LEED™ Implementation Guide for Municipal Green Buildings
LEED™ Implementation Guide for MUNICIPAL GREEN BUILDINGS

Developed by:

PAUL KERNAN ARCHITECT INC.
INTEGRAL DESIGN / ENGINEERING

In association with:

The Sheltair Group Resource Consultants

Under contract to:

Greater Vancouver Regional District
Policy & Planning Department

1st Edition December 2002

This guide has been developed by Paul Kernan Architect Inc., and Integral Design / Engineering, under contract to the Greater Vancouver Regional District (GVRD).

The assistance many municipal officials who participated in a preliminary workshop is gratefully acknowledged, as is the help of the following architectural practices who provided information and photographs and images for the final document.


For more information please call GVRD at 604 436 6818 or e-mail: Thomas.Mueller@gvrd.bc.ca

© Copyright. This document is the intellectual property of the Greater Vancouver Regional District (GVRD), Policy & Planning Department. Distribution without the express written consent of the GVRD is strictly prohibited.
# TABLE OF CONTENTS

## SECTION 1 Green Buildings and Sustainable Design

1.1 Green Buildings .................................................. 1  
1.2 The LEED™ Green Building Rating System ................. 2  
1.3 Role of Municipalities in Green Building .................. 8  

## SECTION 2 Greening Municipal Buildings

2.1 Civic Halls and Municipal Office Buildings ................. 12 
2.2 Works Yards and Facilities Buildings ....................... 19 
2.3 Libraries ................................................................... 22 
2.4 Parks and Field Buildings ........................................ 25 
2.5 Recreation and Sports Centres ................................. 29 
2.6 Green Building Costs and Benefits ......................... 34 
2.7 Design and Construction Considerations .................. 39 

## SECTION 3 Green Building Development, Design & Construction Process

3.1 Overview .................................................................... 45 
3.2 Uses of LEED .......................................................... 46 
3.3 Planning for Green Building Projects ....................... 49 
3.4 Site Selection and Preparation ................................. 55 
3.5 Integrated Design Process ....................................... 56 
3.6 Construction Process ............................................... 64 
3.7 Commissioning and Post Occupancy Evaluation .......... 66 

## SECTION 4 Case Studies

4.1 Vancouver Island Technology Park ............................ 68 
4.2 City of Vancouver Engineering Works Yard .............. 71 
4.3 City of White Rock operations Building .................... 73 
4.4 Liu Centre for the Study of Global Issues ................. 75 

## SECTION 5 Resources

5.1 Sustainable Sites .................................................... 78 
5.2 Water Efficiency ..................................................... 82 
5.3 Energy and Atmosphere .......................................... 84 
5.4 Materials and Resources ......................................... 91 
5.5 Indoor Environmental Quality ................................. 96
The range of environmental pressures the planet faces are familiar to most people, and have resulted in a widespread acceptance of the need to change many aspects of current practices in order to reduce our impacts on the natural environment. What is sometimes not always perfectly understood is the precise nature of the relationship between particular activities and environmental impacts.

Buildings, through the energy and resources they consume over their lifecycle (design, construction, operation and demolition) are closely related to many of the most significant negative environmental impacts at local, regional and global scales. Buildings within the GVRD are responsible for 32% of solid waste generated, and are the second largest source of greenhouse gas emissions (28%). Commercial and institutional buildings are among the highest users of water in Greater Vancouver.

Buildings also have significant economic and social impacts. Nationally the construction industry contributes almost 10% to gross domestic product and employs almost 600,000 people. Building also provide the setting for the vast majority of our economic, and social activities; we spend almost 90% of our time indoors. There is increasing awareness within the field of green design that the success of green buildings will increasingly be measured against economic and social parameters. Triple Bottom Line reporting (TBL) which seeks to achieve, economic prosperity by accounting for those environmental and social impacts and benefits outside conventional economic considerations, is becoming a key concept in green building design and sustainable development.

1.1 GREEN BUILDINGS

Over the last 10 years the concept of green buildings has become an important, though still small part of conventional building design and construction. There have been a number of well-publicized local examples of buildings that seek to reduce environmental impacts by reducing energy consumption, conserving materials and resources, and creating healthy environments for building occupants.

The success of these buildings both in terms of environmental performance, and more conventional evaluation criteria has demonstrated the benefits of green design. They have also shown that there need be no fundamental contradiction in designing buildings that address environmental issues in an economically sound and socially beneficial way.
manner. There is increasing evidence that many of the features of green buildings that specifically aim to enhance environmental performance will also result in economic benefits such as reduced operating costs and enhanced marketability. In addition green design features that improve indoor environmental quality will in many cases increase worker productivity, reduce absenteeism, and limit potential liability resulting from the unhealthy indoor environments often found in more conventional buildings. Many green buildings are being designed and constructed for owners who want to take advantage of these economic and social benefits.

The City of Vancouver’s Materials Testing Lab. and Richmond City Hall are two examples of an increasing body of local work with a green focus.

1.2 THE LEED BUILDING RATING SYSTEM

With increasing numbers of green buildings, a need has arisen for frameworks to guide design as well as a consistent method of evaluating and comparing performance. A number of alternative methods and tools have been developed for this purpose. The Leadership in Energy and Environmental Design (LEED™) Building Rating System appears to be the system of choice in North America generally, and within the local BC design and development community. The majority of larger green buildings currently in development are using LEED directly, or as an informal framework.

LEED is a self-assessment tool designed to help design teams and owners identify green design strategies, measure and monitor progress,
and document achievement. Originally developed by the US Green Building Council, the system is currently being adapted for use in BC. LEED BC is based on LEED 2.1; the primary difference being the replacement of referenced US standards, with equivalent or better BC or Canadian standards. A LEED BC Adaptation Guide is being developed by a partnership of the GVRD, City of Vancouver, Ministry of Competition, Science & Enterprise, BC Buildings Corporation, BC Gas, and BC Hydro. A national version of LEED (LEED Canada) is also currently being developed under the leadership of the Sustainable Building Canada Committee. A Canadian Green Building Council is being established and is expected to be operational in 2003.

The rating system identifies five sustainable design categories, and a design process and innovation category. The system allocates credits for application of particular green design strategies, and achievement of specified levels of performance.

**Sustainable Sites**

This section deals with site selection, characteristics, and development. Credits are obtained by avoiding particularly sensitive sites, by locating development in higher density urban areas, by remediating previously developed sites, managing stormwater and facilitating alternative means of transport. Selection of urban and brownfield sites, and control of stormwater will reduce requirements for new infrastructure. Credits promoting the use of public transit, and encouraging alternative means of transportation are consistent with Greater Vancouver’s urban growth strategy and GHG (greenhouse gas) reduction goals.

<table>
<thead>
<tr>
<th>SS Design Category</th>
<th>Points</th>
<th>Percentage of total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Sites</td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>• Site Selection</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Urban Redevelopment</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Brownfield Redevelopment</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Alternative Transportation</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>• Reduced Site Disturbance</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Stormwater Management</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Reduce Urban Heat Islands</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Light Pollution Reduction</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Water Efficiency**

This section primarily deals with reduction in water use for irrigation, and water use within buildings. Credits are achieved for specific reductions in use below a baseline performance that specifies minimum consumption levels for particular plumbing fixtures. Credit 2, for innovative wastewater technologies, is more difficult to achieve due to public health concerns.
Section 1

Green Buildings and Sustainable Development

<table>
<thead>
<tr>
<th>WE Design Category</th>
<th>Points</th>
<th>Percentage of total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Efficiency</td>
<td></td>
<td>7%</td>
</tr>
<tr>
<td>• Water Efficient landscaping</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Innovative Wastewater Technology</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Water Use Reduction</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Energy and Atmosphere

Energy use in buildings is a key contributor to the greenhouse gases that are the primary cause of global warming and associated climate change. Currently 28% of greenhouse gas emissions in the Lower Mainland come from building operations. The Energy & Atmosphere section deals with operating energy, the energy required to heat, cool and light buildings. Points are awarded for strategies that achieve specific reductions in operating energy compared to a minimum base performance level. Additional points are achieved for on-site generation of building energy, renewable sources of energy, improved commissioning, measurement and verification practices, and elimination of ozone depleting substances (HCFCs, Halons).

<table>
<thead>
<tr>
<th>EA Design Category</th>
<th>Points</th>
<th>Percentage of total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy &amp; Atmosphere</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>• Optimize Energy Performance</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>• Renewable Energy</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>• Additional Commissioning</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Ozone Depletion</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Measurement and Verification</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Green Power</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Materials and Resources

Worldwide almost 40% of our natural resources are used to construct buildings. The intent of this section is to promote the use of materials that have fewer environmental impacts and to encourage construction and demolition waste management strategies. Credits are obtained by selecting materials with recycled content, salvaged materials, rapidly renewable materials, and locally produced materials and components. This section deals with many issues that impact directly on local areas of concern.

<table>
<thead>
<tr>
<th>MR Design Category</th>
<th>Points</th>
<th>Percentage of total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials &amp; Resources</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>• Building Reuse</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>• Construction Waste Management</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Resource Reuse (Salvaged materials)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Recycled Content</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Local / Regional Materials</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Rapidly Renewable Materials</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Certified Wood</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Indoor Environmental Quality (IEQ)

This section promotes strategies that result in healthy indoor environments. As people spend increasing amounts of time indoors, the nature of the materials and finishes, and heating and ventilation systems used in buildings becomes a key determinant of human health and well-being. Issues addressed include thermal comfort, effective ventilation, use of low emission materials and finishes.

<table>
<thead>
<tr>
<th>IEQ Design Category</th>
<th>Points</th>
<th>Percentage of total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Environmental Quality</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td>• CO2 Monitoring</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Increased ventilation effectiveness</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Construction IAQ Management Plan</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Low-Emitting Materials</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>• Indoor Chemical &amp; Pollutant Control</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>• Controllability of Systems</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Thermal Comfort</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>• Daylight and Views</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Innovation in Design

Innovation in design, the final LEED category is intended to award exceptional performance above the requirements specified in other categories or in areas not specifically addressed by LEED.

Summary of LEED Categories and Associated Points

<table>
<thead>
<tr>
<th>Design Category</th>
<th>Points</th>
<th>Percentage of total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Sites</td>
<td>14</td>
<td>20%</td>
</tr>
<tr>
<td>Water Efficiency</td>
<td>5</td>
<td>7%</td>
</tr>
<tr>
<td>Energy &amp; Atmosphere</td>
<td>17</td>
<td>25%</td>
</tr>
<tr>
<td>Materials &amp; Resources</td>
<td>13</td>
<td>19%</td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>15</td>
<td>22%</td>
</tr>
<tr>
<td>Innovation in Design</td>
<td>4</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Total Points</strong></td>
<td><strong>69</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Points associated with particular credits are totaled to determine an overall performance level and designation for the building. An additional point is awarded if the design team includes a LEED™ accredited professional. LEED identifies 4 levels of certification: Platinum, Gold, Silver and LEED™ Certified. Certification levels and corresponding points requirements are summarized below.

**LEED™ Certification Levels and Required Points**

<table>
<thead>
<tr>
<th>Certification Level</th>
<th>Points required out of 69</th>
<th>Percentage of total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certified</td>
<td>26 – 32</td>
<td>38 – 46%</td>
</tr>
<tr>
<td>Silver</td>
<td>33 – 38</td>
<td>48% – 55%</td>
</tr>
<tr>
<td>Gold</td>
<td>39 – 51</td>
<td>57 – 74%</td>
</tr>
<tr>
<td>Platinum</td>
<td>52+</td>
<td>75%+</td>
</tr>
</tbody>
</table>

Appropriate certification levels for different types of municipal buildings will be discussed in later sections. At the higher LEED certification levels, Gold and Platinum, the number of points needed will require significant improvement in all LEED design categories. At lower levels however, for example Silver and Certified, there is more potential for strategically selecting particular credits and omitting others. These decisions will determine the environmental performance profile of the resulting building. The graphs below illustrate two theoretical buildings that achieve the same LEED rating (Silver) but which acquire the required points in different categories and as a result have different environmental profiles.
The graph opposite indicates points achieved in each LEED design category. The resulting building is highly energy efficient and addresses indoor air quality issues. However no significant progress is made in improving water efficiency or resource use.

The second graph illustrates a building that also achieves a LEED silver rating, but with a different environmental profile and performance characteristics. Here there is no improvement in energy efficiency compared to a conventional building and also no improvement in IEQ.

In addition to providing a basis for independent assessment and certification of green building performance, LEED also provides a wealth of technical information on green building strategies, and a framework for integrating these strategies into the design and construction process. Although it is desirable to achieve a LEED rating and certification since it provides a clear benchmark of building performance, it is possible to use this information and framework without seeking certification for the completed building.

Application of the LEED system, documentation requirements, etc. is discussed in more detail in section 3. Additional information and documentation on the LEED system is available from the US Green Building Council, at www.usgbc.org.
1.3 ROLE OF MUNICIPALITIES IN GREEN BUILDING

Municipalities are significant owners of buildings, with portfolios that include a range of building types. Within the GVRD municipal buildings such as civic halls, libraries, firehalls and recreation centres represent over 1.6 million square metres of floor area accounting for 5% of total non-residential building stock.

While municipal buildings will have some unique characteristics, fundamentally they are no different from other public or private sector buildings in terms of environmental impacts. However, as building owners, municipalities may have particular unique opportunities to implement green building strategies, and may be well placed to reap the benefits.

Long-term Building Ownership

A common problem in implementing many green design strategies in private sector buildings is the lack of a direct connection between the design and construction of the building and its operation. Developers often have no on-going involvement or interest in the buildings they construct. There are strong economic pressures to minimize capital costs regardless of the impact this will have on longer-term operation costs. Strategies that will reduce operating costs over the service life of the building are often not incorporated if there is any increase in initial construction cost.

In contrast as long-term building owners with an on-going involvement in their buildings, municipalities are well positioned to reap the benefits of operational savings resulting from green design strategies. There is extensive evidence to suggest that significant operational cost savings can be achieved through the application of strategies that result in, at most, modest increases in capital cost. Taking this longer-term approach represents sound fiscal management and responsibility to taxpayers.

Local Environmental Stewardship

Municipalities as government organizations play a key role in addressing many local environmental issues. Both at the municipal level and through the GVRD, municipalities promote environmental initiatives that encourage greenhouse gas emission reduction, improved air quality, water conservation, waste reduction and recycling, and alternatives to single occupant vehicle use. Being seen to incorporate strategies which promote environmental goals in municipal buildings will make acceptance of these strategies by the community much easier.

Employee Well-being

As major employers, with large unionized workforces, municipalities have additional incentives to introduce green design strategies that will improve the quality of the working environment. Strategies that deal with indoor air quality issues, use of natural ventilation, selection of materials with low-off gassing potential, access to daylighting and views, and control of thermal...
comfort, have been shown to mitigate many of the health related problems common in large institutional buildings. A comfortable and healthy environment can result in improved labour relations, and direct benefits in terms reduced sick time and improved productivity.

**Demonstration Projects**

Green municipal buildings can be used as demonstration projects to promote adoption of green design strategies by the private sector development community. This is the first step in achieving a wider acceptance of green buildings as a cost effective demand side management approach to minimizing demand on local and regional infrastructure.
Municipal buildings cover a wide, but well-defined range of types. Buildings vary considerably in terms of size, location, and construction budgets, ranging from small parks buildings to large civic hall complexes. However each generic type has specific characteristics that will in many cases determine the most appropriate and effective green building strategies. For the purposes of this report 5 characteristic municipal building types were selected for analysis.
Establishing Green Design Priorities for Municipal Buildings

Identifying the most appropriate green design strategies for municipal buildings is a difficult process. It is necessary to strike a balance between environmental, economic and community considerations. Ultimately decisions will be made by each municipality based on its particular and often unique circumstances, and priorities and on the particular characteristics of the building in question. The table below provides a summary of the priorities identified by a group of municipal managers for specific building types.

Green Building Priorities for Municipal Buildings

<table>
<thead>
<tr>
<th>LEED Categories</th>
<th>Civic Hall</th>
<th>Rec. Centre</th>
<th>Library</th>
<th>Fire Hall</th>
<th>Works Building</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sustainable Sites</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site Selection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Redevelopment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brownfield Redevelopment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative Transportation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced Site Disturbance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stormwater Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce Urban Heat Islands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Pollution Reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water Efficiency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Efficient landscaping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovative Wastewater Technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Use Reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy &amp; Atmosphere</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimize Energy Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renewable Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Commissioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement and Verification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Materials &amp; Resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Reuse</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Waste Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource Reuse (Salvaged materials)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Content</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local/Regional Materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapidly Renewable Materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certified Wood</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Indoor Environmental Quality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2 Monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased ventilation effectiveness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction IAQ Management Plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-Emitting Materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indoor Chemical &amp; Pollutant Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controllability of Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal Comfort</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daylight and Views</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Priority:
- Low Priority
- Medium Priority
- High Priority
- Essential
2.1 CIVIC HALLS AND MUNICIPAL OFFICE BUILDINGS

As major public buildings, civic halls offer some of the best opportunities to implement green design strategies. Projects are typically of a significant size, construction budgets are relatively generous, and the level of design input is generally high. Projects with these characteristics offer the greatest potential for achieving higher, Gold and Platinum LEED ratings. As showcase buildings with a high public profile, civic halls also provide an opportunity to express municipal values with respect to sustainable design.

Civic halls typically contain municipal planning and building departments and provide an important point of contact with the local development community. These departments, through building and zoning by-laws, often play a key role in introducing new ideas and practices to the construction industry. Developers, architects, engineers and contractors are frequent visitors to civic halls and the benefits of showcasing sustainable design practices should not be underestimated.
Site Design

The nature of typical civic hall site locations will make it relatively easy in many cases to achieve certain LEED points in the Sustainable Sites category. For example SS 1 is awarded for avoidance of inappropriate greenfield development sites such as agricultural land reserve (ALR) or forest reserve land. Typically civic halls will be located close to the urban centre of the areas they serve. As such, points for urban redevelopment will be acquired without great effort, as will points in the alternative transportation category for proximity to public transit routes (SS 4.1).

Prestigious buildings such as Civic Halls will typically have well developed sites, and will generally have more significant budgets for landscaping and site development than other municipal building types. If located in urban areas they will often have civic plazas, or other hard landscaped areas. In more suburban locations there may be extensive landscaped areas. Both types of sites have potential for green design strategies. In urban areas efforts can be made to reduce the extent of impervious surfaces and to provide shading. It may also be possible to use water features as detention ponds in a stormwater flow reduction strategy. With larger suburban sites there will be greater opportunity for stormwater management and treatment (SS 6.1 and 6.2).

The LEED point for light pollution reduction (SS 8) is achieved by controlling exterior and interior lighting to ensure that no direct light leaves the site. The reference standard for this credit, IESNA Recommended
Practice Manual: Lighting for Exterior Environments, recognizes different maximum brightness levels depending on the location of the site. Higher ambient brightness levels are permitted in urban areas. As is the case with all strategies that reduce lighting levels there is also potential to reduce operating costs.

**Water Efficiency**

Water consumption in office buildings is generally low, and primarily results from washroom use. Reductions in building water use (WE 3.1 and 3.2) are easily achieved through the use of ultra-low flow, or dual-flush, toilets, waterless urinals and low-flow faucets. Some low-flow fixtures, such as waterless urinals, are currently slightly more expensive than comparable conventional fixtures. However, institutional and commercial building budgets tend to support the use of higher quality plumbing fixtures and ultra low consumption fixtures may be possible within typical construction budgets.

Civic buildings may also contain facilities such as cafeterias that often result in higher water consumption. (Water consumption for food services can range from 20 to 100 litres per meal served.) In addition where large volumes of hot water are used, for example for dishwashing, there are significant opportunities to save costs by reducing water heating energy costs.

The most significant water use in civic hall buildings, however, is likely for outdoor irrigation, particularly if there are extensive landscaped areas. LEED points are achieved if out-door water use is reduced, one point for a 50% reduction and 2 for 100% reduction in irrigation water use (WE 1.1 and 1.2). Key strategies to achieve these reductions include the use of xeriscape (dry landscape) designs using native plant species, and possible collection and storage of rainwater for irrigation and omission of an irrigation system.

