C·V·R·D

ENVIRONMENT COMMISSION

JANUARY 19, 2012
6:00 PM – CVRD Boardroom, 175 Ingram Street

AGENDA

Pages

1. CALL TO ORDER

2. ELECTIONS
A. Nominations for Chair
B. Nominees Brief Address to Board
C. Election by Ballot
D. Proclaim Chair for 2012
E. Nominations for Vice Chair
F. Election by Ballot
G. Proclaim Vice Chair for 2012

3. APPROVAL OF AGENDA 1-2

A1 Overview of a Regional District

4. ADOPTION OF MINUTES

M1 Adoption of Minutes of Environment Commission from December 15, 2011 — 3–5

5. BUSINESS ARISING OUT OF MINUTES

B1 Commission Work Plan – J. Straker — Verbal

B2 Update on land use recommendations — Verbal

B3 Economic Development Committee appointment — Verbal

B4 Meeting Schedules

6. CORRESPONDENCE

7. SUB-COMMITTEE REPORTS

R1 Communications – Video contest feedback — 6-9

R2 Agriculture – Workshop

8. INFORMATION

IN1 North Cowichan Climate Action and Energy Plan — 10

IN2 Natural Capital Policy Review
http://www.davidsuzuki.org/publications/reports/2011/natural-capital-policy-review-a-review-of-policy-options-to-protect- — 11-77

enhance-and-/

IN3	Annual Report – Vancouver Island Drinking Water Team	78-85

9. NEW BUSINESS

NB1	Private Sector Green Building Strategy – Rachelle Rondeau	86-99
NB2	Solid Waste Management Plan – Bob McDonald http://cvrd.bc.ca/DocumentView.aspx?DID=522	100-104
NB3	Tri-Regional Waste to Energy update – Bob McDonald http://cvrd.bc.ca/DocumentView.aspx?DID=8035	105-167
NB4	Corporate Strategic Plan Implementation Jacob Ellis	Verbal

10. ADJOURNMENT

11. NEXT MEETING: TBA

Distribution:

CVRD Director Gerry Giles
CVRD Director Rob Hutchins
CVRD Director Phil Kent
CVRD Director Jon Lefebure
Rodger Hunter
Dave Polster
Tyler Innes
Larry George, Cowichan Tribes
Justin Straker
Judy Stafford
Roger Wiles
Peter Keber
Janna Jorgensen
Sophy Roberge
Roger Hart

As Well As:
Warren Jones, CAO, CVRD
Brian Dennison, General Manager, Engineering and Environment Services
Kate Miller, Manager, Regional Environmental Policy Division

Agenda Cover Only:
Director B. Fraser
Director M. Marcotte
Director M. Dorey
Director M. Walker
Director I. Morrison
Director T. McGonigle
Director L. Iannidinardo
Director P. Weaver
Director L. Duncan
Tom Anderson, General Manager, Planning and Development Services

Minutes of the regular meeting of the ENVIRONMENT COMMISSION held in the CVRD Boardroom, 175 Ingram Street, Duncan, on December 15, 2011 at 6:00 pm.

PRESENT:	Justin Straker – Co-Chair	Director Giles – Co-Chair
	Director Duckworth	Dave Polster
	Director Kent	Roger Wiles
	Pete Keber	Judy Stafford
	Chris Wood	Janna Jorgensen
	Tyler Innes	Bruce Fraser
	Sophy Roberge	Roger Hart
	Rodger Hunter	

ALSO PRESENT: Director Duncan
Brian Dennison, General Manager, Engineering & Environment Department
Dyan Freer, Recording Secretary

REGRETS: Director Hutchins, Kevin Visscher, John Morris, Rodger Hunter, Kate Miller

Introduction of new member to the Environment Commission, Roger Hart. The Chair asked if he would accept the position of representative to the Economic Development Committee from this committee. He accepted, there being no other volunteers from the commission members and no objections.

APPROVAL OF AGENDA

It was moved and seconded that the agenda be approved with a change of order moving NB1 to first item, before B1;

MOTION CARRIED

ADOPTION OF MINUTES

It was moved and seconded that the minutes of the November 17, 2011, Environment Commission meeting be adopted as presented.

MOTION CARRIED

BUSINESS ARISING OUT OF MINUTES

B1

Members term expirations – thank you to Bruce Fraser, Kevin Visscher, and Chris Wood. Chair acknowledged their time and work spent on Commission matters and presented each with a gift. New directors may be nominated from the Board for 2012 as well.

B2

It was moved and seconded that we accept the verbal report of the Communications video contest sub-committee to receive the 12 uploaded videos and approve the awarding of ten prizes.

MOTION CARRIED

7:00 pm

Janna Jorgensen and Sophy Roberge gave a brief overview of the video contest criteria and judging. More feedback will be forthcoming. Discussion ensued. Video Contest – viewing of winning videos and the presentation of prizes took place. The winning videos and names were posted on the www.12things.ca website.

B3 Updated Commission Work Plan – J. Straker – Justin made some revisions

It was moved and seconded to accept the work plan as presented and to plan to begin work on it in January, 2012.

