City of Springfield, Missouri Environmental Protection Agency Sustainability Pilot

Recommendations for Sustainable Design and Adaptive Reuse: Commercial Street Historic District

March 20, 2009

Completed by *Vita Nuova LLC*

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FINAL REPORT

City of Springfield, Missouri - Environmental Protection Agency Sustainability Pilot

Recommendations for Sustainable Design and Adaptive Reuse
Commercial Street Historic District

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Introduction

The U.S. Environmental Protection Agency Brownfields Program (USEPA) selected the Commercial Street Historic District projects as Brownfields Sustainability Pilots. Vita Nuova LLC, and Brownfield Redevelopment Solutions, Inc., subcontractors to SRA and USEPA, were assigned the task of assessing plans for adaptive reuse of three building properties. The properties are located on Commercial Street, Springfield, MO, and are classified as brownfields. This report provides green design recommendations for the adaptive reuse of the three buildings and also offers recommendations to facilitate sustainable reuse of the properties. The report represents the outcome of a site visit, December 15-16, 2008, by consultants Donald Watson, FAIA, Vita Nuova architect and planner, and Susan Sciarratta, P.E., Brownfield Redevelopment Solutions,

brownfield consultant and LEED™ AP. These topics represent the primary assignment and opportunities listed in the Scope of Work (**Appendix A**). This project was executed under USEPA Contract No. EP-W-07-023, Work Assignment 018, entitled, "Technical Assistance to Pilot Communities."

The EPA brownfields program

EPA's brownfields program enables local communities to assess, clean up and revitalize key community properties through collaboration between relevant stakeholders. EPA's Brownfields Sustainability Pilots are intended to facilitate and encourage sustainable redevelopment of brownfield sites through technical assistance on sustainability practices. Brownfield sites are defined by EPA as real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of hazardous substances, pollutants or contaminants.

As noted below in "Limitations of Recommendations," at the time of the site visit and writing of this report, the architectural and engineering plans of the projects are not advanced sufficiently to provide more than generalized recommendations. These recommendations follow from experience in similar projects that have proven to be cost effective and, in some cases, have reduced construction costs. If the architectural and engineering work proceeds, as recommended by LEED guidelines, to include integrated design and computer simulation of options (parametric analysis) by the owners' teams, it will be possible to identify more exact specifications as to insulation, daylighting and related energy strategies.

Recommended follow-up steps that advance the projects include:

Project goals and team formation

- Each project to establish a Project Design Team consisting of an architect, engineer, and owner (and if possible contractor) to review recommendations of this report and establish design goals and integrated design process to incorporate LEED and similar design efficiencies. (See Table in "Summary of Recommendations" for reference to recommendations and design team professional assignments).
- The Architect and qualified building energy professional member of each team will determine what form of energy simulation program is appropriate for assessing options that allow reduction in size of mechanical systems. This can be done by increasing insulation levels in order to step-down size, cost and energy demand.
- If a contractor has not been selected, include a construction expert in the design process to identify "constructability" opportunities. For special technical requirements, such as brewery manufacturing and/or health spa equipment, include process and controls engineering specialists.

Peer consult design workshop (as possible follow-up under EPA sponsorship)

- Each team will develop preliminary concepts and options (schematic designs) in preparation of a "peer consult" workshop.
- Preparation will include a working estimate of construction cost and costs for maintenance and operation (M&O), including energy and water.
- All teams (with all working members) will meet in a design workshop with EPA consultants. Consultants will work with teams to review LEED process and energy-efficient design, using LEED-rating guidelines to advise on design and specifications appropriate to each project. Ideally, this workshop is scheduled approximately halfway through schematic design when options are still open and design adjustments are still possible.

- At the end of the design workshop, teams realign their cost estimate and M&O costs to identify construction and operating cost efficiencies that would be achieved using LEED and/or related consultant recommendations.

Following the workshop (after EPA Pilot Program consultation)

- Each project team will be able to complete the LEED process and/or variations of it, subject to their own schedule, pursuant to opportunities identified during the EPA Pilot Program.

List of participants in Site Visit December 15-16, 2008

Monday, Dec. 15 Site Tours & Meetings

Attendees at all Monday meetings:

- Steve Kovac, Branch Manager, EPA Region 7
- Alma Moreno-Lahm, Brownfields Project Manager, EPA Region 7
- Olivia Hough, Associate Planner, City of Springfield
- Donald Watson, FAIA, architect and planner, Vita Nuova
- Susan Sciarratta, P.E., LEED AP, Brownfield Redevelopment Solutions, Inc.

8:30am Initial Meeting with Commercial Street Group (Mama's Coffee House)

- Mary Collette, City Council and Commercial Club board member
- Juliet Mee, owner, Day Spa
- Carol Morlock, Day Spa facilities manager & instructor
- Vern Morgan, City of Springfield
- Paul Parker, Commercial Club President

9:30am Tour of Day Spa Site

- Juliet Mee, owner, Day Spa
- Carol Morlock, Day Spa facilities manager & instructor

Via teleconference:

- Robbie Price, Architect, Simon & Associates
- Nick Bordmeier, LEED AP, architect, Simon & Associates

11:00am Tour of Microbrewery Site

- Buz Hosfield, owner, C Street Brewery
- Chris Frost, owner, C Street Brewery
- Doug ____, owner, C Street Brewery
- Mary Collette, City Council and Commercial Club Board Member
- Chris Straw, Engineer, Butler Rosenbury & Partners
- Vern Morgan, City of Springfield

3:00pm Tour of Commercial Club

- Randy Dunlap, Architect, City of Springfield
- Phil Broyals, Public Works Municipal Facilities Director, City of Springfield
- Ron Walker, Commercial Club Board Member
- Donnie Rogers, C-Street Coordinator
- Jim Web, City of Springfield

Tuesday, Dec. 16 Site Tour & Meeting at the Jordon Valley Innovation Center, MSU

- Alma Moreno Lahm, Brownfields Project Manager, EPA Region 7
- Olivia Hough, Associate Planner, City of Springfield
- Donald Watson, FAIA, Architect and Planner, Vita Nuova
- Allen Kunkel, Director, Innovation Center
- Doug Sampson, Architect, MSU
- Brad Keilhofner, Engineer
- David Vaughn, Environmental Engineer

Summary of Recommendations

This report summarizes consultant recommendations related to:

I 505 W. Commercial Street (Microbrewery)
II 233 E. Commercial Street (Day Spa)
III 299 E. Commercial Street (Commercial Club Building)
IV LEED certification and green design lessons learned

The three sites are reviewed individually in the first three sections. Part IV addresses LEED certification questions raised in the Scope of Work.

The selection of the three brownfield sites for adaptive reuse is itself a positive decision of sustainable design. The three Commercial Street projects are accessible by public transportation and pedestrian traffic via the historic footbridge that connects to the nearby residential neighborhood. Outdoor design features, such as a green roof terrace, rainwater harvesting, and landscaping, if implemented, will be within the view of the footbridge. They will help define the public face and spirit of Commercial Street Historic District renewal as a community that is as much a part of the future as the past.

The primary recommendations of this report are:

- **Establish green design goals based on cost effectiveness and performance.** Green design goals can and should define targets as the basis of design and performance evaluation. Whether or not full LEED certification is pursued, green design helps to establish measurable outcomes that establish community health, economic viability and environmental quality as essential design priorities.

- **Use the integrated team** design approach to reduce costs and improve quality of construction and operation. The integrated design approach is recommended by LEED certification. A key lesson learned from evaluating successful green projects is that the integration of architectural design and engineering analysis at the earliest design phases produces the most cost-effective results.

- **Sponsor a Commercial Street Design Peer Consult / Workshop to advance the projects and to spread the initiative to other Commercial Street properties.** While each project has specific budget and time schedule requirements, there is an advantage to mutual consultation and support. This report concludes with a recommendation to organize a peer consult /design workshop as the projects advance through their respective design phases, to share knowledge and expertise and to incorporate green goals in the larger community revitalization process.

Summary of energy efficiency and environmental improvement opportunities
The table below summarizes the recommended features for consideration in each of the projects. The cross-reference indicates opportunities for mutual consultation.

O = Owner
A = Architect
Eng = Engineer (various specializations, MEP, process, controls)
LC = Lighting, including daylighting
LA = Landscape Architect
ES = Energy Analysis Specialist

PROJECTS			**RECOMMENDATIONS**	**PRINCIPAL EXPERTISE**					
I	**II**	**III**		O	A	Eng	LC	LA	ES
B1			**Process engineering**	√		√			√
B2	D2	C2	**HVAC systems**		√	√			√
B3	D8	C3	**Energy Management Systems (EMS)**			√			√
B4	D9		**Daylighting / energy-efficient lighting**		√		√		
B5			**Cool roof**		√	√			
B6	D1		**Water conservation / greywater systems**			√		√	
B7			**Recycling**	√					
B8	D5		**Airlocks**		√	√			
B9			**Expansion and future adaptive reuse**	√	√				
B10	D12	C8	**Community environ. / health promotion**	√					√
B12	D4	C1	**Insulation**		√	√			√
	D3		**Solar hot water heating**			√			√
	D6		**Acoustical damping**		√		√		
	D7		**Radiant floor heating**		√	√			√
	D10	C4	**Green roof terrace**		√			√	
	D11	C6	**Green materials**	√	√				
B11		C5	**Greenscaping**					√	
		C7	**Special program uses**	√	√				

Summary of recommendations in terms of general costs and benefits
The recommendations summarized in the table above represent design and construction experience and documented performance of buildings similar to those reviewed in this report. With a few exceptions that are noted, they fall within the category of short-term payback, that is, annual savings in energy and operational costs exceed the added cost of construction within five- to seven years.

Whether or not the recommendations are appropriate for the specific projects will require energy modeling using local weather data, local energy costs, including peak use "demand charges," if applicable, and the parameters of use (energy and water demand) of each project. Energy modeling is a tool that aids in the design of the architectural envelope and the mechanical (HVAC) systems. Energy modeling is most appropriate near the end of schematic design, when most design and use parameters are defined. For each project, the cost to install the features is being considered by the project's cost consultant. The following guidelines are provided to anticipate what energy modeling and cost/benefit analysis might consider:

B1 Process engineering

Cost: Design fees for process engineering may be included in equipment purchase and/or shared with HVAC design fee.

Benefit: Efficiency of operation, opportunity for heat (and water) recovery.

Process engineering is a required step in design of special equipment (such as production equipment for the brewery and the plumbing system for the Day Spa). Process engineering reveals opportunities for energy savings by establishing control temperatures, scheduling production (to take advantage of off-peak rates, if applicable), and matching production requirements to energy equipment. The heat gain from the Brewery's production equipment, for example, will establish the space heating and cooling requirements of the entire building.

B2 HVAC systems

Cost: Design fees are normally included in the A&E fee. Energy modeling may be an added cost.

Benefit: Efficiency of operation, opportunity to downsize and reduce HVAC cost.

HVAC engineering is a key component of energy/environmental design. In some projects (such as the Brewery and Day Spa) HVAC may represent 30% of construction cost. The size of equipment, length of runs, and mechanical space requirements can by reduced as much as 50% if insulation is added to the roof, walls, and/or other decisions are made to reduce HVAC demand (such as zoning of internal spaces to aggregate uses and to permit the use of modular equipment). Some energy modeling protocols, such as DOE.2, permit analysis of all energy costs, including fans, pumps, and equipment.

B3 Energy Management Systems (EMS)

Cost: Equipment may add to electrical division cost of controls, depending on the system. Cost may include security and alarm system controls. EMS may also include a "dash board" display of energy and operational data.

Benefit: Energy and operation savings and automation. Reduced HVAC and lighting cost (reported in the range of 20% and greater).

Energy Management Systems (EMS) have proven to be cost effective with paybacks within one or two years of operation, as well as increased comfort. EMS permits automated scheduling of HVAC and lighting, custom designed for the specific building. Display of energy management and use can be part of internal control documentation and/or made part of public informational display (see item B10 below). The design of EMS controls is normally provided by the equipment supplier and should be included in integrated design team discussion. [Reference: Federal Energy Management Program: Building Life-Cycle Cost Jun., 2008. The User's Guide is part of the BLCC5 Help system. It is useful for evaluating the costs and benefits of energy and water. Energy Price Indices and Discount Factors for Life Cycle Analysis http://www1.eere.energy.gov/femp/information/download_blcc.html]

B4 Daylighting and energy efficient lighting

Cost: Skylights add to roof construction costs, based on the size and number of skylights. Energy efficient lighting may cost more than conventional fixtures. Increased skylighting permits reduction in electric lighting installation and operation.

