Sustainability in Professional Engineering and Geoscience:

A Primer

Part 3e: Practice-Specific Module - Consulting Engineering and Geoscience

Developed by the Sustainability Committee of the
Association of Professional Engineers and Geoscientists of British Columbia
APEGBC

www.apeg.bc.ca

www.sustainability.ca

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Part 3e: Practice-Specific Module – Consulting Engineering and Geoscience

"The wise and moral man
shines like a flower on a hilltop
making money like the bee
who does not hurt the flower."

The Pali Canon 500 BC[1]

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[1] H. Dressel, D. Suzuki, *Good News For a Change*, Greystone Books, 2002.

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1 Introduction

APEGBC Sustainability Guidelines

Core to APEGBC's articulation of sustainability are the Sustainability Guidelines that state that, within the scope of a Member's task and work responsibility each Member, exercising professional judgment, should:

1) Develop and maintain a level of understanding of the goals of, and issues related to, sustainability.

2) Take into account the individual and cumulative social, environmental and economic implications.

3) Take into account the short- and long-term consequences.

4) Take into account the direct and indirect consequences.

5) Assess reasonable alternative concepts, designs and/or methodologies.

6) Seek appropriate expertise in areas where the Member's knowledge is inadequate.

7) Cooperate with colleagues, clients, employers, decision-makers and the public in the pursuit of sustainability.

The Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) has developed the Sustainability Primer as part of its implementation of a Sustainability Management System (SMS). The Primer's purpose is to act as an initial step in raising knowledge of sustainability, and to function as a simple, readily accessible resource on sustainability for engineers and geoscientists. It is intended as an aid to help engineers and geoscientists implement sustainability principles in the course of their everyday activities.

Part I: Introduction of the Sustainability Primer outlines general issues that provide context for all our sustainability activities as professional engineers and geoscientists.

Part 2: Applying the Guidelines develops some suggested approaches to applying APEGBC's Sustainability Guidelines (left) across the spectrum of engineering and geoscience activities.

This document, ***Part 3e: Practice-Specific Module Consulting Engineering and Geoscience***, provides additional resources for Consultants.

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2 Review of the APEGBC Sustainability Guidelines

The APEGBC Sustainability Guidelines presented in *Sustainability in Professional Engineering and Geoscience: A Primer Part 2 Applying the Guidelines* provide guidance for systematically incorporating sustainability into engineering and geoscience practice. They are briefly reviewed below.

2.1 Increasing Awareness of Sustainability

Guideline # 1:	*Develop and maintain a level of understanding of the goals of, and issues related to, sustainability.*

Guideline #1 encourages ongoing education about sustainability. APEGBC has identified awareness of sustainability as one of the primary barriers to its implementation, and has identified Members as the main target group for increasing awareness. Once Members have the information they need to begin implementing sustainable solutions, the focus will shift towards clients, employers and wider audiences.

The resources found in this Primer are intended as a starting points for further research and continuing education on sustainability.

2.2 Fully Investigating the Impacts of Potential Actions

"In every deliberation, we must consider the impact on the seventh generation."

From the Great Law of the Haudenosaunee (Six Nations Iroquois Confederation)

Guideline # 2:	*Take into account the individual and cumulative social, environmental and economic implications.*
Guideline # 3:	*Take into account the short- and long-term consequences.*
Guideline # 4:	*Take into account the direct and indirect consequences.*

These three guidelines address the short and long term, direct and indirect impacts of our designs and activities. They encourage us to transcend traditional project boundaries and to consider the greater temporal and spatial impacts of our designs and projects. As we learn more about how humans and ecosystems interact we also learn how to ensure that we enhance the wellbeing of current and future generations and ecosystems.

Tony Hodge, P.Eng., describes Guidelines Two, Three and Four:

> These ideas veer sharply away from thinking in terms of "trade-offs," human vs. ecosystem wellbeing. There are obviously hundreds of small trade-offs in any practical application: between interests, between components of the ecosystem, across time and across space. However, in a macro sense, the idea of sustainability calls for each of human and ecosystem wellbeing to be maintained or improved over the long term. Maintaining or improving one at the expense of the other is not acceptable from a sustainability perspective because either way, the foundation for life is undermined.[2]

2.3 Weighing the Impacts of Alternative Solutions

Guideline # 5: Assess reasonable alternative concepts, designs and/or methodologies.

Conventional engineering solutions often rely on historical data and a linear approach to problem solving. Many problems are 'solved' by plugging in a standard formula 'proven' throughout the years, irrespective of the uniqueness of that problem's particular setting, its timeframe, or the people and the ecosystems involved. The process of evaluating various solutions, with the contribution of other professionals as well as affected communities, can save money, increase public acceptance, and build relationships between stakeholders.

Central to the assessment of alternatives lies the consideration of whether the design contributes to human *and* ecosystem wellbeing. Tony Hode, P.Eng, expands on this idea:

> The 'positive contribution to sustainability' criterion is different from- though built upon- the 'mitigation of adverse effects' criterion that is the focus of traditional environmental and social impact assessments. The implications of the shift are two-fold. On the one hand, the 'positive' orientation opens the door to a much fuller recognition of benefits that result from engineering and geoscience activities than has traditionally been the case with impact assessment approaches. On the other hand, the same positive orientation sets the bar higher- it is harder to demonstrate a contribution than it is to mitigate a negative.[3]

[2] Tony Hodge, PEng, PhD, "APEGBC Sustainability Policy", Draft 2, April 2003.
[3] Ibid.

2.4 Fostering Consultation and Partnerships

Guideline # 6: Seek appropriate expertise in areas where the Member's knowledge is inadequate.
Guideline # 7: Cooperate with colleagues, clients, employers, decision-makers and the public in the pursuit of sustainability.

Partnerships with fellow professionals on areas we are unfamiliar with is only half of our responsibility to consult with others. The other half is actively soliciting local community input on what is important to them. Experts can often help answer “what could be”, but it’s up to the public to answer, “what should be”.

3 Consulting Engineering and Geoscience: The Context

Consulting Engineering employs more than 54,000 people across Canada, and contributes gross revenues of more than $6.4 billion to the Canadian economy. Many consulting engineering firms also employ Professional Geoscientists. Most consulting engineering and geoscience firms employ fewer than 25 people and specialize in a particular discipline, however a number of large, integrated consulting firms exist that offer services in all disciplines. The industry is also active overseas. Canada ranks fourth in the world for export of engineering services[4].

In British Columbia, forestry is ranked as the highest revenue generating industry for consulting firms, followed by mining, transportation and building. Other prominent sectors are municipal engineering, industry and manufacturing, energy, water and wastewater. Over 75% of revenue comes from the private sector. In the public sector, the Provincial Government is the largest client, followed by municipal governments. It is estimated that Engineering Services contribute 712 million dollars, or approximately 0.7% to British Columbia's GDP. In 1999, almost 9,000 people were employed in the consulting engineering industry in BC. In 1997, 45% of the total revenue for BC's consulting engineers came from international projects[5].