Reducing irrigation water use is a key regional priority, and municipalities play a role in enforcing sprinkler regulations and in encouraging alternative approaches to landscape design. Xeriscape designs in highly visible locations such as civic halls can function as demonstration projects for the public, and can also offer municipal staff an opportunity to become familiar with the practices and techniques involved. In addition, there will be cost saving from not having to install, operate and maintain an irrigation system.

**Energy and Atmosphere**

Municipal halls are essentially office buildings although they typically also contain various assembly spaces and public areas. Energy use intensity is typically in the mid range (1.57GJ/m²), with energy for heating, lighting and plug loads being the largest components.
Comparison of energy use by building type

<table>
<thead>
<tr>
<th>Building Type</th>
<th>energy use (GJ/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare</td>
<td>3.0</td>
</tr>
<tr>
<td>Hotel / Restaurant</td>
<td>2.7</td>
</tr>
<tr>
<td>Retail</td>
<td>1.8</td>
</tr>
<tr>
<td>Recreation</td>
<td>1.5</td>
</tr>
<tr>
<td>Schools</td>
<td>1.4</td>
</tr>
<tr>
<td>Offices</td>
<td>1.4</td>
</tr>
<tr>
<td>Warehouse</td>
<td>1.3</td>
</tr>
<tr>
<td>Residential</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Source: National Resources Canada End-Use Energy Data handbook 1990 - 2000

Energy Use in Typical Office Building

Source: CBIP Technical Manual, Appendix D

There is a wide range of well-established strategies to reduce operating energy use in buildings. The success of these strategies has been extensively documented. In order to achieve the greatest level of improvement in a cost-effective manner it is important to tailor the strategies to the particular energy consumption characteristics of the building in question. LEED relies extensively on the ASHRAE 90.1 standard in establishing requirements for energy efficiency, and identifies 3 principles to be applied in reducing operating energy consumption:
Reduce Demand
This principal seeks to reduce internal energy requirements by improving the performance of the building envelope, minimizing energy requirements and by reducing internal loads. Applicable strategies include:

- Increasing building envelope thermal performance by increasing insulation levels, selecting appropriate glazing, minimizing air leakage etc.
- Use of occupancy sensors to automatically control building equipment operation and turn off services when not required.
- Appropriate design of lighting layouts and illumination levels

Harvest Site Energy
Strategies in this category are based on utilizing the particular characteristics of the building site to maximize the benefits of daylighting, optimize natural ventilation and passive solar heating opportunities. Strategies include:

- Daylighting strategies that will permit reductions in lighting energy use
- Appropriate building orientation to benefit from passive solar gain
- Building design and window location to benefit from natural ventilation

Maximize Efficiency
Strategies in this category seek to maximize the energy consumption efficiency of mechanical and electrical equipment.

- Appropriate selection of mechanical and electrical equipment, and design of distribution systems.
- Use of energy-efficient lighting

Materials and Resources
In almost all cases civic halls and office buildings are likely to be of non-combustible construction. Typically buildings of this type, in the Lower Mainland, have a concrete structural frame, although steel may also be used. With both of these materials there are opportunities of achieve LEED points for recycled material content (MR 4). Structural steel has a high-recycled content, and the use of fly ash, as a supplementary cementitious material in concrete is also considered recycled content for the purposes of this credit. (www.ecosmart.ca)

There may be opportunities for some salvaged materials use, particularly if heavy timbers or glulams can be used as structural members, however code requirements for non-combustible construction may limit the use of such material to a point where LEED points (MR 3.1 or 3.2, for 5% and 10% reuse respectively) cannot realistically be achieved.

The GVRD’s Guide to construction recycling provides practical guidance to setting up job-site waste management programs. (MR 2)
Large assembly spaces, such as council rooms often have wide column free spans requiring the use of large structural members. Components such as large steel or engineered wood beams have the potential for future reuse, and should be installed in a manner that will permit future disassembly and reuse. The same ‘design for disassembly’ strategy can be implemented in other areas of the building. Although no LEED points are specifically allocated for this strategy, if it were implemented to a significant degree, points may be achieved in the Innovation in Design Process (ID) category.

Construction waste management strategies are readily applied to buildings of this size. Many of the contractors undertaking projects of this size are already familiar with the process. Materials such as wood waste, cardboard and scrap metal can be recycled, generating savings in waste disposal costs.

**Indoor Environmental Quality**

As is the case with all office buildings, designing a healthy and comfortable interior environment should be a key goal. The use of low emitting materials and control of indoor pollutant sources should be a high priority.

In a building with a large number of office workspaces achieving a visual connection between indoor spaces and the outdoor environment should be readily achievable. LEED credits EQ 8.1 and 8.2, deal with providing minimum daylight levels (daylight factor of 2% in 75% of space occupied for critical visual tasks) and direct lines of sight to vision glazing (from 90% of all regularly occupied spaces). Strategies to achieve these points not only result in a more comfortable and productive working environment but, when coupled with appropriate lighting controls, will also reduce operating costs by reducing lighting energy requirements. Care should be taken in applying daylighting strategies to ensure that undesirable solar gain does not make spaces close to the building perimeter uncomfortable working environments.
Light shelves can be combined with exterior shading devices to reduce direct sunlight penetration and extend the area that receives indirect light.

**Summary of Key Green Building Strategies**

<table>
<thead>
<tr>
<th>LEED Credit</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 4.1</td>
<td>Alternative transportation Proximity to public transit</td>
</tr>
<tr>
<td>SS 6</td>
<td>Stormwater management Use of landscape features for flow reduction and detention.</td>
</tr>
<tr>
<td>WE 3</td>
<td>Water use reduction Low flow plumbing fixtures</td>
</tr>
<tr>
<td>EA 1</td>
<td>Optimize energy performance Reduce demand Harvest site energy Maximize efficiency</td>
</tr>
<tr>
<td>EQ 8</td>
<td>Daylighting and views Provide daylighting with appropriate controls to work areas</td>
</tr>
</tbody>
</table>
2.2 MUNICIPAL WORKS YARDS AND FACILITIES BUILDINGS

Although they typically contain some office space and staff rooms, most facilities buildings are generally utilitarian, containing large shop spaces, storage areas and vehicle bays. Finishes are minimal and mechanical and electrical services generally basic.

Just as civic halls provide opportunities to demonstrate green building techniques to the development community, public works buildings may be used to showcase strategies that support municipal green infrastructure development. Municipal staff can gain valuable experience in implementing strategies that support municipal goals, such as reducing potable water consumption, on site stormwater management and treatment of wastewater.

Having skilled staff available with expertise in various engineering fields may remove some of the risks associated with implement strategies that rely on innovative technology. For example staff familiarity with plumbing design may be useful in implementing such innovative strategies as the use of rainwater for toilet flushing. Staff may also be able to deal with potential building code difficulties by identifying installations as pilot projects.

City of Vancouver National Street Works Facility, Omicron Consultants

**Site Design**

New public works buildings will typically be located in existing works yard areas, however if new sites are being developed there may be opportunities for development of contaminated sites.
As there will likely be large areas of paving for vehicle parking, storage etc. controlling surface water run-off should be a key goal. LEED point 6.1 is awarded for minimizing stormwater run-off and increasing on-site infiltration. Stormwater treatment to remove contaminants and pollutants (SS 6.2) may also be important given the nature of many works yard activities and materials being stored.

The LEED credit for alternative-fuel vehicles (SS 4.3) may be easily achieved if refueling facilities are provided for non-petroleum based fuels such as electricity, propane, natural gas, methanol or ethanol. The point for bicycle storage and showering facilities (SS 4.2) may also be easily achieved as many works yard buildings will have the required changing and showering facilities.

**Water Efficiency**

Water use in facilities buildings and for landscape irrigation is likely to be much less significant than water use for activities such as vehicle washing and process water use for works yard activities. Although LEED points WE 1, and WE 3 (for reductions in irrigation water use and potable water use within buildings) may be easy to achieve, the greatest saving in water use are likely to be achieved in other areas such as vehicle washing.

**Energy and Atmosphere**

Facilities buildings typically contain spaces with a range of different thermal requirements. Offices and similar spaces will have many of the characteristics of office buildings and conservation strategies appropriate for that building type will apply. Other spaces will have lower occupant densities and less rigid thermal requirements. In these areas it may be possible to relax temperature design criteria to allow for a wider range of interior temperatures. Occupancy sensors may also be appropriate to turn off lighting and equipment when rooms are not in use. In buildings with a range of different design temperatures, and spaces that may effectively be outdoor areas, appropriate thermal design of separating walls is important. In areas where lighting is required but where work routines do not involve critical visual tasks, the most efficient lighting sources should be used.

**Materials and Resources**

Facilities buildings may offer many opportunities for green design strategies that reduce resource use. The use of salvaged materials may be particularly applicable if the building can be constructed of combustible materials. As the buildings are often utilitarian there may be a greater acceptance of some of the minor imperfections that are inevitable when materials are reused.

In buildings where interior finishes and mechanical and electrical services are minimal structural components will represent a larger component of the overall building cost. As a result LEED points for salvaged material
use (MR 3), which are based on the cost of the material used may be easier to achieve than in any other building type. The City of Vancouver Materials testing Lab was constructed with 80% salvaged and recycled materials.

Works yards may also play a role in supporting the use of salvaged materials in other municipal building projects by providing space to store suitable materials for future use.

**Indoor Environmental Quality**

Indoor environmental quality is less of a concern in public works buildings than in more densely occupied buildings. Where staff will spend longer periods working, for example in office areas the same strategies identified for office buildings can be applied.

Strategies to control indoor chemical and pollutant sources will be particularly important as many of the materials and products involved may be potentially more dangerous than those encountered in more conventional buildings. LEED point EQ 5 deals with separating chemical storage areas and providing separate ventilation to the exterior to avoid contamination of other spaces within the building. There are also requirements for appropriate plumbing design to ensure safe disposal of contaminated liquid waste.

**Summary of Key Green Building Strategies**

<table>
<thead>
<tr>
<th>LEED Credit</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 3</td>
<td>Brownfield redevelopment</td>
</tr>
<tr>
<td></td>
<td>Appropriate site selection</td>
</tr>
<tr>
<td>SS 6</td>
<td>Stormwater Management</td>
</tr>
<tr>
<td></td>
<td>Control water run off from large paved areas. Collection of rainwater for operational uses</td>
</tr>
<tr>
<td>WE 3</td>
<td>Water use reduction</td>
</tr>
<tr>
<td></td>
<td>Efficient water use for vehicle washing and operational activities</td>
</tr>
<tr>
<td>MR 3</td>
<td>Resource reuse</td>
</tr>
<tr>
<td></td>
<td>Salvaged material use</td>
</tr>
<tr>
<td>EQ 5</td>
<td>Indoor chemical and pollutant source control</td>
</tr>
<tr>
<td></td>
<td>Appropriate storage and ventilation</td>
</tr>
</tbody>
</table>
2.3 LIBRARIES

Libraries range in size form large central facilities to smaller branch libraries. With larger buildings there are likely to be many opportunities to implement green design strategies. With smaller branch buildings opportunities may be limited, particularly if buildings are leased, or where an existing structure is being fitted out. However even in small projects considerable improvements in performance are possible, particularly in the key area of indoor environmental quality.

Site Design

Libraries are typically located in urban areas and generally do not require large sites. In the case of central library facilities there may be outdoor civic space, particularly if the building is part of a larger civic complex. Generally however outdoor space is relatively small and utilitarian, and is primarily confined to car parking areas. Because of the nature of library building locations, a number of points in the LEED Sustainable Sites category may be achieved relatively easily.
Most libraries will be located in urban areas and will typically be close to public transport routes (LEED SS 2 and SS 4.1). Where landscaped areas are limited the use of xeriscape planting material provides a cost effective alternative to irrigation and achieves a LEED point (WE 1.2).

**Water Efficiency**

Water consumption in libraries is typically low and is primarily related to washroom use. Installing ultra-low flow, or dual flush, toilets, waterless urinals and automatic sensor controls on faucets will likely result in sufficient reductions in consumption to achieve LEED points (WE 3.1 or 3.2) however, the overall savings in consumption may not be significant due to low usage.

**Energy and Atmosphere**

Energy use patterns will generally be similar to those of civic office buildings, and similar conservation strategies may be employed (see section 2.1).

The use of natural lighting is desirable and provides opportunities for energy conservation by reducing reliance on artificial lighting. Control of natural light is essential both to provide visual comfort and reduce the potential for heat gain. Reductions in lighting energy use of 40 to 50% less than the Model National Energy Code for Buildings (MNECB) were achieved in the Alice Turner Branch Library, Saskatoon, through the use of natural lighting with, 3 lamp T8 fluorescent fixtures with electronic ballast and automatic daylight control, and occupancy sensors.

**Materials and Resources**

Building reuse (LEED MR 1) may be an appropriate strategy for libraries, particularly in the case of smaller branch libraries. Programming requirements are relatively flexible (large open areas for stacks with smaller spaces for office and other functions) and can be adapted to many existing buildings. Libraries are most often located in urban areas where suitable buildings are most likely to be available.

Libraries may be of a size that permits the use of combustible or heavy timber construction. Stack areas and public areas are typically large open areas but do not necessarily have to be column-free providing many opportunities for using salvaged wood or engineered wood columns and beams.
There may also be opportunities to use salvaged wood for furniture, shelving etc. Quantities of material required are small and high quality salvaged material is readily available from local sources. This may also be an area where certified wood from sustainably managed forests could be used (MR 7).

**Indoor Environmental Quality**

Providing a high quality indoor environment should be a key strategy to benefit both staff and public users. Libraries will tend to have larger amounts of carpeting, furniture, shelving etc. than many other building types. These components are traditionally fabricated and finished with materials that off-gas volatile organic compounds (VOCs) and other indoor air contaminants. Control of VOC emissions is particularly important in children’s areas where kids may sit on the floor while reading. A total of 4 LEED points (EQ 4) are awarded for strategies that substitute low-emitting materials for conventional adhesives, paints, and urea formaldehyde free composite wood products. Achieving these points should be a high priority.

Libraries usually contain large copying facilities with multiple copiers and storage for large volumes of paper. LEED point for indoor chemical and pollutant source control (EQ 5) can be achieved if applicable areas are isolated from the remainder of the building and separately vented to the exterior. Much of the reading material in libraries, particularly periodicals and magazines may also off-gas pollutants. Increased ventilation effectiveness may be an appropriate strategy to deal with this issue, particularly if natural ventilation can be used.

Access to daylighting should be a key strategy, both to reduce lighting energy requirements and to provide a comfortable interior environment. Achieving the required intensity and distribution of daylighting to achieve
LEED point EQ 8.1 may be difficult in stack areas unless some form of skylights or roof monitors are used.

<table>
<thead>
<tr>
<th>LEED Credit</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR 1</td>
<td>Building reuse</td>
</tr>
<tr>
<td>MR 3</td>
<td>Resource reuse</td>
</tr>
<tr>
<td>MR 7</td>
<td>Certified wood</td>
</tr>
<tr>
<td>EQ 4</td>
<td>Low emitting materials</td>
</tr>
<tr>
<td>EQ 5</td>
<td>Indoor chemical and pollutant source control</td>
</tr>
<tr>
<td>EQ 8</td>
<td>Daylight and Views</td>
</tr>
<tr>
<td></td>
<td>Branch library in existing building</td>
</tr>
<tr>
<td></td>
<td>Use of salvaged wood structural materials.</td>
</tr>
<tr>
<td></td>
<td>Use of certified wood for furniture and shelving</td>
</tr>
<tr>
<td></td>
<td>Low VOC carpets, furniture, shelving etc.</td>
</tr>
<tr>
<td></td>
<td>Isolation and ventilation of storage areas, copy rooms etc.</td>
</tr>
<tr>
<td></td>
<td>To reduce lighting energy and for environmental comfort.</td>
</tr>
</tbody>
</table>

### 2.4 PARKS AND FIELD BUILDINGS

Park and field buildings are typically small simple buildings, generally not occupied on a continuous basis. One of the most common buildings of this type is public washrooms and changing rooms adjacent to parks or playing fields. Construction budgets, and level of design input will normally be modest. Levels of mechanical and electrical services are generally minimal.

Typical parks building containing washrooms and staff facilities
Site Design

A key characteristic of parks and field buildings is that they are often located at a distance from streets or lanes where utilities and services are generally located. This is particularly the case in larger parks or remote locations. Servicing these buildings can be expensive because of the distances involved. This situation may provide an opportunity to introduce green design strategies that deal with waste water disposal and power generation on site. LEED points for stormwater management (SS 6.1) will be relatively easy to acquire as paved areas will be limited and distances to piped disposal will likely make strategies which promote on-site infiltration cost effective. The nature of parks buildings and typical site will also make it easy to introduce strategies that reduce site disturbance and limit required parking spaces.

Water Efficiency

In the case of public washroom or changing room, water use is a key issue. Water consumption is reduced through the use of ultra-low flush toilets, waterless urinals, and low-flow faucets and showerheads. LEED points are awarded for 20% and 30% reductions in building water use (WE 3.1 and 3.2). However, it is important to understand that the performance baseline established by LEED assumes a high performance level that is based on low consumption fixtures. This baseline performance is similar to current BC building Code requirements for water consumption. Further reductions will require the use of waterless or ultra-low flow toilets. Achieving reductions in shower or faucet consumption may require the use of automatic sensor controls, although this may be problematic in remote locations.

Ultra-low-flush toilets use 6.0 litres per flush compared to 13.25 litres for new code compliant fixtures in BC. However, LEED uses the US standard EPA 1992 as a baseline for performance. This standard requires a maximum 6.0 litre flush. In order to achieve further reductions in water use it is necessary to use dual-flush toilets with a 3 or 6 litre flush.
In specifying ultra low consumption and non-conventional toilets it is important to consider other performance criteria, and in particular durability. Washroom buildings are often located in area where security and vandalism may be an issue.

In locations without a piped water supply to washroom buildings there are a number of alternative technologies that may be applied, including the use of composting toilets and waterless urinals.

**Energy and Atmosphere**

Energy use in parks and field buildings presents challenges. In many cases buildings located at some distance from utility lines and providing electrical or gas service can be expensive. However as energy loads will typically be light, there may be opportunities for use of renewable energy sources. Photovoltaic panels have been widely used to provide power to small buildings in remote locations. Renewable energy may also be used for solar water heating, however it may be appropriate to consider eliminate the use of heated water in washroom buildings.
Materials and Resources

If they can be constructed of combustible construction, small buildings such as field houses have good potential for use of salvaged materials. Quantities involved are relatively small making sourcing of suitable material relatively simple. However many small parks buildings are constructed of combustible construction, using concrete and masonry. Making the use of salvaged materials more difficult.

LEED points for materials with recycled content may be easier to achieve. High-density polyethylene (HDPE) toilet partitions manufactured from recycled plastic are available and may be used in washroom buildings. Although initial cost of recycled content dividers may be higher than conventional products, they are durable and require little maintenance. When used at the High Cliff State park in Wisconsin, they resulted in lower maintenance and repair costs. Steel partitions with a high-recycled content are also available.

Indoor Environmental Quality

Indoor environmental quality is less of a concern in buildings that are only occupied for short periods of time. In addition the nature of the building use typically requires the use of minimal finishes of the type that commonly cause IEQ problems. Low VOC adhesives and paints, or self-finishing materials such as concrete or masonry can be used.