Benefit: Potential reduction of electric lighting installation and operational costs, plus improved productivity, health and safety. At an estimated incremental first cost

increase of $0.50 to $0.75 per square foot of occupied space for dimmable ballasts, fixtures and controls, daylighting has been shown to save from $0.05 to $0.20 per square foot annually (1997 data) [Source: Lawrence Berkeley Laboratory].

Skylights can be small (e.g., 18 inches square) and placed to provide ambient lighting sufficient to meet lighting requirements during daylight hours. In addition there are post-occupancy reports of productivity, health and safety benefits. The use of daylighting in factories improves acuity of lighting, due to its ambient and multidirectional incidence. Daylighting works best in high ceiling spaces, and in many applications, prompts the elimination of a "hung ceiling" (which can reduce costs). Careful study of lighting (in schematic design phases) will result in further cost reduction opportunities by careful (and minimal) allocation of lighting fixtures to reduce and eliminate unnecessary lighting fixtures. Energy efficient lighting, while more expensive per fixture, can meet or beat typical lighting budget allocation by use-specific specification and placement of lights. Lighting controls (automatic and zoned for use) can reduce lighting costs in the range of 50% to 75% for typical commercial applications. A photometric control of lights is recommended where skylights or clerestories provide daylighting. Studies by Lawrence Berkeley Laboratory and others document that daylighting can realize a return on investment within five- to seven-years, subject to application. [Reference: *Daylighting - Whole Building Design Guide*, Nov. 2008, Technologies Division, Lawrence Berkeley National Laboratory, http://www.wbdg.org/resources/daylighting.php]

B5 Cool Roof

Cost: No additional cost if new roof is required. A white EPDM rubber roof provides one form of a cool roof. Added costs may include added insulation (above Code requirement).

Benefit: Cool roofs can reduce annual air conditioning consumption by 10 % to 40%, depending on location, building design and climate. Reduced air conditioning demands have enabled many buildings to downsize air conditioning.

A light-reflective roofing surface reduces the heat buildup and reduces summer peak load air-conditioning requirements. If clerestory lighting is utilized, a white reflective roof increases reflected daylight. Benefits include reduced air-conditioning resulting from a cool roof (light reflective surface). Even in such cases, there is an atmospheric benefit of reducing the ambient temperature of the urban environment, because a cool roof does not hold heat in same manner as dark roofs (typical of urban roofing), air conditioning units run less, which reduces wear and maintenance on the units. [Reference: http://www.dcd.com/insights/novdec_2005_9.html]

B6 Water conservation/greywater systems

Cost: In addition to required stormwater management, an added cost is a cistern, sized to meet dry season landscape requirements. On-site water retention requirements (normally required) may be met in small part by a cistern. Although increasingly used and thus lowering in cost, advanced water-conserving plumbing fixtures are generally more costly than older stock items and/or special-order items. Some water-conserving fixtures, such as aerators, are good practice and do not add to the cost of plumbing installation.

Benefit: Cost-benefit analysis of water conservation is largely determined either by local water utility rates or liability of local water control requirements (summer drought). In principal, potable water should be viewed as a precious resource and a poor choice for landscaping uses. Collected rainwater, on the other hand, is ideal for landscaping. In the case of the Brewery, process water that would

otherwise be added to the sewerage system might instead be used for landscaping purposes. [Reference: For a good description of the cost/benefit of greywater systems, see http://www.letsgogreen.com/greywater-recycling.html]

B7 Recycling

Cost: Recycling strategies do not normally add to the cost of construction or operation. Construction recycling normally saves contractor outlays for dumpster removal and, where on-site materials are reclaimed, can reduce material supply cost (such as aggregate fabricated from old masonry units recovered on site). Recycling of materials normally disposed in operation of a facility typically results in some cost reimbursement.

Benefit: Recycling has a direct benefit in reduced dumpster and waste-removal fees. In some instances, recycling of building materials that come from "deconstruction" of existing buildings can provide jobs and contribute to the local economy.

B8 Airlocks

Cost: The cost of airlocks (double entry doors) is normally a requirement of normal construction and not an added cost. Airlocks must have sufficient space between inner and outer doors to avoid "through flushing" when both doors are held open.

Benefit: Providing airlocks that work as intended reduces heat gain (in summer) and heat loss (in winter). They improve interior comfort for staff and the public using areas near the entry. Airlocks also provide a confined floor area for wiping feet to remove snow, water, dirt (and salt if used for ice control). This simplifies cleaning requirements in other parts of the building, while also reducing slipping hazards.

B9 Expansion and future adaptive reuse

Cost: Designing for future expansion does not normally add to cost.

Benefit: Some future changes can be completed more economically.
Given that an investment in the construction of a building is from 50 to 100 years, any design and engineering should anticipate future adaptability and changes of zone uses within a building, as well as additions (where the site permits). These options may lead to interior space and HVAC/lighting systems that are "modular" and easily added to, without replacement of the central plant. Future expansion or internal remodeling is also aided by detailing of interiors for easy change (without disrupting on-going operations).

B10 Community environmental health promotion

Cost: Designing materials for environmental and health promotion is inexpensive compared to most other construction costs. Such materials may include interior signage and/or printed literature. Interior signage may be included as part of standard ADA compliance and directional signage.

Benefit: Improved public relations and cooperation of building users.

Providing information about health, environmental and energy goals of building design and operation helps "spread the word." It addresses a common concern of energy efficient building design: that buildings are not used in the sustainable manner addressed in their design (e.g., lights are left on although there is plenty of daylight, water is left running in toilets, etc.). Environmental health promotion informs all building users—including staff, volunteers and the public—that they are participants in sustainable design. The information helps "brand" the buildings as "green and clean."

B11 Greenscaping

Cost: Greenscaping is part of the landscape budget. Porous paving is part of site paving budget. Greenscape approaches can be held within conventional budgets for these items. They can often be used effectively to reduce costs by reducing stormwater management infrastructure requirements.

Costs for porous asphalt are approximately 10% to 15 % higher than those for regular asphalt. Limiting paving areas only to trafficked lanes and leaving parking spaces as gravel can reduce costs. The higher cost installation cost of porous pavements can be offset to some extent by the elimination of curbs, gutters, and storm drains. In some cases this may lower the overall cost for a project (Field et al., 1992). The final economics associated with a particular site are also affected by site-specific conditions, such in situ permeability, and the cost and proximity of gravel supplies. [Reference: See fact sheets at The Stormwater Manager's Resource Center, http://www.stormwatercenter.net/]

Benefit: In addition to amenity of landscape, greenscaping can reduce the cooling load on buildings (by shading) and increase the outdoor comfort in public areas (such as terraces) by shading and evaporative cooling. Greenscaped parking lots can reduce measured ambient outdoor temperature (at the paved surface) from 150F to 90F, and even more with evaporative cooling.

Greenscape includes landscape planting and rain gardens (absorptive, water-collecting plants), and—subject to architectural design—the addition of trellises for green wall screens. Also included are porous paving and/or structured tree soil cells that retain and absorb stormwater runoff. [Reference: EPA Green Infrastructure Initiative, http://cfpub.epa.gov/npdes/greeninfrastructure.cfm]

B12 Insulation

Cost: Insulation above what is required by code adds to construction cost. In general, adding to roof insulation is the first and best allocation of additional insulation value. Window coverings (shades) are normally part of a "furniture" budget. Options are available from large distributors (such as Hunter Douglas) that combine shading and insulation values.

Benefit: More comfortable buildings year round. Reduced operational cost. Reduced operation of mechanical equipment increases the life of equipment. Adjustable window insulating shades provide control of light, heat gain and heat loss.

Typically, an increase in construction cost to include insulation in the range of 5% can result in energy cost reductions in the range of 50%. Much greater improvements are possible and should be explored to reduce operational costs for the life of the building. Added construction cost can be partly or entirely offset by downsizing of HVAC system size and by reduced heating and cooling costs. Energy modeling provides fine-tuning of the relationship between added insulation and reduced HVAC requirements. Typically, during the schematic design phase, various levels of insulation are compared using parametric analysis (one improvement at a time compared to a percentage improvement over a "base case" code compliant building). Construction cost estimates are provided for each option to determine payback, utilizing local energy cost projections. In general, added insulation is the best investment to provide for carbon footprint reduction and lowest life-cycle cost of operation. An exception may be a manufacturing plant, such as the Brewery, where internal heat gains due to the Brewery process may require space

cooling even in winter months. This determination is subject to process engineering for the Brewery. [Reference: http://www.insulation.org/foundation/research.cfm]

D3 Solar hot water heating

Cost: A solar hot water heating system to provide domestic hot water (two panel system) currently costs in the range of $4,000 to $8,000, depending on system size.

Benefit: Solar hot water heating can provide all water heating requirements in summer months, typically the period of "high peak demand" for energy. It may also permit the elimination of fossil fuel energy sources for water heating in summer. Subject to specific site and use conditions, the investment in solar hot water can realize a payback in 5 to 12 years.

Solar domestic hot water heating systems are now well-established. They make the most economic sense in facilities with higher than normal hot water demand (such as the Day Spa). In other cases, the practicality of solar hot water depends on demand (typically considered to be low in public buildings such as the Commercial Club). [Reference: http://apps1.eere.energy.gov/consumer/your_home/water_heating/index.cfm]

D6 Acoustic damping (recommended as an occupant and workplace productivity amenity, not an energy feature: see discussion in Section II below).

D7 Radiant floor heating

Cost: For a system that utilizes water pipes, the installation cost may average $8 to $10 per square foot.

Benefit: Heating cost reductions from 10% to 40% are reported. The greatest advantage is comfort, that is, providing heating by radiant floors allows air temperatures to be lower, with less air-drying.

Radiant floor heating is a premium system due to the warm floor, which is felt at the level of occupancy. Its economy depends on other decisions, that is, whether or not additional heating and cooling equipment sizes can be downsized or reduced. It is a quiet (essentially silent) heating system, ideal in a spa where quiet is desired. [Reference: http://www.radiantfloorheatinginfo.com/Radiant_Floor_Heating_Cost.html]

D10 Green roof terrace

Cost: Added costs for green roofs are estimated to average $15 to $20 per square foot for all use types (i.e., high density residential, commercial, and industrial). The highest costs associated with green roof creation are the soil substrate/growth medium and the plant components associated with it. Green roof retrofit projects may have increased cost associated with traffic and resource scheduling concerns, as well as the on-site availability of equipment and materials.

Benefit: Rooftop vegetation moderates the temperature extremes of a roof surface and prevents it from being exposed to ultraviolet (UV) radiation and cold winds that could accelerate its deterioration. The result is an extended life span for the roof. A vegetated roof, on average, can be expected to prolong the service of the life of a conventional roof.

Benefits include energy cost reduction, hydrology and reduction of the urban heat island effect. Additional potential benefits such as air quality, public health, reduced green house gas emissions, increased property values, and aesthetic enjoyment. The "energy payback" is not

competitive with simply adding insulation. These added costs are normally prohibitive for small areas as represented by the Commercial Street projects. A green roof is listed as an option for consideration at the Day Spa, as a possible aesthetic feature combined with a roof terrace (and is thus a use amenity, rather than an energy-saving feature). Green roofs are ideally considered where there are large roof areas in sites where the absorptive role of the roof vegetation contributes to stormwater runoff reduction. Green roofs are also worth considering as part of a larger urban effort that would include substantial green infrastructure to reduce urban heat island effect. [Reference: http://www.lid-stormwater.net/greenroofs_cost.htm]

D11 Green materials

Cost: Expect a wide range of costs, with many new materials being introduced to respond to market interest and demand. Many standard products are now being upgraded to include green features, such as gypsum wallboard with recycled content and "green" paints with low-VOC content. Some added costs might be expected as new products enter the market.

Benefit: Improved indoor air quality is a possible benefit that is important to individuals prone to allergies and chemical sensitivity. Another benefit is the showcasing of materials and processes that have less environmental impact. This is certain to aid businesses and industries developing green materials and products. Salvage work required to use recycled materials is often a source of local jobs (refinishing lumber removed from deconstructed or demolished buildings, for example).