MOTION CARRIED

Justin will send out a list of the sub-committees and ask members to volunteer.

B4 **Update on land use recommendations – J. Straker**
A handout was distributed which gave CAO's response to his enquiry to update on the Commission's request on recommendations on land use. A steering committee will be formed to review presentations and proposals from consultants in Spring 2012. Chairs suggest that a member of the Environment Commission be appointed on the steering committee – J. Straker to send this request via e-mail. General Manager, E&E will ask General Manager, Planning and Development if an Environment Commission member could be involved in developing the 'proposed approach' (Terms of Reference) for the Integrated Regional Sustainability plan prior to formation of the steering committee.

The Board approved the spending of $30,000 to support the Agricultural Mapping Project.

7:00 pm Video Contest – viewing of winning videos, presentation of prizes took place The winner's videos and names were posted on the www.12things.ca website.

CORRESPONDENCE

C1 Email from Peter Nix dated November 25, 2011. Justin Straker will respond to Mr. Nix.

C2 Pesticide Survey forwarded by Roger Wiles December 13, 2011

REPORTS

R1 **Land Committee** – no report.

R2 **Communications Committee** – Video Contest prizes awarded

R3 **Water Committee** – no report

R4 **Agriculture** – Judy Stafford gave an update regarding the planned Agricultural Forum at Duncan United Church from 9 -3 pm, January 19th, 2012. J. Stafford to provide an update presentation on the activities of the CVRD Environment Commission as part of this forum.

NEW BUSINESS

NB1 Moved to B1

NB2

2012 scheduling of meetings – do we want the third Thursday of the month to continue. We may not need monthly meetings if the sub-committees are working actively. Support to continue monthly meetings on the 3rd Thursday or each month, perhaps with July/Aug. off. To be re-visited if necessary once the 2012 workplan is underway. Suggestion to hike up Mt. Tzouhalem for our May meeting to renew our connections to the environment. Another place to visit would be the Eagle Heights Grasslands in June, and the Koksilah Old Growth forest.

ADJOURNMENT

The meeting adjourned at 9:05 pm.

NEXT MEETING

January 19th, 2011

_____ _____

Chair Recording Secretary

Dated: _____

CVRD Environment Commission – State of the Environment Video Contest DRAFT FEEDBACK

2011 R1

The first installment of the CVRD State of the Environment Video Contest had some great successes and there were also some good learning opportunities for next year. The CVRD staff did an excellent job in setting up and promoting the contest and minor adjustments for next year will help build on the success of the first. In terms of submissions, overall there was some disappointment in the low number of videos submitted, and the quality of most videos offset the deficiencies in others.

This table provides a first draft of informal (unstructured) feedback collected from three sources: (1) the video judging panel, (2) initial input from the Environment Commission, and (3) one-on-one feedback from participants and their family members/helpers collected in person by Sophy and Janna. Coloured text in quotation marks is sourced from written feedback (i.e., unedited).

This document should be viewed as a living document and is intended to inform enhancements to the process for the next video contest. This information is not exhaustive or complete, and is raw data only. Some data contradict each other because no analysis/recommendations have been formed.

It is recommended that the Communications Sub-committee plan to gather more feedback, and make recommendations to the Environment Commission on changes for next year, as appropriate, based on an analysis of these points and other lessons learned.

Category	Sub-Category	Comments/Ideas for Improvement
Rules/Contest Structure	Participation/Eligibility	- We need to determine and articulate terms of eligibility (i.e., based upon out-of-area entries that may have local relevance) - If we have prize money available in a given prize category, but we have an entrant whose video is relevant to our work but lives out of the region, do we want the right to consider that video? - Do we want to reserve the right to not consider an entry, even if they meet the residency requirement? For example, if the quality is low do we want to the right to NOT assign a prize ranking?
	Criteria	- Find a way to recognize that different youth have different access to technology and know-how. Decide in advance how important this aspect will be in the judging process
	Theme/Topic	- Keep it open - Narrow it down - Focus on a specific theme - Ask for a response on three questions rather than 10 if narrowing it down - If you change the topics/themes, also consider implications for the prize categories (ensure

		people don't choose a topic/theme because of low perceived interest and higher potential for prize winning) - Take 3 questions and localize them, or break it into three types of questions: (1) Global, (2) local - regionally, geographically or industry specific, (3) in the home. - Provide some sort of structure/guidelines/questions to consider for the submissions along the lines of "What do you want to do?" or "What changes can you commit to" or "Why does it matter to you" or "How does it impact your life" or "How do you want to be heard." If the EC decides on what it is hoping to achieve by doing this contest then this can inform the guiding questions - "Consider having it grouped around the 12 things or the SOE targets... the question we asked really was not addressed by any of the videos..."
	Categories for Judging/Prizes	- Develop two categories of (1) individuals/small groups of friends and (2) youth groups/organizations - Suggest award money less for individuals than for youth groups/organizations
	Age Group-specific comments	- "The comment that was made re the mid age group (16-18) was interesting in that they need mentors to some extent"
	Timing	- Pick dates for next year now and promote year-round - December does not work in schools, but Oct/Nov and Jan/Feb are good - Start in September or January – this aligns better with youth availability - September best as the Aboriginal Film Festival is doing its outreach in schools at that time anyway
	Prizes	- Consider giving out a non-monetary prize (eg. A handicam) - Find a way to equalize the awards - $500 is a lot of money for an 8-year-old, but not for a youth group - "I think the overall prizes where too much money – perhaps consider individual and team versions."
	Promotions/Advertising	- Have a person going out and doing face-to-face promotions - Have a person providing support (technical/other) throughout contest