Summary of Key Green Building Strategies

<table>
<thead>
<tr>
<th>LEED Credit</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 6</td>
<td>Stormwater management</td>
</tr>
<tr>
<td></td>
<td>Reduced paving areas</td>
</tr>
<tr>
<td>WE 2</td>
<td>Innovative wastewater technologies</td>
</tr>
<tr>
<td></td>
<td>Composting toilets</td>
</tr>
<tr>
<td>WE 3</td>
<td>Water use reduction</td>
</tr>
<tr>
<td></td>
<td>Ultra-low consumption toilets and waterless urinals</td>
</tr>
<tr>
<td>EA 2</td>
<td>Renewable energy</td>
</tr>
<tr>
<td></td>
<td>Photovoltaics</td>
</tr>
<tr>
<td>MR 3</td>
<td>Resource reuse</td>
</tr>
<tr>
<td></td>
<td>Salvaged materials</td>
</tr>
<tr>
<td>MR 4</td>
<td>Recycled content</td>
</tr>
<tr>
<td></td>
<td>Toilet partitions, floor tiles, concrete</td>
</tr>
</tbody>
</table>
2.5 RECREATION AND SPORTS CENTRES

Recreation buildings are among the most heavily used municipal buildings; used by large numbers of the public and often operating for extended hours. They are also one of the more expensive types of building to operate, and offer considerable potential for operating cost saving as a result of energy efficiency measures.

As recreation centres are used exclusively by the public they represent a high visibility location to showcase green design strategies. Many of the strategies that are applicable to recreation and sports buildings, for example, in the area of water conservation, are the same strategies municipalities and the GVRD are promoting to the public.

Walnut Grove Aquatic Centre, Langley, BC

Site Design

As is the case with other building types, certain LEED points will be achieved with little effort due to the particular site characteristics of recreation buildings. Points in the alternative transportation category, (SS 3) for proximity to public transit, bicycle storage and showering facilities, and reduced car parking will likely be achieved with little difficulty. Credit SS 2, for urban development may also be possible although if the facility has outdoor sports field or courts more suburban locations will be more appropriate.

Recreation centres that have extensive outdoor sports fields and courts may offer additional opportunities for green design strategies that will
achieve LEED points. For example credit 6.1 for minimizing stormwater runoff and credit 5.2 achieved by limiting the footprint of the building and exceeding open space requirements.

Ideally herbicides and pesticides should not be used on playing fields. If "cosmetic" lawn chemicals cannot be avoided some form of on site treatment should be provided to remove residues before stormwater is discharged (SS 6.2).

**Water Efficiency**

Water consumption in recreation centres is high compared to other building types, and there are considerable opportunities for water savings. Significant amounts of water will be used in shower and washrooms. The use of low-flow showerheads and faucets and dual-flush toilets and waterless urinals can save significant volumes of water in these areas. However it is important to understand that LEED points for water consumption reduction (WE 3.1 and 3.2 for 20% and 30% reductions respectively) anticipate a baseline performance similar to BC plumbing code requirements. Although the plumbing code itself represents a significant improvement over current average consumption rates more can be done, at minimal cost to improve water efficiency. As much of the water used in recreation buildings is heated there are also opportunities for energy conservation and associated cost savings.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Litres / minute</td>
<td>Litres / minute</td>
<td>Litres / minute</td>
</tr>
<tr>
<td>Showerheads</td>
<td>5.7 to 18.9</td>
<td>9.5</td>
<td>5.3</td>
</tr>
<tr>
<td>Faucets</td>
<td>7.6 to 11.3</td>
<td>9.5 (BC 8.3)</td>
<td>5.6 (With faucet aerator)</td>
</tr>
<tr>
<td>Toilets</td>
<td>6 to 30</td>
<td>6.0 (BC 13.2)</td>
<td>4.5 (Dual flush average)</td>
</tr>
</tbody>
</table>

Outdoor uses of water for irrigation of sports fields represents one of the largest use of water in recreation centres. Irrigation of playing fields during summer months can consume up to 5 litres of water per square metre, per week, during the hottest months of July and August. Applied to a typical soccer field this would result in a requirement for approximately 276,000 litres of water.

Because of the large volumes of water required, and because the periods when irrigation is required coincide with the lowest rainfall months, collection of rainwater is not a viable strategy. Recycling of water may offer the best opportunities for conservation. Although not common in
North America, collection and reuse of irrigation water can result in savings in potable water of up to 70%. Irrigation water run off from playing field is collected via open drains at the perimeter of the field, filtered and stored for reuse. Stored water is supplemented with potable water as required. The reuse of grey water from swimming pools and showers could also be explored.

Improved irrigation practices and revisions to turf maintenance practices can reduce requirements for irrigation water. In certain cases with appropriate selection of turf species, and an acceptance of straw-coloured turf in mid summer the requirements for irrigation water can be eliminated.

**Energy and Atmosphere**

On a per square foot basis energy consumption in sports buildings without swimming pools is similar to that of a conventional office building. However in buildings with swimming pools energy consumption can double.

Significant energy is required in heating and maintaining water temperature in indoor pools. In addition high levels of ventilation are required, often on a 24 hour basis, to control indoor humidity levels and avoid condensation. Almost 70% of heat loss from swimming pools results from evaporation. One of the most effective measures to reduce energy is the use of pool covers when the building is not operational. Covers eliminate evaporation and reduce heat loss by convection and conduction and can generate savings of 20% in energy use.

Reducing the water temperature in lap pools by one or two degrees can also result in savings, both in water heating energy and reduced ventilation requirements resulting from lower evaporation rates. Heat recovery from exhaust air may also be economically feasible in swimming pools.

Insulated covers, applied when the pool is not in use, can significantly reduce energy requirement in swimming pools.
Energy Conservation Measures for Swimming Pools

- Install an insulated pool cover
- In lap pools reduce water temperature by one or two degrees
- Turn off water features such as wave machines and water slides when usage is low
- Use a vacuuming system that returns water to the pool after removal of debris

In recreation centres that do not contain swimming pools the largest energy requirements are for space heating, ventilation and lighting. Ice rinks have significant energy requirements for refrigeration; however, these are balanced by reduced heating requirements. Energy conservation strategies include, energy-efficient mechanical equipment, appropriate sizing of equipment to meet requirements, and energy-efficient fans.

Traditionally sports halls have excluded natural light in an attempt to reduce glare and control solar heat gain. However daylight can be introduced in ways that avoid these problems and can be used to supplement artificial lighting. In order to effectively reduce lighting requirements, appropriate controls are required.

In buildings with high energy use, strategies to improve commissioning (EA 3) and provide ongoing measurement and verification (EA 5) will be useful in optimizing energy performance and finding opportunities for additional savings.

Materials and Resources

In most cases recreation centres will be constructed of non-combustible construction making them more suitable for LEED strategies involving the use of recycled materials rather than salvaged materials.

There are a number of categories of materials with recycled-content which may be suitable for use in recreation buildings including rubber floor tiles and toilet and shower partitions. Steel structural members and concrete with a high fly ash content also qualify as recycled materials. Calculation of recycled content of building materials for the purposes of LEED points is based on the cost of recycled materials relative to the total cost of the materials in the building. Achieving the points for recycled-content based on the use of structural steel and concrete will be easier in buildings such as recreation centres where structural elements represent a more significant percentage of total cost than in other building types.
Indoor Environmental Quality

As is the case with all public buildings maintaining a high quality indoor environment should be a priority.

The use of natural lighting is an appropriate strategy to reduce energy consumption in recreation buildings. Providing access to daylighting and views in order to improve indoor environmental quality may also be implemented, and an increasing number of sports halls and swimming pools provide access to natural lighting. LEED credit 8.1 is awarded for achieving a minimum daylight factor of 2%, however it is necessary to exclude all direct sunlight penetration. Meeting these requirements may be difficult given the large spaces and large glazing areas involved. Careful control of building orientation would be necessary. Minimum daylighting factors would apply to all major spaces within the building but would exclude storage rooms, mechanical rooms and changing rooms.

Given the nature of activities within recreation buildings access to views (EQ 8.2) is less critical but may be desirable in leisure pool and some other areas. In order to achieve the LEED point is necessary to provide direct views to the outside from 90% of all regularly occupied spaces.

Summary of Key Green Building Strategies

<table>
<thead>
<tr>
<th>LEED Credit</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 6 Stormwater management</td>
<td>Treatment to remove contaminants</td>
</tr>
<tr>
<td>WE 1 Landscape irrigation reduction</td>
<td>Water recycling Appropriate turf species selection</td>
</tr>
<tr>
<td>WE 3 Water use reduction</td>
<td>Dual-flush toilets, low flow showerheads and waterless urinals</td>
</tr>
<tr>
<td>EA 1 Optimize energy performance</td>
<td></td>
</tr>
<tr>
<td>MR 4 Recycled content</td>
<td>Toilet partitions, floor tiles, hvfa concrete, steel</td>
</tr>
<tr>
<td>EQ 8 Daylighting and views</td>
<td></td>
</tr>
</tbody>
</table>
2.6 GREEN BUILDING COSTS AND BENEFITS

In any comparison of green buildings with conventional buildings the issue of cost must be addressed. All building owners are concerned with construction costs, and with achieving buildings which can be maintained and operated cost-effectively. Municipalities, like other public sector building owners, are subject to particular scrutiny with respect to building construction and must pay close attention to both the design and construction costs of green buildings.

There are a number of reasons to expect that certain green design strategies will result in increased construction costs. Application of some strategies can sometimes involve the use of new and innovative technologies and materials, for example the use of on-site renewable energy sources. Contractors may be unfamiliar with the technologies and materials involved, and may compensate for real or perceived risk by increasing costs.

On the other hand, there are a number of green building strategies, which will tend to reduce construction costs. Strategies such as the use of natural ventilation, passive solar heating, and daylighting will reduce the requirement for mechanical and electrical equipment and fixtures. Other strategies which promote the omission of finish materials, and replacement with durable self-finishing materials reduce material and maintenance costs. Green approaches to site design, that minimize site work and retain existing natural vegetation also have potential to reduce capital costs.

Impact of Green Design Strategies on Costs

<table>
<thead>
<tr>
<th>Green Design Strategies that may increase capital costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Brownfield redevelopment (LEED SS 3)</td>
</tr>
<tr>
<td>• Stormwater treatment (LEED SS 6.2)</td>
</tr>
<tr>
<td>• Innovative wastewater technologies (LEED WE 2)</td>
</tr>
<tr>
<td>• Use of renewable energy technology (LEED EA 2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Green Design Strategies that may decrease capital costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Parking reductions (LEED SS 4.4)</td>
</tr>
<tr>
<td>• Stormwater flow reduction (LEED SS 6.1)</td>
</tr>
<tr>
<td>• Irrigation free landscaping (LEED WE 1.2)</td>
</tr>
<tr>
<td>• Building reuse (LEED MR 1)</td>
</tr>
<tr>
<td>• Waste management (LEED MR 2)</td>
</tr>
<tr>
<td>• Resource reuse (LEED MR 3)</td>
</tr>
<tr>
<td>• Use of local materials (LEED MR 5)</td>
</tr>
</tbody>
</table>
Green Design Strategies that may decrease operating costs

- Improved energy performance (LEED EA 1)
- Energy measurement and verification (LEED EA 5)
- Controllability of systems (LEED EQ 6)
- Daylighting (LEED EQ 8)
- Use of renewable energy technology (LEED EA 2)

Life Cycle Costing

However comparison of green and conventional buildings should not be made on the basis of initial capital cost alone. Buildings have a life span that extends beyond initial construction. The majority of building related costs will be incurred in operating and maintaining the building over its life span. A number of strategies that may increase capital costs will over time result in more significant operating cost savings.

Life cycle costing (LCC) provides a measurement method that takes into account not just initial costs but also costs incurred during the service life of the building. While there are some challenges to LCC, it does provide a more representative and complete decision making framework when assessing the impact of green design strategies (LCC is discussed in more detail in Section 3).

For example, a key focus of green design is to reduce fossil fuel energy use in buildings. Various strategies, including improving the thermal performance of the building envelope, appropriate building orientation and form, and optimizing systems efficiency aim to maximize energy performance. As energy costs are a major component of building operating costs, reducing the amount of energy used for heating, cooling, and lighting also generates significant cost savings over the life of the building. Additional capital costs for energy efficiency should be assessed against the long-term savings potential.

An additional life cycle impact that can have significant cost implications is the effect building materials, and particularly interior finish materials, will have on building users. Many green design strategies, including appropriate selection of materials and finishes, are designed to improve occupant health and well-being. The benefits of a healthy workplace may be difficult to quantify, but are nevertheless real. Many experts contend they can translate into improved productivity, reduced absenteeism, etc. Research by the Lawrence Berkley National Laboratory suggests that productivity gains associated with improved IEQ could amount to $168 billion annually. When worker salary costs are considered, even minor improvements in productivity (1%) can result in savings that more than pay for additional capital cost.
Comparison of Building Related Costs

<table>
<thead>
<tr>
<th>Cost Description</th>
<th>Cost per Square Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical office building construction</td>
<td>$120</td>
</tr>
<tr>
<td>Typical annual operating and fixed costs</td>
<td>$10</td>
</tr>
<tr>
<td>Typical annual office worker salary costs</td>
<td>$300</td>
</tr>
</tbody>
</table>

**LEED Green Building Costs**

Detailed and precise data on green building cost comparisons is not readily available, and evaluation is complicated by many factors, from the size and type of the project and the overall quality of the building. Within any particular building type, the cost of conventional buildings will differ, often by significant amounts.

Green buildings, while they may incorporate particular design strategies that are more expensive, will also include strategies that reduce capital costs. Depending on the building type and strategies employed, green buildings need be no more expensive than conventional buildings.

The LEED rating system provides a framework for comparing costs. Information from the USGBC suggests that increases in capital costs are modest, in the region of 1 to 5%, depending on the building type and certification level, while operating and energy cost savings range from 30 to 60%. Local experience to date suggests that institutional/commercial buildings can achieve a LEED Silver rating with capital cost increases of less than 1%. Capital costs may be further reduced through use of an Integrated Design Process (see Section 3).

**Impact of LEED Green Design Strategies on Cost**

The cost implications of green building are discussed in Section 1. Provides an indication of the potential for increases or decreases in capital cost associated with application of particular green design strategies. The most significant category of savings resulting associated with green buildings are in operating costs. For example savings resulting from improved energy performance over the life of the building. The potential for operational cost saving is also indicated (It should be noted that each index is independent, it is not intended that implementation costs would be directly comparable with saving in this index.)
### Impact on Capital and Operating Costs

<table>
<thead>
<tr>
<th>Sustainable Sites</th>
<th>Potential Change in Capital Costs</th>
<th>Potential Change in Operating Costs</th>
<th>Productivity Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 1 Site selection</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 2 Urban redevelopment</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 3 Brownfield redevelopment</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 4.1 Public transport access</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 4.2 Bicycle friendly</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 4.3 Alternative fuel refueling</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 4.4 Parking reductions</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 5 Protect restore maximize open space</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 6 Stormwater management</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 7 Landscape reduce heat islands</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SS 8 Light pollution reduction</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

### Water Efficiency

| WE 1 Water efficient landscaping | □ | □ | □ | □ |
| WE 2 Innovative wastewater technologies | □ | □ | □ | □ |
| WE 3 Water use reduction | □ | □ | □ | □ |

### Energy & Atmosphere

| EA 1 Optimize energy performance | □ | □ | □ | □ |
| EA 2 Renewable energy | □ | □ | □ | □ |
| EA 3 Best practice commissioning | □ | □ | □ | □ |
| EA 4 Eliminate HCFCs and halons | □ | □ | □ | □ |
| EA 5 Measurement and verification | □ | □ | □ | □ |
| EA 6 Green power | □ | □ | □ | □ |

### Materials and Resources

| MR 1 Building reuse | □ | □ | □ | □ |
| MR 2 Waste management | □ | □ | □ | □ |
| MR 3 Resource reuse | □ | □ | □ | □ |
| MR 4 Recycled content | □ | □ | □ | □ |
| MR 5 Local / regional materials | □ | □ | □ | □ |
| MR 6 Rapidly renewable materials | □ | □ | □ | □ |
| MR 7 Certified wood | □ | □ | □ | □ |

### Environmental Quality

| EQ 1 CO2 monitoring | □ | □ | □ | □ |
| EQ 2 Increase ventilation effectiveness | □ | □ | □ | □ |
| EQ 3 Construction IAQ plan | □ | □ | □ | □ |
| EQ 4 Low emitting materials | □ | □ | □ | □ |
| EQ 5 Chemical and pollutant source control | □ | □ | □ | □ |
| EQ 6 Controllability of systems | □ | □ | □ | □ |
| EQ 7 Thermal comfort | □ | □ | □ | □ |
| EQ 8 Daylight and views | □ | □ | □ | □ |

* There may be an increase in capital costs if a high performance irrigation system is used, however there is also potential for cost savings if an irrigation system is omitted and xeriscape planting is used.

** Efforts to improve energy performance such as the use of higher performance envelope assemblies may result in increases in costs. Strategies that reduce the requirements for mechanical and electrical systems may on the other hand result in reductions in capital costs.
Municipal Building Construction Costs

Generally larger buildings, with higher per square foot construction costs will offer greater opportunities for green design. Increases in capital costs to implement particular design strategies will have a reduced impact on overall project costs where per square foot construction costs are high. Buildings with a wider range of mechanical and electrical systems, more advanced assemblies and components, and more extensive finishes, will provide greater scope for implementing many green design strategies.

Typical range of construction costs for various municipal building types
2.7 DESIGN AND CONSTRUCTION CONSIDERATIONS

Level of Design Input

Implementing many green design strategies requires additional design input. Design fees are typically determined on the basis of a percentage of construction cost, and as a result larger, higher cost buildings, tend to command higher design consultant fees. Professional fee levels are directly related to scope of work and degree of design input required. For example, civic halls are considerably more complex than parks buildings and require a corresponding level of design time and effort. It is often easier to integrate green design strategies into this type of design process than into a more basic level of service associated with simpler low-cost buildings.

The table below provides an indication of the degree of effort required during the design phase of the project to implement each particular LEED strategy. Some strategies are straightforward, for example IEQ 1 requires that CO\textsubscript{2} sensors be installed in HVAC equipment. This is easy to implement (although there may be an associated cost), compared to a strategy that for example requires the use of building integrated photovoltaics. Ease of implementation is an indication of the degree to which any particular strategy results in a change from conventional design practices or outcomes and gives an indication of level of additional consultant input required.

