and became the second Oregon project certified. As of spring 2002, another 18 Oregon projects have registered under the LEED program.

What is LEED™?

LEED is an acronym for Leadership in Energy and Environmental Design. It is a certification awarded by the U.S. Green Building Council, a national non-profit organization based in Washington, D.C. Buildings that are energy efficient and environmentally sustainable receive a LEED certification. According to the U.S. Green Building Council, its criteria are based on accepted energy and environmental principles and strike a balance between known effective practices and emerging concepts.

LEED calls for building designs and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants in five broad areas:

- ◆ *Sustainable site planning*
- ◆ *Safeguarding water and water efficiency*
- ◆ *Energy efficiency and renewable energy*
- ◆ *Conservation of materials and resources*
- ◆ *Indoor environmental quality*

Points are awarded for meeting specific sets of criteria. Some criteria are mandatory; some are optional allowing builders and owners opportunity to customize their projects. (See Viridian Place scorecard on page 23.)

There are four levels of certification with 69 points possible.

- *LEED Certified* 26 - 32 points
- *Silver Level* 33 - 38 points
- *Gold Level* 39 - 51 points
- *Platinum Level* 52 or more points

Those looking at LEED projects must follow a three-step process:

Step 1: Project registration

Step 2: Technical support, reference package and credit rulings

Step 3: Building certification upon documentation submittal and U.S. Green Building Council review

Project Background

The idea for Viridian Place originated in the 1990s when Tom Kelly, president of Neil Kelly Company of Portland, was looking for a new location for his Westside showroom. Neil Kelly Company, established by Tom's father in 1947 in North Portland, is the largest home remodeling specialist in the Pacific Northwest and ranks among the top 20 residential remodelers nationally.

Ray Derby, president of Blazer Development and a friend of Kelly, became interested in the project. Derby would be a co-owner, co-tenant and the contractor for the new office building. As past presidents of the Portland Metropolitan Homebuilders Association, Kelly and Derby recalled an open lot immediately next door to the Association's headquarters. The site, 15573 Bangy Road in Lake Oswego, is along Interstate 5 and close to the partners' growing suburban Portland market. They made a presentation regarding their proposed office building to the Portland Metropolitan Home Builders Association board of directors. In the process, Kelly and Derby found their third partner — John Godsey, president of Consulting Engineering Services Northwest (CES/NW). Godsey liked the visible location of the lot and the easy access to I-5 and Highway 217. The three launched RTJ Properties and bought the lot on Bangy Road. Godsey's partners in CES/NW, Carl Jensen and Anthony Weller, later became co-owners of the building.



RTJ partners, from left: John Godsey, Ray Derby and Tom Kelly.

Kelly had the vision for a green building. He is a supporter of The Natural Step, an international organization dedicated to building an ecologically and economically sustainable society, and of Business for Social Responsibility. He is also a life-long Oregonian and acutely aware of the impact of population growth on the Northwest environment. Oregon is the ninth fastest growing state in the nation and saw a 16 percent increase in population between 1990 and 1999.

Derby, a builder of high quality custom homes, also had an interest in environmental issues. He had built some solar homes in the 1980s. He was receptive to the idea of building a more sustainable office building, as was John Godsey.

"We wanted to build what we call a responsible building because we think business should take steps to protect the environment when it practically can," Kelly said. "We also think it makes financial sense over the long run. Building a really efficient building now is good business."

The RTJ partners, all involved in the building industry, wanted to "walk the talk." They set out to demonstrate that energy efficiency and more sustainable building practices were possible in a small commercial building project.

The Project Team

Owners: RTJ Properties, Inc.

Tom Kelly - President Neil Kelly Company

Ray Derby - President Blazer Development

John Godsey - President Consulting Engineering Services Northwest (CES/NW)

Carl Jensen - CES/NW

Anthony Weller - CES/NW

Tenants:

Neil Kelly Company Westside showroom

Blazer Development

Consulting Engineering Services Northwest (CES/NW)

2,500 square feet available for lease

Architects: Thompson Vaivoda & Associates

General Contractor: Blazer Development

Civil Engineer: Consulting Engineering Services Northwest (CES/NW)

Electrical/Mechanical Engineer: Glumac International

Structural Engineer: kpff Consulting Engineers

Landscape Architect: Terra Sol Landscape

Earth Smart Analysis: Hatten/Johnson Associates

Commissioning Agent: Will Miller Consulting

LEED Consultants: Green Building Services

Financing: The Oregon Office of Energy Loan Program

Construction Financing: Centennial Bank and ShoreBank Pacific

Utility Incentives: Portland General Electric

Ground breaking: September 22, 1999

Dedicated: June 2, 2000 by Oregon Governor John Kitzhaber

Project Development

Lighting

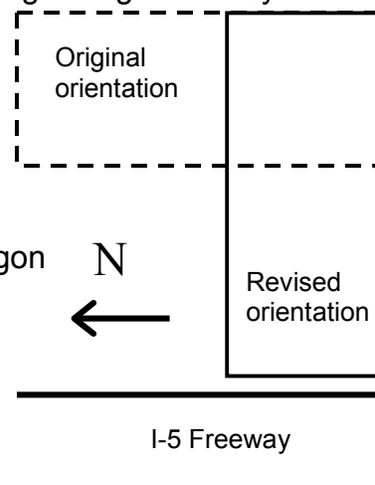
One of the goals of a green building is to make it energy efficient. "We suspected energy costs were going to go up so building a really efficient building made financial sense over the long term," Kelly said.

Lighting uses large amounts of energy in standard office buildings and the heat it produces triggers cooling systems to activate more often and for longer periods of time. By using natural light effectively, Viridian Place owners wanted to reduce their reliance on artificial light and decrease their energy use. This process is called "daylighting." The building exterior wall area is approximately 32 percent glass to allow natural light to permeate the space. It was discovered on this project, however, that effective daylighting was not simply a matter of having lots of glass. Building orientation was key to improved daylighting for Viridian Place.

The architects, Thompson Vaivoda and Associates of Portland, designed the building to be built along the east property line facing west toward the freeway. The owners had requested this so they would have high visibility from both directions of the freeway.