		- Tie it in with other festivals/contests (eg. Aboriginal Film Festival) – this could be a first project for participants in the Aboriginal Film Festival, for example - Use youth ages 18 – 20 to work with participants as mentors/support - Press release was a great idea! - Like the idea of showing the winning videos at the next Board Meeting
	Funding/Resources	- Consider putting some money toward hiring a resource person for the contest (10 hrs a week)
Integration	Evaluation/Feedback	- Solicit feedback from prize winners and those who supported them – face-to-face best, but could also do a survey
	"Hearing" the message	- "I recommend the Communications Sub-committee assign at least three people to re-watch the videos and do a bit of a meta-analysis to see what information/ideas, if any, can inform the processes, work, or functions of the Environment Commission. If there are no pieces that are of use, this provides some good insight into how we may way to change things for next year."
	Building Connections	- Good idea to tie it with other film/multi-media activities in the community - Who did we miss this year? - How can we get this contest integrated with other efforts/initiatives? - Are there global contests that we can enter our winners into?
Judging Process	Advance	- Ask panel members to view the videos in advance and provide them with their scoring sheets – provide approx one week lead time - Only allow judging panel members who can attend in person since the discussion can impact rankings - "Videos can be uploaded as received and previewed so that the public can see them as they come in." - "Allowing the public to vote on them (clear criteria or public choice)."
	Facilitating Judging Session	- View the videos according to category - View one video at a time

		○ Give one minute for scoring/comments - Facilitate group discussion after each category - Provide people with an opportunity to re-watch any videos if necessary - Give people a chance to re-score/adjust ranking accordingly before moving onto next category - For overall winners, consider rankings rather than cumulative score to minimize inadvertent judging bias introduced through acquired scoring scale adaptation/adjustments
Miscellaneous		- VIU is starting a film program (unconfirmed) - Aboriginal Film Festival is happy to coordinate efforts/X-promo - Michele Staples is able to promote and provide assistance to participants through fall school term (for a fee). She is already doing a lot, and will continue to, but cannot do more without compensation. - Michele S. is making a video showing the dialogue the two youth group submissions ('U Fix it Friday' and the 'Inclusive Leadership' group from the Intercultural Society), and French-immersion elementary school (Duncan Elementary) engage in to determine how the money will be spent. This would be informative as we consider re-vamping the contest categories next year. - "The website design and structure is largely there and ready to be used again and it would be nice to see it as a annual event which links to other local partners. Hopefully the communications group is interested in doing it again with lessons learned." - "Definitely the commission members should be actively involved" - Staff can help but it is really not their role to act as the point person or designer of the contest

Municipality of
North Cowichan
Climate Action & Energy Plan

NORTH COWICHAN VS CLIMATE CHANGE

You have ideas to fight climate change.