Clients, ranging from homeowners to multinational companies to governments, turn to consulting engineers and geoscientists for technical solutions. Consulting engineers and geoscientists have wide ranging expertise, from information technology to bridge design. It is not the area of expertise but rather the business model that unifies the field. Consultants typically work on short term contracts and in project/construction management. With the expected increase in Public Private Partnerships, longer term contracts such as build-own-operate-transfer (BOOT) contracts are expected to increase. Other types of contracts include studies and investigations, site reviews and non-construction related methods[6]. There may be a number of consultants working in different areas on any given project. The business environment is competitive, sometimes on a global scale, and, although quality based selection is considered optimum, price based selection does occur. Consulting engineers and geoscienctists that sell a solution within a narrow field of expertise will ultimately

[4] Obtained May, 2004 from the Association of Consulting Engineers of Canada Webpage: http://www.acec.ca/en/industry/industry.html.
[5] *2000 Industry Profile*, Consulting Engineers of British Columbia, Vancouver, 2000.
[6] *ACEC 2002 Business Survey*, Compas Inc., Toronto, 2002.

have less resilience than those that explore innovative solutions that provide multiple benefits in diverse areas.

3.1 Associations and Organizations

In addition to being licensed as a professional by a regulatory association such as the Association of Professional Engineers and Geoscientists of BC, many consulting engineers and geoscientists belong to industry specific professional organizations. The Consulting Engineers of British Columbia and The Consulting Engineers of Alberta are such examples. These provincial organizations are allied with the federal Association of Consulting Engineers of Canada (ACEC), which in turn is related to the International Federation of Consulting Engineers (FIDIC). These organizations work to promote and pursue the business interests of their members.

International Federation of Consulting Engineers (FIDIC)

FIDIC is based in Geneva, Switzerland and has 65 national consulting engineering associations as members, including the Association of Consulting Engineers of Canada. FIDIC represents the consulting engineering industry internationally and works to promote the industry's business interests and development.

FIDIC has taken a leadership role on sustainability. Their policy on Consulting Engineers and the Environment states that:

> Engineers should provide leadership in achieving sustainable development — development that will meet the long term needs of future generations of all nations without causing major modification to the earth's ecosystems.

They go on to recommend that consulting engineers should "…take appropriate action or even decline to be associated with a project, if the client is unwilling to support adequate efforts to evaluate the environmental issues or to mitigate environmental problems." [7]

[7] *Consulting Engineers and the Environment*, FIDIC, 1990, Obtained May 2004 from the International Federation of Consulting Engineers Webpage: http://www1.fidic.org/about/statement04.asp

Association of Consulting Engineers of Canada (ACEC)

ACEC is a voluntary industry association that defines itself as "the national organization representing the business interests of consulting engineers in Canada" . However they do not limit themselves to purely business affairs. Indeed, Gary Bolton, P.Eng, Chair of ACEC states:

> The core nature of our business is problem solving, and the increasing need for more efficient, environmentally friendly projects will require all of us to develop the necessary skills for delivering our engineering value to the client.

He goes on to say:

> We now have the opportunity, and responsibility, to raise the bar for sustainable projects through innovative strategic planning with the entire design team early in a project's life. We have a duty as engineers to continue to promote to clients and funding agencies a decision-making process which is based on life-cycle costs.[8]

Consulting Engineers of British Columbia (CEBC)

Brian McAskill of the CEBC describes his organization:

> CEBC is a member of the Association of Consulting Engineers of Canada (ACEC). CEBC is a voluntary industry association that was formed in 1976 to promote the business interests of its approximately 100 member firms. CEBC works to raise the industry profile, representing the interests of consulting engineers, their employees and clients, while maintaining a strong commitment to the safety and well being of the public. It runs a prestigious awards program for local, national and international consulting engineering projects involving B.C. consultants. Since 1997 sustainability has been included as a criterion for selection in the CEBC awards program.

Sustainability fits in with the CEBC Code of Ethics:

> *Members shall practice their profession with a concern for the social and economic well being of society.*

Sustainability also fits in with the CEBC Mission Statement.

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[8] G. Bolton, "Engineering Energy", *Canadian Consulting Engineer*, Vol 44, No 6, Don Mills, 2003.

> *Our professional activities are carried out in a spirit of respect for, co-operation with and understanding of individuals, corporations and public agencies, as well as the environment.*

Provincial Consulting Engineers Associations exists across Canada.

3.2 Consulting Engineers and Geoscientists Roles, Responsibilities and Scope of Influence

Consulting Engineers and Geoscientists have influence over the type of technical solution adopted by the client. In addition to selecting and applying existing technology Consulting Engineers and Geoscientists often develop and use new technology for their projects. These technologies are then transferred to their clients and ultimately effect society and the environment. Therefore the design decisions of Consulting Engineers and Geoscientists can have wide reaching implications for the client, community and environment.

J. M. Steyn Laubscher, President of FIDIC, offered the following thoughts on the role of Consulting Engineers in *Consulting Engineer International*, 1/98

> The building of infrastructure is the core of the business of engineers - the designing, building and creation of the infrastructure on which the future economic success of business, our countries and people rely. The future of our children, both economically and environmentally, is dependent on the performance of the engineers of the world.

Brad Allenby, Vice President of Technology and Environment at AT&T Research sums up the roles and responsibilities of Consulting Engineers and Geoscientists:

> Anthropogenic climate change; loss of biodiversity and critical habitat; degradation of soil, water, and air resources; dispersion of toxic metals and organics – these are the fruits of human engineering just as surely as the computer, the automobile, and the highway infrastructure.[9]

Many practicing consultants work in a specific field constrained by cost and client expectation. Consultants have influence within the boundaries of providing the best value to their clients. Sustainability provides multiple benefits in diverse areas making it ideal for this competitive industry.

[9] M. Altomare, B. Natrass, *Dancing with the Tiger*, New Society Publisher, Gabriola Island, 2002.

4 Sustainability in Consulting Engineering and Geoscience

CH2M HILL Environmental Sustainability Policy

In accordance with our firm's mission to make "technology work to help our clients build a better world," CH2M HILL remains committed to improving the economic and social quality of human life and the preservation of the carrying capacity of nature for future generations. We embrace this commitment in the context of our core belief that our long-term success requires that we create value for our clients, owner-employees and the communities in which we live. We recognize that fulfilling our commitment is a journey with many uncertainties rather than a known end point. To this end, we strive to adhere to the following principles.

In the service of our clients we will:

Provide the best counsel available on the application of sustainable practice to help our clients meet their objectives.

Partner with clients wherever possible to share with others the learning gained from new sustainable solutions to the difficult challenges they face.

Sustainability is a journey and the struggle to prosper without causing harm is an age old human dilemma. Those whose design results in harm to society and the environment probably do not intend to make the world a worse place. Tools and criteria are available to help determine the most sustainable design. Some of the most common and important are described below.