Green materials that promote healthy indoor air quality offer the most benefit for the Day Spa, whose market niche is health. Many portions of construction finishes are now available from recycled materials, including rubber flooring, sheet linoleum, recycled content counters, low- and no-added formaldehyde cabinets and furniture, carpeting that carries "cradle-to-cradle" certification, etc. A related design approach, which reduces construction cost, is to reduce or eliminate interior detailing (plastics and oil-based products) that normally cover structure and mechanical equipment, using instead an aesthetic of exposed walls and ceilings typical of "bare bones" remodeling and adaptive reuse.

Limitations of the recommendations

The report is submitted for review and possible follow-up consultation as the EPA Pilot may proceed in late Winter-Spring 2009. At the time of the site visits and preparation of this report, the architectural planning for the projects had not yet advanced to the point that conceptual or schematic design plans were available. This offers an advantage because conceptual and formative recommendations are timely and do not impose revisions on completed work.

The recommendations in this report are "conceptual," representing green design approaches that have been used successfully in similar projects. The priority of recommendations is loosely ranked, based on generalized results. To decide conclusively how cost effective any particular recommendation may prove to be will depend on further project definition and design development. The process of energy design, widely adopted by energy design professionals and required by the LEED process, is to undertake a parametric analysis of options at the schematic design phase using state-of-the-art computer simulation. More detailed evaluation of green design options will be possible in terms of energy cost/benefit after the respective schematic design phases have advanced sufficiently to permit energy analysis and cost estimating of options.

Definitions of sustainable design

The objective of sustainable design—also called green design—is to enhance and sustain a high quality of community values and environmental health in design and construction of built

infrastructure, transport, landscape, and buildings. Sustainable design applies the principles and practices of resource conservation and renewable energy design.

In General Services Administration (GSA) publication *Sustainability Matters* (**Ref. 1**), sustainable design goals are defined as…

> *"….to reduce consumption of non-renewable resources, minimize waste, and create healthy, productive environments. Such an integrated approach positively impacts all phases of a building's life-cycle, including design, construction, operation, and decommissioning."*

The GSA definition continues…

"Sustainable design principles include the ability to:

- *optimize site potential,*
- *minimize non-renewable energy consumption,*
- *use environmentally preferable products,*
- *protect and conserve water,*
- *enhance indoor environmental quality,*
- *optimize operational and maintenance practices."*

I 505 W. Commercial Street (Microbrewery)

Green design goals of 505 W. Commercial Street will be best achieved by integration of the process engineering of Microbrewery production for which energy and water costs are the dominant requirement for capital and operational cost. State-of-the-art microbrewery equipment and operation will offer energy efficiency and may provide opportunities for heat recovery and energy conservation for some or all building space and occupancy requirements.

The Microbrewery plant (C Street Brewery) and related commercial retail space are in the early phases of site preparation. Architectural plans are being prepared for remodeling the 1924 structure on a .53-acre property at 505 W. Commercial Street.

From the late 1980s to early 1900s, the site was a feed mill, Anchor Mills, and subsequently became The Abbott Coal Yard until the early 1930s. The building was constructed in 1924. From the 1930s to 1960s, the building was used as a peanut butter plant and as an automotive repair shop, while the southeast corner functioned as a filling station. The building was most recently occupied by Welhener Awning (1962-2006) and by Saville Ornamental Iron Company (2001-2006). EPA-funded Phase I and II Environmental Site Assessments (ESA) revealed that the site previously contained aboveground storage tanks, underground storage tanks and asbestos floor tiles. The underground storage tanks were removed along with contaminated soil and groundwater monitoring wells were installed. Following the removal, the Missouri Department of Natural Resources issued a "no further action" letter and a subsequent update to the Phase I report found no further recognizable environmental conditions. (**Ref. 2**)

The site has been acquired by investors who plan to own and operate a microbrewery and related retail spaces (tenants not yet selected). The current plan for reconstruction and renovation of the building is to repair and reuse portions of existing walls while replacing all roof and interior assemblies. Portions of the exterior walls that are presently painted will be stripped to reveal its original exterior brick color and pattern. The building site is already stripped of metals and other recoverable materials. With a new roof and interior systems, the project is properly defined as

new construction.

Construction documents for a new roof structural plan are completed and being readied for contractor bidding by Butler Rosenbury & Partners, Architects and Engineers. In the recommendations that follow, it is assumed that the roof structure will be completed as presently configured. The plan indicates two skylights over a portion of the interior envisioned as leasable space or circulation space serving rentable retail space. It may be feasible to add small skylights within the present structural configuration without undue reengineering.

At the time of the site consultancy, the architectural plans of the interiors and the site plan were not developed. The interior space uses are envisioned as primarily manufacturing (microbrewery) for which the manufacturing equipment has not yet been selected. Tenant allocations and uses of retail spaces remain unspecified. The owners' vision is to enable the public to tour the facility and to sample the crafted brews, which may lend itself to future retain uses such as a brewpub, beer garden, tasting room, and store for beer, brewing and logo items.

A number of breweries in various regions of the U.S. are adopting energy conservation and environmental goals as part of their business and marketing. A web search of "Breweries Green Design" yields the following listings, indicating sources of similar efforts.

THE BEST OF GREEN DESIGN: A Colorado brewery invents the recipe for green beer.
http://www.popularmechanics.com/science/earth/4212733.html

Hopworks Urban Brewery –Sustainable & Responsible Business of the Week
http://sustainablebusinessdesign.blogspot.com/2008/12/hopworks-urban-brewery-sustainable.html

Green Micro-breweries
http://www.triplepundit.com/pages/green-microbrew.php

New Belgium Brewery: "If It Isn't Fun, It Isn't Sustainable"
http://www.newbelgium.com/sustainability

Green Options/Full Sail Brewery: Sustainable Craft Beer Proves Class Act
http://greenoptions.com/tag/brewery

Energy & Resource Conservation for Breweries - Deschutes Brewery
http://www.deq.state.or.us/aq/factsheets/04-AQ-004-BAPDeschutes.pdf

Organic Beer & Water
http://www.breworganic.com/tips/tips_water.htm

Case Study: Standing Stone Brewing Company
http://www.oregon.gov/ENERGY/CONS/BUS/docs/StandingStone.pdf

Special requirements of the microbrewery business operation
Two distinct uses are proposed for the building, a microbrewery zone to remain under the owners' direct operational control, and a separate tenant retail zone. The size and allocation of these spaces was not indicated at the time of the site visit. The relative size of each area may change over time, so that the recommendations apply in a general sense to the entire structure.

Manufacturing area

The manufacturing area is to be a secure, non-public workplace (with workplace requirements for 2-3 staff). If the public is to be admitted, higher standards may be required by insurers or by code. (This is a common challenge for manufacturing and food processing plants, often solved by a limited viewing area overlooking plant operations).

The requirements of microbrewery equipment and operation will dominate the green design choices. Energy and environmental requirements for the manufacturing zone are determined by the engineering requirements of the brewing process and equipment, to be provided by consultation with manufacturing product engineers.

B1 **Process engineering/state-of-the-art equipment**

Process engineering with state-of-the-art microbrewing equipment is required to identify energy and water resource efficiency advantages. The microbrewing industry is highly competitive. Most state-of-the-art equipment suppliers have to meet current European ISO (International Standards Organization) 9000 standards for manufacturing operations. The engineering requirements of specific equipment and plant operations are obtained from manufacturers.

Process engineering of the entire materials delivery, handling and brewing process will reveal further opportunities for energy efficiency. This may include boiler efficiency, boiler heat recovery, efficient dish-washing, variable speed exhaust hoods and fans, combining hood exhaust with Energy Recovery Ventilation, and Energy Management Systems (EMS), each of which is described more fully below.

B2 **HVAC systems**

Microbrewery operations typically require a range of temperatures to be maintained simultaneously in different areas of the plant. For example, some plants may maintain a "hot zone" for brew kettles with process heat requirements of 150F (66C) and a "cold zone" of 45F (7C) along with refrigeration for storage. In such cases, there are advantages in economizer boilers with waste heat recovery. Likewise, refrigerant/cold storage energy demands may be reduced by outdoor ambient air during winter months. Other HVAC system efficiencies are realizable with Energy Recovery Ventilation (ERV) during winter and economizer cycle cooling during the summer. There may be advantages to waste heat recovery from process equipment operation for space heating of the brewery and/or adjacent spaces (retail space).

B3 **Energy Management Systems (EMS)**

Efficiencies may be gained by coordinating automation of equipment and Energy Management Systems (EMS). Current microbreweries are automated with special environmental controls required for electronic controls. EMS electronic controls are sensitive to environmental conditions, requiring close coordination of controls engineering layout and HVAC.

B4 **Daylighting and energy-efficient lighting**

Daylight creates a variety of interior light, which can also improve visual acuity (by multidirectional light sources). Daylighting through modestly sized skylights or south-facing clerestories can meet the lighting requirements for manufacturing areas. The entire ambient lighting requirement of the manufacturing floor can be reasonably met by small skylights utilizing approximately 2% - 5% of the roof area, spaced in similar fashion to lighting fixtures. Sun tracking skylights can reduce the skylight aperture requirement,

increasing cost effectiveness and reducing summer cooling (see **Appendix B** for examples). A clerestory configuration (vertical glass), facing south with an overhang for summer shading, is equally effective. Photo-responsive controls along with energy-efficient light zoning and switching should be designed to coordinate with the daylighting system.

B5 **Cool roof**

A "cool roof" surface such as white EPDM rubber roofing (equal to Hypalon™) provides a reflective surface that reduces cooling loads and would augment clerestory daylighting if selected. A light-colored roof has the greatest advantage in roofs with limited insulation (that is, code compliant but not beyond). The greater the insulation value, the less impact is provided by a cool roof.

B6 **Water conservation/greywater systems**

Brewing typically requires a large volume of water, as well as high volumes of water that is flushed and drained. Water-conserving hose heads and bottle washing will reduce water requirements. Non-chemical water softeners should be considered if required to improve water quality of first use (brewing), which in turn increases safe reuses. In similar operations, the wastewater can be used for off-site commercial re-uses (subject to health codes). Given high volume of water flushing, a greywater recovery system (cistern) could be considered to provide water for landscaping adjacent public areas (on the street or for the proposed parking to the north). Similarly, the remainder of spent grains has potential reuses as crop fertilizer, compost or livestock feed.

B7 **Recycling**

In addition to greywater systems, brewing operations may provide opportunities for additional recycling.

Process and packaging materials recycling. The building operation should have a dedicated recycling area for glass, packaging cardboard, plastic, and metals. Subject to waste hauling requirements, some waste may be co-mingled. Packaging offers opportunities to use recycled content cartons, with unbleached labels. Growlers could be sold with a deposit for redemption.
*Construction materials recycling***.** To reduce disposal costs and landfill burden, construction materials should be recycled (already evident in on-site materials separation.) Refuse masonry can be ground on site for landscaping aggregate (a commonly adopted on-site cost-reduction strategy).

B8 **Air locks**

The loading dock and service area should be a separate air-lock zone. In most manufacturing plant operations, loading and off-loading operations require some part of the interior to be opened to outdoor conditions, essentially the single greatest source of heat loss or heat gain. In winter, opening and closing of loading dock doors is a major heat loss, with the reverse in summer (if the interior plant is air conditioned). A similar air lock advantage exists at public entries.

B9 **Expansion and future adaptive reuse**

HVAC and electrical systems provide for expansion of the microbrewery plant operation. The building has space for undefined rentals. This provides space for future expansions of the manufacturing operations.

B10 **Community environment/health promotion**
Green design improves the health of the workplace, including a high standard of process operation. Hygienic conditions at the plant are improved by removing pollutants and chemicals from construction materials and cleaning operations. Green design—along with the due diligence to reduce the environmental impact of the entire chain of materials and water resources—can be part of the business promotion and marketing. Visitor tours and signage can be designed to make these features visible.

B11 **Greenscaping**
The site plan (not yet developed) will include parking and service. Porous paving may have advantages to reduce cost (with aggregate recovered by grinding waste masonry elements from the site) and to reduce stormwater run-off. An on-site stormwater retainage may include a rain garden or tree cells .The southeast corner of the site provides opportunity for trees, seating and water features. (See **Appendix B** for examples).