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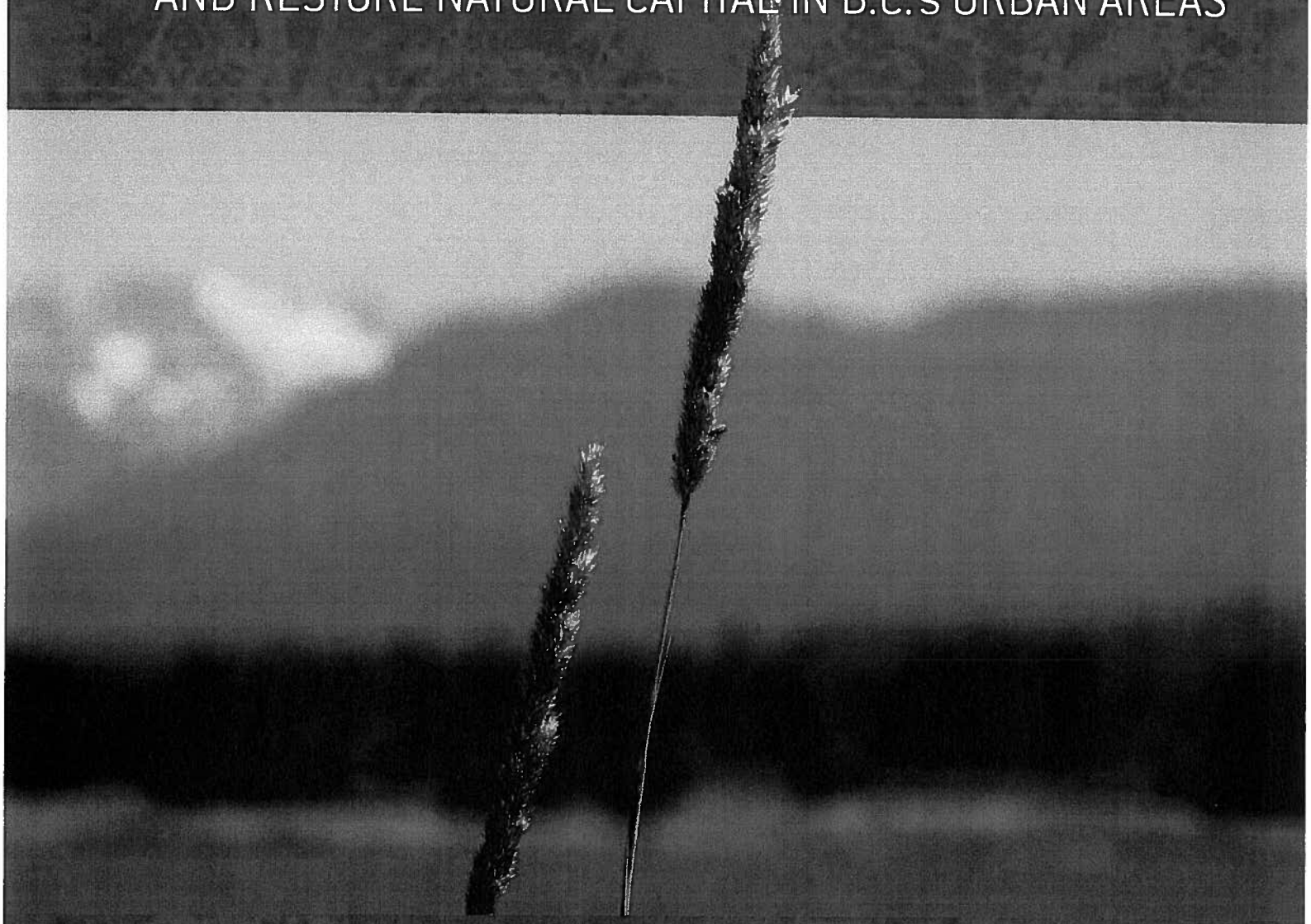
IN 2

Natural Capital Policy Review

A REVIEW OF POLICY OPTIONS TO PROTECT, ENHANCE AND RESTORE NATURAL CAPITAL IN B.C.'s URBAN AREAS



David Suzuki Foundation

SOLUTIONS ARE IN OUR NATURE

NATURAL CAPITAL POLICY REVIEW

A Review of Policy Options to Protect, Enhance and Restore Natural Capital in B.C.'s Urban Areas

September 2011

By Michelle Molnar

This report was made possible through the generous support of the Vancouver Foundation

vancouver foundation

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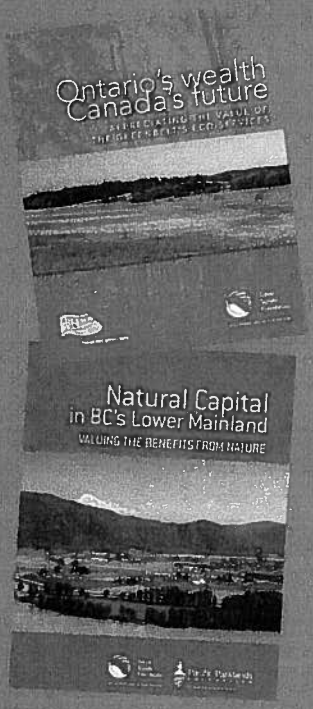

Download this report, our 2008 report on natural capital in Ontario, and our 2010 report on natural capital in B.C.'s Lower Mainland at davidsuzuki.org/publications/

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Executive Summary

WHETHER WE ARE AWARE OF IT OR NOT, humans depend on nature for our health and well-being. We often think of nature as something out there; that its utility in the city is generally confined to recreational pursuits. But nature within and surrounding our communities provides much more than a place to jog or have a picnic. These ecosystems provide a vast array of ecological services and benefits that are virtually priceless.

Healthy, intact, urban ecosystems purify our air, regulate micro-climate, maintain river flows and groundwater levels, treat our waste, and mitigate natural hazards, *in addition* to providing cultural and recreational activities. These ecological services have supported the extraordinary growth and progress of humanity but are now at risk due to the compounding factors of population growth and their invisibility in our modern economies. The degradation and loss of these natural assets can have serious economic impacts, threatening health, food production, and basic needs such as clean air and water.

Local governments have a critical role to play in the preservation of nature, and its associated ecosystem services. The practical realities of population growth that is sharply focused towards cities, coupled with the provincial downloading of responsibilities, have left local governments with the burden of managing much of our threatened natural capital, often with few resources and little guidance on how to implement or enforce provincial mandates and policies.