4.1 The Natural Step Framework

The Natural Step is a framework developed in Sweden by Dr. Karl-Henrik Robert in the 1990s. Dr. Karl-Henrik Robert describes a framework for transition to sustainability that combines the following two aspects:

1. Each investment provides as flexible a platform as possible for subsequent investments in the direction given by the framework.

2. Highest priority is given to “low hanging fruits,” i.e. investments that are believed to give rapid returns on investment; this finances and empowers the steps that follow which, in turn, become the next flexible platform from which additional low hanging fruits are chosen in an iterative process[10].

The Natural Step Framework is based on the four system conditions for sustainability that are derived from the laws of thermodynamics. The first law of thermodynamics states that matter and energy cannot be created or destroyed. Nothing disappears; burning solid garbage transforms it into heat, particulates and gases. Wind farms transform kinetic energy into friction and electricity. The second law of thermodynamics states that entropy increases, i.e. matter and energy tend to disperse. Whatever is introduced into the biosphere will eventually disperse throughout it. Human birth control hormones in wild fish demonstrate this law.

[10] M. Altomare, B. Natrass, *The Natural Step for Business*, New Society Publisher, Gabriola Island, 1999.

CH2M HILL Environmental Sustainability Policy Cont.

In the operation of our firm we will:

Seek economically feasible opportunities to apply sustainable development concepts to do more with less, reduce the use of toxic materials, conserve natural resources, and minimize waste and emissions.

Encourage the adoption of sustainable practices by our suppliers and seek partnerships with those suppliers that share our objectives.

Create workplaces for our employees that are safe, healthy and functional and that embody sustainability principles to the highest practicable degree.

Periodically seek out the views of experts and others outside the company to gain additional perspectives on our quest to conduct business sustainably.

Develop, adopt and continuously improve metrics to measure and monitor our progress in achieving our goals.

The Natural Step's Four System Conditions for Sustainability:

1. *Substances from the Earth's crust must not systematically increase in the biosphere.*

2. *Substances produced by society must not systematically increase in the biosphere.*

3. *In order for a society to be sustainable, nature's functions and diversity are not systematically impoverished by displacement, over-harvesting, or other forms of physical manipulation.*

4. *In order for a society to be sustainable, resources must be used fairly and efficiently in order to meet basic human needs globally.*

The familiar scientific basis may be one of the reasons that The Natural Step framework has enjoyed widespread uptake. It has been adopted by a range of organizations, including major corporations (Nike, Bank of America, Home Depot etc.), municipalities (Whistler, BC), and consulting engineering firms (CH2M Hill). The framework is commonly described as a compass, pointing the way towards sustainable, profitable business. The case study below demonstrates how a large multidisciplinary consulting engineering firm benefits from The Natural Step.

Case Study – The Natural Step at CH2M Hill Canada

CH2M Hill is an international multidisciplinary consulting engineering firm. Senior leadership at CH2M Hill chose the Canadian operations to be a testing ground for The Natural Step and Sustainable Development. At that time (1999) CH2M Hill Canada was known as CH2M Gore & Storrie. CH2M Gore & Storrie adopted the Natural Step in 2000 under the leadership of Nicholas Sonntag. In an interview with APEGBC in 2001, Mr. Sonntag confirmed his belief that The Natural Step is a good approach, but not the only one. He discussed the following issues related to sustainability: education and the importance of spending time to learn about sustainable development; the need to identify early adopters and create strategic relationships with them; the usefulness of case studies to demonstrate the practical application of sustainability; and the importance of taking the time to pass on the knowledge and experience gained to the community and fellow engineers/geoscientists.

CH2M Gore & Storrie has now become CH2M Hill, Canada, Mr. Sonntag has moved on to the China Division, and The Natural Step approach has grown into an overall sustainable development strategy that is now integrated into the business strategy at CH2M Hill Canada.

CH2M HILL Environmental Sustainability Policy Cont.

In participation with other stakeholders we will:

Seek opportunities to work with communities, governments and non-governmental and professional organizations to help articulate, teach, and advance the principles of sustainability.

Let our journey on the pathway to a sustainable world be its own reward.

Source: Obtained May 2004 from: http://www.ch2m.com

CH2M Hill Canada has adopted internal initiatives to promote sustainability within the company's operations and external initiatives to integrate sustainability into client relationships. They have an Environmental Sustainability Policy that addresses sustainability both internally and externally. They have internal education on sustainability for employees and work to develop partnerships with leaders in sustainability worldwide. These partners include the World Business Council for Sustainable Development and the US Green Building Council. In client relationships, the firm sees sustainability "as a method of planning positively for the future". One example of this is CH2M Hills involvement in developing the Integrated Storm Water Management System for the residential development on Burnaby Mountain[11]. This storm water management system aims to return the hydrological cycle to its natural state, reducing the need for storm water infrastructure and replenishing waterways with naturally filtered groundwater. This system is a classic case of sustainable design, where multiple dividends are realized in diverse areas. Costs and infrastructure burdens are reduced, while fisheries and environmental health are enhanced.

4.2 Cradle to Cradle

One possible criticism of the Natural Step Framework is that it focuses on the negative potential of humanity. A positive, creative approach to design has been outlined by William McDonough and Michael Braungart of McDonough Braungart Design Chemistry. Although they are not Engineers or Geoscientists (William McDonough is an Architect and Michael Braungart is a Chemist), their design strategy is easily transferred to Consulting Engineering and Geoscience.

The traditional cradle to grave model of the first industrial revolution is a linear process of natural resource extraction, manufacture and distribution followed by disposal. Products are not designed for re-cycling, and so with each recycling there is a loss of quality and an increase in pollution and energy use. McDonough and Braungart suggest a "Cradle to Cradle" approach, where design is motivated by retaining the feedstock of industry, such as metals and polymers, for continual reuse, without loss of quality or unintended consequences. An example from their book *Cradle to Cradle*, is the recycling of plastic bottles into clothing (known as PET, it is a common component of sports clothing). Although this seems to be an efficient use of resources, plastic bottles were not designed to become clothing. They contain heavy metal catalysts (such as antimony) that are carcinogenic and become bio-available when placed next to sweating

[11] M. Altomare, B. Natrass, *Dancing with the Tiger*, New Society Publisher, Gabriola Island, 2002.

The Hannover Principles: By William McDonough and Michael Braungart, 1992

1.Insist on rights of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable condition.

2. Recognize interdependence.

3. Respect relationships between spirit and matter.

4. Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems and their right to co-exist.

5. Create safe objects of long-term value.

6. Eliminate the concept of waste.

7. Rely on natural energy flows.

8. Understand the limitations of design.

9. Seek constant improvement by the sharing of knowledge.

skin. Furthermore, PET clothing is not recycled into new clothing, so the recycling of plastic bottles only slightly extends the lifespan of a cradle to grave process.

A comparable example from Consulting Engineering is South East False Creek in Vancouver, an industrial brown field that is now being re-developed to become a high density residential neighborhood. In both of the above examples, the initial design is very important for the future availability and safety of the resource.