Ease of Implementation – Design Phase

<table>
<thead>
<tr>
<th>Sustainable Sites</th>
<th>Degree of Effort</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 1 Site selection</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>SS 2 Urban redevelopment</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>SS 3 Brownfield redevelopment</td>
<td>Challenging</td>
<td>Site rehabilitation</td>
</tr>
<tr>
<td>SS 4.1 Public transport access</td>
<td>Easy</td>
<td>No change to conventional practice</td>
</tr>
<tr>
<td>SS 4.2 Bicycle friendly</td>
<td>Easy</td>
<td>No change to conventional practice</td>
</tr>
<tr>
<td>SS 4.3 Alternative fuel refueling</td>
<td>Easy</td>
<td>No change to conventional practice</td>
</tr>
<tr>
<td>SS 4.4 Parking reductions</td>
<td>Easy</td>
<td>No change to conventional practice</td>
</tr>
<tr>
<td>SS 5 Protect, restore, maximize open space</td>
<td>Easy</td>
<td>No change to conventional practice</td>
</tr>
<tr>
<td>SS 6 Stormwater management</td>
<td>Moderate</td>
<td>Additional design - Mechanical and landscape</td>
</tr>
<tr>
<td>SS 7 Landscape reduce heat islands</td>
<td>Moderate</td>
<td>Green roof design</td>
</tr>
<tr>
<td>SS 8 Light pollution reduction</td>
<td>Challenging</td>
<td>Specialist consultant input</td>
</tr>
</tbody>
</table>

Water Efficiency

<table>
<thead>
<tr>
<th>Sustainable Sites</th>
<th>Degree of Effort</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>WE 1 Water efficient landscaping</td>
<td>Easy / moderate</td>
<td>Mechanical and landscape</td>
</tr>
<tr>
<td>WE 2 Innovative wastewater technologies</td>
<td>Challenging</td>
<td>Innovative design</td>
</tr>
<tr>
<td>WE 3 Water use reduction</td>
<td>Easy / moderate</td>
<td>Appropriate fixture specification</td>
</tr>
</tbody>
</table>
Energy & Atmosphere

<table>
<thead>
<tr>
<th>EA 1</th>
<th>Optimize energy performance</th>
<th>Moderate</th>
<th>Depending on degree of improvement achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 2</td>
<td>Renewable energy</td>
<td>Challenging</td>
<td>Innovative design</td>
</tr>
<tr>
<td>EA 3</td>
<td>Best practice commissioning</td>
<td>Easy</td>
<td>No change to conventional practice</td>
</tr>
<tr>
<td>EA 4</td>
<td>Eliminate HCFCs and halons</td>
<td>Easy</td>
<td>Appropriate component specification</td>
</tr>
<tr>
<td>EA 5</td>
<td>Measurement and verification</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>EA 6</td>
<td>Green power</td>
<td>Moderate</td>
<td>Post-construction strategy</td>
</tr>
</tbody>
</table>

Materials and Resources

<table>
<thead>
<tr>
<th>MR 1</th>
<th>Building reuse</th>
<th>Moderate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MR 2</td>
<td>Waste management salvage /</td>
<td>Easy</td>
<td>Primarily a construction phase</td>
</tr>
<tr>
<td></td>
<td>recycles</td>
<td></td>
<td>strategy</td>
</tr>
<tr>
<td>MR 3</td>
<td>Resource reuse</td>
<td>Challenging</td>
<td>Specifying and sourcing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>non-traditional materials</td>
</tr>
<tr>
<td>MR 4</td>
<td>Recycled content</td>
<td>Moderate</td>
<td>Specifying and sourcing non-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>traditional materials</td>
</tr>
<tr>
<td>MR 5</td>
<td>Local / regional materials</td>
<td>Easy</td>
<td>No change to conventional</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>practice</td>
</tr>
<tr>
<td>MR 6</td>
<td>Rapidly renewable materials</td>
<td>Moderate</td>
<td>Specifying and sourcing non-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>traditional materials</td>
</tr>
<tr>
<td>MR 7</td>
<td>Certified wood</td>
<td>Moderate</td>
<td>Specifying and sourcing non-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>traditional materials</td>
</tr>
</tbody>
</table>

Environmental Quality

<table>
<thead>
<tr>
<th>EQ 1</th>
<th>CO2 monitoring</th>
<th>Easy</th>
<th>Component specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ 2</td>
<td>Increase ventilation</td>
<td>Easy /</td>
<td>Easy for mechanically</td>
</tr>
<tr>
<td></td>
<td>effectiveness</td>
<td>challenging</td>
<td>ventilated buildings,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>challenging for naturally</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ventilated</td>
</tr>
<tr>
<td>EQ 3</td>
<td>Construction IAQ plan</td>
<td>N/A</td>
<td>Construction phase strategy</td>
</tr>
<tr>
<td>EQ 4</td>
<td>Low emitting materials</td>
<td>Moderate</td>
<td>Specifying and sourcing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>non-traditional materials</td>
</tr>
<tr>
<td>EQ 5</td>
<td>Chemical and pollutant</td>
<td>Moderate</td>
<td>Additional design</td>
</tr>
<tr>
<td></td>
<td>source control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EQ 6</td>
<td>Controllability of systems</td>
<td>Easy /</td>
<td>Addiitonal design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>moderate</td>
<td></td>
</tr>
<tr>
<td>EQ 7</td>
<td>Thermal comfort</td>
<td>Easy</td>
<td>Appropriate systems design</td>
</tr>
<tr>
<td>EQ 8</td>
<td>Daylight and views</td>
<td>Easy /</td>
<td>No change to conventional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>moderate</td>
<td>practice</td>
</tr>
</tbody>
</table>

LEED Submission Requirements

Achieving LEED certification requires that the building design be reviewed by the USGBC and evaluated for conformance with specific requirements in each points category. In order to demonstrate compliance it is necessary to submit documentation in the form of drawings, specification etc. In many cases the submittal will be based on typical project documentation and no significant additional work will be required. However in some cases considerable additional work will be required of the design team in order to meet submittal requirements (it has been estimated that achieving a LEED certification requires between 60 and 200 additional hours of consultant input, depending on the nature of the project, the strategies selected and the experience of the consultant). The table below provides a brief review of level of input, and type of submission required for each LEED credit area.
### LEED Submission Requirements

<table>
<thead>
<tr>
<th>Sustainable Sites</th>
<th>Level of input</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 1 Site selection</td>
<td>Minimal</td>
<td>Declaration</td>
</tr>
<tr>
<td>SS 2 Urban redevelopment</td>
<td>Moderate</td>
<td>Area plan and density calculations</td>
</tr>
<tr>
<td>SS 3 Brownfield redevelopment</td>
<td>Minimal</td>
<td>Confirmation of brownfield site and remediation efforts</td>
</tr>
<tr>
<td>SS 4.1 Public transport access</td>
<td>Minimal</td>
<td>Area map</td>
</tr>
<tr>
<td>SS 4.2 Bicycle friendly</td>
<td>Moderate</td>
<td>Plan and calculations</td>
</tr>
<tr>
<td>SS 4.3 Alternative fuel refueling</td>
<td>Moderate</td>
<td>Plan and calculations</td>
</tr>
<tr>
<td>SS 4.4 Parking reductions</td>
<td>Moderate</td>
<td>Plan narrative and calculations</td>
</tr>
<tr>
<td>SS 5 Protect, restore, maximize open space</td>
<td>Moderate</td>
<td>Drawings specifications and narrative</td>
</tr>
<tr>
<td>SS 6 Stormwater management</td>
<td>Extensive</td>
<td>Drawings, calculations, management plan</td>
</tr>
<tr>
<td>SS 7 Landscape reduce heat islands</td>
<td>Moderate</td>
<td>Plan and calculations</td>
</tr>
<tr>
<td>SS 8 Light pollution reduction</td>
<td>Extensive</td>
<td>Drawings and calculations</td>
</tr>
</tbody>
</table>

#### Water Efficiency

| WE 1 Water efficient landscaping | Extensive | Drawings, calculations and narrative |
| WE 2 Innovative wastewater technologies | Extensive | Drawings, specifications calculations and narrative |
| WE 3 Water use reduction | Moderate | Cut sheets and calculations |

#### Energy & Atmosphere

| EA 1 Optimize energy performance | Extensive | Drawings, narrative and compliance form |
| EA 2 Renewable energy | Moderate | Drawings, specifications calculations |
| EA 3 Best practice commissioning | Extensive | Design reviews |
| EA 4 Eliminate HCFCs and halons | Minimal | Confirmation letter |
| EA 5 Measurement and verification | Extensive | On going measurement and verification plan |
| EA 6 Green power | Moderate | Confirmation documentation |

#### Materials and Resources

| MR 1 Building reuse | Extensive | Drawing and calculations |
| MR 2 Waste management | Moderate | Waste management plan and calculations |
| MR 3 Resource reuse | Extensive | Calculations and cost |
| MR 4 Recycled content | Extensive | Calculations and cost |
| MR 5 Local / regional materials | Extensive | Calculations and cost |
| MR 6 Rapidly renewable materials | Extensive | Calculations and cost |
| MR 7 Certified wood | Extensive | Calculations and cost |

#### Environmental Quality

| EQ 1 CO2 monitoring | Moderate | Drawings specifications and cut sheets |
| EQ 2 Increase ventilation effectiveness | Extensive | Testing, calculations, airflow simulation |
| EQ 3 Construction IAQ plan | Moderate | IAQ plan and supporting documentation |
| EQ 4 Low emitting materials | Minimal | Cut sheets and MSDS |
| EQ 5 Chemical and pollutant source control | Moderate | Drawings and narrative |
| EQ 6 Controllability of systems | Extensive | Drawings, cut sheets and calculations |
| EQ 7 Thermal comfort | Moderate | Drawings, cut sheets and calculations |
| EQ 8 Daylight and views, distribution quality | Extensive | Drawings, narrative and calculations |
**Contractor Management Skills**

Larger, higher cost buildings tend to attract larger general contracting companies who will generally have more sophisticated administration and project management capabilities. These skills will be an advantage in implementing many construction phase green design strategies such as construction site waste management (MR2), and construction phase indoor air quality plan (EQ3). In addition implementation of design strategies such as the use of salvaged materials (MR3) and materials with recycled content (MR4) will require input from the contractor in calculating and documenting material quantities.

In the same way that application of particular green design strategies requires changes from conventional design practice, changes are also at times required during the construction phase of the project. Increased difficulty during design does not always correlate with the same level of change in construction. Ease of implementation is an indication of the degree to which any particular strategy results in a change from conventional construction practices, or the use of innovative materials or technologies.

**Ease of Implementation – Construction Phase**

<table>
<thead>
<tr>
<th>Sustainable Sites</th>
<th>Degree of Effort</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 1 Site selection</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>SS 2 Urban redevelopment</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>SS 3 Brownfield redevelopment</td>
<td>Challenging</td>
<td>Site rehabilitation</td>
</tr>
<tr>
<td>SS 4.1 Public transport access</td>
<td>Easy</td>
<td>No additional construction input required</td>
</tr>
<tr>
<td>SS 4.2 Bicycle friendly</td>
<td>Easy</td>
<td>No change in construction practice</td>
</tr>
<tr>
<td>SS 4.3 Alternative fuel refueling</td>
<td>Moderate</td>
<td>Construction of refueling facilities</td>
</tr>
<tr>
<td>SS 4.4 Parking reductions</td>
<td>Easy</td>
<td>No change in construction practice</td>
</tr>
<tr>
<td>SS 5 Protect, restore, maximize open space</td>
<td>Easy</td>
<td>No change in construction practice</td>
</tr>
<tr>
<td>SS 6 Stormwater management</td>
<td>Easy</td>
<td>No change in construction practice</td>
</tr>
<tr>
<td>SS 7 Landscape reduce heat islands</td>
<td>Moderate</td>
<td>Green roof construction</td>
</tr>
<tr>
<td>SS 8 Light pollution reduction</td>
<td>Easy</td>
<td>No change in construction practice</td>
</tr>
</tbody>
</table>

**Water Efficiency**

| WE 1 Water efficient landscaping | Easy | No change in construction practice |
| WE 2 Innovative wastewater technologies | Challenging | Non-conventional practice |
| WE 3 Water use reduction        | Easy             | No change in construction practice |

**Energy & Atmosphere**

| EA 1 Optimize energy performance | Moderate | Depending on degree of improvement achieved |
| EA 2 Renewable energy           | Challenging | Non-conventional practice |
| EA 3 Best practice commissioning | Moderate | Additional time required |
| EA 4 Eliminate HCFCs and halons | Easy     | Appropriate component specification         |
| EA 5 Measurement and verification | N/A      | Post-construction strategy                  |
| EA 6 Green power                | N/A      | Post-construction strategy                  |
Materials and Resources

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MR 1</td>
<td>Building reuse</td>
<td>Moderate</td>
</tr>
<tr>
<td>MR 2</td>
<td>Waste management</td>
<td>Moderate</td>
</tr>
<tr>
<td>MR 3</td>
<td>Resource reuse</td>
<td>Challenging</td>
</tr>
<tr>
<td>MR 4</td>
<td>Recycled content</td>
<td>Easy</td>
</tr>
<tr>
<td>MR 5</td>
<td>Local / regional materials</td>
<td>Easy</td>
</tr>
<tr>
<td>MR 6</td>
<td>Rapidly renewable materials</td>
<td>Easy</td>
</tr>
<tr>
<td>MR 7</td>
<td>Certified wood</td>
<td>Easy</td>
</tr>
</tbody>
</table>

Environmental Quality

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ 1</td>
<td>CO2 monitoring</td>
<td>Easy</td>
</tr>
<tr>
<td>EQ 2</td>
<td>Increase ventilation effectiveness</td>
<td>Easy</td>
</tr>
<tr>
<td>EQ 3</td>
<td>Construction IAQ plan</td>
<td>Moderate</td>
</tr>
<tr>
<td>EQ 4</td>
<td>Low emitting materials</td>
<td>Easy</td>
</tr>
<tr>
<td>EQ 5</td>
<td>Indoor chemical and pollutant source control</td>
<td>Easy</td>
</tr>
<tr>
<td>EQ 6</td>
<td>Controllability of systems</td>
<td>Easy</td>
</tr>
<tr>
<td>EQ 7</td>
<td>Thermal comfort</td>
<td>Easy</td>
</tr>
<tr>
<td>EQ 8</td>
<td>Daylight and views, distribution quality</td>
<td>Easy</td>
</tr>
</tbody>
</table>

Type of Construction

The nature of the materials and components used in the building will have an impact with respect to some of the Materials and Resources credits. The building code classification of combustible and non-combustible construction is the primary distinction. Smaller buildings are permitted to be of combustible or non-combustible construction, large buildings must be non-combustible.

The majority of the wood based structural materials components used in combustible construction are locally produced. For this reason the LEED points for use of locally produced materials (MR5) are much easier to achieve in smaller wood-framed buildings. The use of salvaged construction materials, a large portion of which are wood products, is also easier to incorporate into this type of building. In contrast the range of non-combustible salvaged materials, available from local suppliers is limited, and achieving LEED points will be more difficult in larger non-combustible buildings. However credits for use of materials with recycled content may be more achievable in non-combustible construction buildings.

Level of Design and Construction Technology

Many early green buildings pioneered new technologies, construction techniques and materials. Innovation in design and construction is often associated with risk. A perceived relationship between green design strategies and new or unique technologies can be an impediment to green building. However the design construction industry in the Lower
Mainland is becoming increasingly adept at applying many of the strategies in question.

### Level of Technology Required

<table>
<thead>
<tr>
<th>Sustainable Sites</th>
<th>Level of Technology Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 1 Site selection</td>
<td>N/A</td>
</tr>
<tr>
<td>SS 2 Urban redevelopment</td>
<td>N/A</td>
</tr>
<tr>
<td>SS 3 Brownfield redevelopment</td>
<td>Non-typical Conventional</td>
</tr>
<tr>
<td>SS 4.1 Public transport access</td>
<td>N/A</td>
</tr>
<tr>
<td>SS 4.2 Bicycle friendly</td>
<td>Conventional Conventional</td>
</tr>
<tr>
<td>SS 4.3 Alternative fuel refueling</td>
<td>Innovative Depending on fuel type</td>
</tr>
<tr>
<td>SS 4.4 Parking reductions</td>
<td>N/A</td>
</tr>
<tr>
<td>SS 5 Protect, restore, and maximize open space</td>
<td>N/A</td>
</tr>
<tr>
<td>SS 6 Stormwater management</td>
<td>Non-typical</td>
</tr>
<tr>
<td>SS 7 Landscape reduce heat islands</td>
<td>Innovative Green roofs</td>
</tr>
<tr>
<td>SS 8 Light pollution reduction</td>
<td>Conventional</td>
</tr>
</tbody>
</table>

#### Water Efficiency

<table>
<thead>
<tr>
<th>Water Efficiency</th>
<th>Level of Technology Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>WE 1 Water efficient landscaping</td>
<td>Non-typical</td>
</tr>
<tr>
<td>WE 2 Innovative wastewater technologies</td>
<td>Innovative</td>
</tr>
<tr>
<td>WE 3 Water use reduction</td>
<td>Non-typical</td>
</tr>
</tbody>
</table>

#### Energy & Atmosphere

<table>
<thead>
<tr>
<th>Energy &amp; Atmosphere</th>
<th>Level of Technology Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA 1 Optimize energy performance</td>
<td>Conventional Innovative at higher levels</td>
</tr>
<tr>
<td>EA 2 Renewable energy</td>
<td>Innovative</td>
</tr>
<tr>
<td>EA 3 Best practice commissioning</td>
<td>Conventional</td>
</tr>
<tr>
<td>EA 4 Eliminate HCFCs and halons</td>
<td>Conventional</td>
</tr>
<tr>
<td>EA 5 Measurement and verification</td>
<td>Conventional</td>
</tr>
<tr>
<td>EA 6 Green power</td>
<td>Innovative</td>
</tr>
</tbody>
</table>

#### Materials and Resources

<table>
<thead>
<tr>
<th>Materials and Resources</th>
<th>Level of Technology Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR 1 Building reuse</td>
<td>Conventional</td>
</tr>
<tr>
<td>MR 2 Waste management salvage / recycles</td>
<td>Non-typical Low technology</td>
</tr>
<tr>
<td>MR 3 Resource reuse</td>
<td>Non-typical Low technology</td>
</tr>
<tr>
<td>MR 4 Recycled content</td>
<td>Non-typical Low technology</td>
</tr>
<tr>
<td>MR 5 Local / regional materials</td>
<td>Conventional</td>
</tr>
<tr>
<td>MR 6 Rapidly renewable materials</td>
<td>Non-typical</td>
</tr>
<tr>
<td>MR 7 Certified wood</td>
<td>Non-typical</td>
</tr>
</tbody>
</table>

#### Environmental Quality

<table>
<thead>
<tr>
<th>Environmental Quality</th>
<th>Level of Technology Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ 1 CO2 monitoring</td>
<td>Conventional</td>
</tr>
<tr>
<td>EQ 2 Increase ventilation effectiveness</td>
<td></td>
</tr>
<tr>
<td>EQ 3 Construction IAQ plan</td>
<td>Non-typical</td>
</tr>
<tr>
<td>EQ 4 Low emitting materials</td>
<td>Non-typical</td>
</tr>
<tr>
<td>EQ 5 Indoor chemical and pollutant source control</td>
<td>Non-typical</td>
</tr>
<tr>
<td>EQ 6 Controllability of systems</td>
<td></td>
</tr>
<tr>
<td>EQ 7 Thermal comfort</td>
<td></td>
</tr>
<tr>
<td>EQ 8 Daylight and views, distribution quality</td>
<td>Conventional</td>
</tr>
</tbody>
</table>
3.1 OVERVIEW

Buildings are inherently complex systems; each component affects the operation of every other. The design process that leads to a successful green building typically reflects this reality: integrated, multi-disciplinary teams collaborate to explore a wide range of environmentally responsive design approaches that satisfy the functional program within budget constraints.

This teamwork is particularly intense early in the design process, during programming, concept and design development. As the graphic below shows, early design offers the best opportunity for life-cycle cost savings, with the least design, construction and operation expense.

Every development project has definite functional and fiscal performance targets for the facility and its construction. Green projects supplement these with explicit environmental performance targets that help guide
development, design and construction. Many recent green buildings show that this focus on environmental performance also results in lower operating costs and improved occupant satisfaction. The LEED™ framework can help, by providing an established set of environmental performance criteria.

**Key Differences with a Green Development Process**

Effective green design and construction typically differs slightly from projects less concerned with reducing environmental impacts:

- Close inter-disciplinary teamwork between architects, engineers, green design and costing specialists, occupants and operations staff from the design process,
- Explicit environmental performance targets for life-cycle energy, water and resource consumption, pollutant emissions and operating costs to guide facility design, construction and operation, defined jointly by the design team and owner.
- An “Integrated Design” process is used, in which the design team collaboratively explores, evaluates and refines a wide range of concepts during concept design and design development.
- Design teams strive for simple and systemic solutions that address multiple goals simultaneously, minimize material and energy consumption, and reduce construction cost.
- Use of computer energy simulation to optimize building form and envelope, electrical and mechanical system design, to reduce heating, cooling and lighting operating costs.
- Continued attention to waste reduction, health and environmental protection throughout design and construction.
- Post-occupancy evaluation of facility performance, to provide feedback to the owner, designers and contractors on the success of their efforts.

**3.2 USES OF LEED**

The LEED™ rating system provides a useful framework for green building design, construction and commissioning. LEED is typically used in one of two ways:

- To seek independent certification of building performance in environmental issues, publicly recognizing superior quality; and
- As a framework to guide designers pursuing better environmental performance, without seeking formal LEED™ certification.
Reasons for LEED Certification

As a trusted “brand” that publicly distinguishes a buildings’ superior environmental merits to the general public, LEED is aimed at market transformation, providing prospective buyers and lessors with impartial certification of better performance. Formal LEED certification involves a rigorous, independent review of the facility’s design and verified post-occupancy performance; and benefits are communicated with a prominent plaque and press coverage.