Commercial retail area
The following green design guidelines apply to typical commercial space operations designed for tenant leasing of portions of the project.

B2 **HVAC systems**
(Supplement to B2 recommendation above): Heating and cooling system layout should provide multiple zone controls with separate metering (to accommodate modular equipment operation and to allow separate metering and cost recovery from each tenant). As noted above, heating energy can conceivably be supplied by waste heat use from the adjacent microbrewery plant operation.

B5 **Daylighting and energy-efficient lighting**
(Supplement to B4 above) In all areas except where merchandise highlighting is desired, small skylights can meet the ambient lighting requirement of public uses. Energy-efficient LED lighting can be used for merchandise lighting.

B12 **Insulation**
Higher than code-compliance levels of insulation of the ceiling (roof) and exterior walls results in reductions in size and cost of HVAC systems. Choices are determined by analysis of building loads, with “step down” cost efficiencies identified by energy simulation (parametric analysis).

Summary of green design features with short-term (0-5 year) payback (in approximate order of added cost):

- White roof membrane for “cool roof” summer heat reflection.
- Increase roof insulation to reduce HVAC system requirements (commercial space).
- Energy-efficient lighting, designed for flexible controls and uses.
- Water-efficient plumbing.
- EMS system controls.
- Daylighting.
- Zoned HVAC for modular operation and zones with separate metering.

Other green design features

- Greenscape landscaping, porous paving gravel and /or grass pavers, rather than non-porous surfaces in parking spaces and low-use driveways.

- Trees planted in street forecourt could provide a welcoming shaded entry area, attractive to customers of tenant retail venues. Native plantings can be selected to reduce watering and maintenance.
- Safe, biodegradable cleaning agents.
- Small photovoltaic installation (consider for fan ventilation and emergency power).
- Greywater for landscape watering.

II 233 E. Commercial Street (Day Spa)

Green design goals for 233 E. Commercial Street can help the Day Spa's branding of its health and wellness message through a very high standard of indoor air quality, hygiene, comfort, natural lighting, and roof greenscape. The Day Spa can represent an oasis of nature and respite in the city.

The Day Spa and Professional Massage Training Center (PMTC) plan to expand into an adjoining property, a 5,000 square foot site at 233 E. Commercial Street. Prior uses of the site include a print shop from the 1880s to 1910 and a gasoline filling station that operated on the site from early 1900s to the early 1940s. The Phase I and Phase II Environmental Site Assessments (ESA), funded by EPA, reveal that the site may have petroleum or petroleum-related contamination from its historical use as a filling station. Soil and groundwater impacts appear to be concentrated within the central area of the site and beneath the building. The ESAs did not reveal concentrations above non-residential standards. (**Ref. 3**)

The building is a 4,700 square foot, single-story building, most recently owned by Davis Appliances. Exterior walls are concrete block construction, typical of 1960s retail store construction with an open space interior. A large single plate glass window faces the street, with a substantial overhang extending over its streetside sidewalk.

The new owner has embarked on architectural planning to rehabilitate the structure to expand the Day Spa and PMTC. As part of the development of the business, a very high standard of care is to be represented in green design for economic, environmental and health-related benefits. For this reason, the owner considers that fulfilling U.S. Green Building LEED™ requirements in design and construction of the new facility is a sound investment.

At the time of the site consultancy, architectural plans had not been developed. As part of the site visit, green design options were reviewed in a telephone conference discussion with the owner and with Simon and Associates, Architects.

D1 Water conservation / greywater systems

In the spa operation, there is a high volume demand of heated water (plunge baths), which is drained and cleaned after each use. Water conserving fixtures include low-flush toilets and energy-conserving aerators on faucets and showerheads, as well as clothes (towel) washing. Given the high volume of water flushing, a greywater recovery system (an outdoor cistern or an indoor tank) could be considered to provide water for landscaping adjacent public areas (on the street or for the proposed parking to the north). Small-scale greywater systems are also available, such as the AQUS system, available from WaterSaver Technologies (http://www.watersavertech.com/). This system is designed to work in a single bathroom, recycling greywater from a sink for use in flushing a toilet.

D2 **HVAC systems**

Green design goals include a high standard of care for interior airflow to provide comfort, remove indoor pollutants and control mold. These goals are best met by an air ventilation strategy utilizing low supply to high return so that airflow is upward. Return air registers should also be located over office equipment and / or the kitchenette in order to remove pollutants directly from these major sources. This quickly removes pollutants from the occupied zone. To minimize noise in fan motors and ducts, the system sizing should be based on slow moving large volume flow, using open-space planning to facilitate air movement where possible (essentially the large volume of interior space is the "return air duct"). Rooms that require acoustical privacy will need both supply and return ducting. Continual advances in heat pumps provide efficient heating and cooling for air systems. Electrostatic air cleaning units can be specified to achieve very high levels of interior air quality. Further efficiencies are realizable with Energy Recovery Ventilation (ERV).

D3 **Solar hot water heating**

Solar heated domestic hot water may be advantageous, providing full solar heating for summer uses and partial solar heating year-round. Instantaneous demand heaters can supplement high use/quick recovery requirements for hot water.

D4 **Insulation**

Higher than code-compliance levels of insulation of the ceiling (roof) and exterior walls results in reduction in the size and cost of HVAC systems. Choices are determined by analysis of building loads, with "step down" cost efficiencies (parametric analysis). Insulating the concrete walls on the outside (EIFS and/or other "out-sulation" systems) has advantages: It minimizes thermal bridging (and the issues of condensation at cold thermal bridges). It encloses the thermal mass of the concrete to the interior, where the masonry acts as a "thermal fly wheel," with advantages for summer cooling and winter heating comfort.

An insulating curtain (with bottom-up closure options) on any large south-facing glass can address shading in summer, as well as nighttime insulation.

D5 **Airlocks**

The building will be connected to the present Day Spa and the combined spaces will have one public entrance. The new or reused entry should be an airlock, with sufficient space between outer and inner doors to prevent "through flushing" when used in normal entry and exit.

D6 **Acoustical damping**

An issue raised at the site visit was noise intrusion from the adjacent rail yard operations. A well-insulated structure, with solid windows and doors and effective air sealing, will dampen transmission of outside noise, which follows air passages. Sound will intrude through any open air passages, including exterior exhaust vents, which should be located away from the noise sources.

D7 **Radiant floor heating**

Although more costly than conventional heating, a radiant floor has advantages in achieving a high standard of green design and health goals: heating comfort is provided by a radiant floor, so that air temperatures can be much lower (in the range of 64F) rather than the higher temperatures required for warm air systems (in the range of 74F). The lower air temperatures are more hygienic and reduce concerns for mold. Radiant floor heating

reduces air movement requirements for heating (radiant floors have a lower delivery temperature requirement compared to air systems) and can substantially reduce the requirements for heating duct runs, normally required to run to perimeter areas.

D8 **Energy Management System (EMS)**

Energy Management System (EMS) controls provide benefits for cost-effective operation. EMS controls have proven to be a cost-effective approach for controlling heating, cooling, humidity, and lighting.

D9 **Daylighting**

Sunlighting through south-facing clerestories, skylights and the south-facing entry offer sun tempering and passive solar heating. Direct sunlighting in winter (and a small amount of filtered sunlight penetration in summer) will also provide aesthetic and health benefits. Direct sunlight can assist in hygiene and mold control.

Daylighting through modestly sized skylights can meet lighting requirements for ambient lighting. The ambient lighting requirement of both public and private areas can be met by small skylightings, approximately 2% - 5% of the roof area, spaced like lighting fixtures. (See **Appendix B** for examples).

South-facing glazing or skylight clerestory lighting provide areas favorable for indoor plants. A water feature would help with acoustical damping and provide evaporative cooling and air freshening. Electric lighting should be zoned and controlled in accord with daylighting availability and to provide a range of variable lighting levels.

D10 **Green roof terrace**

The roof could be used for a garden/green roof terrace. A garden roof would provide a program amenity as a “green oasis” for rest and relaxation (public access or private terrace). The terrace garden is open to full east and south sun and shaded on the west. Rainwater recovery could provide water sufficient for any green landscape maintenance. This is a program amenity. A green roof could assist in insulation, but only modestly and not as effectively as insulation made part of the roof and ceiling construction itself. An alternative to a full green roof (and easier to construct if the roof is to include generous daylighting) is roof planters and vertical planting, with low-maintenance native planting and water provided by rainwater harvesting. The roof terrace and vegetation can also provide winter bird feeding, a water basin and cover.

D11 **Green materials**

As part of the “health” message of the business, the interior finishes can demonstrate a range of many materials that convey environmental lessons. Viable choices are increasing in number and cost effectiveness.

Trim: recycled wood, recycled EPS molding (Timbron), expanded polystyrene (AZEK) for high moisture mold-free trim.
Wood paneling for built-ins: Formaldehyde-free laminations (Sierra Pine) or prefabricated cabinet units (IKEA units are sealed and encapsulated on all surfaces and edges).
Counters: recycled materials, Bio-glass, Paperstone, etc.
Flooring: bamboo, linoleum (Marmoleum), tile, recycled rubber, recycled brick.
Shading systems (for large window areas): Enviro-shades, EcoSmart, etc.
Doors, hardware and trim: possibly sourced from salvaged materials.

D12 **Community environment/health promotion**

A portion of the entry and possible roof terrace access could be open to the public where interpretive and educational displays can present the green features and the health and environmental values of the building and spa operation. An alternative to public access to the roof terrace would be development of the outdoor street and sidewalk patio, with shade trellis, rain garden and seating.

Summary of green design features with short-term (0-5 year) payback (in approximate order of added cost)

- Water efficient plumbing.
- Increase roof insulation to reduce HVAC system requirements.
- Zoned HVAC designed for slow, quiet air circulation, cleaning with low supply, high return airflow (smoke-free facility).
- Energy-efficient lighting, designed for flexible controls and uses, and task and purpose.
- EMS system controls.
- Skylighting for natural lighting (to provide ambient light).
- Ceiling fans for slow-moving remix of air (heat diffusion in winter, cooling in summer).
- Green materials and finishes.
- Zoned HVAC for modular operation and zones with separate metering.
- Solar heated domestic hot water system.
- Small panel solar electric (photovoltaic) power (for fan ventilation and emergency power).

Other green design features

- Green roof terrace with rainwater collection.
- Rainwater harvesting and/or greywater recovery for landscaping.
- Opportunity may exist in site planning of the sidewalk to increase softscape landscaping and to utilize porous paving for some portion of the walk (gravel and/or grass pavers, rather than non-porous surfaces).

III 299 E. Commercial Street (Commercial Club Building)

The Commercial Club building is a 10,400 square foot, three-story historic structure that has served as a community club center dating from 1910. The property is owned and operated by the City of Springfield, currently housing a police substation and the offices of the Urban Districts Alliance and Commercial Club of Springfield. The Phase I and Phase II Environmental Site Assessments (ESA), funded by EPA, reveal that the site may have petroleum or petroleum-related contamination due to its proximity to a property that was previously used as a filling station. In addition, a portion of the site was also used for "gas tank" operations. A visual survey revealed potential asbestos containing materials (e.g., ceiling plaster, floor tiles). Soil and groundwater impacts appear to be concentrated within the central area of the site and beneath the building. The ESAs did not reveal concentrations above non-residential standards. (**Ref. 4**)

As a historic structure, the existing brick walls must be maintained on the exterior, which presents special concerns regarding moisture control, as noted below. In all other respects, green design options follow recommendations similar to those stated above, adapted in the case of the Commercial Club Building to accommodate the mix of uses. The mix includes office occupancy and various rooms for multipurpose public meetings (especially the third floor).

C1 **Insulation**

Exceeding code-compliance levels of insulation in the ceiling and exterior walls provides

cost-reduction options in HVAC equipment. The choices are determined by careful analysis of building loads, with "step down" and "cascading cost efficiencies" identified by energy design analysis (parametric analysis).

In the case of a historic structure like the Commercial Club Building, the brick exterior is part of the historic image and should be retained. In any other case, it is better to insulate on the outside of a masonry structure and to provide for a moisture barrier and rain shield on the exterior and to create a stable thermal mass on the interior.

Insulating the brick walls from the interior poses special concerns when designing a wall section to prevent moisture from condensing within the wall structure. All potential paths for thermal bridging (and moisture freeze/thaw cycling in isolated locations) have to be accounted for, to prevent mold, rust, and other moisture-related damage.