The Cradle to Cradle approach outlines five steps to effective design.

1. Get free of known culprits. This step means designing to eliminate the use and release of substances that are known to bio-accumulate and cause harm. Such substances include PVC, cadmium, lead and mercury. This step could also be extended to include design that is known to cause environmental degradation such as large scale clearcut forestry practices, wetlands draining and CO_2 emissions.

2. Follow informed personal preferences. It is impossible for any consultant to know all the details of every product or all the possible consequences of a design. Therefore, professional and personal judgment can facilitate choice. Choosing third party certified products, or choosing to work with organizations that have sustainability policies are examples.

3. Create a passive positive list. This step means looking for design steps or products that can be defined as completely healthy and safe for humans and the ecosystem. For example, concrete could be compared for fly-ash vs. Portland cement content, or endocrine disrupting pulp bleaching agents could be replaced with biodegradable agents.

4. Activate the positive list. Once the positive alternatives have been identified, the task is then to design a service or product consisting only of safe, positive elements. According to Cradle to Cradle design all material flows would be closed loop so at the end of the service life the material could be re-used safely.

5. Reinvent. The final and most ambitious step is to design processes and products that not only do no harm but actually contribute positively to the human and natural environment. A good example of this is the case study below.

Cradle to Cradle design dares us to "imagine what a world of prosperity and health in the future will look like, and begin designing for it right now.[12]"

Case Study – Eagle Lake Micro Power Generation

Compiled with the help of Sean Brophy, P.Eng., and Howard Dallimore, P.Eng., Dayton and Knight Ltd.

The Eagle Lake Micro Power Generation project in the District of West Vancouver exemplifies many of the Cradle to Cradle design concepts. This project utilizes existing municipal infrastructure to create an entirely beneficial source of electricity. It is an example of reinventing design to contribute positively to the human and natural environment.

Eagle Lake is a high elevation drinking water reservoir owned and operated by the District of West Vancouver. The infrastructure includes a 1 kilometer long pipe with a 150 meter drop that conveys water from Eagle Lake to an underground service reservoir. Originally, a pressure reducing station dissipated the potential energy before the water discharged into the reservoir. Dayton & Knight Ltd. suggested harnessing this energy by replacing the pressure-reducing valve with a turbine. The concept was discussed with Pacific Hydro Inc., a company with extensive relevant expertise, and was further discussed with the District of West Vancouver's staff.

As a consequence, it was agreed that a project could be developed to demonstrate that at Eagle Lake, energy lost at the pressure reducer could be used for power generation. Essentially, it would involve the installation of a Pelton wheel turbine to replace the pressure-reducing valve. Potential energy in the water would then be used to drive a turbine and generate electricity for sale to BC Hydro. Dayton and Knight Ltd. reviewed the project in detail and came to the conclusion that it would be feasible and economically viable.

This was a project unlike any other undertaken by the District. The initial challenge was to build a network of integrated partnerships that would result in this "Green Power Generation" concept becoming reality. Meetings were arranged and the necessary relationships formed.

From the outset it was clear that the project would have to meet the Provincial Electric Utility's detailed low environmental impact and social responsibility criteria. For a project to be considered "green" it must be:

[12] M. Braungart, W. McDonough, *Cradle to Cradle*, North Point Press, New York, 2002.

- **Renewable**: The energy source must be replenished by natural processes within a reasonable length of time. A hydroelectric project clearly meets this criterion.
- **Licensable:** The project must meet all relevant regulations and standards.
- **Socially responsible:** The project must be developed in a socially responsible manner. Every project within the Utility's green acquisition process is reviewed according to specific social responsibility criteria.
- **Environmentally responsible:** The project must avoid unacceptably high environmental impacts such as damage to fish populations, endangered species or air quality.

The overall objective was to design, build and operate a profitable pilot project that would become a springboard for other municipal projects.

The District of West Vancouver's primary objective was to ensure that the project would not have any potential to compromise the drinking water supply. The power generation control system would need to be simple to operate and designed to ensure that, under all conditions, the demands of the water distribution system would be given priority.

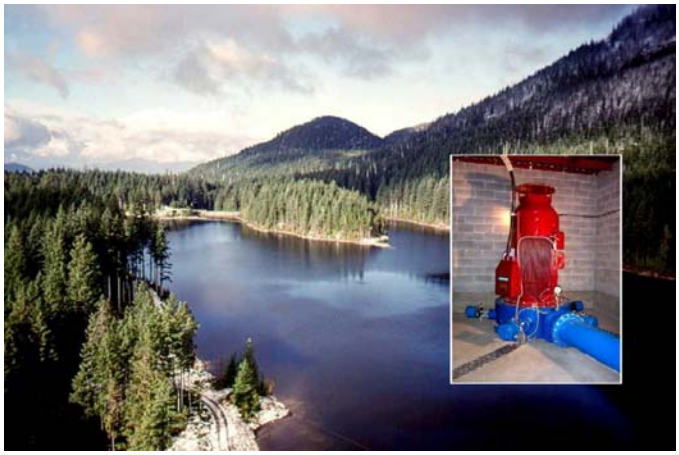
Dayton and Knight Ltd. was responsible for reviewing the project in detail to ensure its integrity and confirming that all criteria referred to above were met.

The project was completed in 2003 and now supplies approximately 1.1 gigawatt-hours of electricity per year. This represents about 20% of the District Operation's power demand.

Innovative aspects include not only the original concept but also the assembly of stakeholders with the ability to turn the concept into reality. Without an imaginative approach, a willingness to reinvent, this project would never have been brought to fruition.

The majority of new electricity in North America is generated by natural gas fired power plants. These produce greenhouse gas emissions and other pollutants, deplete a non-renewable natural resource, and draw complaints from local communities. By comparison, the Eagle Lake Micro Power Generation project has no environmental impact, creates windfall revenue from existing infrastructure and is a point of pride for the community. Although the actual amount of electricity generated is relatively small, this project could serve as a demonstration project for other BC communities. Many of these, particularly along the coast, are at low elevation compared to their water sources. As a result, this project has the

potential to be replicated across the province. The resulting impact would be significant



Eagle Lake and Turbine. Source: *Dayton and Knight Ltd*.

4.3 Climate Change

It is becoming increasingly important to consider climate change when working on projects where climate data is fundamental to performance and design, or on projects that traditionally release greenhouse gas emissions. The Canadian Council of Professional Engineers has released a position statement on climate change stating that:

> Engineers will be responsible for building and maintaining infrastructure that can withstand new climatic threats and for developing innovative approaches that minimize greenhouse gas emissions.[13]

The position paper emphasizes the need for engineers to become educated about adaptation to and mitigation of climate change. Mitigation can be generally defined as the reduction in atmospheric greenhouse gas (GHG) levels. Adaptation refers to adjusting design to account for climate change.