<table>
<thead>
<tr>
<th>LEED™ Building Certification</th>
<th>Member/Non-Member Price</th>
<th>LEED project registration and certification costs (2002)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Registration</td>
<td>$350/$500</td>
<td></td>
</tr>
<tr>
<td>Registers projects in development w/ USGBC; sets up access for technical credit interpretation support; 2-year free access to ruling web page; 2 credit interpretation requests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Certification</td>
<td>$1200**/$1500*</td>
<td></td>
</tr>
<tr>
<td>Includes 2-4 hrs technical review; certification committee review; certificate and metal plaque; listing on USGBC website; media announcement in trade magazine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Support</td>
<td>$220/$220</td>
<td></td>
</tr>
<tr>
<td>Credit interpretation (per submission)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

However, as the sidebar shows, direct and indirect costs (shown in US dollars) of official LEED certification are not insignificant. The effort required to document LEED credit performance can add to design cost – especially if the submittal is assembled “after the fact”, rather than as a routine design documentation task. As a result, project managers should decide early if formal certification is desired, and designers and contractors should be notified from the start, to minimize the effort required to document performance and seek certification.

Among the intangible benefits that should not be undervalued is the public education a LEED-certified green building offers. Currently, most building buyers and lessors are unaware of performance and environmental benefits of a green building; a LEED-certified building is one of the best ways to raise public awareness and understanding.

LEED Certification Process

The US Green Building Council has a three-step process for official certification:
Step 1: Project Registration  
Step 2: Technical Support  
Step 3: Building Certification

Further information can be found at [www.usgbc.org](http://www.usgbc.org)

**Project Registration**

For many municipalities, the first step may be to join the US GBC as a member. Membership reduces certification costs (particularly for multiple facilities), and affords additional support, information resources and tools. However, US GBC membership is not required to certify a facility.

If LEED certification is desired, the building owner registers the project and pays the registration fee before beginning the design process. Registrants obtain introductory LEED information, including the latest “Reference Guide” and a “Welcome Packet” which includes spreadsheets that aid point calculations and ease the documentation task.

**Technical Support**

Registration provides two-year access to the LEED Credit Interpretation Ruling web page; two free credit interpretation requests per registered project, and sets up access for additional “pay as you go” credit interpretation requests. The US GBC targets a two- to five-week turnaround time for decisions on on-line requests for interpretations.

**Certification Application & Submittals**

Once construction is complete and required documentation is compiled, the project team provides the USGBC with the required submittals. These are typically submitted after commissioning and occupancy, often with a contract in place for subsequent re-commissioning or a post-occupancy review prior to expiry of the warranty.

Submission requirements listed in the LEED Reference Guide are detailed and extensive. Usually, compiling the LEED submittal binder is the responsibility of the project manager, the architect of record or a designated specialist such as a LEED certified professional; detailed documentation of each individual credit is the responsibility of the professional or contractor most concerned. An early start with LEED record-keeping, and continued update throughout design, construction and commissioning, is key to efficiency; documenting features after the fact is likely to increase cost and effort unnecessarily.

Once the LEED documentation compiled by the design team is submitted to US GBC, its technical staff review it to ensure that all required information is submitted in an understandable form. Assuming this is the case, US GBC staff performs a preliminary review, providing detailed comments on each prerequisite and credit, a tentative rating,
and lists any documentation deficiencies. The design team then responds with any additional information required; with this submitted, the initial review is completed, and US GBC staff recommend a final score to the LEED Steering Committee. The LEED Steering Committee then accepts or rejects the recommended score, notifies the project team of the certification level awarded, issues press releases to selected publications, and presents the owner with a plaque to mount on the building. The project can then be referred to as a “LEED™-certified” building.

**LEED as a Green Design Framework**

Formal LEED certification, with the public recognition and education it offers, may be less important to the building owner than improving the facility’s environmental performance. In these situations, the LEED framework, with its credits, point awards and criteria can be used to guide design, document preparation and construction without seeking official LEED performance certification.

This route avoids the direct costs of US GBC certification. However, maintaining the same documentation standard as that required for certification follows a tried and tested method of monitoring performance throughout the development process.

### 3.3 PLANNING FOR GREEN BUILDING PROJECTS

Planning for a green building project begins early in the development process; ideally, when developing its pro forma or business case and determining budgets. Similarly, the decision to “go green” may influence the nature of construction and design contracts, and the project schedule; so early consideration is a good idea.

Typically, green project planning is influenced by the following factors:

- Life-cycle cost estimation for major design decisions
- Environmental performance targets
- Salvaged materials use
- Performance-based design and construction contracts
- Environmental and transportation considerations for site selection.

**Life-Cycle Cost Analysis**

Ideally, planning for a high-performance, environmentally responsive building emphasises minimizing the total life-cycle cost (LCC) of the facility; and begins when generating its business case, functional program and budgets. Developers of green buildings – especially public funded agencies – aim to maximize the value of the facility over its entire life, within a realistic construction cost budget. An informed balance of

---

“Life-cycle cost analysis (LCCA) is an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and ultimately disposing of a project are considered....”

capital and operating costs, aimed at minimizing the total life-cycle cost of ownership, helps to craft construction budgets for best lifetime value.

To measure life-cycle cost, Net Present Value or Internal Rate of Return fiscal indicators are used to assess and select between different investment and design alternatives. Both include the time value of cash flows over a long period, often the facility life. Governments typically seek the highest net present value (NPV); while the private sector often uses a minimum internal rate of return (IRR) measure.

Both take into account inflation and discount rates, maintenance, repair and replacement costs, and energy cost escalation; LCC analysis reliability depends on realistic estimates for these factors. Some factors are easily determined, such as discount rate (typically the developers’ cost of long-term, secure debt); but others, such as inflation and energy escalation rates estimates over decades, are highly uncertain. Often, scenarios are used to explore the effects of uncertain, but critical life-cycle cost factors, to help establish risk exposure and opportunity costs. (The “simple payback” measure commonly used in the speculative development industry ignores many operating costs, since they are typically paid by building occupants, rather than the developer.)

Life-cycle cost analysis helps decision-makers understand and minimize the risks of large development investments. It is best used to help establish the development budget; and throughout the design process to assess different design alternatives, and establish which offers the best long-term value. A realistic development budget, with a contingency to take advantage of operating cost savings opportunities that arise during design, can help improve the final result, and avoid irreversible decisions that may later be regretted.

Life-cycle cost estimates are typically reserved for decisions likely to affect both construction cost and energy performance. Green building designs, including those applying LEED, typically use computer energy simulation during design to estimate energy operating costs. This energy operating cost data is coupled with construction, maintenance, repair, replacement – and sometimes, occupant productivity – cost estimates over a twenty to fifty year building life, to arrive at a Net Present Value or Internal Rate of Return to compare against other design alternatives.
Planning for Salvaged Materials Use

Fiscal and contract planning for a green design project should consider opportunities for opportunities to purchase salvaged materials prior to construction. Early planning can greatly ease incorporating salvaged materials throughout design and construction, and reduce their costs.

The GVRD publishes a number of excellent guides to a wide variety of salvaged materials and equipment sources in BC, which can help greatly. (see [www.gvrd.bc.ca/services/garbage/sustainable_design.html](http://www.gvrd.bc.ca/services/garbage/sustainable_design.html) for details.)

Municipalities or a local landowner often have obsolete buildings suitable for deconstruction that could provide materials for the new facility, sometimes providing material cost savings. Promising deconstruction candidates should be identified early, salvageable material audits performed on likely sources; and if favourable, a budget allocation made for salvage and materials processing prior to re-use. If significant salvaged material opportunities exist, the design contracts should also account for design time spent sourcing and inspecting salvaged materials.

Several recent green BC projects with extensive salvaged material content have shown that it is often worthwhile to allocate a portion of the construction budget for early purchase of salvaged materials and equipment during the design process. As well, arrangements should be made for protected storage of salvaged materials until their use in construction.

If major salvaged materials opportunities exist, use of a construction management process should be considered, since it allows greater flexibility in sourcing, storing and processing salvaged and recycled materials, and can reduce contractor and owner risk. Construction management contracts can allow greater flexibility; and has been
successfully used for many local projects making extensive use of salvaged building materials. Many contractors are as yet unfamiliar and uncomfortable with salvaged materials use, and may charge a risk premium if they are required by design documents. Using a construction manager with proven salvaged material experience can ease their use, but can make construction cost control more complicated.

**Design Contracts**

If a standard design/tender/build development process is used, green building developers should consider design and construction contracts that reward better performance for both designers and contractors. Traditional design contracts often provide irrational incentives, since they are based on the cost of construction for each discipline, rewarding designs with higher construction cost. Contractors have a direct interest in reducing construction cost, even if this may increase operating cost. Structuring design and construction contracts to reward demonstrated operating savings and performance provides more appropriate signals and better facilities. The Rocky Mountain Institute outlines several alternatives for performance-based design and construction contracts, at www.rmi.org

Requests for design proposals and design contracts should highlight the owner’s requirements for a high-performance, sustainable building. They should also summarise expectations for LEED use, energy simulation and an integrated design process, commissioning and post-occupancy evaluation.

The increased effort required for green design and LEED certification should be recognized when setting design fee budgets. The design premium can range from 0 to 5%, depending on design constraints, complexity and the design teams’ experience. Additional green design tasks may include:

- Energy engineering & simulation, which range from $10-$15,000
- Research and analysis of new and innovative design alternatives (fees vary with alternatives explored)
- Commissioning and post-occupancy evaluation (fee varies with design complexity)
- Specialized sub-consultants, such as a certified LEED professional, stormwater management, green materials evaluation specialists, etc. (fees vary with alternatives explored)
- Documenting LEED credit performance and certification by the US GBC, typically requires 100 to 300 hours, exclusive of building energy simulation.

Documentation required for official LEED certification is both detailed and extensive; the estimate above assumes that the task starts at the beginning of the project. Ensuring that this LEED documentation is...
collected in an organized manner throughout design, rather than hastily collated at the end, can greatly reduce these costs.

Design contracts should detail how to deal with poor performance of innovative design approaches. Contracts should review how performance risk information will be communicated; how performance will be measured; and how to address potential costs of correcting problematic constructions and technologies. Use of contract performance bonds or bonuses, preparation of fallback design alternatives, and other ways to ensure innovation does not compromise performance should be considered.

Design team selection criteria should recognise demonstrated green design experience, and previous LEED use, as well as traditional issues of talent, design approach, experience with the building type, fees, etc. Expressions of Interest, Requests for Proposals and evaluation criteria should reflect demonstrated skills.

**Commercial Buildings Incentive Program: Reducing Design Costs of Energy Efficiency**

Design costs to the owner for advanced energy and green design are often reduced or completely offset by Natural Resources Canada’s Commercial Building Incentive Program (CBIP). The CBIP program pays developers to address energy efficiency with simulation in their design efforts, by providing monetary incentives of 2% of the annual energy cost savings (compared to a defined Model National Energy Code “reference” model). CBIP incentive payments can reach $60,000 per project, making simulation feasible even for most projects as small as 7-800 square meters floor area. (See [http://cbip.nrcan.gc.ca/cbip.htm](http://cbip.nrcan.gc.ca/cbip.htm) for details.)

**Tender Documents & Construction Contracts**

Requests for Proposal, construction tender documents and construction contracts should also emphasize the desire for a green building, and the owners’ intended use of LEED. With LEED and green construction currently new to many BC contractors, it is often wise to highlight these issues in a pre-bid information meeting, and address bidders’ questions and concerns prior to their submissions. This reduces the potential for contractors to overestimate fees, since contractor uncertainty with unfamiliar priorities and techniques is reduced.

The issue of risk for experimental design features should also be directly addressed in the construction contract, if the project intends to be a pioneer for innovation. Contracts should explicitly define their commissioning requirements; and address how potential problems will be addressed. This can be done by defining warranty periods or performance bonds; and with designs that offer fallback approaches in the event of disappointing performance.
For LEED certification, the contractor must prepare a variety of supplementary documents, including a construction stormwater management plan, a construction waste management plan, reports on green materials costs; and collaborate in commissioning of the building and its systems. These efforts should be addressed in the contract documents, and their satisfactory performance made a condition for progress payments.

Green building construction tender documents should highlight items that are not currently standard practice:

- Desire to seek formal LEED certification; or use of LEED to track project performance
- Goal of minimizing facility life-cycle costs, within pre-defined construction and site preparation budgets
- Defined energy, water, materials and indoor environmental quality performance targets and measurement methods
- Deconstruction and materials salvage efforts
- Habitat, stream, heritage and health protection requirements during construction
- Use of innovative design approaches and equipment
- Use of salvaged, recycled and healthy materials, particularly bookkeeping required to document LEED credit performance
- A formal commissioning process, and use of an independent commissioning agent
- Post-occupancy performance evaluation

When selecting the successful contractor, previous experience implementing any complex or novel green design features and previous LEED use should be considered, as well as traditional concerns of reputation, resources, skills and costs.

Design-Build Contracts

Design-build contracts have their own challenges and opportunities for green projects. Any design-build contractor has a direct incentive to minimize construction cost, but this may militate against approaches that reduce operating and maintenance costs. However, the increased collaboration and communication between designers and builders in design-build offers opportunities to explore innovative approaches and construction techniques that offer both capital and life-cycle cost savings.

Careful definition of the design-build specifications’ performance requirements is key to ensuring a satisfactory result and dispute-free process. This is particularly the case for projects with a sustainable design focus, since environmental, resource and occupant well-being issues have only recently become central considerations in building program requirement; many design-build contractors will be new to their implementation.
It is essential to structure design/build contracts to reward demonstrated life-cycle performance in terms of explicit targets, set by the owner in the original design-build specification. Contracts should address how performance of each target will be assessed; use of an experienced independent commissioning agent, responsible directly to and paid by the building owner, is an excellent way to ensure both better performance and fairness.

Design/build contracts should structure payments to provide meaningful motivation for better life-cycle cost performance, as well as on meeting construction budget and schedule expectations. Seeking official, independent LEED certification can help with such a performance-based approach.

Design/build contracts should highlight items that are not currently standard practice listed previously for design/tender processes; and it is worthwhile emphasizing these issues in a pre-bid information meeting with a briefing on expected use of LEED, and to address questions and concerns prior to design/build bidder’s submissions.

### 3.4 SITE SELECTION & PREPARATION

**Site Selection**

Early decisions about the site determine the constraints and opportunities for green and energy-efficient facility design. As a result, the following design issues should be also considered during site selection, as well as traditional program priorities:

- **Habitat, stream & heritage protection** (SS Credits 1, 5 & 6)
  Protecting limited habitat, streams and heritage structures is especially important in urban areas, where they are rare and hence more valuable.

- **Transit, pedestrian & non-car access** (SS Credits 2 & 4):
  Locating buildings, such as libraries, with good transit access can have as much impact on transportation energy consumption and emissions as the design of the building itself.

- **Restoration of brownfield sites** (SS Credit 3)
  Remediation and reuse of existing brownfield sites has immediate, demonstrable environmental benefits.

- **Solar & wind access** (EA Credits 1 & 2)
  Access to sun and wind make climate-responsive, passive design much more feasible, and offers the potential for major energy operating cost reductions.
• **Local air & noise pollution** (EA Credits 1 & 2)
  Sites with air and noise pollution issues are much more challenging for natural ventilation and cooling design.

**Site Preparation**

Once a site has been selected, it should be surveyed to identify valuable heritage structures, site features and habitat to be protected from construction damage; and to assess any opportunities for salvaged materials or plants for reuse. These should be clearly communicated to the design team, and to contractors that may work on the site prior to or during construction. The University of British Columbia’s Liu Centre and C.K. Choi buildings are excellent examples of this approach.

Site preparation contracts should require a detailed inventory of salvageable and recyclable materials and vegetation; allow sufficient time for deconstruction and salvage; and detail how existing habitat and nearby streams will be protected.

Building deconstruction for sale or reuse (including storage) of salvaged materials from any existing structures on a site should be an integral part of any re-development process. Deconstruction often offers cost savings, both from sale of salvaged materials and reduced landfill charges.

Stormwater management on the selected site should aim at eliminating the loss of sediments and pollution to receiving water bodies. Stockpiling salvaged topsoil, protecting bare soil areas from rain and erosion, and other effective measures should be implemented to ensure this.

### 3.5 INTEGRATED DESIGN PROCESS

Many European and North American green building projects have found that an “Integrated Design” process is key to cost-effective design excellence, including most BC green buildings, including the C.K. Choi and Liu Centre at UBC, BC Gas’ new Surrey Operations building and others. Integrated design of green buildings uses an enhanced design team that collaboratively explores a wide range of design alternatives aimed at better performance and reduced environmental impact. Much of this work happens early in the design process, often in intense design charrettes or workshops, and is informed by objective information on the environmental, energy and life-cycle cost performance of design alternatives, assisted by computer energy simulation. (See the process diagram on the following page.)

Successful integrated green design processes routinely include:

• Inter-disciplinary work between architects, engineers, costing specialists, operations people and other relevant actors from the beginning of the design process
• A common understanding between client and designers of the relative priorities and performance targets for resource and environmental issues
• Use of life-cycle costing to assess design alternatives that influence operating and construction costs
• Addition of an energy specialist, using computer energy simulation to inform the design team of the performance of different design alternatives
• Clear documentation of performance targets and design strategies, updated throughout the process by the design team

While integrated design of hospitals and other complex facilities is now routine, many commercial, institutional and industrial projects follow a more linear and less collaborative design process. With the conventional process, the architect and the client agree on the functional program and a design concept that satisfies it, including massing, orientation, and general appearance. With these largely decided, engineers are asked to design appropriate systems that meet comfort and health needs – but have little input to architectural design decisions that affect their work. By contrast, in integrated green design, the entire team is engaged in setting performance targets aimed at superior long-term health, environment and cost performance; and collaborative, inter-disciplinary efforts are emphasized.

Many green projects have found that one or more design workshops or “charrettes” early in the design process can greatly improve interdisciplinary collaboration. Together, the enhanced design team works in a focussed setting to brainstorm solutions; identify information needs and “off-line” tasks; and/or assess and compare relative performance of alternate approaches. Concept design and design development are typically iterative as the design is refined: the initial focus on passive form and envelope design shifts to electrical and mechanical systems in later workshops and meetings.

“The Integrated Design Process is an iterative design approach in which all the minds associated with the design and construction of a given building are brought to bear simultaneously. The objective is to realise an elegant design solution that is more energy efficient, in both construction and use, and (thus) more cost effective.”

Section 3
Green Buildings, Development, Design and Construction

Integrated Green Design Process Using LEED
Priorities & Performance Targets

Resource & Environmental Priorities

It is important to begin the design process with consensus and ‘buy-in’ from the developer and the design team on realistic goals and performance targets, given the opportunities and constraints of the site, functional program and construction budget. In almost all integrated green design processes, a portion of the customary initial design team orientation is devoted to understanding the site, its microclimate, and defining what resource and environmental issues the project can address best.

Most green performance rating systems, including LEED, use a generic, broad-brush weighting of resource and environmental issues that may not reflect the particular issues of the project, site or region. Collaboratively defining priorities and performance targets specific to the site results in personal and professional commitment to sustainable design that address real environmental issues of the region. Typically, resource, environmental and cost issues prioritized for a green facility design include:

- Greenhouse gas & ozone-depleting substance emissions
- Regional air pollutant emissions
- Potable water demand and consumption
- Non-renewable energy demand and consumption
- Water quality degradation
- Materials consumption
- Stormwater management
- Toxic materials reduction
- Indoor air quality & comfort conditions
- Land & water habitat protection
- Site preparation & construction costs
- Operating, maintenance & repair costs
- Transportation demands

Each of these should be jointly considered, and a priority assigned, as well as any others that may be unique to the site, region or municipality.

When doing this, the owner and the design team should understand and balance the issues of utilities that provide power, heat, water or other resources to the facility, as well as issues of environment and construction cost. “Upstream” energy and utility infrastructures have major influence on the overall environmental impact resulting from the new facility; and managed utility demand growth can defer or eliminate the need for large capital investments in new infrastructure by municipalities, the GVRD and energy suppliers.
Explicit Performance Targets

In projects using LEED, setting these priorities helps the team review each LEED credit and decide which best address local resource and environmental issues. The owner and the design team then jointly determine explicit draft performance targets in terms of points for each LEED credit, to guide later design efforts. These draft targets are typically documented in the Concept Design report; and reconfirmed at the end of design development, when the design is more mature.