Approximately three months into the design process, however, the owners were offered consulting advice from Portland General Electric's Earth Advantage Program. They offer specific guidelines for designing high-performance buildings that conserve resources and provide a superior indoor environment. One of their first steps was to commission an energy study by Hatten/Johnson Associates, a Eugene energy engineering firm.

Hatten/Johnson received assistance from the University of Oregon Architecture Department. Faculty and students from the department's Building Laboratory, under G.Z. "Charlie" Brown, reviewed building schematics for daylight potential. The

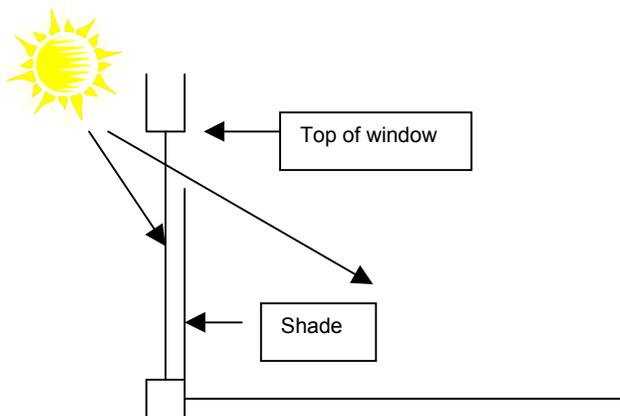


Hatten/Johnson energy efficiency analysis noted that the west-facing building would compromise efforts to maximize the building's daylighting potential. Their recommendation — a building that faced north — concurred with an early suggestion made by Glumac engineers.

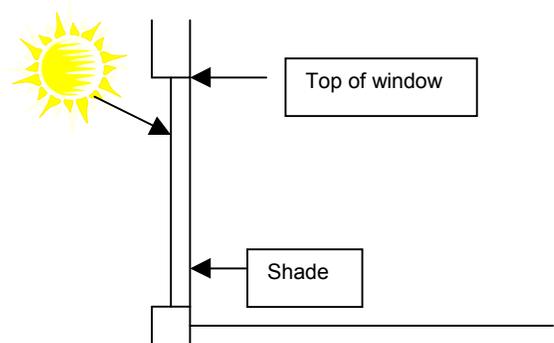
The architects reoriented the building with the longest walls facing north and south (see diagram page 5). The footprint is long and narrow, approximately 110 feet long by 50 feet wide. It has large windows on the south and north that can provide daylighting for most of the floor area. This new building orientation did not compromise public visibility. In some respects, it is even more visible from Interstate 5 South. But, the new alignment did make a big difference in the amount of natural light that enters the building. The new site orientation improved daylighting potential.

The building was constructed with the intent to use daylighting to reduce reliance on artificial lighting. Those who modeled the daylighting worked on the assumption at the time that there would be an open floor plan with no partitions. However, two of the tenants decided to share the second floor so there was a need for security. Some floor-to-ceiling interior walls were installed lengthwise down the building to separate the two tenants. This mitigated the daylighting benefits.

In addition, shades were added after the building was occupied. The shades were mounted at the highest point of the window opening because there were concerns that the 16-foot wide window frames may not have held the shades mounted mid-point as recommended. Electric shades mounted at the bottom were considered cost prohibited. The high mounted shades block the daylight that would extend into the building. Building occupants now have better control of the daytime glare, but electric lighting loads are higher to compensate for the natural light lost.



When the internal shade is mounted mid-point on the window or at the bottom and pulled upward, it allows daylight to enter at the top and go deep into the building while blocking glare for occupants at floor level.



When the internal shade is mounted at highest point of the window, the daylight entering the building is blocked at all levels.

A recommendation from the University of Oregon Building Laboratory staff to use exterior shading devices was not fully implemented. That decision was made at the time because a strand of 100-foot fir trees along the south face provided shading. Budget constraints were also a factor at this point in the project. Provisions were made for the addition of the exterior sun shelves in the future.

Daylighting

Natural, non-glare light is important to the well being of those who work inside the building. Studies show that workers are more productive, students perform better and retail sales improve when skylights and windows bring natural light inside. In addition, natural light can reduce electric lighting and its associated costs and increased air conditioning load.

Buildings designed for daylighting optimize the penetration of diffuse light into open interiors using skylights, light shelves, light wells, etc. Daylighting works best with windows that are placed high and are more or less continuous on the building facade. View windows are eye-level and are not for this purpose. High, light-colored ceilings and light shelves bring the light deeper into the open interior of a building. The Pacific Northwest's overcast skies provide abundant indirect light to make daylighting work well. High-performance glazing on properly located windows allows the light in, but not the heat.

Daylighting is most effective when light fixtures, shades, ductwork, and other obstructions are oriented to minimize interference with daylight entering near the ceiling. Shades can be mounted from the bottom and pulled upward to block glare for occupants at floor level, or they can be mounted at mid-point and pulled down to allow the daylight near the ceiling to enter the room unobstructed. To improve energy savings, lighting fixtures closest to the windows are circuited separately from interior fixtures so they can be turned off or down when adequate daylight is available. Having sensors monitor the occupancy of different floor areas is also a valuable control. The lights aren't on when the area is vacant.

Heating and Cooling

Another major use of energy is in heating and cooling a building. Heating, ventilation and air conditioning (HVAC) systems are designed to meet the extremes — the warmest and coolest days of the year. Most sustainable designs seek to mitigate these extreme conditions. Making a decision on the Viridian Place HVAC system proved an unexpected challenge that required considerable discussion on the part of the project team and consultants. The front-running HVAC contractor proposed a 45-ton rooftop variable-air-volume unit for the 15,000 square-foot building. In comparison, the peak cooling load predicted by the energy study was 22 tons. The contractor had not reviewed the energy study before making his proposal and guide specifications did not reflect the load findings of the energy study. Thus, the contractor's recommendation was based on standard sizing methods. This resulted in a substantial cost overrun that the owners discovered prior to awarding the mechanical contract. Once the

design team had reviewed the sizing information, the owners accepted a 29.5-ton system consisting of two high-efficiency residential compact units per floor.