Design that avoids GHG emissions also avoids significant risk. The regulatory burden on GHG emitters is already increasing with the implementation of the Kyoto Protocol and can be expected to continue to grow. Controversy and reputation damage are increasing for GHG

[13]Obtained May 2004 from the Canadian Council of Professional Engineers webpage: http://www.ccpe.ca/e/files/positions_climatechange.pdf.

emitters, as shareholders demand accounting for climate change risk, and the public becomes increasingly aware of climate change. Therefore, design that avoids the release of GHGs is more robust and sustainable for long term low cost implementation.

Not all projects involve choices over GHG emissions. However, mitigation strategies can be found elsewhere, such as the use of tree plantations to remediate contaminated sites, or the development of wetlands for water treatment. By absorbing CO_2, the tree plantation or wetland is performing the bonus activity of mitigating climate change. In some cases, emissions credits can be obtained for such projects resulting in a windfall bonus for the design choice.

It is generally recognized that climate change is already upon us, and that adapting to it is important. According to Dr. Hengeveld, a senior Environment Canada scientist, the future climate is very likely beyond our experience. It is therefore unwise to rely exclusively on past climate data for engineering design. Examples of engineering and geoscience projects designed for climate change include the Confederation Bridge between Prince Edward Island and New Brunswick and the Diavik Diamond Mine in the Northwest Territories. Expertise on ways to adapt to climate change is still in its infancy. Climate change affects the natural landscape, including natural resource distribution such as forests, fish and water. Adaptation is therefore a very complex endeavor, likely to succeed only in a simplistic fashion. For example, adapting industrial installations to withstand increased climate variability does not address the migration of industrial feedstock. It is best to work towards both climate change mitigation and adaptation.

The case study below shows how a small local consulting geoscience firm used its knowledge of climate change to expand its professional capabilities.

Case Study – Kingcome Watershed Assessment

Scott Weston, M.Sc., P. Geo., of Madrone Environmental Services provided information on a recent coastal watershed assessment that demonstrates the application of sustainability principles and the importance of climate change in the land based forestry sector. All the information in this case study comes from *Coastal Watershed Assessment-Kingcome River Watershed* prepared for International Forest Products Ltd. by Drew Brayshaw, M.Sc., GIT, and Scott Weston, M.Sc., P.Geo., of Madrone Environmental Services Ltd., Abbotsford, 2004.

The project was a Coastal Watershed Assessment of the Kingcome River Watershed for International Forest Products Ltd. The client was responding to the concerns of the local indigenous community that the

Village of Gwa-Yee. Source: Madrone Environmental.

occurrence of severe flooding capable of causing property damage and endangering human life is becoming more frequent in the village of Gwa-Yee which is located near the mouth of the Kingcome River Watershed.

Madrone Environmental undertook a hydrological assessment of the 1,300 km^2 watershed based on the Coastal Watershed Assessment Procedure (CWAP) (Ministry of Forests, Forest Practices Code, 1999), with the following goals:

1. To evaluate the hydrological effects of both historic and currently proposed forest harvesting (logging and road construction) on the watershed.

2. To assess the cumulative impacts of the past forest practices on the hydrology, sediment budget, riparian (riverside) vegetation and channel stability of the watershed.

3. To make recommendations for restorative works to remedy previous deleterious impacts.

4. To make recommendations for a level of hydrologically sustainable future harvesting.

5. To make an assessment of the potential impacts of proposed new forest harvesting and determine whether this proposed harvesting is hydrologically sustainable.

Before beginning the project, a meeting was held with all the stakeholders to familiarize each with the others' concerns and to establish cooperation in the pursuit of the shared goals of sustainability. Represented were the consultant geoscientists, Madrone Environmental Services Inc., the BC Government Ministry of Forests, the Commercial Interests International Forest Products Ltd. and Scott Paper Ltd., and the local indigenous peoples the Tsawataineuk First Nation.

Madrone Environmental undertook a comprehensive study to determine the short and long term consequences and the direct and indirect consequences of logging activity in the watershed. They relied on a literature review, aerial photography, GIS data and fieldwork. One of the problems they faced was a lack of climatic measurement and hydrometric data for the watershed. To help overcome the lack of data, they utilized the local elders' expertise in historical and current climatic conditions. That expertise was accessed through in-person and over-the-phone interviews with long term Gwa-Yee residents.

The results of their study indicated that forestry activity prior to the introduction of the BC Forest Practices Code resulted in elevated

Satsalla Glacier Lake. Source : Madrone Environmental.

landslide frequency for parts of the Kingcome Watershed. They also found that historical harvesting of riparian vegetation has reduced streamside stability and degraded fish habitat in some sections of the watershed. However, overall their conclusion was that forestry development has had little effect on peak water flows so far. This conclusion stimulated Madrone to do an assessment of reasonable alternatives for the cause of the increased severity of flooding. Scott Weston, P. Geo., and Drew Brayshaw, GIT, had developed and maintained an understanding of the issues related to sustainability, and they were familiar with the work of the United Nations Intergovernmental Panel on Climate Change. That knowledge combined with the information obtained through accessing local expertise on past climatic conditions guided them to a reasonable professional conclusion. The technical assessment of the watershed supported Madrone's conclusion that the increased flooding was caused by global climate change.

One particularly striking piece of evidence for climate change was Madrone's observation of the Satsalla Glacier Lake. This lake at the toe of the Satsalla Glacier in the upper reaches of the Kingcome watershed was 250 metres long in 1951. It has now grown to 4 kilometers long as the glacier recedes.

Madrone's technical expertise and understanding of the individual and cumulative social, environmental and economic implications of forest harvesting and climate change helped them come up with a set of recommendations that laid out a balanced approach based on long term prosperity and cooperation. Those recommendations include:

1. A rate of harvest that will produce no significant effects on peak flow and will maintain watershed hydrological responses within the range of natural variability.

2. Restorative work on road deactivation and riparian habitat in areas degraded by pre- BC Forest Practices Code activities.

3. Consideration of ongoing climate change and future increase in the frequency of damaging floods, the size of the largest floods and the proportion of rainfall to snowfall in emergency planning and building design for the village of Gwa-Yee.

This assessment demonstrates the importance of developing and maintaining an understanding of issues related to sustainability. Climate change is considered by many to be the biggest environmental problem of our time. Consideration of climate change is an important part of developing the best design and providing the best value for our clients, for society and for the environment.

5 Measurement and Assessment

Engineers and geoscientists are familiar with the need to assess and measure initiatives in order to determine whether the intended benefit is being derived. The need to measure and assess is especially important in sustainability, with its myriad definitions. Several tools to assess and measure progress towards sustainability are presented below.

5.1 Reporting

Sustainability reporting is a useful tool to organize and assess an organization's sustainability initiative. Sustainability reports clearly define and provide data on sustainability indicators. Indicators are chosen appropriate to the area of practice to reflect performance on financial, environmental and social issues. Sustainability data published in the report is audited by an independent third party.