The purpose of this report is to evaluate the efficacy of existing policy options and provide recommendations for new solutions that should be adopted in order to protect and restore ecosystem services in developed regions of British Columbia. Following a review of the challenges and opportunities facing local governments, a three-part classification is employed to organize policy evaluations: (1) public ownership, (2) regulation, and (3) market-based instruments. Three policy options emerge from this. They strive to address the drivers of loss to ecosystems, the unique circumstances facing threatened municipalities, and incorporate the most promising policy tools.

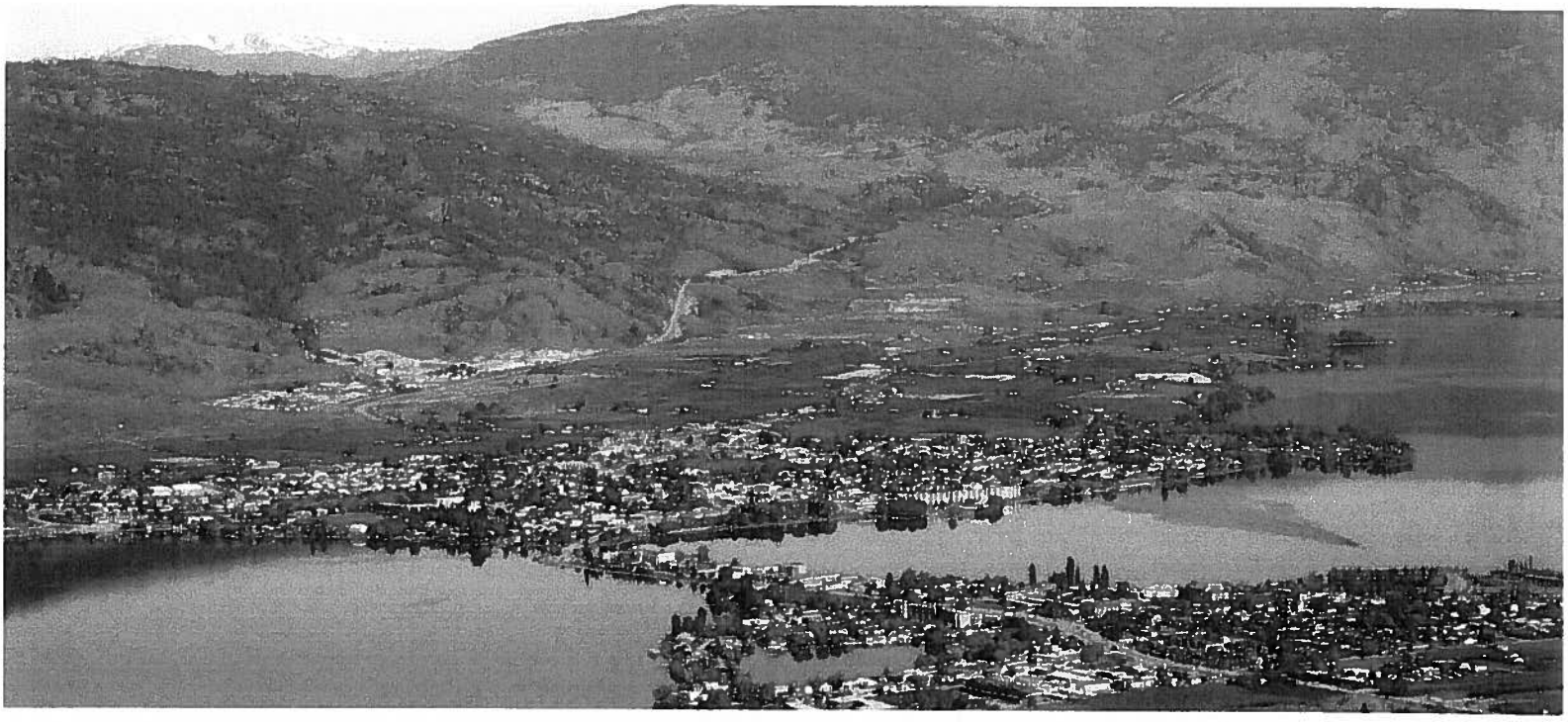
- NATURAL CAPITAL ACCOUNTS: Regional governments take the lead in developing natural capital indicators and targets to track the health of ecosystem services, as well as the effectiveness of related policies.
- CONNECTING OUR PROTECTED AREAS: Regional and municipal governments collaborate to develop a comprehensive protected areas strategy to strengthen the Agricultural Land Reserve regionally and connect it to protected areas at the municipal level.
- MAINSTREAMING ECOSYSTEM SERVICES: Municipal governments build ecosystem service considerations into economic and development planning to minimize ecosystem degradation and manage for ecological health.

To avoid irreversible damage to ecosystems and their associated services, we must radically change the way we use and think about them. Fortunately, we have the knowledge, technology, and tools to make such changes. We have an opportunity to develop the groundwork for policies and programs that strive to manage our ecosystems in a manner that fosters their resilience in the face of increasing pressures.

Research by the David Suzuki Foundation and others has shown that natural capital – the fields, farms, forests, wetlands, and rivers within and surrounding our communities – and the benefits it provides, are extremely valuable in monetary terms, and in reality they are truly priceless.