C2 **HVAC systems**
Green design goals for offices and public meeting spaces are best met by an overall air ventilation strategy from low supply to high return, so that airflow is upward. An underfloor plenum system for office areas may be advantageous for easy upgrades. The technical advances in heat pumps provide efficient heating and cooling for air systems. Rooms that require acoustical privacy will require both supply and return ducting, as well as attention to air passages that conduct sound (such as open walls above dropped ceilings, outlets, etc.). During winter operation (heating season), an Energy Recovery Ventilation (ERV) unit can recover heat from the exhaust air stream to preheat the fresh air supply.

C3 **Energy Management System (EMS) controls promote cost-effective operation.** EMS controls have proven to be a cost-effective approach to control heating, cooling, humidity, and lighting.

C4 **Green roof terrace**
At the site visit, the small roof terrace was discussed for possible "greening," by creating a garden roof terrace. The value of a green roof for insulation would be relatively modest compared to more cost-effective means of providing insulation layers within the roof construction. As a result, a green roof in this location is too small to make a significant contribution to the project. For an alternative with more visibility and energy and comfort benefit, see the following suggestions related to green walls and tree cells.

C5 **Greenscaping**
Greenscaping describes greenery that can improve energy-efficiency and reduce environmental impact while also contributing aesthetic value to the building and site infrastructure. **Appendix B** describes a number of these features. They include wall and Tree Cell landscaping of the Commercial Club and adjacent properties. With much of the site currently hardscaped, there is need and opportunity to add green landscaping and trees to the Commercial Club project and surrounding public ways.
A *green wall* could be a "public mural," essentially a planted trellis wall on the west façade of the Commercial Club building that will provide shading and evaporative cooling against the summer sun and reduce cooling loads on the interior (such as Elevated Plant Technologies, http://www.eltlivingwalls.com/).

Tree cells closely spaced in urban landscapes (such as DeepRoot Silva cells) permit trees to be placed within parking and or streetscape areas and to flourish with less watering. Rainwater recovery from both the Commercial Club roof and from wastewater from the

adjacent Day Spa could provide water sufficient for any green landscape maintenance. See **Appendix B** for further citations.

C6 **Green materials**

As part of the green message of the Commercial Street development, the interior finishes can demonstrate a range of many materials that convey an environmental lesson. The choices are increasing in number and cost effectiveness. Conceivably, these could be products and services offered by Commercial Street owners and businesses. Conversely, reuse of local salvaged doors, hardware and wood reinforces local history and adaptive use approaches.

C7 **Special program uses**

The building's upper floor is a generous and open space, ideal for community meeting as used currently. The entry wall space, circulation areas and the top floor room provide display space for temporary and changing exhibits and shows (photography, art, etc.). The building adaptive reuse could feature green approaches that would demonstrate possible local businesses, which could be supported by incubator advisory services from experts at MSU and other local organizations. Additional spaces and uses of the building include a tourist visitor center, community organization offices, offices for start-up businesses, and public exhibits. The convenience of its location will be greatly augmented with completion of the parking envisioned at the rear of the Commercial Street properties (former BN Railroad track). The building landscape can thus extend to the adjacent plaza that has a covered outdoor pavilion and footbridge.

C8 **Community environment/health promotion**

The historic character of the street and theme of railroading could be further highlighted, if possible, to retain some part of the existing railroad track. One section could provide for a relic display of a period railroad engine and car as an outdoor exhibit for a railroad museum housed nearby. (In other words, the museum does not have to be directly adjacent, but could be located within a few blocks. (For example, South Street Seaport in New York City is several blocks away from the waterfront piers where its historic ships are docked.)

Summary of green design features with short-term (0-5 year) payback (in approximate order of added cost)

- Increase roof and wall insulation to reduce HVAC system requirements.
- Energy-efficient lighting, designed for flexible controls and uses.
- EMS system controls.
- Ceiling fans for slow-moving remix of air (heat diffusion in winter, cooling in summer).
- Environmental materials and finishes.
- Zoned HVAC for modular operation and zones with separate metering.

Other green design features.

- Green wall as public art mural on west façade.
- Opportunity may exist in site planning of the front plaza and sidewalk to increase softscape landscaping and to utilize porous paving for some portion of the walk (gravel and/or grass pavers, rather than non-porous surfaces).

IV LEED certification and green design lessons learned

At the site visit, questions and comments were raised regarding whether the U.S. Green Building Council's LEED certification program would offer a framework for adaptive reuse of the three properties. There are added costs in applying for LEED certification. For small projects with limited budgets, these costs could be burdensome and unaffordable (some of the costs are the same whether for small or large projects). This section provides some background and perspective on these questions.

Adoption of sustainable design is gaining increasing acceptance. The practices of sustainable design have been communicated to design professionals and the public through a number of checklists and performance standards. Currently, the most widely known and accepted reference for evaluating sustainable design (green design) of buildings is the U.S. Green Building Council *LEED™ Checklist for New Construction* 2008 (**Ref. 5**). This reference is appropriate for building projects that are new or—as proposed for Commercial Street—requiring extensive reconstruction and retrofitting of exterior envelope and internal systems.

The LEED™ *Rating System* defines standards for energy and environmental performance of buildings and systems. To achieve a high rating requires careful attention and balancing of the architectural envelope, insulation, mechanical, electrical, and plumbing systems. LEED rating is required by the General Services Administration in new building construction and has been adopted in various forms by other federal and state governments.

A number of studies have analyzed the cost and performance of LEED certified projects. The studies have reported a range of estimates for added costs of LEED certification and construction. Recent studies indicate cost increments from 0% - 3%, while earlier reports estimated incremental costs from 8% to 11%.

The lower estimate for added costs in the 0% - 3% range are documented in reports from the U.S. Green Building Council Research Publications, accessible on the web (**Ref. 6**). The listing includes a recent compilation of costs in a report by Davis Langdon International, *Cost of Green Revisited* 2007 (**Ref. 7**). It summarizes survey results of several thousand green building projects and concludes:

> *There is no significant difference in average cost for green buildings compared to non-green buildings…Most notably, few [of current green] projects attempt to reach higher levels of energy reduction beyond what is required by local ordinances, or beyond what can be achieved with a minimum of cost impact.*

This finding also documents the importance of cost and performance-driven design by a committed design team. The most advantageous opportunities for cost control and reduction are identified early in the project process.

Gearing up to create green project goals for buildings and for larger community efforts does take time, effort and cost investments. When organizations and their design professionals first consider green design the task may appear daunting because it is new and involves a range of technical issues related to energy, health and environmental concerns. As a result, the perceived barriers to changing conventional practices of design and construction loom large and may be represented by higher design fees and by construction cost increases.

The process of filing through completion of the requirements to achieve LEED certification does involve added costs, directly attributable to the requirements of the certification and filing process (as distinct from added costs for green design features).

Understanding allocation of costs helps to determine whether it is worth completing the LEED certification or simply applying green design without obtaining official certification. The advantages of completing the full certification requirements are firstly, the recognition of achievement, and secondly and perhaps of equal value, the due diligence that the process requires to represent achievement of energy and environmental goals in documentation acceptable to third-party review. The disadvantage is that the costs could be invested in the project itself, provided that the funds are properly invested.

The Commercial Street Historic District has the opportunity to realize cost savings by hiring one LEED accredited professional to advise all three and possibly shepherd one or all projects through certification. A continuing consulting assignment is appropriate because the LEED process involves a wide range of technical requirements that need to be assessed at many points in the development of design and construction documents.

The higher range estimate of cost if LEED certification is applied for is in the range of an 8% to 11% increase of project costs. This range is reported in a 2003 study, "Analyzing the Cost of Obtaining LEED Certification" (**Ref. 8**). This report's data was limited by the smaller number of green buildings completed in 2003. Construction cost estimates were not fully documented, only "guesstimated," and as a result the report is now out of date. However, the report does document the design fees and related costs for applying for LEED certification.

In **Ref. 8**, LEED certification costs are listed for four separate budget lines, with increments to design fees (or "soft costs") indicated as follows:

	Mean	Range
Design costs	0.5%	0.4% - 0.6%
Energy modeling	0.1%	0.1%
Building commissioning	1.0%	0.5% - 1.5%
Documentation and application fees	0.7%	0.5% - 0.9%
Total soft cost increment (all above)	2.3%	1.5% - 3.1%

The above cost increments increase with the level of LEED certification that was achieved:

LEED certification (lowest point level)	1.8%
Silver	3.5%
Gold or higher	4.5%

The value of integrated design process

The LEED rating system requires an integrated design process. The term "integrated design" defines a design decision management protocol wherein all design, engineering and construction specializations are made part of an iterative, performance goal-oriented process from early program and schematic design through project delivery. In the process, the owner and design team develop integrated design concepts —building envelope, mechanical systems, lighting, controls, maintenance and operation along with constructability (contractor) expertise —using energy cost and performance comparisons (parametric analysis) to evaluate alternatives. Parametric analysis is represented in the **Ref. 8** tabulation as "energy modeling." Additional tests of performance are represented in "building commissioning."

In documented case studies, substantial efficiencies in construction and operation have been identified through such collaboration. Successful team integration is one of the "secrets" of reducing construction costs and improving the quality of outcomes (**Ref. 9**).

The value of defining explicit goals and objectives
Successful green design is not different from any value-driven design process that is targeted to achieve high standards. The LEED rating system provides benchmarks by which to evaluate (and encourage) design and construction goals that exceed "minimum code compliance." The performance goals become benchmarks of evaluation of schematic design choices and all subsequent reviews of design, including building commissioning.

Establishing the outcomes and measures as explicit project criteria streamlines decision-making towards accomplishment of project targets and avoids otherwise costly "rework" in cases when cost and performance goals are not achieved. **Ref. 7** makes this point by concluding that the key to successful green design is, "*the willingness of the project team to embrace the project's sustainable goals and make the necessary choices to achieve the result.*"

Energy and carbon footprinting costs – present and future
For the businesses proposed for the buildings considered in this report, the "bottom line" incentive to invest in energy-conserving green design has to be evaluated in terms of the monthly and annual cost reduction of energy and operation.

In Springfield, current energy and water costs are relatively low and may not yet be significant enough to change business or consumer decisions towards energy conservation. The low cost of electricity was mentioned during the site visits as reason that energy conservation measures face a "hard sell" in terms of cost-effective investment and near-term payback. If off-peak rates are offered, the architectural and HVAC decisions for time-of-day peak shaving, such as night-time cooling, are given an added financial incentive. Currently, the Springfield area enjoys relatively low electric power costs, produced by coal with some renewables reported (http://www.sourcewatch.org/index.php?title=City_Utilities_of_Springfield).

In addition, the municipal cost of water is reasonable, so that water conservation and reuse technologies are not in demand (http://www.allbusiness.com/energy-utilities/utilities-industry-water/6606402-1.html).

Green design decision-making has to look forward for the projected life cycle of investment and to anticipate future energy costs. This should include costs that may be imposed by carbon taxes or other measures to achieve clean coal and other environmentally responsible energy production measures.

Reduction of carbon footprint
Carbon footprint tracking presents, for many organizations and municipalities, an entirely new set of issues over and above the familiar terms of energy conservation. As a result of a pact agreed to at the 2008 United Nations Climate Change Conference in Bali, there is increasing attention on reducing greenhouse gas (GHG) emissions and the carbon footprint. In building and site operation maintenance, this translates to reduction and possible elimination of fossil fuel and other greenhouse gas emitting sources, including wood as a fuel.

At some point in future, carbon capping may impose additional costs on coal-based electric generation, sufficient to dictate energy cost increases and corresponding energy conservation

measures at a regional scale.

There are substantial efficiencies to be addressed in both energy conservation and carbon footprint production in all aspects of municipal and business operation. Major corporations and organizations are tracking greenhouse gas emissions. Many expect that they will be subject to "cap and trade" regulatory requirements within a half-decade. It is likely that GHG emission reporting and reduction will be required within a few years.

Three "scopes" of GHG emissions are generally reported. The first two are generally required by most reporting programs, while the third is optional.

Scope 1 - Emissions from company-owned or controlled equipment (e.g., power generation, boilers, furnaces, vehicles, emissions from physical or chemical processing).

Scope 2 - Emissions from the generation of purchased electricity (emissions from both transmission and distribution), gas and fuel in company operations.