Cooling

A “ton” of cooling is a term that tells a bit about the history of air conditioning. Before mechanical cooling systems had been developed, blocks of ice harvested during winter were used to keep people cooler in the summer months. A ton of ice could provide 12,000 Btu per hour of cooling for one day.

Features of the HVAC system include:

- ◆ Unit sizing was decreased because of other measures. These measures including daylight dimming of lights, optimized floor and wall insulation, glazing, roof membrane with white reflective surface, and efficient office equipment reduced the heating/cooling loads. The smaller loads can be met by residential size systems that are available with very high efficiencies.
- ◆ Heating system Annual Fuel Utilization Efficiency (AFUE) is 94 percent compared to standard practice efficiency of 80 percent.
- ◆ Compressor cooling is provided at a Seasonal Energy Efficiency Ratio (SEER) of 13.05. Code requires a SEER of 9.7. An air-side economizer allows use of outside air as a first stage of cooling.
- ◆ Building control system is set to run HVAC in economizer mode when building is not occupied and warm-up mode prior to occupancy.

The business needs of the current three tenants require their employees to be in and out of the office during the weekdays. They may be in the office some on the weekends, too. The Neil Kelly showroom, however, is open to the public seven days a week. For that reason, the building was designed to have six HVAC zones — two zones for each of the three floors. The heating and cooling systems are controlled by occupancy sensors to heat and cool each zone separately. This zoning and control made the HVAC system more efficient by allowing operation to match actual occupancy more closely than a simple time schedule can.

It is also important to monitor indoor air quality. The project could not incorporate operable windows because of the noise level and car exhaust fumes from the freeway. The air intake system was placed on the East side of the building, furthest from the freeway, to draw air through surrounding trees. Placing the mechanical systems and bathrooms at the East end of the building also shifted windows to the North and South sides of the building. East-facing windows are exposed to early morning sun in the summer months and can add significantly to the cooling load of most commercial buildings.

Shading

Viridian Place uses some exterior shading devices to help keep the sun's heat out of the building. There is a wood framing and trellis structure with a 17-foot projection from the building between the first and second floors which provides protection from the elements and some shading to the northwest corner glazing. Another projection above the third floor shades the northwest corner of windows. At the northeast entrance, a fin projects eight feet to the



A grove of fir trees provides shading on the south side of the building.

north of all three floors. There is also a 16-foot projecting overhang shelf at the northeast entry above the first floor windows.

The energy study proposed three-foot shelf-type projections above the south-facing windows for all three floors. As noted in the daylighting section, these shelves reduce direct sunlight and glare but also control solar heat gain. The light shelves were not incorporated, however. Because of the shading from trees and budget concerns, internal shades were installed rather than external shading devices.

The large strand of tall fir trees south of the building currently provide substantial shading for most spaces on that side of the building. About the same time the building was opening, however, a freeway sound barrier project removed several trees and some of the valuable shading was lost.

Energy Efficient Equipment

The Viridian Place tenants have some Energy Star® copiers, fax machines, printers, and other office equipment. Energy Star® is a federal program that provides consumers with product specifications needed to bear the Energy Star® label and the amount of energy saved with the product. They anticipate replacing old non-Energy Star® equipment with Energy Star® as needed.

Instead of typical desk computers and full-size monitors, many of the Viridian Place occupants use laptop computers because of their frequent field work. Laptop computers use considerably less energy than full-size models. As the owners purchase replacement computers, they expect to purchase only laptops. The Green Building Services energy analysis estimated at least a 25 percent reduction in equipment energy use with laptops.

Viridian Place workstations have power strips controlled by occupancy sensors. These sensors switch off task lights and other electrical devices when people leave their work areas.

Energy Efficiency Features

- ◆ *Viridian Place uses a layered approach to lighting. The high ceilings on each of the three floors contribute to the diffusion of light from the large, high windows and minimize reliance on general lighting. The general lighting fixtures use energy-efficient T8 lamps with electronic ballasts. Perimeter areas where natural light is greatest have fixtures with dimming ballasts. Individually-controlled task lighting uses compact fluorescent bulbs.*
- ◆ *Exit signs use light emitting diodes (LEDs). Because exit lights must be continuously illuminated, they should be some of the most efficient lighting equipment in a commercial building. LEDs reduce the fixture wattage to less than five watts.*
- ◆ *The R-30 white roof has high reflectivity to reduce heat gain. It has an Energy Star® rating. Only R-15 ratings are required by code.*

- ◆ *The restrooms and other enclosed occupied spaces have occupancy sensors. Unoccupied spaces, such as storage closets, have timer switches.*
- ◆ *Parking lot lights also consume considerable energy. Viridian Place has two solar photovoltaic (PV) panels on its parking lot lights. Sensors turn the lights on automatically at dusk and off at dawn. The PV panels absorb energy during the day and convert the sunlight to electricity to power the parking lights at night. Even with Oregon's reputation for overcast, rainy days, solar works. The system is sized to operate at least five consecutive days without sunlight. The lights use a highly efficient electronic ballast and high-intensity discharge (HID) lamps that are designed to work with photovoltaics.*

Green Products and Materials

Green buildings include products and materials that are environmentally friendly. The owners of Viridian Place found that questioning the resource efficiency and the environmental impact of each product and all the material that became part of the building was very time consuming. It involved a great deal of research. In addition, at that time the green products weren't readily available from the usual industry sources.

For conventional buildings, selecting products and materials is a much easier, less time-consuming process. The costs of products and materials are well known and can easily be priced and compared from several sources. While cost was still a consideration to the owners of Viridian Place, the resource efficiency and environmental impact of the product had a higher priority than on most projects.