ABBREVIATIONS

Agricultural Land Commission	ALC
Agricultural Land Reserve	ALR
Alternative Land Use Services	ALUS
British Columbia	B.C.
Canadian Mortgage and Housing Corporation	CMHC
Capital Region District	CRD
Cowichan Valley Regional District	CVRD
Development cost charge	DCC
Ecologically sensitive area	ESA
Environmental development permit area	EDPA
Environmental impact assessment	EIA
Environmental pricing reform	EPR
Environmental Remediation and Site Enhancement	ERASE
Government Finance Officers Association	GFOA
Gigajoule	GJ
Harmonized sales tax	HST
Intergovernmental Panel on Climate Change	IPCC
Leadership in Energy and Environmental Design	LEED
Millennium Ecosystem Assessment	MA
Ministry of Agriculture and Lands	MAL
Member of the Legislative Assembly	MLA
National Round Table on the Environment and the Economy	NRTEE
Nitrogen Dioxide	NO2
Official Community Plan	OCP
Regional Context Statement	RCS
Regional Growth Strategy	RGS
Species at-risk	SAR
The Economics of Ecosystems and Biodiversity	TEEB
Union of British Columbia Municipalities	UBCM
Urban containment boundary	UCB



GLOSSARY

Abiotic	Relating to, caused by, or produced by living organisms.
Biodiversity	The variety of life forms, as well as the habitat and natural processes that support them, within a particular ecosystem.
Biotic	Of or having to do with life or living organisms.
Ecosystem	Encompasses the living (plants, animals, micro-organisms) and non-living (water, air) elements that interact in a given area.
Ecosystem services	The collective benefits provided by the resources and processes supplied by natural capital.
Natural capital	The planet's stock of renewable and nonrenewable natural resources (forests, minerals, oil, plant and animal species), environmental resources (atmosphere, water) and land.
Public goods	Public goods are nonrival and non-excludable. That is, the consumption of a good by an individual does not reduce the availability of the good for consumption by another (nonrival), and no one can be effectively excluded from using the good (non-excludable).
Rebound effect	The rebound effect refers to increased consumption that results from actions that increase efficiency and reduce consumer costs.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Water harvesting	Rainwater harvesting is the gathering, or accumulating and storing, of rainwater.

SECTION 1

Setting the Stage

The purpose of this report is to evaluate the efficacy of existing policy options and provide recommendations for new solutions that should be adopted in order to protect and restore natural capital and associated ecosystem services in developed regions of B.C

BRITISH COLUMBIA (B.C.) IS CANADA'S most ecologically and biologically diverse province. Influenced by its proximity to the Pacific and Arctic oceans, and shaped by its mountainous terrain, B.C.'s ecosystems are home to more than half of Canada's wildlife and fish species (Meidinger and Pojar 1991; Cannings and Cannings 1996). In addition to being valuable in their own right, ecosystems provide critical services to society. We depend upon healthy functioning ecosystems for everything from purifying our air and providing clean drinking water, to regulating our climate, providing our food, and supplying recreational opportunities.

Today, many of these ecosystems are under stress. Rapid population growth and widespread development in B.C.'s temperate southern region have contributed to the loss of more than half of the original wetlands in the Lower Mainland region. This includes over 70 per cent of the antelope brush and needle and thread grasslands of the Okanagan; and approximately 90 per cent of Garry oak meadows on southeastern Vancouver Island (Fraser Basin Council 2011, BioDiversity B.C., 2007). The limited supply of low elevation areas and grassland habitats has simultaneously drawn a high level of biodiversity and human settlement to these regions. Protecting ecosystems and their associated services need not come at the expense of human activities, but does require consideration of their interconnections and the inherent limits of nature. This task often falls on the shoulders of local governments. As the government level that is closest to the ground, regional and local governments have an intimate knowledge of their landscape and its threats, as well as the people living within them.

The purpose of this report is to evaluate the efficacy of existing policy options and provide recommendations for new solutions that should be adopted in order to protect and restore natural capital and associated ecosystem services in developed regions of B.C. It should be noted that this report has a limited focus on regions and municipalities located within the most threatened regions of B.C. (i.e. southeastern Vancouver Island, Lower Mainland, and Central and Southern Okanagan). In addition, this report does not address First Nations communities throughout the identified regions. Resources did not allow for this, but the need for a similar evaluation is strongly recommended.

METHODOLOGY

This report was prepared over the period of March 2010 – April 2011. Data was gathered from three sources. The first source included a literature review that included an examination of regional growth strategies (RGS), official community plans (OCPs), and environmental bylaws through government websites, as well as policy evaluations obtained from academic journals, grey literature, and conservation-based websites. This information was then grounded through a set of ten personal interviews conducted in the fall of 2010 with key environmental planners, coordinators, and managers at the municipal and regional levels of government. Interviewees were asked to comment on threatened ecosystems within their region and the perceived drivers of loss, challenges and opportunities associated with protecting these ecosystems, and the effectiveness of current policies. Lastly, a workshop was held in the spring of 2011 with a similar group of participants to examine the viability of four proposed policy options. The workshop attendees represented a wide range of government interests (e.g. finance directors and mayors) to obtain a balanced perspective.