Energy Simulation and Life-cycle Costing

Research indicates that for Canadian buildings, operating energy consumption is by far the largest part of their life-cycle environmental and resource impacts - typically ~75-85%, energy embodied in the structure and furnishings form the balance). As a result, reducing non-renewable energy consumption is a major focus of green design (and operating cost savings) efforts. LEED point awards reflect this reality; the Energy & Atmosphere category totals 17 possible points, more than any other. Energy Credit 1 alone offers ten points, recognizing the value of objective information on emissions and costs of design alternatives offered by computer energy simulation.

Computer energy simulation of buildings is typically the responsibility of specialist energy engineers, who use sophisticated software to provide the design team with energy load data and the operating cost implications of different form, envelope and systems approaches. Coordinated with construction and maintenance cost estimates, energy simulation allows the design team to evaluate the life-cycle costs of design alternatives, and to optimize the design for long-term savings.

However, energy simulation of all but the simplest of buildings requires significant effort - and experienced modellers - for reliable design guidance. Typical costs of energy simulation range from ~$7-9000 for a single performance verification model (required for LEED certification); to $14-17,000 for full energy engineering services, including iterative, multiple computer analyses; optimization of form, daylighting, natural ventilation, envelope, and HVAC and electrical system alternatives; and culminating in a final LEED verification model.

Energy simulation costs are often completely offset by CBIP incentives for energy-efficient design, discussed previously.

Integrated Design Workshops

Energy, environmental and cost issues of buildings are systemic: each element affects every other. As a result, each individual in the design team must understand how their particular design concerns influence the performance of other building elements and overall project costs; this is best done in a face-to-face, focussed setting. As a result, integrated green design processes often feature several intense design workshops
(often called “charrettes”) during concept design and design development, to propose design alternatives, compare and assess their performance, and refine the design to optimize life-cycle value.

In these collaborative workshops, the traditional design team core of architects and engineers is often supplemented with selected building occupants, operations and maintenance staff, cost consultants, and/or specialists in particular aspects of green planning, design or construction. These additional participants can provide a better understanding of builder, occupant, operations and maintenance requirements, and help harness their creativity to aid effective inter-disciplinary design efforts.

Workshops and charrettes often also feature a designated facilitator, to free design team attention for design issues; in LEED projects, this role is frequently filled by the LEED accredited professional. A trained green design facilitator stimulates team communications and problem solving, integrates individual designers’ experience and technical knowledge, and keeps track of information exchanged and decisions made. Facilitator selection should consider the green design experience of the owner and the design team; the right facilitator may assist with specialist green design knowledge and education.

The early integrated design process is iterative, with each workshop progressively refining the details of promising approaches identified earlier. Design of some assemblies often follow a slightly different sequence to more traditional design processes; for example, envelope insulation levels may be selected in concept design, informed by computer simulations, instead of later in design development. Similarly, principles for selection of non-toxic finish materials may be set in concept design, since it allows more ventilation flexibility.

**Concept Design**

During concept design, one or more collaborative workshops are typically focussed on proposing, exploring and assessing several form, siting and massing alternatives. These alternative concepts explore how passive strategies - insulation, air sealing, solar control, natural ventilation, thermal storage and daylighting – can be integrated to minimize heating, cooling and lighting loads. The common aim is to shrink – or eliminate – the need for mechanical and electrical systems, with their high cost and energy consumption.

As well as functional program, context and budget issues, the design team should be briefed on site environment and microclimate characteristics: significant soil, habitat and water features; solar angles and shading, local air quality and wind regime, etc. Data on typical energy & load characteristics for the use and region help the team understand where their efforts are best focussed; and are often introduced by a specialist energy engineer: peak heating, cooling & lighting loads; energy end-use profiles, etc. The energy engineer also provides load feedback on the passive insulation, daylighting, solar...
heating, thermal storage and/or natural ventilation approaches; and their interaction with HVAC and lighting concepts, using appropriate building simulation tools.

Frequently, ideas generated in an initial concept design workshop require “offline” research, design or analysis by individuals before joint decisions can be made. A later workshop then focuses on evaluating the performance of each concept, and refining the design of the most promising.

The end result is a single preferred concept design, and a selection of green design approaches for more detailed investigation, that should meet or exceed the resource & environmental targets drafted earlier. For most projects, these strategies, and the performance targets they address, is documented in a Concept Design Report; and for LEED projects, in its submittal binder.

**Design Development**

Having selected the most promising concept design, the design team typically moves on to the next finer scale of design detail in the first design development workshop. Here, they collaboratively integrate and refine the concepts’ elements in more detail, seeking solutions that serve several goals simultaneously. The team identifies design approaches requiring further investigation: envelope constructions, and mechanical and lighting systems to meet the (now minimal) loads efficiently. Typically, superior concept design and green design features become the focus of energy simulations and construction cost estimates, to assess operating and life-cycle cost performance, that are reviewed in the next gathering.

As in concept design, an integrated design development process is iterative; two or more workshops may be required. In the final design development workshop, the design team reviews design details and the construction budget; and finalize energy, environmental and resource performance targets for each LEED credit, aided by building occupants, operations and maintenance staff and the owner.

At the end of design development, required LEED documentation is typically collated, summarized and distributed as part of the Design Development report, to direct contract document preparation.

Projects following an integrated green design process typically extend the concept design and design development phases, and result in more detailed designs. As a result, the subsequent contract document preparation is often accelerated, since the preferred design approaches have been better fleshed out initially. As a result, using an integrated green design process typically has little scheduling impact when compared to the more traditional linear design process.
Contract Document Preparation

While preparing construction documents, each coordination meeting should dedicate time to monitor progress toward each LEED target, as a routine agenda item. Consistent follow-up through document preparation and construction is often critical to ensure that design intentions are met. It is most efficient if design team members continue to file green design documentation in their LEED submission binders, avoiding wasted time and effort collating this information after the fact.

As the construction documents approach 80-85% completion, a final energy simulation is performed to inform the pre-tender construction and life-cycle costing. This final simulation gives the owner and the design team confidence that the proposed design will perform as intended; and forms the basis of LEED Energy Credit 1 point awards and CBIP incentive payments. The final simulation is best performed just before the final documents are completed, so the design can be “tweaked” to ensure energy performance targets are met.

Specifications

Specification writers should ensure that specifications respond to LEED credit requirements; and that specific requirements for construction, including documentation or information provided by the contractor(s) are clearly articulated. Important specification sections required for LEED certification include:

- Construction stormwater management plan (SS Prerequisite 1);
- Site feature, habitat & vegetation to be protected (SS Credit 5.1);
- Basic and Additional commissioning requirements (EA Prerequisite 1 & AE Credit 3);
- Construction waste management plan (MR Credit 2);
- Contractor provision of separate cost breakdowns of salvaged, recycled-content, local/regional, rapidly-renewable materials, and certified woods (MR Credits 3, 4, 5, 6 and 7, respectively);
- For renovations of existing buildings, requirements for a plan protecting indoor air quality during construction (IEQ Credit 3);
- Details of operation manuals, guides, as-built documents, and operator and occupant training.

For more detail on document submittals required for LEED certification, see the LEED v2.0 Reference Guide.

“Unless project managers are vigilant, once construction begins, decisions about value-engineering processes, change orders and product substitutions may be made on the basis of reducing first costs or staying on schedule, with little or no consideration of the implications of such design changes for the overall performance and lifecycle economics of the building.”

ESource
3.6 CONSTRUCTION PROCESS

The construction process of green buildings differs in several ways from projects which pay little attention to environmental or resource issues. Typically, a green project applying LEED must address the specification items listed previously. As well, sustainable design features should be closely monitored in construction progress meetings, as a regular agenda item.

As discussed in the section on Tender Documents & Construction Contracts, it is important that these elements are clearly identified in the tender package, and in a pre-bid meeting of interested contractors, to ensure that they can be accurately priced and competitively bid. It should be made clear that environmental protection is a high priority, not just for the building itself, but also during its construction – especially for general and subcontractors who may be unfamiliar with these practices. Getting contractor buy-in to the sustainable features of the design and construction process is vital to ensure the quality of the development.

Stormwater Management, Heritage and Vegetation Protection

LEED v2.0’s Sustainable Sites Prerequisite 1 requires the contractor to submit a formal construction stormwater management plan, to prevent topsoil loss and the entry of site sediment to storm sewers or receiving streams. The GVRD’s “Best Management Practices Guide For Stormwater”; Appendix H surveys a wide range of methods to protect topsoil and prevent sediment pollution during construction.

As well, the general contractor should protect heritage features, stream setbacks and site vegetation clearly identified in the construction documents, from construction damage. Fencing requirements and other protection measures should be carefully reviewed and monitored until project completion.

Construction Waste Management & Green Materials Tracking

Construction waste management requirements may also be new to many contractors. LEED Materials Credit 2 requires a formal, written plan for waste reduction, materials to be recycled, and toxic waste handling; and tracking of waste materials diverted from landfills. Construction waste management offers valuable side-benefits to contractors; typically, recycling reduces waste disposal costs, and worker health and safety is enhanced. However, initial and periodic follow-up subcontractor and worker training are often wise, since it is not yet a widespread practice.
LEED Material Credits 3 through 7 address use and tracking of a wide variety of healthier, low-impact materials:

- Salvaged materials
- Recycled-content materials
- Locally/regionally sourced materials
- Rapidly-renewable materials
- Certified sustainable-harvested woods
- 

While the designers will specify many of these products, substitute products proposed by the contractor should be closely examined to ensure they meet performance requirements – particularly if LEED certification is desired, since material documentation “cut sheets” must be submitted for US GBC review. It can save time, effort and money if contractors are made aware of sources for these materials, and their performance requirements clearly identified prior to the start of construction. Contractor submittals for alternate materials with these features should be copied to the LEED documentation binder.

Applying LEED requires some additional bookkeeping on the part of contractors to track use of these materials. These Materials Credits all use a similar method for measuring performance: comparing the actual or market cost of the greener materials to the total project materials cost. This requires that contractors track these costs (or equivalent market costs) in an organized way, and retain documentation of material sources and specifications for LEED certification submittal. It is usually most efficient to use a spreadsheet to track these costs on an ongoing basis, rather than trying to collate them at the end of construction; these should be regularly reviewed in progress meetings, and for progress payments.

**End of Construction**

Several green construction efforts occur at or near the end of construction; and it is often difficult to ensure time for them with the schedule slippage commonly experienced. Careful and organized project management is required to keep project schedules on track – but flexibility in the occupancy target can allow these important procedures to occur, if all else fails.

These end-of-construction green efforts include:

- A two-week flushout period prior to occupancy, which significantly reduces occupant exposure to off-gassed pollutants from interior finishes and furnishings, particularly strong when they are newly installed.
• Preparing detailed operations manual, guides and as-built documents. These are essential to operate a building following the design intent; but these documents are often neglected – to the detriment of occupants and owner.

• Thorough commissioning of the building and its systems, to ensure that the building and its systems are performing as designed. This is particularly important for innovative green systems and equipment which may be new to designers, contractors, building occupants and operators.

3.7 COMMISSIONING & POST-OCCUPANCY EVALUATION

Commissioning

A “fundamental” commissioning of the building and its systems is a requirement for LEED certification, in Energy & Atmosphere Prerequisite 1; and “advanced” commissioning is an opportunity for additional points in Energy Credit 3. With more depth than the traditional “test and balance” procedure, commissioning is a systematic process that ensures that building mechanical, electrical and other systems and equipment perform following the design intent and the occupant’s needs. Typically, commissioning begins in concept design, with appointment of a formal agent, beginning a commissioning plan, and documenting design goals, targets and assumptions.


The Fundamental Commissioning required by the Prerequisite includes:

• A commissioning authority, responsible for ensuring performance.
• A review of design intent and assumptions with the design team.
• Requirements for commissioning in the contract documents.
• A formal, written commissioning plan.
• Functional performance verification of pieces of equipment individually, and under operational conditions.
• Preparation and handover of operator’s manuals, as-built drawings; and operator and occupant training.
• Submittal of a formal commissioning report, and a signed letter of certification.
• Ongoing monitoring of warranty performance.
While Prerequisite 1 does not require it, the developer may consider hiring the commissioning authority directly, so commissioning is independent from the contractor, ensuring a fair and objective process. This is especially important if payments are tied to satisfactory performance of the building and its systems.

The “Additional” commissioning for Energy Credit 3 point awards aids owner protection requires an independent “commissioning authority”. The commissioning authority is responsible for

- A design review prior to preparation of construction documents
- Review of near-complete construction documents
- Review of contractor submittals of commissioned equipment

As well, Energy Credit 3’s additional commissioning includes

- Preparation of a Recommissioning Management manual
- A review of building and systems performance, with occupant and deficiency surveys, post-occupancy or two months prior to expiry of the building warranty.

**LEED Certification Submittals**

LEED certification documentation is submitted as commissioning nears completion; the process can take up to 3-4 months before a final certificate is issued. (See the previous section 3.2 on LEED Certification.) It is important to ensure that the submitted documentation is complete, or delays may result from requests by the independent assessor for more information.
4.1 VANCOUVER ISLAND TECHNOLOGY PARK, SAANICH, BC

Vancouver Island Technology Park (VITP) provides a home for high-technology businesses, often known for their environmental concern. The Technology Park responds with green building and site design that protects the environment while providing healthy, cheerful - and productive - workspaces.

Overview
An existing 40-year old building was adapted to create 15,300 sq. m. of commercial space, as the first phase of redevelopment of the former Glendale Lodge hospital and grounds. Resource and environmental issues were championed by a dynamic development manager and integrated design team, and reflected in the comprehensive on-site stormwater, and energy-efficient mechanical designs.

A collaborative planning, design and economic development process consciously engaged the local community from the beginning, greatly easing planning, building, and site innovations. A sustainable transportation study improved transit access for the neighbourhood; green space valued by neighbours was enhanced and expanded; and use of an innovative grass paving and stabilized gravel system helped bring a new manufacturing capacity to the province. Practical and simple design principles reduced life cycle and maintenance costs, with no increase in capital cost.
The VITP is the first LEED Gold certified building in Canada. The project also won the 2002 BOMA / BC Hydro Power Smart Earth Award for environmentally responsible design.

Green Features

The first BCBC project to achieve a LEED 2.0 Gold certification, the facility coupled practical design principles with collaborative community and economic development efforts.

- Adaptive reuse and retrofit of the existing hospital reduced material use, and allowed use of existing road, water and sewer services – with significant site development cost savings. 99.9% of the building structure was reused, and approximately 91% of shell elements.

- Redevelopment of the site improved transit access, and the retrofit added secure bicycle storage and cyclists' shower facilities to encourage non-car commuting.

- The comprehensive site planning process with the Horticulture Centre of the Pacific identified and protected significant trees, and created a wildlife corridor with new trails lined with fruit and nut bearing trees. HCP students' landscape plan uses only native plant species, eliminating the need for irrigation; and allowing an Integrated Pest Management program that minimizes pesticide use. A total of 75% of the development is now green space, with 99% of the existing trees preserved.

- Stormwater runoff from the site was reduced with parking areas using an innovative grass paving, served by driving aisles of a stabilized gravel system that increase site permeability and treat pollutants. A local company was encouraged by the project manager to manufacture and distribute the product in BC – a new business in the Capital Regional District.

- Stormwater on the site and from upstream properties is detained and treated by bioswales and ponds located in setback areas and undevelopable low spots, to protect the nearby salmon-bearing Viaduct Creek, and provide waterfowl habitat.

- Waterless urinals, sinks with IR-sensor faucets and efficient dual-flush toilets helped reduce water consumption by 55% compared to traditional designs. This saves approximately 6.2 million litres of water annually - with no net increase in capital costs. Waterless urinals reduced both initial plumbing costs, since supply piping was eliminated; and regular maintenance costs for replacement of valves, etc.

- Cooling loads were reduced by installing indirect T8 fluorescent lamps, supplemented by task lighting; and with solar film applied to south windows.

- An energy-efficient, DDC-controlled distributed heat pump system with thermal storage; and variable volume pumps with 2-way valves
reduce water loop pumping energy. Computer energy modeling showed the renovated design should perform approximately 27.5% better than an ASHRAE/IESNA standard 90.1 –1999 – compliant building, and save approximately $5000 annually in operating costs.

- Indoor air quality is enhanced by placing roof air intakes distant from pollutant sources; and interior finishes, sealants and glues were selected for low-VOC and pollutant emissions. In many areas, T-bar ceilings were eliminated, reducing exposure to man-made mineral fibres, and all supply air passes through premium 40% efficient filters.

- LEED Innovation points were awarded for exemplary demolition waste management. Retrofit, salvage and recycling during building retrofit diverted 98% of demolition waste from landfill, with $600,000 savings to the building owner. Innovation points were also awarded for reuse of a historic building and inclusion of a LEED certified professional on the design team.

- One-third of the value of materials used in the new building had major recycled content; and almost a quarter of the building fittings were salvaged, including insulation, ductwork and cabinets.

Contacts

Developer:
British Columbia Buildings Corp.
www.bcbc.bc.ca
http://www.vitp.ca/
BCBC Project Manager: Joe van Belleghem
JVanBelleghem@bcbc.bc.ca

Architect:
Bunting Coady Architects
tcoady@buntingcoady.com

LEED Score: Gold (40 points)
4.2 CITY OF VANCOUVER CHESS STREET WORKS YARD, VANCOUVER, BC

Overview
Under design by the City of Vancouver Engineering Services in spring 2002, the new engineering works yard is intended to replace existing outdated facilities, as a base for water, sewer, streets and electrical operations crews and their tools. The facility will include office, shop, storage and crew staging components in 5 individual buildings on a 5 ha site; completion is scheduled for summer 2003. The main administration building (30,000 sq. ft.) and the parking operations building (3000 sq. ft.) are being designed to meet LEED v2.0 Silver requirements or better. This is intended to be the City’s first LEED-certified project. As part of this project the Engineering Department is looking at a large number of sustainable building strategies, from recycling to water use reduction and storm water management.

Green Features
The two LEED buildings will balance functional requirements with occupant comfort and aesthetics, employing many sustainable design features. The following green features and targets have been set and will be incorporated into the design:

- Design to maximize occupant comfort and control. The buildings are oriented on an east-west axis and skylights and clerestory windows are provided to maximize daylighting. Operable windows along the entire perimeter for natural ventilation and individual occupant control of heating, cooling as an explicit design goal. The buildings also expose ceiling structures to enhance thermal storage.

- Indoor air quality is protected by specification of low VOC carpets, paints, adhesives and wood composites.
• Energy consumption will be reduced by 35% or more, as compared to ASHRAE 90.1-1999 requirements. The two buildings will be heated and cooled using a DDC-controlled ground source heat pump system in conjunction with radiant panels. Lighting fixtures, equipped with daylight and occupancy sensors to maximize energy efficiency, are also being considered. A portion of the building energy will be provided using photovoltaic panels.

• Water consumption will be reduced by a more than 30% beyond the LEED baseline (1992 US Energy Policy Act). The two buildings will include water saving features such as low-flow fixtures, dual flush toilets and waterless urinals to reduce the total building water use. Onsite landscaping is specified as drought resistant and does not require irrigation.

• The buildings will be constructed with high fly ash concrete, high recycled component steel piling and structure and high-recycled content finishes.

• An aggressive construction waste management plan will be pursued with a target of recycling 75% of all construction waste generated onsite.

• Good access to transit and secure bicycle storage and shower facilities to encourage alternative transportation to the site. The project will include a walking path to the nearest Skytrain station.

• Collection of rainwater and on-site storage for toilet flushing and vehicle washing.

• Stormwater management with a gravel paver system and a green roof feature.