Some examples of green products and materials used:

- ◆ The owners dramatically improved indoor air quality by carefully selecting paints, flooring and carpet adhesives that had low or no volatile organic compounds (VOCs). These products use water as a carrier instead of petroleum-based solvents. Low-VOC or no-VOC products also contain no or very low levels of heavy metals and formaldehyde. The levels of harmful emissions from water-borne surface coatings are significantly lower than solvent-borne surface coatings. The hydraulic oil for the elevator system is vegetable-based instead of petroleum-based. Finding acceptable low-VOC and no-VOC products required considerable research time and effort for the project team at Viridian Place. Since the construction of Viridian Place, more low-VOC and no-VOC products have gone to market.
- ◆ The Forest Stewardship Council (FSC) certified approximately 30 percent of the wood used in the building. At Viridian Place, all of the deckings are FSC certified. The beams are from a managed forest, but are not certified. Certification would have increased costs by one third.
- ◆ Much of the flooring and built-ins are sustainable and/or are recycled content. This includes the carpet (53 percent recycled content), showroom bamboo flooring (bamboo is a "rapidly renewable " material), recycled concrete countertops, drawer pulls of madrone (an Oregon weed), recycled-content asphalt paving and wheel stops in parking and exterior areas.
- ◆ The cabinets are wheatboard with Machinche cherry veneer. Wheatboard is created from wheat chaff as a substitute for traditional wood fiberboard. Unlike wood fiberboard, it does

not use formaldehyde. Most of the cabinets are Neil Kelly cabinets that use FSC-certified wood and environment-friendly finishes.

- ◆ The sheet flooring is marmoleum, a vinyl substitute made with linseed oil. It is non-toxic and biodegradable.
- ◆ The sheetrock contains recycled content gypsum and recycled backing material. The thermal insulation contains recycled fiberglass.

- ◆ The window frames at Viridian Place are a composite made by from wood shavings and plastic taling, all recycled material. The windows have low-emissivity (e^2) coatings that reduce the heat transfer between the layers of

glass because of microscopically thin, virtually invisible metal or metallic oxide layers deposited on the glass and Argon gas filled space between the layers of glazing.



The windows at Viridian Place are made from recycled material.

Builders now have some advantages over the Viridian Place owners. LEED guidelines specify many green products and materials, so many of the decisions are more readily made. In addition, demand for green product lines has increased, so there are more green product choices and cost can be more easily considered in the decision-making process.

Forest Stewardship Council (FSC)

The FSC is an international non-profit organization founded in 1993 to support environmentally appropriate, socially beneficial, and economically viable management of the world's forests. Its goal is to improve forest conservation and reduce deforestation. FSC provides international labeling for forest products based on management practices for sustainable harvest, ecosystem health and community benefits. In order for products originating from certified sources to carry the FSC trademark, the timber has to be tracked from the forest through all the steps of the production process until it reaches the end user. This tracking must be independently verified for the product to carry the FSC logo.

Environmental Friendly Practices

The building industry is a traditional one. The "way we've always done it" is the norm. Change is difficult, especially since there are many contractors and subcontractors involved with any one project. But sustainable buildings require practices that are "friendly" to the environment. Those often are not the traditional practices in the building industry.

Construction site recycling is important, but many construction workers are not familiar with the process. It required a change in their practices to make it work. During construction of Viridian Place, 71 percent of construction waste was recycled.

Viridian Place owners used local sources of construction materials whenever possible. This reduced energy use because materials aren't transported long distances.

Some measures took less effort, but contributed to an environmentally sound building. Some were even low-cost. For example, a carpool parking space is available. There is secure bicycle parking and a shower and locker available for those who bike to work. And, tenants follow an established recycling system.

Water Conservation

Finding lavatory faucets that flow at less than the code-maximum 1-gallon-per-minute was a challenge. And, finding toilets that were better than the 1.6 gallon-code and worked efficiently took time. But, each of these decisions contributed to the overall reduction in water use. Viridian Place was designed to use 20 percent less water than buildings built to code.

The selection of a landscape design was also important in reducing water use. By choosing native and adapted plantings, the site did not require irrigation once plantings became established. The landscaping also does not require fertilizers and pesticides. Fertilizer use can increase watering needs.

Commissioning

Commissioning is an important part of green building construction but is an unfamiliar or ambiguous process to many owners and builders. A commissioning agent is a third party who ensures that building systems are specified, installed and operated according to their design intent and the owner's needs.

Tom Kelly admits that he and his partners didn't intend to use a commissioning agent because of the extra expense involved. Because of their Oregon Office of Energy demonstration loan agreement, they did hire a commissioning agent. However, Will Miller, the commissioning agent, came on board later in the project than is generally recommended. As the partners worked through the LEED certification, they discovered that commissioning was a mandatory component.

"I do see the importance of commissioning," Kelly said. "Having a commissioning agent helps you get what you pay for." Because of budget concerns, and a general perception that the entire project team understood the sustainable goals for the project, commissioning activity was narrowly focused. This result was a less-than-ideal commissioning program.

"I didn't know what to expect from commissioning," said Ray Derby. "I'd never been involved with it before."

Miller's commissioning report identified several efficiency issues that were corrected and a few others that had not been. Miller's late entry in the project hampered efforts to correct the

changed course of some design elements. "It would have been so much simpler and better managed with a commissioning agent in it from the beginning," Kelly added.

Perhaps the biggest catch related to the lighting system. When Miller came on board, the basic lighting system had been laid out with more installed power than allowed by code. A decision to preserve the natural color of exposed wood in the ceiling reduced reflectivity. Lighting models indicated less reflected light which dictated an increased number of fixtures. The designers revisited the lighting and reduced the lighting power so that it was closer to the energy efficiency recommendations.

Other adjustments initiated by the commissioning process included:

- ◆ The increase in the outside economizer set point that extended the free cooling period;
- ◆ The elimination of compressor operation during unoccupied periods;
- ◆ The establishment of a partial holiday schedule; and
- ◆ The correction to allow for Daylight Savings Time.

The report recommended that these adjustments be automated if possible.

Concerns related to the HVAC system, however, lay fallow until a review of utility history indicated some unrealized savings. Because the commissioning report came at a point in the job where tenants were ready to move in and because occupants were comfortable once they moved in, the owners did not address the issues brought up in the report. A lack of user training and some questions about system operation during unscheduled periods went unexplored for over a year.

Commissioning

Commissioning is the systematic process of ensuring that building systems are designed, installed, tested and capable of being operated and maintained to perform according to the design intent and owners' needs. A commissioning agent is important to ensuring the overall success of a sustainable project.