Scope 3 - Indirect emissions, excluding those already included in Scope 2 (e.g., employee commuting / travel, leased assets, waste disposal). The variability of considerations in this scope is the reason that it is optional. Nevertheless, a good rationale for reporting on such activities is that this scope might identify "easy wins" from which to start emission reductions.

The peer consult workshop

A peer consult workshop process has proven valuable to assignments similar to the three adaptive reuse projects as well as new projects—especially those that have limited budgets and are not able to afford full LEED certification costs. The process is simply described:

1 Several project teams (from three to six projects typically) meet in a combined workshop setting. Each project is represented by the architect, engineer, consultants, and owner.

2 The teams bring their project documentation to the workshop. Ideally the project is early in the design phase (i.e., program, conceptual design or schematic design).

3 The workshop is facilitated with each project team working separately but assisted by a series of experts. The experts represent energy conservation, engineering, lighting, landscape architecture, interiors, and other specializations appropriate to the set of projects being reviewed. Each consultant spends up to 30 minutes with each team in a round-robin format.

4 After the first round of consultations (that is, each team has received a consult from each of the experts) a plenary reporting shares the discussions of each team, so that the entire range of assignments are reviewed in plenary.

5 The teams then work to further integrate the consultant recommendations, working individually or in teams, and then prepare for a final "show time" of how the consultant recommendations have been incorporated.

6 The projects are then evaluated by consultants and teams to "guesstimate" the order of improvement that might be realized by implementing the recommendations.

A peer consult process has been used for rapid implementation of new expertise into projects that are "on the boards." The process has been promoted by EPA, such as the 1996 Environmental

Design Charrette Program (**Ref. 10**). The State of Connecticut has tested the process and found that it achieves greater results with less investment than full LEED certification and is most appropriate for projects with limited budgets (under $5 million).

As a concluding recommendation, a peer consult process should prove invaluable for advancement of the Commercial Street projects and its wider constituency within the City of Springfield.

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Phase II Environmental Site Assessment, 233/299 E. Commercial Street. March 10, 2008

Ref. 4
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U.S. Green Building Council
LEED Rating System for New Construction

The LEED for New Construction Rating System is designed to guide and distinguish high-performance commercial and institutional projects. Qualifying projects include office buildings, high-rise residential buildings, government buildings, recreational facilities, manufacturing plants, and laboratories.

Because the projects proposed for Commercial Street involve nearly complete remodeling, that is, replacement of envelope and internal systems, they will be required by the local building authorities to meet existing code requirements. As such, they must meet LEED guidelines as "New Construction."

There are LEED guidelines for existing buildings that apply principally to operations and maintenance. The LEED for Existing Buildings Rating System helps building owners and operators measure operations, improvements and maintenance, with the goal of maximizing operational efficiency while minimizing environmental impacts. LEED for Existing Buildings addresses whole-building cleaning and maintenance issues (including chemical use), recycling programs, exterior maintenance programs, and systems upgrades. It can be applied both to existing buildings seeking LEED certification for the first time and to projects previously certified under LEED for New Construction, Schools, or Core & Shell.

As of January 1, 2006, all LEED for New Construction projects must register under the most current rating system: Version 2.2. The Rating System lists the intent, requirements, submittals, and technologies/strategies for each credit and includes the Credit Checklist. The following four-page summary provides a topic listing. For more information, see http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220.

See attached summary of LEED Checklist Version 2.2 (**Appendix C**).

APPENDIX A

Statement of Work
Commercial Street Historic District Brownfields Site-Specific Green Building Evaluations
Springfield, Missouri Sustainability Pilot Project

The following statement of work describes the tasks to be completed by Vita Nuova and Brownfield Redevelopment Solutions, Inc., under a subcontract with SRA International, an EPA contractor, to aid in the sustainable redevelopment of three buildings on brownfield sites in the Commercial Street Historic District in Springfield, Missouri. Vita Nuova will provide technical assistance to Springfield in designing appropriate remedies for cleaning and site preparation to facilitate sustainable reuse of the buildings. The work will focus on providing options and recommendations for the targeted properties.

Task 1: Review building renovation plans

Vita Nuova will confirm the priority sites with the City of Springfield and examine any available building documents and related project documentation for the targeted properties. The buildings are located at the following addresses: 505 W. Commercial St. (Microbrewery); 233 E. Commercial St. (Day Spa); and 299 E. Commercial St. (Commercial Club Building). The purpose of the review is to prepare to provide technical assistance to Springfield in designing cleanup and site preparation activities that will facilitate sustainable reuse of the brownfields properties.

Task 2: Conduct Site Visit

Vita Nuova and Brownfield Redevelopment Solutions will meet with local contacts at the site for a guided assessment and visual survey of each building within the context of the Commercial Street Historic District. Vita Nuova will meet with the building owners, the Springfield Brownfields Program staff, and any other appropriate parties requested by the building owners and Springfield officials, to assess relevant information. Vita Nuova will use this information to provide technical assistance to Springfield in designing sustainable cleanup and site preparation activities at the brownfields properties.

Deliverable (interim report): Outline of Recommendations

Based on Tasks 1 and 2, Vita Nuova and Brownfield Redevelopment Solutions will present an Outline of Recommendations to the client. The outline will focus on the critical cleanup and site preparation issues facing the redevelopment team and leading plan and action strategies.

Task 3: Analyze Options & Prepare Draft Report

Vita Nuova will evaluate cleanup and site preparation options including green design appropriate to renovate each of the three buildings, particularly as represented in nationally recognized programs such as LEED and Energy Star. Brownfield Redevelopment Solutions will review cleanup and site preparation options and conduct an analysis of the LEED certification levels attainable under each scenario. In addition, Brownfield Redevelopment Solutions will provide recommendations for options, which will enable the development to move to the next higher LEED certification level. Vita Nuova will compile the results of these analyses into a comprehensive report. The report will compare costs and benefits so that the renovation team can make informed decisions regarding cleanup and site preparation activities.

Task 4: Review Draft Report with Client

Vita Nuova and Brownfields Redevelopment Solutions will hold a conference call with the client and project partners to review the cleanup and site preparation options identified. The goal of this review will be for Vita Nuova and Brownfield Redevelopment Solutions to clarify specific details as necessary and gather input from the client that will aid in developing a Final Report.

Task 5: Develop Final Report

Based on the feedback gained in Task 4, Vita Nuova and Brownfield Redevelopment Solutions will prepare a Final Report that summarizes cleanup and site preparation options to promote sustainable redevelopment and makes specific recommendations for cleanup and site preparation strategies rated on cost/benefit, demonstration and replication. Brownfield Redevelopment Solutions will work with Vita Nuova to ensure that the final recommendations are consistent with the LEED certification requirements.

Deliverable: C-Street Historic District Brownfields Site Specific LEED Evaluations
The Final Report will address details of the cleanup and site preparation options of three buildings in the Commercial Street Historical District, including recommendations in support of cleanup and site preparation strategies addressing:

- Best practices for sustainable design: site and building scale, with reference to LEED and other state-of-the-art criteria and standards.
- Cost analysis of various options for green renovation.
- Identify best practices in building renovation and site planning from these site-specific evaluations.
- Develop fact sheet or other communication piece to highlight best practices.

Task 6: Community Workshop

Vita Nuova and Brownfield Redevelopment Solutions will share the results of the report in a workshop with key stakeholders including local officials and the owners of brownfields properties. This could be a half-day workshop or evening workshop to share lessons learned. Vita Nuova will send 2-3 experts in cleanup and site preparation activities including sustainable reuse and green building approaches.

DELIVERABLES DATES:

Documents sent to contractors for review:	As soon as practicable
Site visit:	TBD with EPA and Springfield
Outline Recommendations & Review:	Approximately 1 month from site visit
Draft Report:	Approximately 6 weeks from site visit
Workshop:	Upon completion of Draft report
Final Report	2 weeks after review comments received

APPENDIX B

Appendix B lists the features of sustainable infrastructure, with definitions and web-based resources. Each of the features may be considered in a comprehensive approach to sites and building integration.

Daylighting technologies

Daylighting can replace electric lighting for ambient lighting (general area lighting) and, in many cases, for task lighting. Daylight provides a higher quality of light for work areas, providing greater acuity for detailed work due to multiple directional lighting and reduced shadows. Research at Lawrence Berkeley Laboratory indicates that a combined ceiling aperture area in the range of 2% - 5% of total roof is sufficient in most climates to provide ambient area lighting. (See Fig. B15 *Solar Tracking Skylight* at end of this report.). Daylighting is energy efficient only when coordinated with controls of electric lighting. Photo-responsive controls or light sensors, energy-efficient CFC lighting controls zoning and switching should be designed to operate only when additional lighting is required.

Fig. B1 – http://www.solatube.com/

Fig. B2 – http://www.treehugger-gym.com/

Native planting

A cost-effective measure by which to reduce municipal costs and improve environmental benefits is to replace traditional lawn planting and maintenance with native planting. Native planting conserves water and eliminates the need for pesticides and chemical fertilizers. Native plants grow well together—they evolved growing along side one another—and to predictable sizes. They do not need watering (except during initial planting), nor do they require chemical fertilizers or any of the commercial biocides—herbicides, insecticides and fungicides. They are adapted to local conditions and resistant to local insects. In contrast, manicured lawns and bark-mulch beds (typical of commercial landscapes) rely upon synthetic chemicals, pesticides and fertilizers. Additional negative impacts of traditional landscape include noise and air pollution from lawn cutting, emitting exhaust fumes and air-borne chemicals. Mowers emit 10-12 times as much pollution as a typical auto, string trimmers 21 times and blowers 34 times. See: http://www.nps.gov/plants/.

Fig. B3 – Sullivan's milkweed: http://www.missourinativeplantsociety.org/image/plants

Fig. B4 – Aster novae-angliae: http://www.missourinativeplantsociety.org/image/plants

Alternatives to pesticide use in landscape maintenance: Part of watershed management is to reduce pollutants from stormwater surges, especially those that flood lawn and agricultural areas that carry fertilizers, chemical pesticides and other toxins into adjacent water bodies. Reducing and eliminating the source pollutants increases the effectiveness of native planting, riparian buffers and access to water for recreation. Extensive web-based resources include: http://www.epa.gov/pesticides/ and http://www.nrdc.org/health/pesticides/.

Alternatives to salt use for de-icing
The common practice of salting roadways for snow-ice melting creates significant harmful pollution of surface and ground water, with negative effects on the environment, human health and groundwater systems. Salt may attract deer, increasing accident hazard. The abrasives—sand, gravel, pumice—are acceptable but messy and degrade to dust, which can create low visibility conditions and make dry roads slippery. Studies by Vladimir Novotny, Northwestern University address these alternatives. See: http://www.epa.gov/owm/mtb/ice.pdf.

Urban treescape
Trees are indicators of a community's ecological health. When trees are large and healthy, the ecological systems that support them—soil, air and water—are also healthy. Healthy trees provide valuable environmental benefits. The greater the tree cover and the less the impervious surface, the more ecosystem services are produced: reducing stormwater runoff, increasing air and water quality, storing and sequestering atmospheric carbon, and reducing energy consumption due to direct shading of residential buildings. An ideal design strategy is to combine urban parking with porous paving water storage, which allows trees to have sufficient water without a large soil bulb. For discussion of benefits of urban trees, see http://www.walkable.org/assets/downloads/22%20Benefits%20of%20Urban%20Street%20Trees.pdf.

Structural soil cells
Structural soil cells are modular interlocking plastic frameworks placed around landscaped tree roots, originally developed by Dr. James Urban, landscape architect. The cells provide support for paving and contain soil and loose aggregate to store water for urban tree root systems. They are commonly used to create "Green Oasis" for parking and streetscapes. They permit closer spacing of trees and less soil while also directing stormwater to tree roots. There are a number of reference examples. See Fig. B16 *Tree cell construction detail*, http://www.toronto.ca/planning/pdf/james_urban.pdf and http://www.deeproot.com/pdfs/PNW_Trees_article.pdf.