Contacts

Owner
City of Vancouver
www.city.vancouver.bc.ca/

Project Manager
Peter Bremner, P.Eng.
peter_bremner@city.vancouver.bc.ca

Architecture, Engineering and Construction Management: Omicron Consulting Group
www.omicronconsulting.com/main.html
4.3 CITY OF WHITE ROCK OPERATIONS BUILDING, WHITE ROCK, BC

Overview

The new Operations Centre will be located within the confines of the existing Works Yard, originally the site of a sewage treatment plant. The new facility program calls for a relatively small building (6,500 sq. ft.) and will house both the Field Crew Facilities and the Office Staff Facilities. Detailed daylighting and shading studies coupled with energy simulation in an integrated design process resulted in a low, 2-storey form locating workspaces in two wings in order to optimize passive solar and natural ventilation performance.

The project is currently in the early stages of construction (Fall 2002).

Green Features

- The building was consciously sited to rehabilitate a brown-field site, and take advantage of an existing basement for new foundations; and its massing makes good use of the sun for passive heating and daylighting. Windows were placed primarily on the south elevation, and limited on other exposures as part of optimizing their energy contributions and losses.

- Shadow studies were used to design shading specific to each elevation: east and south sides of the office block feature large roof overhangs; and deciduous trees planted to the east will control morning heat gains and glare. On the south face, a 9-metre sunscreen, set lower than the roof eave, controls summer sun entry to the workplace. A wood trellis running the length of the west face of the building includes vertical shading fins and a horizontal plant trellis.

- The narrow floor design allowed natural ventilation and cooling by cross-ventilation through occupant-controlled operable windows.
Prevailing winds create negative pressures on the north side and behind the fin-trellis on the west, promoting natural airflow across each floor. As a result, mechanical air conditioning and its associated ozone-depleting chemicals were eliminated, with considerable mechanical cost savings.

- Daylight distribution inside the building is enhanced with glass walls between enclosed offices and open office areas. This allows low artificial building lighting power levels of 0.85 watts/ft², supplemented by task lighting.

- Computer simulations indicate that the facility will use approximately 45% of the energy of a similar project built to meet the Model National Energy Code for Buildings; with projected operating cost savings of approximately $4,785 per year, based on current energy prices.

- A “Green Roof” over the one storey portion of the building assists in reducing and treating storm water runoff from the building, and also moderates cooling loads.

- An existing 340,000 litre concrete tank was re-used as a stormwater storage tank to provide water for truck washing and toilet flushing, reducing potable water use. Existing storm piping was used to collect runoff by gravity, avoiding the costs of pumps.

- Waterless urinals, dual-flush toilets, and low-flow showerheads and faucets further reduce potable water consumption.

- A water-source heat pump system also uses the stormwater storage tank to supply heat for the building, supplemented by high-efficiency gas boilers; evacuated-tube solar water heaters are also being studied for their cost-effectiveness.

- Innovation points are anticipated for the reuse of the existing basement and creative dual use of the existing water tank. Inclusion of a LEED certified professional on the design team will also provide a point.

### Contacts

**Developer**  
City of White Rock  
Manager  
Greg Scott  
gscott@city.whiterock.bc.ca

**Architect**  
Busby & Associates, Architects  
[http://www.busby.ca/projects.htm](http://www.busby.ca/projects.htm)  
David Dove  
ddove@busby.ca

---

**Preliminary LEED Score:**  
Gold (41 points)
4.4 LIU CENTRE FOR THE STUDY OF GLOBAL ISSUES, VANCOUVER, BC

Overview
Recipient of a Architectural Institute of BC 2001 Architectural Innovation award, and the Lieutenant Governor’s Medal in Architecture, the Liu Centre is surrounded by a second growth fir and cedar forest, which provides cooling shade, beautiful views and the contemplative atmosphere required by the Institute and its scholars. Its integrated design process included forty stakeholders to define objectives, qualities and sustainable performance goals; and the 1750 sq.m. building was carefully fit into the site of an existing building, preserving and enhancing the urban forest. A seminar wing provides public spaces for receptions and conferences, and a three-storey research wing is used for more private functions. The wings are connected by a glazed lobby, creating two courtyards, one a formal entry and the other for outdoor events.

Naturally ventilated, cooled and daylighted, the building makes extensive use of salvaged and recycled materials, and provides premium amenities and environmental stewardship for a modest budget of $3.1 million ($1,771 / m²). While LEED was not used in the design process, it is estimated that it would have achieved a LEED 2.0 Silver rating if formally certified.

Green Features
- The building was located to preserve existing site trees (including a rare katsura), and avoid damage to tree roots; heavy machinery use was restricted to avoid soil compaction. Courtyards include a stone garden, native ferns and wild grasses that restore the forest.
floor and minimize irrigation requirements. The courtyard and building form provide natural ventilation for and views from surrounding workspaces.

- Floor plates were deliberately narrow to maximize natural ventilation and daylighting; and free-span structures offer flexibility for a long useful life as uses evolve.
- Building materials and systems were evaluated on durability, efficiency, embodied energy, environmental impact and economic feasibility using a forty-year life cycle cost analysis.
- Exposed building systems - concrete floors, timber and concrete ceilings, cable trays, sprinklers and mechanical ducts - minimize the amount of interior finishing required.
- High-performance, low-e, argon-filled glazing and curtain wall systems were used for thermal performance.
- Careful electrical and lighting design, with daylight or occupancy sensors controlling many fixtures, eliminated the need and cost for a new substation, required by a more typical design.
- Design of the building for natural ventilation and cooling eliminated the need for mechanical air-conditioning and ducting. The design includes areas with narrow plans and operable windows for cross ventilation; exposed concrete structure for thermal storage; and tall assembly spaces and interconnected floors, for air stratification.
- Air-to-air heat exchangers for the seminar room, and displacement ventilation in the case room eliminated ventilation ducts and reduced operating costs. The building uses at least 25% less energy than one designed to the Canadian Model National Energy Code for Buildings (MNECB).
- Covered bicycle stalls and on-site shower facilities promote alternative modes of commuting.
- The seminar wing roof was built of salvaged glulam beams and structural decking from the building previously on the site; beams were lightly sandblasted and fully exposed as a finished heavy timber ceiling. Other high quality salvaged materials – bricks, pavers, glulams and structural decking – were collected from recently demolished buildings at UBC and used building materials yards in the region. Use of salvaged building materials resulted in a 50-60% cost savings over using new materials of the same type.
- Concrete and cement quantities were minimized with pre-cast planks and poured-in-place frames with high fly ash content (replacing 50% of cement content); the first Canadian non-industrial building to use high volumes of fly ash, a waste by-product of the coal industry, in its concrete.
Interior paints and adhesives were selected for low-toxicity and pollutant emissions.

Careful construction waste management and deconstruction allowed 94% of the materials of the existing building on site to be reused or recycled.

**Contacts**

Owner: University of British Columbia
www.sustain.ubc.ca/2ourinitiatives/green_build.html#2

Architect
Architectura Planning
Architecture Interiors Inc., in collaboration with Arthur Erickson.
Noel Best (partner-in-charge)
nbest@architectura.ca
SECTION 5

Resources

This resource list is compiled from resources identified in the Draft LEED BC Applications Guide, December 2001, prepared by Dr Raymond J Cole, Environmental Research Group, School of Architecture, University of British Columbia, for the LEED BC Committee. Resources are compiled under the 5 LEED sustainable design categories and are listed for each prerequisite and credit. Some resources are applicable to more than one credit and are listed in each applicable section.

5.1 SUSTAINABLE SITES

Site Prerequisite 1: Erosion and Sedimentation Control


Site Prerequisite 2: Streamside protection


Site Credit 1: Site Selection

Campbell, C., and Ogden, M., Constructed Wetlands in the Sustainable Landscape, John Wiley & Sons, 1999

Site Credit 2: Urban Redevelopment

Wilson, A., et. al., Integrating Ecology and Real Estate, John Wiley & Sons, 1998

Site Credit 3: Redevelopment of Contaminated Site

EPA Sustainable Redevelopment Brownfields Program: A comprehensive site on Brownfields that includes projects, initiatives, tools, and other resources to address Brownfield remediation and redevelopment. Site: www.epa.gov/swerosps/bf/
The Brownfields Non-Profits Network: A collection of non-profit organisations that provide information on Brownfield redevelopment.
Site: www.brownfieldsnet.org/

Site Credit 4: Alternative Transportation


Bicycle Federation of America, Internet Resource Centre: Comprehensive coverage of a host of policy, planning and design guidelines supporting bicycle use.
Site: http://www.bikefed.org

Long Term Bike Parking: Useful overview of design considerations for long-term bicycle storage offering essential and optional features for caged facilities, bike rooms, bike lockers and shower & clothes locker rooms.
Site: http://www.jps.net/cbc/longbikepark.html


Alternative Fuels Data Centre: section of the US DOE Office of Transportation Technologies that has information on alternative fuels and alternative fueled vehicles, a locator for alternative refueling stations, and other related information.
Site: www.afdc.doe.gov/

California Electrical Code, Chapter 6, Article 625. Electric Vehicle Charging System Equipment: The new section of the California Electrical Code applying to electric vehicle charging stations.
Site: http://www.energy.ca.gov/afvs/ev/ev_building_codes.html

Site Credit 5: Reduced Site Disturbance
Natureescape British Columbia: Program for restoring, preserving, and enhancing wildlife habitat in urban and rural landscapes throughout BC.
Site: http://www.hctf.ca/nature.htm

Soil and water Conservation Society: An organisation focussed on fostering the science and art of sustainable soil, water and related natural resource management. Site: www.swcs.org


Lyle, J. T., and Woodward, J., Design for Human Ecosystems: Landscape, Land Use, and Natural Resources, Milldale Press, 1999

Site Credit 6: Stormwater Management

GVRD Stormwater Homepage: Site providing numerous resources for stormwater management Site: http://www.gvrd.bc.ca/services/sewers/drain/Stormwater_home.html

The Health of Our water: Toward Sustainable Agriculture, Agriculture and Agrifood Canada, Research Branch: General information on surface water quality, ecological issues and protecting water quality. Site: http://res2.agr.ca/research-recherche/science/Healthy_Water/e10g2.html

GVRD Stormwater Homepage: Site providing numerous resources for stormwater management Site: http://www.gvrd.bc.ca/services/sewers/drain/Stormwater_home.html

The Health of Our water, Agriculture and Agri-food, Research Branch: Comprehensive coverage of water quality issues. Although primarily from the standpoint of agricultural impacts and consequences, makes links to urban issues and stormwater. Site: http://res2.agr.ca/research-recherche/science/Healthy_Water/e10g2.html

Site Credit 7: Landscape and Exterior Design to Reduce Heat Islands

US EPA Energy Star Roofing Products: provides solar reflectance levels required to meet Energy Star labeling requirements. Site: yosemite1.epe.gov/estar/consumers.nsf/content/roofbus.htm

Color Matters: includes discussion and statistics on colour choices and their energy use effects. Site: www.colormatters.com
Cool roofs program: provides rebate incentives to reduce the peak electricity demand from air conditioning systems resulting from solar energy absorbed by roof surfaces and rooftop ducts and transferred as heat into air-conditioned space. Site: http://www.lgc.org/techserve/coolroofs/

Green Roofs for Healthy Cities: The purpose of initiative is to promote the development of a North American market for green roof products and services in order to take full advantage of the many benefits these technologies offer. The current market environment fails to fully value the tangible public and private benefits of these technologies. Site: http://www.greenroofs.ca

Site Credit 8: Light Pollution Reduction

The International Dark-Sky Association: A non-profit agency dedicated to educating and providing solutions to light pollution. Site: www.darksky.org/ida/ida_2/index.html


5.2 WATER EFFICIENCY

Water Credit 1: Water Efficient Landscaping

City Farmer: Canada’s Office of Urban Agriculture: Contains information on water efficient lawn care and other practices with links to related organisations.
Site: http://www.cityfarmer.org/grass.html

Irrigation Industry Association of British Columbia: Provides guidelines, standards and specifications for the design and installation of irrigation systems in BC.
Site: http://www.irrigationbc.com/index.htm

Site: www.waterwiser.org


Natural Lawn Care. Greater Vancouver Regional District. 2000

Water Credit 2: Innovative Wastewater Technologies

US EPA Water Saving Tips
Site: www.epa.gov/OW/you/chap3.html

Greater Vancouver Regional District: Water Conservation: provides guidance to residential, commercial and industrial water users on water conservation.
Site: http://www.gvrd.bc.ca/services/water/conserve/index.html

Water Credit 3: Water Use Reduction

A Water Conservation Strategy for British Columbia. 1998. Ministry of Environment, Lands and Parks (MELP), Province of British Columbia. The strategy provides a common framework for water management activities throughout the province while accommodating regional differences.
Site: http://www.elp.gov.bc.ca/wat/wrs/strategy/index.html

Water-use Efficiency Catalogue for British Columbia. 1998. Ministry of Environment, Lands and Parks (MELP), Province of British Columbia. The Water-use Efficiency Catalogue is part of the development of the Water Conservation Strategy. It catalogues water conservation activities throughout the province and promotes cooperation and information sharing between stakeholders.
Site: http://www.elp.gov.bc.ca/wat/wrs/waterusecat/cat01in.html

Canada’s Water Efficiency Experiences Database. The water efficiency database was developed by the Canada Water and Wastewater Association (CWWA) and Environment Canada. Information in the database is classified by key activities, geographic location, main water use (like domestic water or laundry water) and sectors (like government or commercial).
Site: http://www.cwwa.ca/wed.htm
Green Building Checklist. December 2000 Edition. Ministry of Finance and Corporate Relations, Province of British Columbia. In the summer of 1999, Cabinet directed that all new provincially funded projects, beginning with the fiscal year 2000/2001, incorporate green design principles. The Green Building Checklist provides a framework against which provincially funded projects can evaluate their incorporation of Green Design principles. None of the items contained in the Checklist are presently mandatory. 
Site: http://www.fin.gov.bc.ca/cd/policies.htm


Biological Toilets and Grey-water Systems. Canada Mortgage and Housing Corporation (CMHC) Research Division. 1993


5.3 ENERGY AND ATMOSPHERE

Energy Prerequisite 1 Fundamental Building Systems Commissioning Required

Web-sites

Model Commissioning Guide. 1997. Portland Energy Conservation Inc. The PECI site has an excellent Guide, case studies and other resources for free download, for design and construction commissioning. Primarily aimed at larger projects, the Guide provides boilerplate language, content, format and forms for specifying and executing commissioning.

Site: http://www.peci.org/cx/index.html


American Society of Heating, Refrigerating & Air-conditioning Engineers. The Guideline describes the commissioning process for all types and sizes of HVAC systems, from predesign through final acceptance and post-occupancy. It covers procedures, methods, and documentation requirements for each phase of the commissioning process, including preparation of documentation, and training of operation and maintenance personnel.

Site: http://www.confex.com/ashrae/store/standards/guide1.htm


Site: http://www.eren.doe.gov/femp/techassist/bldgcomgd.html

Print media

Commissioning Specifications. Natural Resources Canada, C-2000 Program. 1995. The specification used for Canada's C2000 projects; oriented toward construction, rather than design; and cold weather climates.

C-2000 Program, Energy Mines & Resources, Energy Efficiency Division, 7th Floor, 580 Booth St., Ottawa, Ontario, Canada K1A 0E4.

HVAC Systems Commissioning Manual. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), 1993. Oriented to construction, not design. SMACNA, 4201 Lafayette Center Dr., Chantilly, VA 22021.

Energy Prerequisite 2: Minimum Energy Performance

Web-sites


Site: [http://www.nrc.ca/irc/catalogue/energy2.html](http://www.nrc.ca/irc/catalogue/energy2.html)

Performance Compliance for Buildings. 1999. Canadian Commission on Building and Fire Codes, National Research Council of Canada. Elaborates on the various functions that the compliance software must be capable of performing in order to assist a user in demonstrating that a proposed design complies with the MNECB. The intended audience is software development agencies that will develop or adapt software and related manuals for this purpose.

Site: [http://www.nrc.ca/irc/catalogue/energy2.html](http://www.nrc.ca/irc/catalogue/energy2.html)

Commercial Building Incentive Program. 2000. The home website of Natural Resources Canada's Commercial Building Incentive Program (CBIP) links to design features of selected CBIP buildings, case studies of buildings and integrated design processes used, as well as the Technical Guide (below); the CBIP web screening tool and free CBIP-EE4 software for energy simulation.

Site: [http://cbip.nrcan.gc.ca/buildings/index_e.html](http://cbip.nrcan.gc.ca/buildings/index_e.html)

Commercial Building Incentive Program II Technical Guide. 2000. The Technical Guide to Natural Resources Canada's Commercial Building Incentive Program (CBIP) lays out the details of the program and its procedures, with guidance for specific building types.

Site: [http://cbip.nrcan.gc.ca/techguidelines_e.html](http://cbip.nrcan.gc.ca/techguidelines_e.html)


Site: [http://www.csa.ca/](http://www.csa.ca/)


Site: [http://www.ashrae.org/](http://www.ashrae.org/)

Print media

Energy Prerequisite 3: CFC Reduction in HVAC&R Equipment

Web-sites

Stratospheric Ozone Depletion Table of Contents. 2000. BC Ministry of Environment, Lands & Parks Air Resources Branch. This provincial government website indexes reports on the science of stratospheric ozone layer depletion, management plans for halons in fire-fighting equipment, and the provincial regulation.
Site: http://www.elp.gov.bc.ca/epd/epdpa/ar/ozone/index.html

Environment Canada Ozone-Watch Bulletins. This website, hosted by Environment Canada’s Meteorological Service, presents online bulletins and charts of current and historical stratospheric ozone levels in various areas of Canada.
Site: http://gfx.weatheroffice.ec.gc.ca/ozone/index_e.html

US Environmental Protection Agency Global Warming. Hosted by the US EPA, this website presents general discussions, facts and figures on global warming.
Site: http://gfx.weatheroffice.ec.gc.ca/ozone/index_e.html

Energy Credit 1: Optimise Energy Performance

Web-sites

Site: http://www.nrc.ca/irc/catalogue/energy2.html

Performance Compliance for Buildings. 1999. Canadian Commission on Building and Fire Codes, National Research Council of Canada. Elaborates on the various functions that the compliance software must be capable of performing in order to assist a user in demonstrating that a proposed design complies with the MNECB. The intended audience is software development agencies that will develop or adapt software and related manuals for this purpose.
Site: http://www.nrc.ca/irc/catalogue/energy2.html

Commercial Building Incentive Program. 2000. The home website of Natural Resources Canada's Commercial Building Incentive Program (CBIP) links to design features of selected CBIP buildings, case studies of buildings and integrated design processes used, as well as the Technical Guide (below); the CBIP web screening tool and free CBIP-EE4 software for energy simulation.
Site: http://cbip.nrcan.gc.ca/buildings/index_e.html

Commercial Building Incentive Program II Technical Guide. 2000. The Technical Guide to Natural Resources Canada's Commercial Building Incentive Program (CBIP) lays out the details of the program and its procedures, with guidance for specific building types.
Site: http://cbip.nrcan.gc.ca/techguidelines_e.html

Site: http://www.csa.ca/

*Site:* http://www.eren.doe.gov/

US DOE Lawrence Berkeley Laboratory Environment Energy Technologies Division. Authoritative North American building energy researchers, LBL has several areas of building energy-efficiency research: energy simulation; windows, daylighting & lighting systems; indoor environment; energy analysis.

*Site:* http://eetd.lbl.gov/

**Print media**


**Energy Credit 2: Renewable Energy**

**Web-sites**

Natural Resources Canada’s Renewable Energy Deployment Initiative (REDI). The federal governments Renewable Energy Deployment Initiative program offers incentives of up to 25% of the capital cost of solar water and air heating, and efficient biomass combustion systems for commercial building projects of 75kW or more, to a maximum of $50,000. It also has created an excellent set of Excel spreadsheet tools for early design screening of solar thermal, photovoltaic, biomass and ground-source heat pumps, under the general name, RETScreen.

*Site:* [http://www.nrcan.gc.ca/es/erb/reed/redi_e.htm](http://www.nrcan.gc.ca/es/erb/reed/redi_e.htm)

Solar Energy Society of Canada, Inc. (SESCI). SESCI is the primary Canadian non-profit solar organisation, established to advance the awareness, understanding and use of solar energy in Canada. SESCI’s website carries breaking Canadian solar news, workshops and conferences; and allows on-line purchase of the Canadian Renewable Energy Guide, one of the best sources for Canadian RE information, designers and suppliers.