Commissioning begins in the design phase and lasts at least one year after project closeout. It documents that all building systems perform interactively according to the documented design intent and the owner's operational needs. It includes the training of operating staff.

During the rush to complete essential building elements prior to occupancy, owners frequently overlook incomplete or deficient systems. They may "work," but not optimally or as intended. Getting contractors to return to the job after completion and occupancy can be difficult. Some deficiencies may go permanently undetected to the detriment of building control, energy use, equipment reliability and tenant comfort.

The primary goal of commissioning is to prevent or mitigate all of these problems. The commissioning agent's task is to identify system deficiencies as early as possible in the project and to track their status until they are corrected.

The result will be improved tenant comfort and productivity, improved air quality, reduced operation, maintenance and equipment replacement costs and lower energy costs.

The cost of commissioning can vary considerably with the size of each project and the level of commissioning. For whole-building commissioning, the price range is normally 0.5 to 1.5 percent of total design and construction cost. Commissioning agents may be an independent third party, a design professional, a general contractor or a mechanical contractor. The RTJ partners hired an independent third party consultant and invested less than 0.3 percent of the total design and construction cost.

Energy Use

After 18 months of occupancy, the owners have begun to evaluate energy use at Viridian Place. The PGE analysis estimated that Viridian Place would consume nearly 40 percent less energy than a similar building constructed to Oregon codes, some of the highest standards in the nation. The LEED submittal, based on utility costs rather than energy use, estimated 37 percent savings. Initial review of utility records indicated only a small portion of these savings was being realized. Office of Energy staff members are working with the building's designers to examine the causes with the goal of proposing solutions. We will update this case study when that information is available.

Viridian Place Energy Use					
Condition	Floor Area (square feet)	Electricity (kilowatt hours per year)	Natural Gas (therms per year)	Total (million Btu* per year)	Energy Use Index (Btu* per square feet per year)
Baseline**	15,000	196,725	1,335	804.9	53,661
Projected	15,000	95,617	1,497	476.0	31,736
Actual***	15,000	175,680	1,477	751.5	50,100

* British thermal units

** Baseline estimates were calculated on the final building orientation with nominally better-than-code envelope, lighting, and HVAC components. Baseline assumptions have not been adjusted to reflect actual occupancy patterns and miscellaneous equipment loads (display lighting, number of computers, etc.).

*** January 2001 through December 2001

Financing

When the RTJ partners were in preliminary discussions on their energy-efficient, sustainable building, ShoreBank Pacific of Portland referred them to the Oregon Office of Energy.

The Office of Energy offers low-interest, fixed-rate, long-term loans for projects that save or produce energy. The low-cost energy loans serve as incentives to encourage businesses and governments to incorporate energy efficiencies into their projects and to get more for their money. Generally the loans only finance the energy-efficiency features of a project. However, the loan committee can recommend financing an entire project if the project qualifies as a demonstration project.

The proposed Viridian Place was a prime candidate for a demonstration of sustainable building practices. It was in a market segment — small commercial buildings — where it was important to show that energy efficiency does pay. Viridian Place had solid support from its owners/builders/tenants to build an energy-efficient building. All of the stakeholders were active in the construction industry and saw this as their "demonstration" project. Finally, the building was highly visible from Interstate 5 and would receive ample publicity.

The Office of Energy Loan Program offered the partnership a full take-out loan on the project — a \$1.8 million loan for 15 years at a fixed rate of 7.11 percent. The offer was most attractive. Commercial lenders at the time were quoting 9 percent rates. A fixed rate on a commercial project of this size was not even available from the commercial lenders.

Once the Office of Energy was a partner in the project, staff members became more deeply involved in monitoring the energy efficiency measures. Loan Program Engineering Analyst Kip Pheil joined Energy Analyst Charlie Stephens who had attended early design meetings. The two participated in several Project Team meetings, particularly during efforts to finalize the HVAC system selection.

"The Office of Energy loan made this facility possible," said Tom Kelly. "Without their lower interest rate, we would not have been able to afford the energy measures that made this a demonstration project."

	Energy Loan Program	Commercial Lender
Cost of Building	\$2.3 million	\$2.1 million
Loan Amount	\$1.8 million	\$1.6 million
Loan Rate	7.11 percent fixed	9 percent* variable
Loan Term	15 years	15 years**
Monthly Payments	\$16,382	\$16,228
Energy Efficiency Investment	\$190,124	0
Estimated Savings from Energy Efficiencies	\$3,660 per year	0

* Based on commercial quotes at the time

** Commercial loans quoted had a 5-year term, 15-year amortization. Fixed term assumed for illustration purposes

Energy Loan Program

The Oregon Office of Energy offers low-interest, long-term loans for any qualified Oregon projects that:

- ◆ *Save energy*
- ◆ *Produce energy from renewable resources such as water, wind, geothermal, solar, biomass, waste materials or waste heat*
- ◆ *Use recycled materials to create products*
- ◆ *Use alternative fuels*

The Energy Loan Program can loan to individuals, businesses, schools, cities, counties, special districts, state and federal agencies, public corporations, cooperatives, tribes, and non-profits. Projects must be in Oregon. The loans are generally for the energy-related components of the project.

The rates are fixed for the term of the loan. Most loans are structured so the borrowers can pay back the loan with the energy savings or income produced by the project. The program has made 550 loans totaling more than \$307 million. These loans have financed projects that together have saved enough electricity, natural gas and oil to heat more than 110,000 Oregon homes each year.

Loans can be as small as \$20,000 or as large as millions of dollars. Loan terms are based on the type of project, the amount of energy saved, and other financial considerations.

The Office of Energy usually approves loans up to \$100,000 within two to three weeks. Large loans usually take at least 60 days and are reviewed by the program's citizen advisory committee.

Financial Considerations



Wall of windows on northwest corner add interest to the building.

All involved with Viridian Place acknowledge that there was an up-front premium paid for having a sustainable building. As project architect John Heili points out, however, the cost per square foot is deceiving because of the unusual nature of the building layout and size. "Because the building is small but still three levels, the cost of core structure items such as elevators became disproportionately high," he notes. The tight building site increased costs as well.