Sustainability reporting gives organizations advantages in marketing, public relations and access to capital, in addition to providing an internal reference against which to measure progress. Sustainability reporting creates brand awareness by differentiating an organization from its competitors and providing another avenue for promotion. Reporting is a powerful tool for organizing and quantifying an initiative and for discovering ways to increase efficiency and effectiveness. Some financial institutions and investors favour businesses that can demonstrate progress on sustainability. For example, Vancity Credit Union Green Business Loans criteria consider documented environmental and / or social sustainability.

For large firms, The Global Reporting Initiative (GRI) currently offers the most widely recognized and respected reporting framework. It is used by many Canadian firms including Teck-Cominco, Methanex, and BC Hydro. The GRI was started in 1997 by the Coalition for Environmentally Responsible Companies but is now an independent official collaborating centre of the United Nations Environment Programme (UNEP). Due to its international reputation, GRI is a good choice for multinational organizations.

Case Study – AMEC Annual Sustainability Report

Compiled with the help of Linzie Forrester, Corporate Environmental Advisor, AMEC plc; Ed Fidler, Project Engineer, AMEC Americas Ltd.; and John Pope, Systems Manager, PFI Division, AMEC Americas Ltd.

AMEC is a large multi-national full service consulting engineering firm. AMEC is based in the UK, has operations around the world, employing approximately 45,000 people and is the largest engineering services and project management company in British Columbia employing over 830 people throughout the province.

In 2000 AMEC initiated a sustainability program in response to interest from their shareholders, the UK government, the international investment community, the insurance industry, and their clients. AMEC considered a variety of frameworks for proceeding with its sustainability initiative, including the Global Reporting Initiative and the recommendation in the United Nations Agenda 21. With help from those frameworks, AMEC undertook an assessment across the whole of its global operation and identified common sustainability issues essential to its success. Out of these common sustainability issues AMEC developed a set of Guiding Principles. The Guiding Principles address these impact areas and identify desired behaviors in each area. They were first published in December 2001. AMEC then developed sustainability indicators based on the metrics coming out of the Guiding Principles. The indicators are meant to quantify AMEC's progress towards sustainability. They are still evolving towards becoming perfect tools for that purpose.

The AMEC Sustainability Indicators form the basis for their annual Sustainability Report. 2003 marks the third year of publishing a Sustainability Report and the second year of data collection. To ensure accuracy and credibility, and demonstrate their commitment to sustainability, AMEC follows the international guidelines for sustainability reporting and retains an independent third party to audit their data.

AMEC believes there are 5 absolute benefits of sustainability to their business success. They are: reputation management, risk management, employee satisfaction, access to capital and financial performance.

AMEC Guiding Principles

PROFITABLE GROWTH
Our ability to create employment and build a sustainable business is founded upon our ability to achieve profitable growth and thereby add long-term value for our shareholders and other stakeholders. Put simply, "if we do well, we can do good".

ENVIRONMENT
We will pursue an absolute goal of causing no harm to the environment. We will implement effective environmental management systems, adopt best available practices and engage our people and business partners in driving continuous performance improvement.

HEALTH & SAFETY
We will pursue an absolute goal of causing no harm to our employees or those affected by our activities. We will implement effective health and safety management systems, adopt best available practices and engage our people and business partners in driving continuous performance improvement.

COMMUNITY INVOLVEMENT
We will support the local, national and international communities in which we work. We will seek to contribute to their economic and social well being and engage in consultation on matters of importance to them connected with our activities. Where appropriate, we will also support their charitable, educational and cultural causes through financial donations and 'in-kind' support whilst encouraging employee contribution-matching programs.

AMEC Guiding Principles Cont.

EMPLOYMENT RIGHTS
We value the diversity of our people and will use this to develop the company. We respect the rights of our people to equal opportunity and non-discrimination in the workplace, collective representation, a fair hearing through clearly defined grievance procedures and confidentiality relating to personal data held by the company.

ETHICS AND HUMAN RIGHTS
Our relationships are underpinned by our reputation for being reliable, trustworthy and fair. We will apply high standards of ethics in all we do, acting in ways that meet or exceed applicable laws, meeting our contractual commitments, avoiding conflicts of interest, keeping company data accurate, confidential and secure and abstaining from all forms of corruption.
We respect the human rights and dignity of those affected by our operations in a manner consistent with the obligations and commitments of the international jurisdictions in which we operate and without discrimination of any kind.

Source: Obtained June 2004 from: http://www.amec.com.

AMEC Sustainability Indicators:

Managing Sustainability	• BitC Environmental Engagement Score
Profitable Growth	• Total Turnover • ISO 9000 Compliant Quality Management System by Revenue • Total Operating Profit by Sector
Environment	• Tonnes CO_2 Contribution • Environmental Incidents • Environmental Management System Coverage in AMEC • Waste Disposal Route
Health and Safety	• Lost Time Incidence Frequency Rates • Total Recordable Cases Frequency Rates • Health and Safety Management System Coverage per Employee
Community Involvement	• UK Charitable Donations • Non UK Charitable Donations
Employment Rights	• Workforce Gender Composition • Collective Consultation/Representation
Ethics and Human Rights	• Reported Complaints • Disciplinary Actions

Linzie Forester is the Corporate Environmental Advisor for AMEC plc Worldwide. She coordinates the sustainability program for AMEC's worldwide operations. Linzie has a background in Environmental and Civil Engineering and she has also worked on Health and Safety in Chemical Engineering. She has the following advice for the British Columbia Consulting Engineering and Geoscience Community:

> Sustainability is a developing area, it is certainly on government's agendas. If you want to be an international player, you have to pay attention to sustainability now and start to position yourself. If Canadian companies start looking to Europe they will be well positioned for the future. Sustainability is not going to go away. Engineering companies at the moment have a tremendous opportunity if they get on board and learn about sustainability. They can become leaders in it and advisors to their clients.

To learn more about how AMEC is pursuing sustainability follow the links in the Resources Section.

5.2 Life Cycle Assessment

Life Cycle Assessment was discussed in the Buildings Module of the Sustainability Primer. However, since it is a useful tool for most sectors, it is also discussed briefly here. A good definition of Life Cycle Assessment can be found in The Hannover Principles published in 1992 by W. McDonnough and M. Braungart:

> Life Cycle Assessment is a process in which the energy use and environmental impact of the entire life cycle of a product, process, or activity is catalogued and analyzed, encompassing extraction and processing of raw materials, manufacturing, transportation and maintenance, recycling, and return to the environment.

In reality, Life Cycle Assessment is often carried out over a more limited range. Life Cycle Assessment is useful for discovering environmental and efficiency gains when comparing designs. Life Cycle Assessment methodologies were originally developed to create decision support tools for distinguishing between products, product systems, or services on environmental grounds. [14]

Life Cycle Assessment is useful over a range of detail, from qualitative considerations of durability and environmental impact to detailed quantitative analysis of each component. The process becomes increasingly complex and expensive as the level of detail increases. However, even at a qualitative level it can contribute to greater understanding of the advantage of sustainability. The strength and weakness of Life Cycle Assessment is that it attempts to put all the impacts of a project into economic terms. While that is useful because most projects are assessed on economics, it may worsen the tendency to neglect important non-economic issues such as quality of life, biodiversity and community.