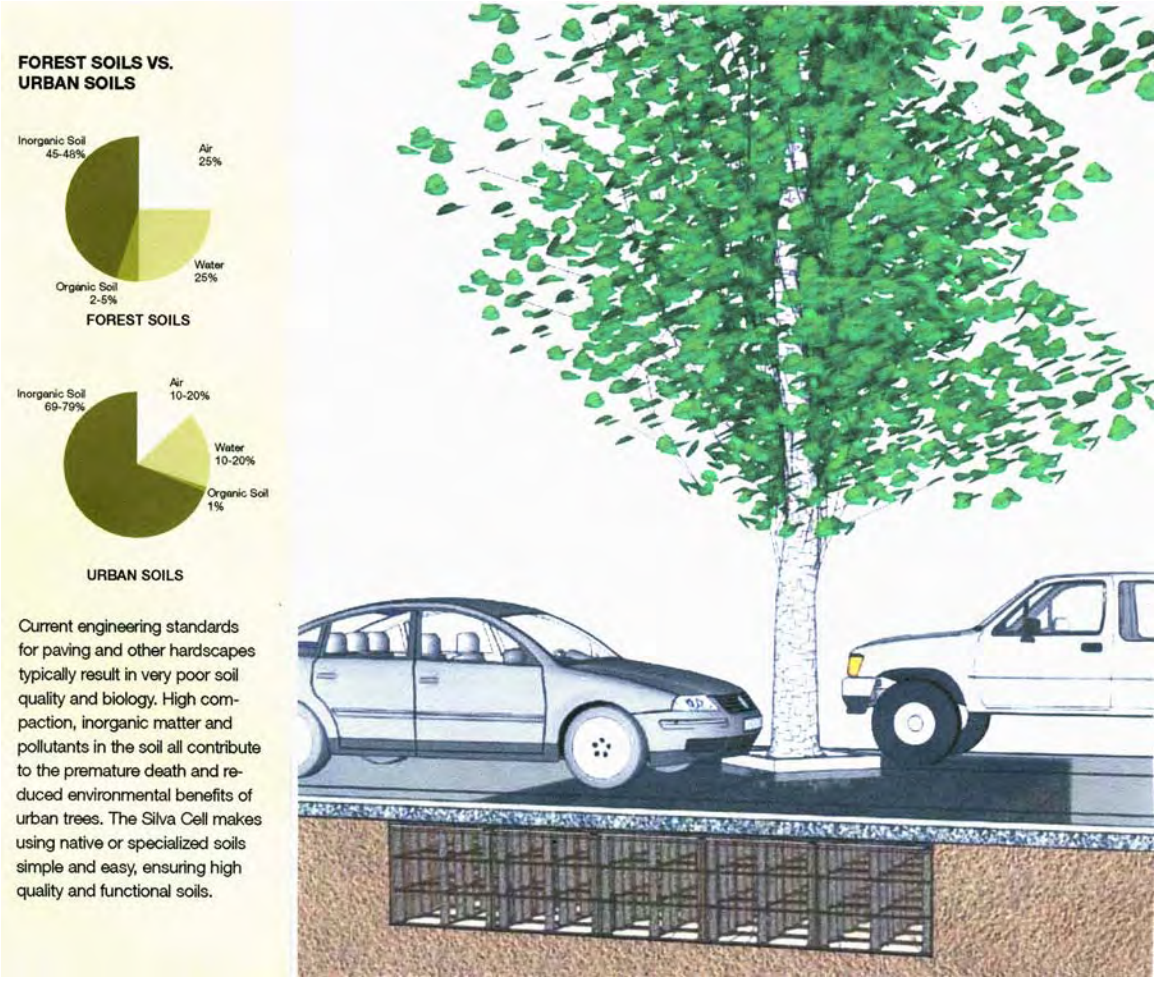

Fig. B5 – Silva Cells™

Fig. B6 – http://www.toronto.ca/planning/pdf/james_urban.pdf

Porous paving

Porous pavement allows rainwater to seep through the surface to a subsurface layer, where it may be absorbed into the ground or stored. This increases groundwater recharge, reduces pollutants in stormwater runoff, and helps to alleviate flooding and contamination to streams. Porous pavement is a permeable pavement surface with a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating into the subsoil. Porous pavement often appears the same as traditional asphalt or concrete but is manufactured without "fine" materials, and instead incorporates void spaces that allow for infiltration, ideal for low traffic, parking areas and walkways. In extremely dense urban areas, porous pavement has been used in redevelopment projects where it treats and stores stormwater without consuming extra land. Porous pavement can also be used on individual sites where a parking lot is being resurfaced. See: http://www.epa.gov/OWM/mtb/porouspa.pdf.

Fig. B7 – GrassPave™

Fig. B8 – http://www.treehugger.com/files/2006/07/porous_paving.php

Bioswales

A bioswale is a landscape swale designed as a water filter to remove silt and pollution from surface runoff water. It consists of a swaled drainage course with gently sloped sides (less than

six percent) and filled with vegetation, compost and / or riprap. It is typically planted with hardy grasses and moisture-tolerant plants and wildflowers. The water's flow path, winding within the wide and shallow ditch, is designed to maximize the time water spends in the swale, which aids the trapping of pollutants and silt. Plants act as biofilters, removing phosphorous, soil sediments and other pollutants. Several classes of water pollutants may be arrested with bioswales: silt, inorganic contaminants, organic chemicals, and pathogens. Water leaving a bioswale is cleaner than when it came in. See: http://www.ia.nrcs.usda.gov/news/brochures/bioswale.html.

Rain gardens

A variation of bioswale is a rain garden. A rain garden is a natural or shallow depression designed to capture and soak up stormwater runoff from roofs or other impervious areas around buildings and driveways, walkways, including compacted lawn areas. Rain gardens can be used as a buffer to wateredge buffers and shoreline areas to capture runoff from the landscape before it enters a lake, pond or river. The rain garden is planted with suitable trees, shrubs, flowers, and other plants, providing bird habitat and a natural filter so that runoff can soak into the ground and protect water quality. There are many websites on the topic. See, for example: http://www.dnr.wi.gov/org/water/wm/nps/rg/index.htm.

Fig. B9 – http://www.urbanwaterquality.org/

Fig. B10 – http://www.uvm.edu/raingardensrefs.php

Water art and play features

Water features can become an aesthetic, recreational and educational amenity, in addition to managing water flow from sky to ground. Puddles, spray bottles, garden sprinklers, water tables, and wading pools naturally fascinate young children. Water is one of the basic raw materials for learning mathematics and science, developing language, and fostering social skills. While playing with water is developmentally appropriate regardless of the child's age or abilities, family members and caregivers should always consider safety factors when children are anywhere near water.

Water for fountains, sculpture courts and elements of community landscape provide opportunity to reveal water as a living element. In most instances, such water can be recycled, provided that concerns of public health are addressed where water is touchable. Water is an effective means of climate conditioning. A spray fountain in a public space can reduce temperature to comfortable levels, such as a courtyard fountain. Water sprays are increasingly popular as an urban plan amenity. Similar uses of water can be used in interiors, such as atrium spaces.
See: National Association for the Education of Young Children, Washington, DC 20036-1426 and http://www.kidsource.com/kidsource/content4/water.play.learn.html.

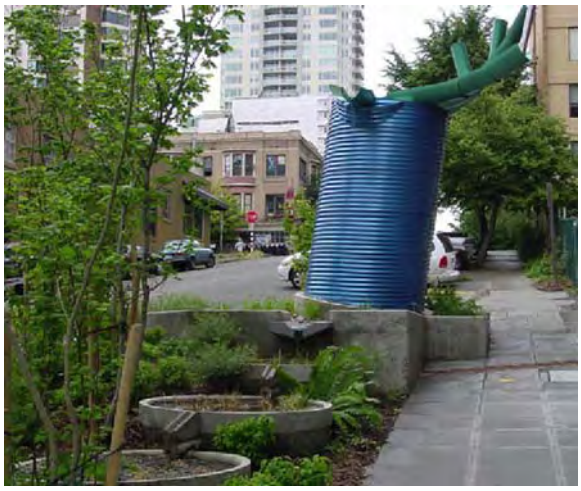

Fig. B11 – Buster Simpson, Landscape Conceptual Artist

Rainwater harvesting

Rainwater harvesting is the collection and storage of rain from roofs or from a surface catchment for future use. The water is generally stored in rainwater tanks or directed into mechanisms that recharge ground water. This is appropriate where there is enough rain for collection and conventional water resources either do not exist or are at risk of being overused to supply a large population. Rainwater harvesting can provide lifeline water for human consumption, reduce water bills and the need to build reservoirs, which may require the use of valuable land. Rainwater harvesting has been practiced in arid and semi-arid areas, and has provided drinking water, domestic water, water for livestock, water for small irrigation and a way to replenish ground water levels. Rainwater harvesting in urban areas adds means to collect supplemental water for landscape watering requirements, to increase soil moisture for greenery, to increase the ground water table through recharge, to mitigate urban flooding, and to improve the quality of groundwater. At a household level, harvested rainwater can be used for flushing toilets and

washing laundry. There are many web-based resources, such as: http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf.

Green roofs and walls

A *green roof* is a flat or sloped roof of a building that is partially or completely covered with vegetation and soil, or a growing medium, planted over a waterproof membrane. It may include additional layers, such as a root barrier and drainage and irrigation systems. Plant size and selection depend on the depth of the roof overburden (growing medium) and local climate, but the plants are almost always drought tolerant. Low growing plants such as grasses, sedums and other cactus-like plants are used where the depth is only a few inches. Where the depth is several feet, shrubs and even small trees can be used. Green roofs represent a significant niche market for horticulturists, especially propagators, who would supply plants for these roofs. For research at Penn State Green Roof Center, see http://horticulture.psu.edu/cms/greenroofcenter/.

A *green wall* provides planting on vertical surfaces, held several inches away from an adjoining structural wall, but offering shading and evaporative cooling of the adjacent structural wall. See http://www.egreenwalls.com/ and Elevated Plant Technologies, http://www.eltlivingwalls.com/.

Fig. B12 – Green Corner Wall

Fig. B13 – Green Wall

Greywater systems

Fresh water is a precious resource. Its uses should be restricted to potable water. Any water that has been used once, except water from toilets, is called greywater. It can be reused for many other purposes, especially landscape irrigation. Plants thrive on used water containing small bits of compost. Dish, shower, sink, and laundry water comprise 50 - 80% of residential "waste" water. The benefits of greywater recycling include:

- Lower fresh water use and related costs of supply.
- Less strain on septic tank or treatment plant capacity.
- Greywater treatment in topsoil is highly effective.
- Less energy and chemical use.
- Reclamation of otherwise wasted nutrients, helping to improve land fertility.

The Gray Water Policy Center provides guidelines for code-compliance of various systems (http://www.oasisdesign.net/graywater/law/index.htm).

In recent years, a number of products have been introduced to utilize water from sinks and laundry for secondary uses. For proper functioning, these either require or recommend use of biodegradable soaps and detergents in the cleaning products that are drained in the plumbing system.

Greywater use at public and municipal scale has been accepted in the International Plumbing Code (IPC). Most municipalities use this or the Universal Plumbing Code (UPC) as their standard. The IPC Code allows that water coming from bathtubs, showers, lavatories (sinks), and clothes washers is “greywater” that is no longer required to discharge into the sewer main. This greywater is now considered collectable for the use of flushing toilets, (and subsurface landscape irrigation) if the proper procedure is followed: one is required to have a sensible storage tank (at least 50 gallons) that won’t leak, connected with appropriate piping. In public installations, the code stipulates that the water must be disinfected, be stored no longer than 72 hours, and be dyed either blue or green with vegetable dye.

Fig. B14 – http://www.triplepundit.com/pages/inhouse-greywat.php

Water-saving fixtures

Water costs can be significantly reduced. Taking simple water-saving measures can save fresh water. About 70% of the total water used in the home and offices is for toilet flushing, laundry and baths. Water saving fixtures are standard options on such appliances, indicated by EPA Energy Star ratings. Water use can be cut as much as 90% in some cases. See: http://www.epa.gov/owow/nps/nps-conserve.html.