Often it was not clear what measures were incorporated strictly for their energy efficiency or for some other reason. For example, a solid "wall" of windows on the northwest corner of the building allows light to penetrate the building, an essential feature of the daylighting measure. However, the wall of windows probably would have been included even if the owners had not wanted to maximize daylighting. The window wall added architectural interest and quality that the owners wanted. In fact, had the wall been based strictly on good daylight design principles, the west facing windows would have been very small to avoid glare and heat gain during summer months. There are other examples. Ray Derby points out the lights that automatically turn on and off when entering and leaving a room. They are attractive both for their energy efficiency and their functionality.

Many of the sustainability measures provide more comfort for the occupants. For example, occupants respond positively when they can work in natural light. It is difficult to put a price tag on occupant comfort, and we should not consider daylighting a strictly energy efficiency measure.

The Viridian Place owners expected to recoup much of the up-front cost of their energy efficiency measures in lower operating and maintenance expenses over time. Financial incentives from the Oregon Office of Energy helped recover some of those initial expenses.

Tom Kelly said he could not have started the project without them. "They made it work. I wouldn't have done it without them, because it would not have made economic sense," Kelly said. "We were on the edge of financial viability, and those programs helped make conservation make sense."

The owners of Viridian Place qualified for a Business Energy Tax Credit of 35 percent of the eligible energy feature costs. The eligible costs had to have a simple payback of 1 to 15 years for full credit. Some of Viridian Place's energy efficiencies, such as the photovoltaic parking lights, could not demonstrate a 15-year payback and had to be pro-rated. Their final eligible project costs for the energy tax credit were \$60,390. The tax credit amount was \$21,136.

Viridian Place Business Energy Tax Credit	
Total eligible cost of energy efficiency features	\$60,390
Business Energy Tax Credit (35 percent of eligible costs)	\$21,136

Kelly acknowledges that sustainable buildings cost more up front, but "my guess is that a LEED building only cost 4 to 5 percent more. It is a good long-term investment for me personally. It's good for the company. It's good for the company image. And, it's good for sustainability. I have no regrets."

Energy Tax Credits

The Oregon Office of Energy offers Business Energy Tax Credits to encourage investments in energy conservation, recycling, renewable energy resources and less-polluting transportation fuels. Any Oregon business may qualify. To date, more than 5,000 energy tax credits have been awarded to Oregon businesses. Their investments save or generate energy worth about \$100 million a year.

The tax credit is 35 percent of the eligible project costs — the incremental cost of the system or equipment that's beyond standard practice or exceeds code requirements. Conservation projects must reduce energy use by at least 10 percent to qualify. Lighting projects must reduce energy use by 25 percent.

Owners of sustainable buildings have an optional approach to qualify for an energy tax credit. Because there are additional costs associated with LEED certification, required commissioning expenses and a payback period greater than 15 years on some sustainable features, a new tax credit calculation for sustainable building projects is available. Sustainable building projects started after January 1, 2001 qualify for a tax credit based on the gross square footage of all conditioned space. (Viridian Place was completed before this date and used the standard Business Energy Tax Credit calculation.)

Eligibility for sustainable buildings can now be based on the LEED Certification it receives. The eligible cost listed in the table below is used for all calculations. The tax credit amount is 35 percent of the eligible cost amount. Renewable energy generation components of sustainable building projects may receive a separate tax credit in addition to the amounts calculated from the table.

<i>As with standard energy projects, building owners must apply for the sustainable building energy tax credit prior to starting the project.</i>						
Building Area	Silver		Gold		Platinum	
	Eligible cost**	Tax credit amount	Eligible cost	Tax credit amount	Eligible cost	Tax credit amount
First 10,000 gsf*	\$5.71 per gsf	\$2.00 per gsf	\$9.29 per gsf	\$3.25 per gsf	\$14.29 per gsf	\$5.00 per gsf
Next 40,000 gsf	\$3.57 per gsf	\$1.25 per gsf	\$4.29 per gsf	\$1.50 per gsf	\$7.86 per gsf	\$2.75 per gsf
Above 50,000 gsf	\$2.00 per gsf	\$0.70 per gsf	\$2.86 per gsf	\$1.00 per gsf	\$5.71 per gsf	\$2.00 per gsf
* Gross square footage (conditioned square footage plus a parking structure allowance)						
** Tax credit is 35 percent of this amount						

Areas of Excellence

Tom Kelly sees several areas of excellence in the project, but the number one is “That my partners and I got through the process, and we got it done! It’s crucial that everyone has to be together with their vision for the project.”

Ray Derby, agrees. He saw the challenge in trying to keep the three partners "on the same page."

Kelly is pleased with the daylighting results. He senses that most people who work in the building are also happy with it. He notes that Oregonians tend to think we have too many clouds and too much rain. It was a pleasant surprise that daylighting would become the centerpiece of the energy efficient building.

Owner/tenant John Godsey says he and his employees appreciate the openness and high natural light level of their space. "It just gives you a good feeling," Godsey said. He also appreciates the lighting system controls that adjust daylight.

Alan Scott with Green Building Services also touts the daylighting features. “There is so much human benefit from daylighting, in addition to the energy efficiency it brings,” Scott said. “It means people are comfortable and close to the outdoors.”

As evidenced by the LEED certification, Viridian Place was designed and built to minimize use of natural resources related to site development, water efficiency, and choices in building materials. The building earned a BEST award in April 2002. The City of Portland, Oregon, sponsors the Businesses for an Environmentally Sustainable Tomorrow (BEST) awards for significant achievement in reducing waste and/or conserving energy and resources. Viridian Place's BEST award was for water conservation.

Frustrations

Tom Kelly recognizes that they spent a lot of time “spinning our wheels” researching products they didn’t use and making decisions they normally wouldn’t think twice about. “It took a lot of energy,” he said. “The biggest challenge is to get everybody to look at it a different way. We’re going against the tide.”

As the general contractor, Ray Derby and his project manager found it frustrating to build a building and not have the range of products they were accustomed to.

John Godsey agreed that the most frustrations involved the availability of materials and their costs. "The cost of wheatboard blew me away," Godsey said. "But, as more people become involved in green buildings and demand the products, manufacturers will produce more and that will bring the cost down."