OUTLINE

This report is divided into three sections:

- Section 1 explains the concepts of natural capital and ecosystem services, and identifies the drivers of their decline. It addresses the role of government in stemming the decline of natural capital and opportunities and challenges of implementing protection policies at a local scale.
- Section 2 reviews and assesses policies available to local governments to protect, enhance, and restore natural capital. Policies are broken into three groups: public ownership, regulatory instruments, and market-based tools. Case studies of promising, innovative, or successful policies are provided throughout.
- Section 3 provides an analysis of three policy options, which are crafted to address gaps in policy and are weighed against a set of five criteria. The section concludes with the report's findings and recommendations.

1.1 What is Natural Capital and Why Does it Matter?

"Natural capital" implies an extension of the economic notion of capital (a factor of production) to include goods and services related to nature.

WHETHER WE ARE AWARE OF IT OR NOT, humans depend on nature for their health and well-being. By feeding us, protecting us, and inspiring and educating us, nature has supported the extraordinary growth of humanity. Although nature and its associated services are arguably more essential to human survival and welfare than other forms of capital, nature remains inadequately valued. In fact, our economies seem to function as if the supply of nature is inconsequential, or endless.

The term 'natural capital' is used extensively in this report. It implies an extension of the economic notion of capital (a factor of production) to include goods and services related to nature. Natural capital has been defined as *"the planet's stock of renewable and nonrenewable natural resources (forests, minerals, oil, plant and animal species), environmental resources (atmosphere, water) and land"* (Olewiler 2007). Just as all forms of capital are capable of providing a flow of goods and services, components of natural capital interact to provide mankind with services that are wide-ranging and diverse. The collective benefits provided by the resources and processes supplied by natural capital are known as ecosystem goods and services, or simply ecosystem services.

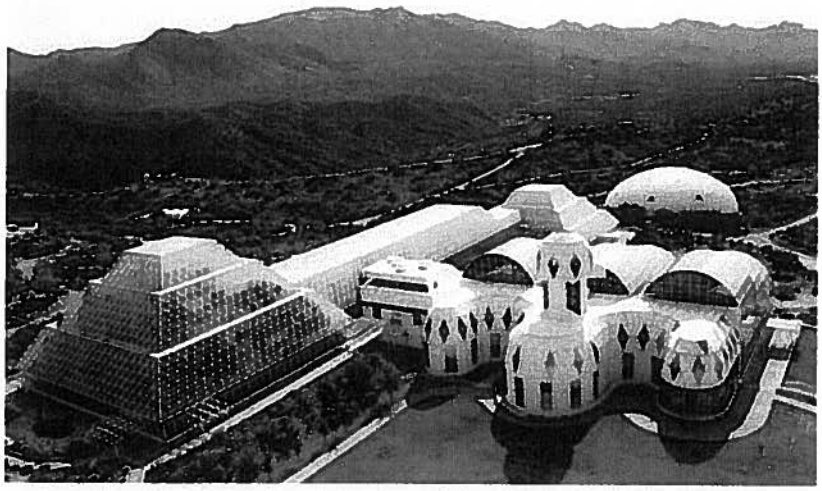
While there is no single classification of ecosystem services that can capture the countless ways in which ecosystems contribute to human wealth and well-being, the latest classification builds upon the Millennium Ecosystem Assessment, which at the time of its publication was the most thorough study on the linkages between ecosystem changes and human well-being. The Economics of Ecosystems and Biodiversity (TEEB), a recent international initiative led by the United Nations, the European Commission, and the German and UK governments, has studied the economic importance of biodiversity and ecosystems, and recognizes four categories of services; provisioning, regulating, habitat, and cultural and amenity services (TEEB Foundation 1, 2010).

- PROVISIONING SERVICES include all the tangible products people obtain from ecosystems, such as food, fuel, and fibre. These services are often well represented in the marketplace, with clear indicators of their monetary value. This class of services has often been artificially replicated, or manufactured, but usually with limited knowledge of its effects. In many cases, an attempt to artificially bolster one service has negative repercussions on others.
- REGULATING SERVICES are the benefits people obtain from the regulation of ecosystem processes, such as water purification and climate regulation. These services are not well represented in the marketplace and attempts to duplicate them with technology have been mixed. Such services occur over vast areas and are connected to a range of other services, making them virtually impossible to isolate for artificial duplication. For similar reasons, their monetary worth is not well documented.
- HABITAT SERVICES represent the critical role habitat plays in species interactions and the regulation of population dynamics. These services are not well represented in the marketplace and attempts to duplicate them have generally met with failure. Their monetary worth is not well documented.

- CULTURAL AND AMENITY SERVICES represent the non-material benefits people obtain from ecosystems through the development of spiritual, cognitive, aesthetic, and recreational activities. The ineffable nature of these services makes them difficult to value in a quantitative manner, nor are they easily duplicated.