Case Study – Meadow Avenue Remediation Avenue

Compiled with the help of Don Bryant, P.Eng., Keystone Environmental Ltd and Harald Kullmann, P.Eng., Westmar Consultants Inc.

The Meadow Avenue Remediation project sprung from an Amended Remediation Order from the British Columbia Ministry of Water, Land and Air Protection to conduct prescribed remediation activities on the site of a former wood preservation operation. The contaminated

[14] *Life Cycle Assessment*, European Environment Agency, 1997.

Meadow Avenue Site Nearing Completion. Source: Westmar Consultants Inc. and Keystone Environmental.

Caisson Dredging. Source: Westmar Consultants Inc. and Keystone Environmental.

Work on Fish Habitat. Source: Westmar Consultants Inc. and Keystone Environmental.

riverfront property involved a number of stakeholders in addition to the Province:

1. Environment Canada.
2. Fisheries and Oceans Canada.
3. The proponents, who did not own the property but had been assigned responsibility for the past contamination.
4. The current property owners and their warehousing tenants.
5. The former BC Assets and Land who manage the foreshore Crown lands and whose mandate is to promote the economic viability of the province.
6. The North Fraser Port Authority, who derive revenue from leasing the dock attached to the foreshore.
7. Other groups affected by the project including adjacent property owners, marine operators and river users.

The remediation order prescribed a “brute force” program for riverfront remediation. It included extensive dredging with the dredged silt disposed of by transport to a landfill. A groundwater treatment facility would be installed on the site that would require ongoing pumping, chemical addition and maintenance. While this solution at first appears straightforward, it is extremely expensive in the short term, relies heavily on disposal of extracted sediments and groundwater, presents significant risks to the environment in its implementation, and continuously consumes chemicals and energy over the long term. It was clear to the proponents that another way had to be found to achieve the regulatory stakeholders’ objectives, that would also be more economical and acceptable to the other stakeholders.

The Remediation Order allowed for the exploration of reasonable, sustainable alternatives, giving the consultants the opportunity to explore the feasibility of a more creative solution. The proponents were enthusiastic about finding a lower cost solution that offered equivalent environmental protection of the fishery resource. A limited life cycle assessment provided a clear case for replacing the groundwater treatment plant and large scale dredging operation. The consultants held a number of collaborative sessions with the stakeholders to improve the design. Fourteen different options were considered; the challenge was to reach consensus among agencies that had differing mandates. A compromise solution based on input from all sides was agreed on.

The final design included a potential future wharf area that partially covers the site and an adjacent capped area, which was covered with a marshland habitat. A sheet pile enclosure provides containment of the contaminants beneath them. The remaining peripheral areas of the site were dredged using a caisson dredging methodology that controls dredge-spoil water content, and river water quality. The sheet piling was configured in such a way to promote natural attenuation of the groundwater, based on the projections of groundwater modeling. Ongoing pumping and water treatment were made redundant. The solution took advantage of and enhanced the natural processes of the site. The solution is designed for a 50 year design life and recognizes that in the future there may be an opportunity to completely remediate the source. Therefore the design allows for flexibility in the future use of the site.

5.3 Environmental Management Systems and ISO 14001

Environmental Management Systems set out an implementation plan for environmental initiatives. They are a powerful tool to provide a framework for checking progress and focusing energy. Many environmental management systems are based on the ISO 14001 system which is well developed and internationally recognized. Although many consultants may not have an environmental management system at their own organization, it is very likely that certain clients will have one. The ISO 14001 environmental certification system is widely adopted in the BC forest and energy sector. ISO 14001 certification is growing in Canada with the number of certified organizations increasing from 475 at the end of 2000 to 1064 by the end of 2002[15].

ISO 14001 certification requires that the organization have an environmental management system (EMS) containing a commitment to continuous improvement, prevention of non-sustainable activities, and compliance with relevant regulations. The EMS is subjected to an external audit and certification is valid for three years. The certified organization must also agree to annual Surveillance Assessments.

The organization may chose which areas to commit to continuous improvement and prevent non-sustainable activities. The EMS must be available to the public. Because the EMS outlines a course of

[15] The ISO Survey of ISO 9000 and ISO 14001 Certifications, Twelfth Cycle Up to and Including 31 December 2002, International Standards Organization. Obtained May 2004 from http://www.iso.ch/iso/en/iso9000-14000/pdf/survey12thcycle.pdf.

continual improvement, it is useful to become familiar with it in order to understand the changes and benefits arising from them.

Case Study - Jacques Whitford Environment Limited Environmental Management Systems (EMS) for Municipalities and Solid Waste Services

By Michael W. Herald, CEA, EMS(LA), Jacques Whitford Environment Limited.

Municipal activities can dramatically affect the biophysical environment. Activities such as land-use planning, water and sewage treatment, and solid waste management all have many environmental aspects related to them. Municipalities, therefore, have the potential to protect and enhance the environment. Private sector organizations have taken a leading role in environmental stewardship by integrating environmental management into their business practices. However, environmental management in Canadian municipalities is still in its infancy. Very few municipalities have developed and implemented an environmental management system (EMS).

The adoption of an EMS for solid waste management, for example, can significantly affect how a municipality addresses its environmental liabilities and risks and can realize long-term cost savings. By taking a positive approach through the use of an EMS, non-compliance events can be minimized. Relative to other city departments and other industries, solid waste management is governed by many legal requirements, has many environmental aspects related to its operations and requires a fairly detailed system of operational controls and record keeping (i.e. waste manifests).

The implementation of an EMS also serves to increase the understanding among employees of where their activities, products and services may interact with the biophysical environment. An EMS forces all levels of employees to get involved in environmental management as opposed to leaving environmental management in the hands of the "environmental specialists" or "environmental managers".

In 1994, The City of Calgary Council endorsed an Environmental Regulatory Compliance Policy (ERCP). The objectives of the ERCP were two fold, to ensure that civic operations are in compliance with all environmental laws and regulations and to demonstrate due diligence in the event of non-compliance. A systematic approach to managing environmental issues and implementing this policy was necessary for Calgary.

Jacques Whitford Environment Limited (Jacques Whitford) was contracted by the City of Calgary's Engineering and Environmental

Services Department (now part of Utilities and Environmental Protection) to provide the baseline information required to develop and implement an EMS based on ISO 14001 for the various business units including Waste and Recycling Services, Wastewater, Roads, Urban Development and Environmental Management. Subsequently, Jacques Whitford was contracted directly by the Waste and Recycling Services to provide assistance in a number of areas of EMS development including development of an EMS Core Manual, facilitation of environmental objectives and targets, assistance in EMS Awareness training, development of environmental audit protocols and the provision of auditors for a management system and compliance audit.

The establishment of an EMS served to create a framework to change responsibilities, attitudes and actions with respect to environmental management. Registering it with ISO 14001 allows the EMS to survive for the minimum registration period of three years. Otherwise it may become a casualty of ever-changing administrations.