There were some miscommunications. Kelly went on vacation for a week and came back to find a wall in his employee break room. The wall went to the ceiling and blocked the daylight needed to illuminate the interior hallway. The wall came down, and Kelly found he spent a lot more time on-site. "More diligent monitoring," he said.

Watching the slow loss of focus on some energy issues caused the Office of Energy staff considerable concern. "Not having the commissioning agent involved from early in the design stage really hurt," Office of Energy Engineering Analyst Kip Pheil said. "Most of us felt that everyone involved understood what was expected and so no one took complete control of oversight for energy issues. And some holes developed." For example, the design/build process seemed to open up areas for misunderstanding the intent of the project. The guide specifications lacked detail on the sustainability concerns so some contractors were not fully informed on the intent of the project as they developed their bids. The on-site project manager was focused on cost considerations and scheduling concerns as directed by the owners. "A commissioning agent with more expanded duties, could have played an important role in making sure the changes made during construction were in line with the intent," said Pheil.

Kelly also expresses some disappointment with public perception of their choice to install photovoltaic (PV) solar panels. The panels had a payback period of more than 40 years. "But we wanted something symbolic to show our commitment. Without those PV panels, there is nothing to say this is a sustainable building by looking at it," he said.

Alan Scott with PGE's Green Building Services saw some frustration with green product choices. For example, low-VOC finishes were used on the wood ceilings, but it turned out they were low-VOC for exterior use and not for interiors.

Missed Opportunities

Tom Kelly would have preferred an eco-roof, but there was not enough information or time to move ahead with that option. An eco-roof or "living" roof is a lightweight roof system of two to four inches of soil with vegetation designed to absorb and slowly release rainwater. The primary benefit of eco-roofs is stormwater management. They can retain 50 to 60 percent of the total annual runoff volume of a roof, reducing the need for stormwater retention. Eco-roofs also provide insulation, protect the roof membrane from ultraviolet radiation and buffer noises. The roof on Viridian Place is white and met LEED standards by reflecting rather than absorbing the sun's heat.

The interior doors were a disappointment for Kelly. Wheatboard, a sustainable product, did not have the strength to hold the glass required for many of the interior commercial doors. The

lack of choices and the hefty price tag on 41 "eco-doors" caused the project team a great deal of frustration.

Alan Scott of Green Building Services sees the choice of window coverings as an area that could be improved. The white blinds are mounted at the top of the windows and have small circular perforations that enable occupants to see out. Scott believes the interior of those blinds would be better if it were black, but with the same transparency. This would eliminate the glow and glare of the white. He also notes that the blinds would be better if mounted a third of the way down the window or mounted at the bottom and pulled upwards. That would allow the top portion to always be open to natural light that would be reflected off the ceilings into the interior of the building.

Scott also noted that the carbon dioxide sensors were not set for occupancy. They trigger the system to bring in fresh air more often than necessary.

Advice

Tom Kelly has three pieces of advice for those wanting to construct a sustainable building:

- ◆ Use LEED as a benchmark, even if you don't apply for the formal certification.
- ◆ Have a project team that is like-minded regarding sustainability. He said that in retrospect he would have had a sustainability consultant spend more time in the early stages of the design process.
- ◆ Don't go to extremes. Be practical, or it won't happen. The Natural Step concept encourages incremental steps.

Ray Derby advises that those getting involved in such a major collaborative project need to know their partners. He believes that a project of this complexity wouldn't have been successful without long-standing trust.

John Godsey recommends evaluating all the products and material up front and not in the middle of the process when it's necessary to keep the project moving to meet sub-contractors' schedules and keep crews busy.

Alan Scott of Green Building Services said he "got a lot of value in working on the certification process of Viridian Place." He likes the LEED framework and says that it encourages people to try harder. "If they are a few points from gold, they see what they can do to get those points and 'go for gold,'" Scott said.

Scott's advice:

- ◆ Have a committed leader
- ◆ Have an integrated team with a good communication process in place
- ◆ Get a mechanical engineer involved in the project early on
- ◆ Make certain you know the cost of a commissioning agent and energy modeling before you begin a project. A commissioning agent can be from .5 to 1.5 percent of the project cost.

The Office of Energy's Charlie Stephens points out the need to follow the process all the way through. After the intent is defined, design to the intent. Build to meet the design and match the intent. Verify proper installation and operation with commissioning. "You're not finished until you've commissioned the building. And you can't complete the commissioning until the building has operated for at least a year." He points to Viridian Place as proving this rule.

John Heili has a similar view of integrating sustainability into the design process. He recalls that the basic design was well under way before the energy analysis was started. This created coordination problems. Heili recommends starting the analysis early in order to adapt the project to acceptable recommendations.

Office of Energy's Engineering Analyst Kip Pheil notes the importance of ensuring building operators and maintenance staff are fully trained to maintain the building in accordance with the original intent. Much of the savings can be lost simply with operator and staff turnover. An important aspect is to make one person accountable to monitor energy use on a monthly basis and use this information to properly maintain the building.

Conclusion

Being a "first," a pioneer of sorts, played a part in many of the difficulties encountered in constructing Viridian Place. The LEED final guidelines were not available until shortly before the building was complete. Having the LEED benchmarks in hand from the beginning would have made it far easier to make many of the decisions.

In addition, because the LEED benchmarks were not available during construction, much of the verification of materials, etc. required by LEED had to be painstakingly reconstructed. There were lots of details, variables, subcontractors, products and receipts involved. Alan Scott estimates it took 600 hours to gather the documentation needed for the LEED paperwork. He hired a temporary employee who had familiarity with the building industry and asked her to make phone calls and follow through until the necessary LEED documentation was complete.

Today, Scott estimates that the cost of the LEED certification process (management, communication and paperwork) ranges from about \$20,000 to \$40,000. With LEED requirements in the specifications, the contractor knows up front what is required and collects the necessary documentation as the project progresses.

Most projects seeking LEED certification are larger than Viridian Place. For Viridian Place, however, the LEED process confirmed the project's success on many fronts. The evaluation involved in completing LEED and preparing this case study also helped identify a few options for improved energy performance.