*Site:* [http://www.solarenergysociety.ca/](http://www.solarenergysociety.ca/)

Canadian Solar Industries Association (CANSIA). CANSIA is the primary Canadian solar energy industry association, fostering research, information exchange and lobbying on behalf of manufacturers and distributors. The public portion of their site includes listings of solar energy technology manufacturers and suppliers, and a “Buy and Sell” database for solar equipment.

*Site:* [http://www.cansia.ca/](http://www.cansia.ca/)

Florida Solar Energy Center (FSEC). The FSEC is the most active State-supported renewable energy research, training, testing and certification agency in the US. Home of the National Solar Collector and System Certification Program, it offers independently-tested collector efficiencies, listed in their “WWW Solar Applications Guide”, with detailed technical information on solar energy applications, for free download.

US National Renewable Energy Laboratory (NREL). A primary resource for renewable energy technologies, the US DOE's National Renewable Energy Laboratory carries introductory, policy and technical information on RE technology and research in North America. The site has a huge Publications Database of research, an excellent search engine, and the PIX image database, a text & visual-thumbail searchable collection of presentation images.


Print media


Home Power Magazine. P.O. Box 520, Ashland, OR 97520. An excellent bi-monthly magazine, offering hands-on experience on photovoltaic and wind energy generation. While mostly oriented toward off-grid, single-family residential applications, it has a good balance of theory and practical experience, and information valuable for commercial/institutional projects. Back issues are available on-line and in CD-ROM format. Available online at [http://www.homepower.com](http://www.homepower.com)


**Energy Credit 3: Best Practice Commissioning**

Web-sites

Model Commissioning Guide. 1997. Portland Energy Conservation Inc: The PECI site has its excellent Guide, case studies and other resources for free download, for design and construction commissioning. Primarily aimed at larger projects, the Guide provides boilerplate language, content, format and forms for specifying and executing commissioning.

Site: [http://www.peci.org/cx/index.html](http://www.peci.org/cx/index.html)


Site: [http://www.eren.doe.gov/femp/techassist/bldgcomgd.html](http://www.eren.doe.gov/femp/techassist/bldgcomgd.html)
Print media


SMACNA, 4201 Lafayette Center Dr., Chantilly, VA 22021.

Energy Credit 4: Elimination of HCFCs and Halons

Web-sites

Stratospheric Ozone Depletion Table of Contents. 2000. BC Ministry of Environment, Lands & Parks Air Resources Branch. This provincial government website indexes reports on the science of stratospheric ozone layer depletion, Management plans for halons in fire-fighting equipment, and the provincial regulation.
Site: http://www.elp.gov.bc.ca/epd/epdpa/ar/ozone/index.html

Environment Canada Ozone-Watch Bulletins. This website hosted by Environment Canada's Meteorological Service presents online bulletins and charts of current and historical stratospheric ozone levels in various areas of Canada.
Site: http://gfx.weatheroffice.ec.gc.ca/ozone/index_e.html

US Environmental Protection Agency Global Warming. This website hosted by the US EPA presents general discussion, facts and figures on global warming. Table EF-6 lists global warming potentials of hydrochlorofluorocarbons at http://www.epa.gov/oppeoee1/globalwarming/emissions/national/gwp.html
Site: http://gfx.weatheroffice.ec.gc.ca/ozone/index_e.html

Estimates of U.S. Emissions of High-Global Warming Potential Gases and the Costs of Reductions. 2001. United States Environmental Protection Agency Air and Radiation Branch. Chapter 7 estimates costs and emission reductions for HFC emissions from refrigeration and air-conditioning; which are expected to be grow threefold from 1999 levels if current trends continue.
Site: http://www.epa.gov/ghginfo/reports/

Print media

Energy Credit 5: Measurement and Verification

*Web-sites*

US Department of Energy International Performance Measurement and Verification Protocol, Appendix II: Measurement & Verification Guidelines: A Generic Application of the IPMVP - Option B: Methods by Technology. This Appendix provides procedures and guidelines for quantifying savings resulting from the installation of energy conservation measures under the IPMVP, a commonly accepted methodology for measuring energy savings associated with performance contracts. This Appendix is intended for general application in commercial, industrial, institutional and local public sector facilities.

*Site:* [http://eande.lbl.gov/CBS/femp/MVdoc.html](http://eande.lbl.gov/CBS/femp/MVdoc.html)

Energy Credit 6: Green Power

*Web-sites*

Environment Canada, Environmental Choice Program. A summary of the Environmental Choice programs many EcoLogo certification criteria for many products, including certified green power.


*Print media*


5.4 MATERIALS AND RESOURCES

Materials Prerequisite 1: Storage and Collection of Recyclables

Greater Vancouver Regional District: Recycling Works Program. The GVRD is the lead agency when it comes to recycling from businesses both in the Industrial, Commercial & Institutional (ICI) and the Demolition, Land-clearing and Construction (DLC) sector. An extensive technical information and assistance program is offered at the regional level.

Site: www.gvrd.bc.ca/services/workplace/workplace/html

Recycling Council of British Columbia (RCBC): RCBC has over 200 members, including governments, businesses, non-profit organisations, and interested individuals from all regions of British Columbia and beyond.

Site: http://www.rcbc.bc.ca

The BC Recycling Hotline is a comprehensive, toll-free service that provides information on waste reduction, recycling, disposal and pollution prevention throughout the entire province. The BC Recycling Hotline Database contains the largest amount of recycling and pollution prevention information in British Columbia on a variety of topics.


Site: http://www.rcbc.bc.ca/

Materials Credit 1: Building Reuse

Greater Vancouver Regional District (GVRD): Job Site Recycling program. This program was launched in 1997 to assist the building industry in reducing and recycling waste generated on construction, demolition and renovation sites. A Demolition & Salvage component assist building owners and project managers with building deconstruction.

Site: http://www.gvrd.bc.ca/services/garbage/jobsite/index.html#demolitionsalvage

3Rs Code of Practice for the Building Industry (1997): The GVRD introduced a voluntary 3Rs (Reduce, Reuse, Recycle) Code of Practice for the Building Industry which identifies waste management priorities for builders and developers in the Lower Mainland. It contains several simple actions the industry can take to reduce the amount of waste generated at construction, renovation and demolition projects.

Site: http://www.gvrd.bc.ca/services/garbage/jobsite/3r-code.pdf

Building Deconstruction Master Specification: Sample specification that outlines the minimum requirements for maximising the salvage and recycling of materials, and hazardous materials abatement procedures on deconstruction projects. A list of salvageable and recyclable materials and their associated handling and storage procedures is also contained in the appendix.

Site: http://www.gvrd.bc.ca/services/garbage/jobsite/deconstruction_spec.pdf

A Project Waste Management Master Specification provides minimum requirements for recycling on construction sites.

Site: http://www.gvrd.bc.ca/services/garbage/jobsite/wastemgmt.pdf

A Building Deconstruction Master Specification provides minimum requirement for material salvage, recycling and hazardous material abatement on deconstruction sites.

Site: http://www.gvrd.bc.ca/services/garbage/jobsite/deconstruction_spec.pdf
National Master Specification Guide to Environmentally Responsible Specifications for New Construction and Renovations: This guideline has been prepared for designers and specifiers involved in Construction, Renovation and Demolition (CRD) projects for the Federal Government of Canada. The purpose of this guideline is to assist project practitioners in developing environmentally enhanced or “green” specifications for construction, renovation, repair and refit projects, including associated demolition work. Particular emphasis is placed on the greening of the National Master Specification (NMS) as a primary instrument for communicating environmental responsibility in CRD projects. Site: http://www.pwgsc.gc.ca/rps/aes/tech/text/nms-e.html

Materials Credit 3: Resource Reuse

Web-Sites

Directory of Resource-Efficient Building Products 3rd Edition, GVRD/BCBC, 2001: To encourage design and building professionals to purchase building products with less impact on the environment, the GVRD developed its Directory of Resource-Efficient Building Products. The Directory contains 252 products that contain either recycled or salvaged materials, utilise materials in a more efficient manner, or conserve energy and water. All products listed in the Directory are available in the Lower Mainland. Contact: Leah Adair, at 1 604 436-6788, fax: 1 604 436-6811 or e-mail: leah.adair@gvrd.bc.ca

The Environmental Choice Program (ECP) - Criteria Documents: A list of over 100 criteria documents that provide the specific criteria that a green products or services have to meet in order to obtain the EcoLogo. The EcoLogo is a registered mark of Environment Canada. Use of the name Environmental Choice or the EcoLogo symbol is prohibited without permission by TerraChoice Environmental Services Inc. The Environmental Choice Program is operated by TerraChoice Environmental Services Inc. under a license agreement with Environment Canada. Site: http://www.environmentalchoice.com/index_main.cfm

Athena Sustainable Materials Institute: The not-for-profit Institute is a world-leading source of data, expertise and tools for designing buildings with the environment in mind. The institute’s databases are regionally sensitive, taking into consideration manufacturing technology, transportation and electricity grid differences as well as recycled content differences for products produced in various regions. The databases are built from the ground up using actual mill or engineered process models and are not reliant on trade or government data sources. Site: http://www.athenasmi.ca/index.html

National Master Specification Guide to Environmentally Responsible Specifications for New Construction and Renovations: This guideline has been prepared for designers and specifiers involved in Construction, Renovation and Demolition (CRD) projects for the Federal Government of Canada. The purpose of this guideline is to assist project practitioners in developing environmentally enhanced or “green” specifications for construction, renovation, repair and refit projects, including associated demolition work. Particular emphasis is placed on the greening of the National Master Specification (NMS) as a primary instrument for communicating environmental responsibility in CRD projects. Site: http://www.pwgsc.gc.ca/rps/aes/tech/text/nms-e.html
Used Building Materials Association (UBMA): The UBMA is a non-profit, membership based organisation that represents companies and organisations involved in the acquisition and/or redistribution of used building materials. 
Site: http://www.ubma.org/


Print Media:


Site: www.gvrd.bc.ca/services/garbage/sustainabledesign.html


Materials Credit 4: Recycled Content

Web-Sites

Athena Sustainable Materials Institute: The Institute’s databases are regionally sensitive, taking into consideration manufacturing technology, transportation and electricity grid differences as well as recycled content differences for products produced in various regions. The databases are built from the ground up using actual mill or engineered process models and are not reliant on trade or government data sources.
Site: http://www.athenasmi.ca/index.html

Used Building Materials Association (UBMA): The UBMA is a non-profit, membership based organisation that represents companies and organisations involved in the acquisition and/or redistribution of used building materials. 
Site: http://www.ubma.org/

United States Environmental Protection Agency - Recycled Content Material Standards Site: http://www.epa.gov/cpg/products.htm

Directory of Resource-Efficient Building Products 3rd Edition, GVRD/BCBC, 2001: To encourage design and building professionals to purchase building products with less impact on the environment, the GVRD developed its Directory of Resource-Efficient Building Products. The Directory contains 252 products that contain either recycled or salvaged materials, utilise materials in a more efficient manner, or conserve energy and water. All products listed in the Directory are available in the Lower Mainland. Contact: Leah Adair, at 1 604 436-6788, fax: 1 604 436-6811 or e-mail: leah.adair@gvrd.bc.ca
The Environmental Choice Program (ECP): Criteria Documents: A list of over 100 criteria documents that provide the specific criteria that a green products or services have to meet in order to obtain the EcoLogo. The EcoLogo is a registered mark of Environment Canada. Use of the name Environmental Choice or the EcoLogo symbol is prohibited without permission by TerraChoice Environmental Services Inc. The Environmental Choice Program is operated by TerraChoice Environmental Services Inc. under a license agreement with Environment Canada.
Site: http://www.environmentalchoice.com/index_main.cfm

National Master Specification Guide to Environmentally Responsible Specifications for New Construction and Renovations: Prepared for designers and specifiers involved in Construction, Renovation and Demolition (CRD) projects for the Federal Government of Canada. The purpose of this guideline is to assist project practitioners in developing environmentally enhanced or “green” specifications for construction, renovation, repair and refit projects, including associated demolition work. Particular emphasis is placed on the greening of the National Master Specification (NMS) as a primary instrument for communicating environmental responsibility in CRD projects.
Site: http://www.pwgsc.gc.ca/rps/aes/tech/text/nms-e.html

Print Media
Available from:www.gvrd.bc.ca/services/garbage/sustainabledesign.html


Materials Credit 5: Local/Regional Materials
Directory of Resource-Efficient Building Products 3rd Edition, GVRD/BCBC, 2001: To encourage design and building professionals to purchase building products with less impact on the environment, the GVRD developed its Directory of Resource-Efficient Building Products. The Directory contains 252 products that contain either recycled or salvaged materials, utilise materials in a more efficient manner, or conserve energy and water. All products listed in the Directory are available in the Lower Mainland. Contact: Leah Adair, at 1 604 436-6788, fax: 1 604 436-6811 or e-mail: leah.adair@gvrd.bc.ca
Materials Credit 6: Rapidly Renewable and Durable Materials

Directory of Resource-Efficient Building Products 3rd Edition, GVRD/BCBC, 2001: To encourage design and building professionals to purchase building products with less impact on the environment, the GVRD developed its Directory of Resource-Efficient Building Products. The Directory contains 252 products that contain either recycled or salvaged materials, utilise materials in a more efficient manner, or conserve energy and water. All products listed in the Directory are available in the Lower Mainland. Contact: Leah Adair, at 1 604 436-6788, fax: 1 604 436-6811 or e-mail: leah.adair@gvrd.bc.ca


Materials Credit 7: Certified Wood

The Ecoforestry Institute Society: An independent initiative dedicated to promoting ecologically, socially and economically responsible forest use that maintains and restores the complexity and diversity of our forests. Site: http://ecoforestry.ca/

Certified Forest Products Council: An independent, not-for-profit, voluntary initiative committed to promoting responsible forest products buying practices throughout North America in an effort to improve forest management practices worldwide. Site: http://www.certifiedwood.org/

The Ecoforestry Institute Society: An independent initiative dedicated to promoting ecologically, socially and economically responsible forest use that maintains and restores the complexity and diversity of our forests. Site: http://ecoforestry.ca/

Certified Forest Products Council: An independent, not-for-profit, voluntary initiative committed to promoting responsible forest products buying practices throughout North America in an effort to improve forest management practices worldwide. Site: http://www.certifiedwood.org/

The Canadian Sustainable Forestry Certification Coalition: An organization that promotes the use of internationally recognized sustainable forest management certification systems in Canada in order for Canadian producers to continually move towards sustainable forest management, secure a sustainable supply of raw material, and to ensure marketplace acceptance of Canadian forest products. Site: http://www.sfms.com
5.5 INDOOR ENVIRONMENTAL QUALITY

IEQ Prerequisite 1: Minimum IAQ Performance

CSA Standard Z204-94 (R1999), Guideline for Managing Indoor Air Quality in Office Buildings: This Guideline defines acceptable indoor air quality (IAQ) and provides methods to help achieve acceptable indoor air quality in office buildings, throughout the conception, design, construction, commissioning, operation, and maintenance stages.


EPA’s IAQ Homepage: Includes a variety of tools, publications, and links to address IEQ concerns in schools and non-residential buildings.

Site: www.epa.gov/iaq

IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control


Site: http://www.worksafebc.com/policy/regs/bcrohs04.asp


Site: http://www.worksafebc.com/priority/smoke/propamend.asp

IEQ Credit 1: Carbon Dioxide (CO2) Monitoring

CSA Standard Z204-94 (R1999), Guideline for Managing Indoor Air Quality in Office Buildings: This Guideline defines acceptable indoor air quality (IAQ) and provides methods to help achieve acceptable indoor air quality in office buildings, throughout the conception, design, construction, commissioning, operation, and maintenance stages.

Part 4: General Conditions / Occupational Health and Safety Regulation - WCB of BC, Sections 4.70-4.80 Indoor Air Quality.

Site: http://www.worksafebc.com/policy/regs/bcrohs04.asp

Building Air Quality: A guide for Building Owners and Facility Managers: An EPA publication on IEQ sources in buildings and methods to prevent and resolve IEQ problems.

Site: www.epa.gov/iaq/base

IEQ Credit 2: Increase Ventilation Effectiveness


IEQ Credit 3: Construction IAQ Management Plan

Web-sites:

EPA baseline IAQ Specifications: specifications include baseline IAQ testing and materials testing procedures.

Site: www.epa.gov/rpt/new-bldg/environmental/s_01445.htm
EPA Fact Sheet: Ventilation and Air Quality in Offices
Site: www.epa.gov/iaq/pubs/ventilat.html

IEQ Credit 4: Low-Emitting Materials


MPI's Approved Product List (APL): This list is printed twice a year, but updated approximately monthly on MPI's web site: - It contains approximately 150 categories of paint under which any paint manufacturer can list if their submitted product qualifies. - Approx. 50 of these categories (generally the ‘most used’ products) are what is called “Detailed Performance”. These categories each have performance-based standards to which the MPI coatings lab tests manufacturer submitted product. If approved as meeting the standard, the product is listed in the APL. It then is subject to random confirmation testing (the rotation is approx. 3-4 years) to ensure that it continues to meet the standard.

MPI's Architectural Painting Specification Manual and Maintenance Repainting Manual(s): These technical manuals contain: - Information on ‘pros and cons’ of paint system choices on most substrates, details on two grades of paint systems, details on surface preparation by substrate, guide specifications, the APL, and other information including definition of responsibilities, etc. - Sections assisting in the determination of the condition of an existing painted surface in order to establish a level-bidding basis for determination of surface degradation. These are available from a number of national associations, from any listing manufacturer, or direct from MPI. A manual of MPI Standards, containing tests done and reference standards used (e.g. ASTM), is available directly from MPI.


Directory of Resource-Efficient Building Products 3rd Edition, 2001: To encourage design and building professionals to purchase building products with less impact on the environment, the GVRD developed its Directory of Resource-Efficient Building Products. The Directory contains 252 products that contain either recycled or salvaged materials, utilise materials in a more efficient manner, or conserve energy and water. All products listed in the Directory are available in the Lower Mainland. Contact: Leah Adair, at 1 604 436-6788, fax: 1 604 436-6811 or e-mail: leah.adair@gvrd.bc.ca

IEQ Credit 5: Indoor Chemical and Pollutant Source Control

City of Santa Monica: Green Building Design & Construction Guidelines, City of Santa Monica, CA, April 1999: Comprehensive guidelines for green building design and construction. Site: http://greenbuildings.santa-monica.org
IEQ Credit 6: Controllability of Systems

Web-Sites

An introduction to the concepts of thermal comfort Indoor Environmental Quality
Site: http://www.innova.dk/books/thermal/thermal.htm

Print Media


IEQ Credit 7: Thermal Comfort

An introduction to the concepts of thermal comfort
Site: http://www.innova.dk/books/thermal/thermal.htm

IEQ Credit 8: Daylight and Views

Web-sites

CIBSE Application Manual - Window Design: Comprehensive site providing strategic design information for daylighting of buildings, produced by the UK Chartered Institute of Building Services Engineers.

City of Santa Monica: Green Building Design & Construction Guidelines, City of Santa Monica, CA, April 1999: Comprehensive guidelines for green building design and construction.
Site: http://greenbuildings.santa-monica.org

The Sustainable Building Technical Manual: Green Building Design, Construction, and Operations. This manual produced jointly by the U.S. Department of Energy (DOE) and Public Technology, Inc. (PTI) is one of the most comprehensive publications now available to help architects, developers, building owners, government officials, and others implement sustainable development practices. It contains more than 300 pages of practical, step-by-step advice on sustainable buildings written by some of the foremost experts in the field.
Site: http://www.sustainable.doe.gov/freshstart/articles/ptipub.htm

Print Media


Other

Seattle Lighting Design Lab offers a host of free and low cost seminars to learn more about energy efficient and human-friendly lighting design.
Site: http://www.northwestlighting.com