Environmental Management Systems will become more common in municipalities and in particular in Solid Waste Management departments. New York City test piloted a project implementing an EMS for its waste management operations. The Regional Municipality of Waterloo's Waste Management Centre is registered to ISO 14001 and the City of Calgary's Waste and Recycling Services has registered its entire waste operations to ISO 14001. In the fall of 2003, the City of Calgary successfully registered to ISO 14001 making it the first municipality in North America and one of the first in the world to register all of its operating business units and corporate EMS to the international standard.

The establishment of an EMS is one method of creating a framework to change responsibilities, attitudes and actions with respect to environmental management. The advantages of using an EMS for Solid Waste Management is that it creates a structured process for incorporating concerns and issues from the public and other stakeholders such as ENGOs, other public sector organizations, etc. into the decision-making process. An EMS specifies regular identification and prioritization of environmental aspects, setting objectives and targets and setting environmental management programs to meet those targets. A municipality has to be responsive to the public, and the establishment of an EMS means that Solid Waste Management is handled in a proactive rather than a responsive manner.

6 Resources

APEGBC Sustainability Guidelines

To learn more about the APEGBC Sustainability Guidelines see the Primer Part 2 available through APEGBC, or by download from www.sustainability.ca.

L. Failing, G. Long, *Sustainability in Professional Engineering and Geoscience: A Primer Part 2: Applying the Guidelines*, APEGBC, 2002.

Association of Professional Engineers and Geoscientists
200-4010 Regent Street, Burnaby BC, Canada, V5C 6N2
Phone: 604-430-8035, Fax: 604-430-8085
Email: info@sustainability.ca Webpage: www.sustainability.ca

Associations and Organizations

International Federation of Consulting Engineers (FIDIC)
World Trade Center II, Geneva Airport
Box 311, CH-1215 Geneva 15
29 route de Pré-Bois, CH-1215 Geneva 15
Tel +41-22-799 49 00, Fax +41-22-799 49 01
Email: fidic@fidic.org Webpage: www.fidic.org

Association of Consulting Engineers of Canada (ACEC)
130 Albert Street, Suite 616, Ottawa, ON, Canada K1P 5G4
Phone: 1-800-565-0569, Fax: 613-236-6193
Email: info@acec.ca Webpage: www.acec.ca

Consulting Engineers of British Columbia (CEBC)
Suite 657 - 409 Granville St., Vancouver, BC, Canada, V6C 1T2
Phone : 604-687-2811, Fax: 604-688-7110
Email: info@cebc.org Webpage: www.cebc.org

The Natural Step Framework

Two books have recently been published that demonstrate how organizations have implemented the Natural Step Framework. The more recent one, Dancing With The Tiger, discusses the implementation of the Natural Step framework at the Canadian Engineering Consulting Firm CH2M Hill.

M. Altomare & B. Nattrass, *Dancing With The Tiger*, New Society Publishers, Gabriola Island, Canada, 2002.

M. Altomare & B. Nattrass, *The Natural Step For Business*, New Society Publishers, Gabriola Island, Canada, 2001.

The Natural Step has branches in many countries. For more resources, including contacts for your region, visit their webpage, call or write to them at:

The Natural Step
Suite 800, 116 New Montgomery Street
San Francisco, CA 94105
Phone : 415-318-8170, Fax: 415-974-0474
Webpage: www.naturalstep.org

Cradle to Cradle

One of the best books on sustainable design outlines the Cradle to Cradle concept.

M. Braungart & W. McDonough, *Cradle to Cradle*, North Point Press, New York, 2002.

For more information on Cradle to Cradle design, including audio and video presentations, contact McDonough Braungart Design Chemistry.

MBDC
700 E. Jefferson Street, Third Floor
Charlottesville, VA 22902, USA
Phone: 434-295-1111, Fax : 434-295-1500
Weppage: www.mbdc.com

Climate Change

For a brief overview of climate change and how it affects Professional Engineering and Geoscience read the APEGBC climate change primer. It can be downloaded from the webpage or ordered by phone.

Association of Professional Engineers and Geoscientists
200-4010 Regent Street, Burnaby BC, V5C 6N2
Phone: 604-430-8035 Fax: 604-430-8085
Email: info@sustainability.ca, Webpage: www.sustainability.ca

For an in depth look at the science and policy issues surrounding climate change the best source is the *Third Assessment Report* by the United Nations Intergovernmental Panel on Climate Change.

IPCC Secretariat, C/O World Meteorological Organization,
7bis Avenue de la Paix, C.P. 2300, CH- 1211 Geneva 2, Switzerland
Phone: +41-22-730-8208 Fax: +41-22-730-8025
E-mail: IPCC-Sec@wmo.int, Webpage : http://www.ipcc.ch/

Reporting

The Global Reporting Initiative (GRI) is a multi-stakeholder process and independent institution whose mission is to develop and disseminate globally applicable Sustainability Reporting Guidelines.

Global Reporting Initiative Secretariat
Keizersgracht 209,P.O. Box 10039
1001 EA Amsterdam, The Netherlands
Phone: 31 (0) 20 531 00 00 , Fax: 31 (0) 20 531 00 31
Webpage: http://www.globalreporting.org/

The United Nations Department of Economic and Social Affairs, Division for Sustainable Development oversees the development and implementation of Agenda 21. Agenda 21 attempts to demonstrate ways to address disparities between and within nations, worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our well-being.

Agenda 21
http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm#pre

The AMEC Sustainability Report is perhaps the best example from the Consulting Engineering and Geosience sector.

AMEC
111 Dunsmuir St., Vancouver, British Columbia,V6B 5W3 Canada
Phone: 1-604-664-4315, Fax 1-604-664-3301
http://www.amec.com/sustainabilityreport2003/index.html

Life Cycle Assessment

A standard for measuring life-cycle costs of buildings and building systems can be ordered through the ASTM website. A summary can be found by searching the standards database.

E917-02 Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems
http://www.astm.org

EMA is a management tool for addressing the often hidden or ignored financial costs associated with impacts on the environment. The site offers a list of resources and tools for environmental management accounting as it relates to decision making in private and public sector organizations.

Environmental Management Accounting International Website
http://www.emawebsite.org/

LCAccess – US Environmental Protection Agency
http://www.epa.gov/ORD/NRMRL/lcaccess/index.htm

A report on LCA – history of LCA, relationship to sustainability, applications, methodology, and information sources.

LCA Guide – European Environment Agency
http://reports.eea.eu.int/GH-07-97-595-EN-C/en

Life Cycle Assessment Links
http://www.life-cycle.org/

Environmental Management Systems and ISO 14001

For information on ISO 14001 visit their website.

www.iso.ch

To learn more about the City of Calgary's Environmental Management System visit their website.

http://content.calgary.ca/CCA/City+Hall/Business+Units/Environmental+Management/Our+Environmental+Management+System/Our+Environmental+Management+System.htm