The Future

Already, green products are becoming more readily available and prices are decreasing. Kelly said prices for no-VOC or low-VOC paint and wheatboard have decreased. "Three years ago when we started this project, we paid a bigger premium for green products. It's simple supply and demand. More demand for these products will make the prices go down (because

manufacturers respond and increase supply),” he said. Kelly also sees a growing number of trade contractors who are gaining expertise in the area of sustainability.

Tom Kelly is getting calls and giving building tours. The project is generating new business for his company. “This helps position us in the marketplace as one of the leaders in green buildings. That’s our purpose — we are profit-motivated.”

Tom Kelly has some interesting green projects already underway. One is a remodel of a Portland home that was in the 1928 Show of Homes. The owner is committed to sustainable concepts, and Kelly is excited to see the result. The other project involves a \$2 million renovation at Holy Redeemer parochial school in Portland. Kelly said this project is especially rewarding because it involves passing the sustainability concepts on to the next generation. “The curiosity and eagerness of the kids and staff involved with the project is special.”

Ray Derby would welcome the opportunity to work on another green building. He sees sustainability as an educational process for his high-end residential customers. “The driving force for a homeowner is a healthy environment and healthy air.”

Alan Scott with Green Building Services is working on 15 LEED certification projects. He, too, is seeing an increased interest in sustainability in spite of the lagging economy.

Scott believes that sustainability will raise property values and will be more attractive to tenants. “We need to educate real estate professionals on sustainability so they can market it,” he said.

The Oregon Office of Energy is currently working on several public sector green projects. A new construction project, the North Mall Office Building, is the pilot project under the Governor's Executive Order on Sustainability. It calls for the design, construction and maintenance of the project to use more sustainable methods and programs. Staff is also evaluating a proposed state-leased building that would be remodeled using more sustainable principles.

Sustainability and Our Future

At the dedication of Viridian Place, Governor John Kitzhaber said: "The adoption of sustainable practices by private businesses will do as much and possibly more for environmental quality in the next 30 years as the Clean Water Act, the Clean Air Act and the Endangered Species Act did in the last 30 years. Our actions, our choices, and our decisions about the use of resources are key to maintaining and improving Oregon's environment."

Viridian Place LEED Scorecard

Viridian Place, LEED Project #0050
 LEED Version 2.0 Certification Level: Certified
 December 11, 2001

28 points achieve out of 69 possible points

Sustainable Sites Possible points: 14

- Prereq Erosion & Sedimentation Control
- 1 Site Selection
- Urban Redevelopment
- Brownfield Redevelopment
- Alt. Transportation, *public transpt. access*
- 1 Alt. Transportation, *bicycle storage & changing rms*
- Alt. Transportation, *alt. fuel refueling stations*
- 1 Alt. Transportation, *parking capacity*
- Reduced Site Disturbance, *protect /restore open space*
- Reduced Site Disturbance, *development footprint*
- Stormwater Management, *rate and quantity*
- 1 Stormwater Management, *treatment*
- 1 Landscape/Exterior Design Reduce Heat Islands, *non-roof*
- 1 Landscape/Exterior Design to Reduce Heat Islands, *roof*
- Light Pollution Reduction

Water Efficiency Possible points: 5

- 1 Water Efficient Landscaping, *reduce by 50%*
- 1 Water Efficient Landscaping, *no potable use or no irrigation*
- Innovative Wastewater Technologies
- 1 Water Use Reduction, *20% reduction*
- Water Use Reduction, *30% reduction*

Energy & Atmosphere Possible points: 17

- Prereq Fundamental Building Systems Commissioning
- Prereq Minimum Energy Performance
- Prereq CFC Reduction in HVAC&R Equipment
- 2 Optimize Energy Performance, *20%new/10% existing*
- 2 Optimize Energy Performance, *30%new/20% existing*
- 1 Optimize Energy Performance, *40%new/30% existing*
- Optimize Energy Performance, *50%new/40% existing*
- Optimize Energy Performance, *60%new/50% existing*
- Renewable Energy, *5%*
- Renewable Energy, *10%*
- Renewable Energy, *20%*
- Additional Commissioning
- Ozone Depletion
- Measurement & Verification
- 1 Green Power

Materials & Resources Possible points: 13

- Prereq Storage & Collection of Recyclables
- Building Reuse, *Maintain 75% of existing shell*
- Building Reuse, *Maintain 100% of existing shell*
- Building Reuse, *Maintain 100% shell & 50% non-shell*
- 1 Construction Waste Management, *divert 50%*
- Construction Waste Management, *divert 75%*
- Resource Reuse, *specify 5%*
- Resource Reuse, *specify 10%*
- 1 Recycled Content, *specify 25%*
- Recycled Content, *specify 50%*
- 1 Local/Regional Materials, *20% manufactured locally*
- 1 Local/Regional Materials, *of above, 50% harvested locally*
- Rapidly Renewable Materials
- Certified Wood

Indoor Environmental Quality Possible points: 15

- Prereq Minimum IAQ Performance
- Prereq Environmental Tobacco Smoke (EST) Control
- 1 Carbon Dioxide (CO₂) Monitoring
- Increase Ventilation Effectiveness
- Construction IAQ Management Plan, *during construction*
- Construction IAQ Management Plan, *before occupancy*
- Low-Emitting Materials, *adhesives & sealants*
- Low-Emitting Materials *paints*
- 1 Low-Emitting Materials *carpet*
- Low-Emitting Materials *composite wood*
- 1 Indoor Chemical & Pollutant Source Control
- Controllability of Systems, *perimeter*
- Controllability of Systems, *non -perimeter*
- 1 Thermal Comfort, *comply with ASHRAE 55-1992*
- Thermal Comfort, *permanent monitoring system*
- 1 Daylight & Views, *daylight 75% of space*
- 1 Daylight & Views, *views for 90% of spaces*

Innovation & Design Process Possible points: 5

- 1 Innovation in Design: *construction waste mngmt 90%*
- 1 Innovation in Design: *recycled content 100%*
- Innovation in Design: *reuse historic building*
- Innovation in Design: *green building demo project*
- 1 LEED™ Accredited Professional