Sun-tracking skylights

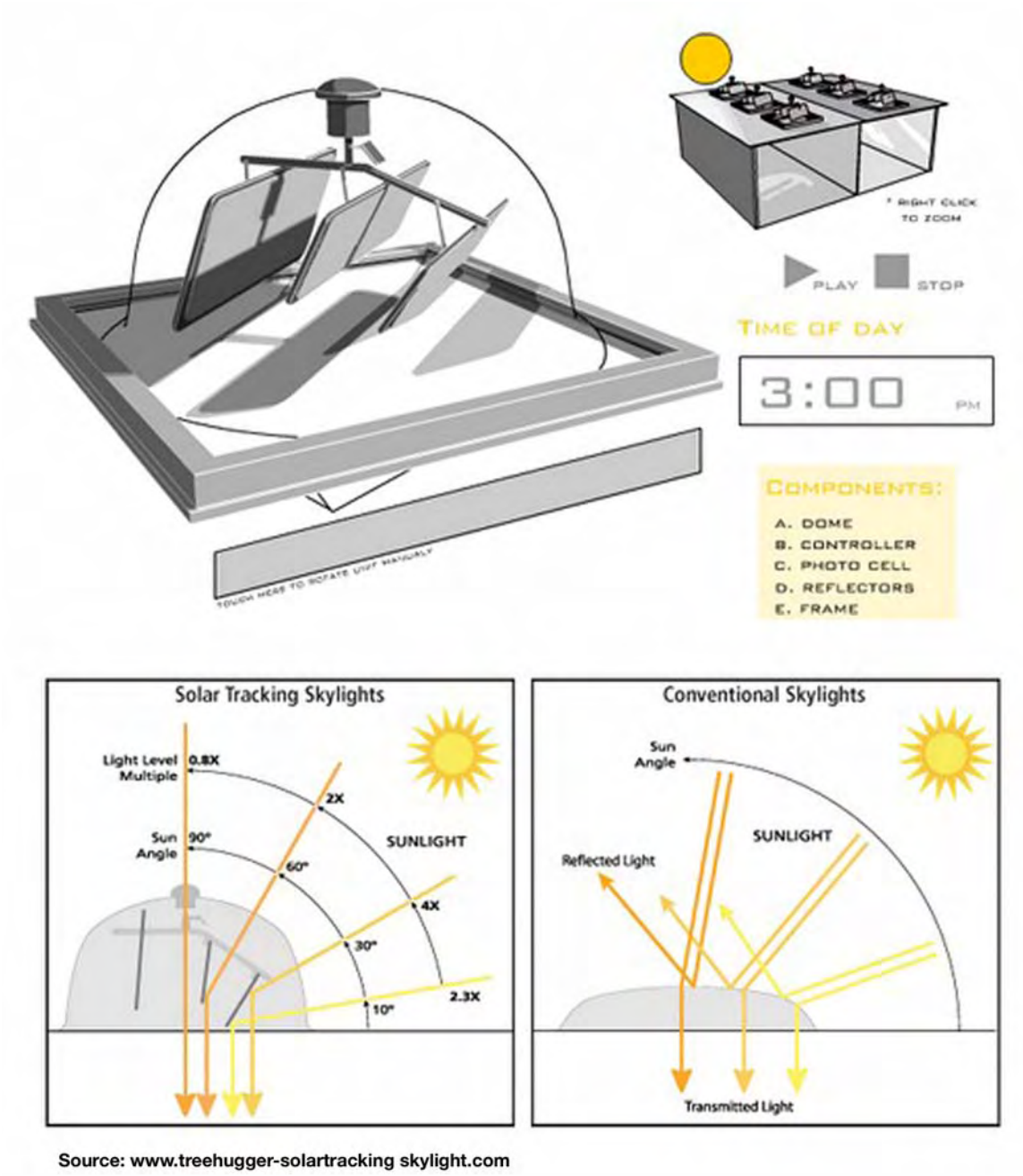

Fig. B15 – Sun-tracking skylight

Tree soil cell detail - Silva Cell

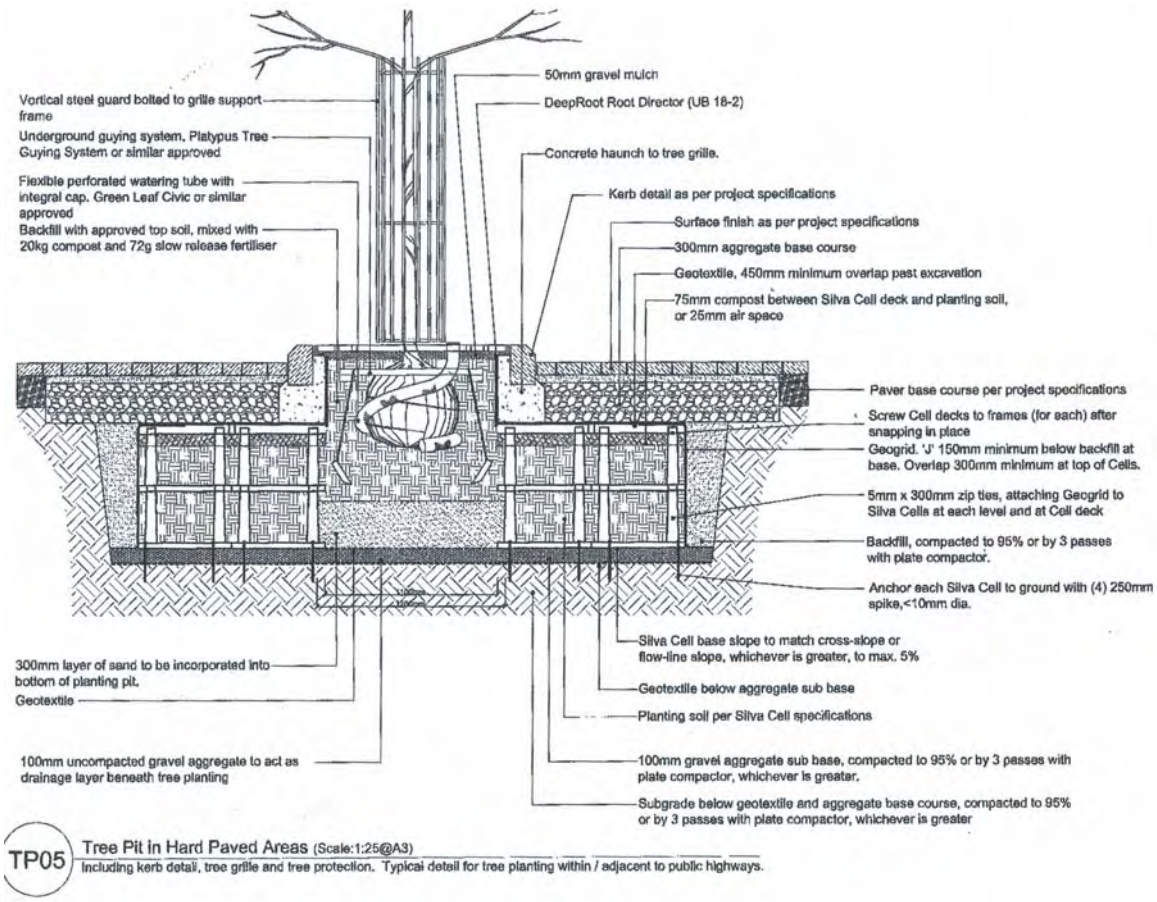

Fig. B16 – Cross section Silva Cell

APPENDIX C

LEED Checklist Version 2.2

LEED for New Construction v 2.2
Registered Project Checklist

Project Name: _____

Project Address: _____

Yes	?	No		
			Project Totals (Pre-Certification Estimates)	**69 Points**
			Certified: 26-32 points **Silver**: 33-38 points **Gold**: 39-51 points **Platinum**: 52-69 points	

Yes	?	No			
			Sustainable Sites		**14 Points**
Yes			Prereq 1	**Construction Activity Pollution Prevention**	Required
			Credit 1	**Site Selection**	1
			Credit 2	**Development Density & Community Connectivity**	1
			Credit 3	**Brownfield Redevelopment**	1
			Credit 4.1	**Alternative Transportation**, Public Transportation	1
			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
			Credit 4.3	**Alternative Transportation**, Low-Emitting & Fuel Efficient Vehicles	1
			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
			Credit 5.1	**Site Development**, Protect or Restore Habitat	1
			Credit 5.2	**Site Development**, Maximize Open Space	1
			Credit 6.1	**Stormwater Design**, Quantity Control	1
			Credit 6.2	**Stormwater Design**, Quality Control	1
			Credit 7.1	**Heat Island Effect**, Non-Roof	1
			Credit 7.2	**Heat Island Effect**, Roof	1
			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
			Water Efficiency		**5 Points**
			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
			Credit 2	**Innovative Wastewater Technologies**	1
			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

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LEED for New Construction v 2.2
Registered Project Checklist

Yes	?	No			
			Energy & Atmosphere		**17 Points**
Yes			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Yes			Prereq 1	**Minimum Energy Performance**	Required
Yes			Prereq 1	**Fundamental Refrigerant Management**	Required

***Note for EAc1:** All LEED for New Construction projects registered after June 26, 2007 are required to achieve at least two (2) points.

			Credit 1	**Optimize Energy Performance**	1 to 10
			Credit 1.1	10.5% New Buildings / 3.5% Existing Building Renovations	1
			Credit 1.2	14% New Buildings / 7% Existing Building Renovations	2
			Credit 1.3	17.5% New Buildings / 10.5% Existing Building Renovations	3
			Credit 1.4	21% New Buildings / 14% Existing Building Renovations	4
			Credit 1.5	24.5% New Buildings / 17.5% Existing Building Renovations	5
			Credit 1.6	28% New Buildings / 21% Existing Building Renovations	6
			Credit 1.7	31.5% New Buildings / 24.5% Existing Building Renovations	7
			Credit 1.8	35% New Buildings / 28% Existing Building Renovations	8
			Credit 1.9	38.5% New Buildings / 31.5% Existing Building Renovations	9
			Credit 1.10	42% New Buildings / 35% Existing Building Renovations	10
			Credit 2	**On-Site Renewable Energy**	1 to 3
			Credit 2.1	2.5% Renewable Energy	1
			Credit 2.2	7.5% Renewable Energy	2
			Credit 2.3	12.5% Renewable Energy	3
			Credit 3	**Enhanced Commissioning**	1
			Credit 4	**Enhanced Refrigerant Management**	1
			Credit 5	**Measurement & Verification**	1
			Credit 6	**Green Power**	1

LEED for New Construction v 2.2
Registered Project Checklist

Yes	?	No			
			Materials & Resources		**13 Points**
Yes			Prereq 1	**Storage & Collection of Recyclables**	Required
			Credit 1.1	**Building Reuse,** Maintain 75% of Existing Walls, Floors & Roof	1
			Credit 1.2	**Building Reuse,** Maintain 95% of Existing Walls, Floors & Roof	1
			Credit 1.3	**Building Reuse,** Maintain 50% of Interior Non-Structural Elements	1
			Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
			Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
			Credit 3.1	**Materials Reuse**, 5%	1
			Credit 3.2	**Materials Reuse**, 10%	1
			Credit 4.1	**Recycled Content**, 10% (post-consumer + 1/2 pre-consumer)	1
			Credit 4.2	**Recycled Content**, 20% (post-consumer + 1/2 pre-consumer)	1
			Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured	1
			Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured	1
			Credit 6	**Rapidly Renewable Materials**	1
			Credit 7	**Certified Wood**	1

Yes	?	No			
			Indoor Environmental Quality		**15 Points**
Yes			Prereq 1	**Minimum IAQ Performance**	Required
Yes			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
			Credit 1	**Outdoor Air Delivery Monitoring**	1
			Credit 2	**Increased Ventilation**	1
			Credit 3.1	**Construction IAQ Management Plan,** During Construction	1
			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
			Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
			Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
			Credit 6.1	**Controllability of Systems**, Lighting	1
			Credit 6.2	**Controllability of Systems**, Thermal Comfort	1
			Credit 7.1	**Thermal Comfort,** Design	1
			Credit 7.2	**Thermal Comfort,** Verification	1
			Credit 8.1	**Daylight & Views,** Daylight 75% of Spaces	1
			Credit 8.2	**Daylight & Views,** Views for 90% of Spaces	1

LEED for New Construction v 2.2
Registered Project Checklist

Yes	?	No			
			Innovation & Design Process		5 Points
			Credit 1.1	**Innovation in Design:** Provide Specific Title	1
			Credit 1.2	**Innovation in Design:** Provide Specific Title	1
			Credit 1.3	**Innovation in Design:** Provide Specific Title	1
			Credit 1.4	**Innovation in Design:** Provide Specific Title	1
			Credit 2	**LEED® Accredited Professional**	1