THE EXPERIMENT: BIOSPHERE II

In 1987, construction began on a three-acre, five-story greenhouse in the Arizona desert named Biosphere II. It was designed to broaden our understanding of how ecosystems function by creating an artificial closed environment that mimics the functions of Biosphere I (i.e. the Earth). Upon completion, it contained a miniature ocean, rainforest, savannah, desert, and farm (see image below).



After less than two years, the Biosphere II project was halted. The atmosphere had gone haywire, carbon dioxide levels fluctuated wildly, and some species died off while others multiplied too rapidly. In the end, this sophisticated artificial world had failed.

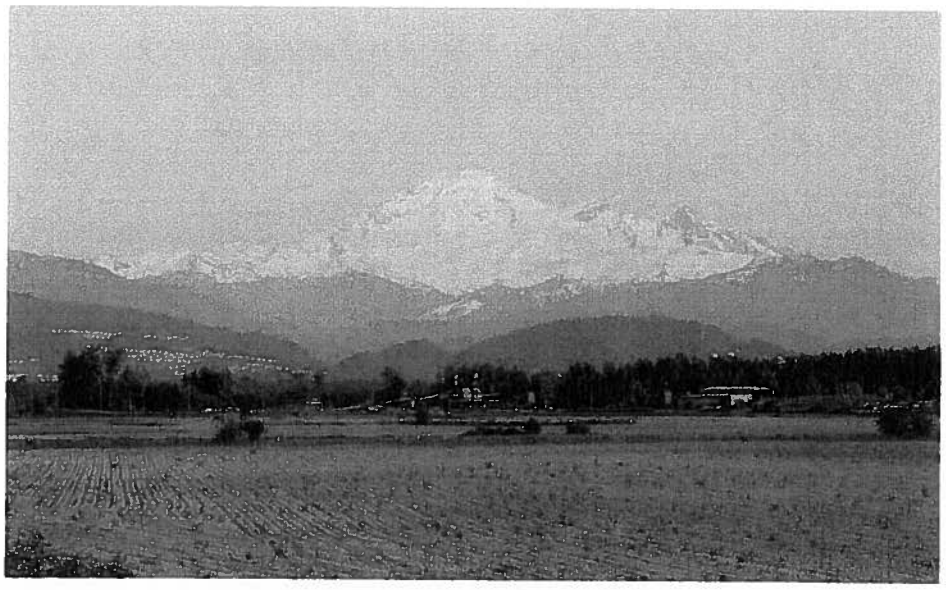
In 1991, with construction complete, a host of plants and animals, including eight people, were sealed inside Biosphere II. After less than two years, the project was halted. The atmosphere within the structure had gone haywire. Carbon dioxide levels fluctuated wildly, and the system required repeated injections of oxygen. A number of species had died off and all pollinating insects died, while other species had multiplied so rapidly they had to be culled. In the end, this sophisticated artificial world had failed.

The experiment demonstrated that our environment is highly complex and interconnected and that human ingenuity is no match for the elegance and sophistication of natural ecosystems.

Sources:

Biosphere 2: The Experiment: www.biospherics.org/experimentchrono1.html

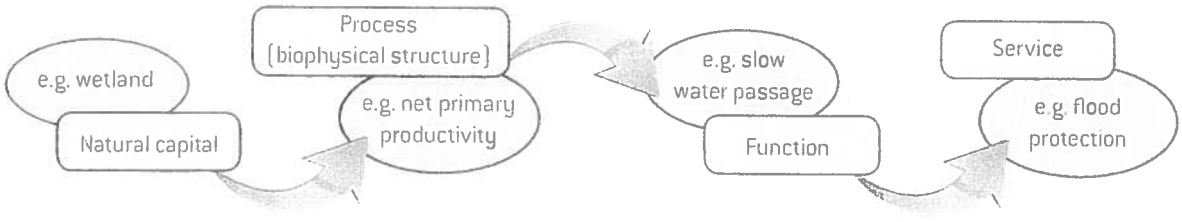
Jamasmie, Cecilia. (2006)



Decision-makers need to understand steps and linkages between natural capital and ecosystem services in order to maintain an acceptable level of ecosystem services for their constituents.

Figure 1 gives a schematic representation of the pathway from ecosystems and biodiversity to human well-being. As the figure shows, there are a number of steps and linkages between natural capital and ecosystem services. Decision-makers need to understand this process in order to maintain an acceptable level of ecosystem services for their constituents. As such, it is important to understand that 'functions' signify the potential that ecosystems have to provide a service, which in turn rests upon the health of biological structures, or 'processes' (TEEB, 2009). For example, flood protection (the 'service') is dependent upon slow water passage (the 'function'), which is dependent upon net primary productivity (the 'process'), which is dependent upon intact wetlands (the 'natural capital'). Furthermore, it is important to understand that the spatial distribution of processes, functions, and services varies considerably depending upon the benefit being considered. Lastly, it is critical for decision-makers to recognize what we don't know. There is scant knowledge on how ecosystem services are produced and maintained; how they are impacted by biotic and abiotic changes; how they relate to biodiversity; and how processes and functions interact with one another (Molnar et al, 2009).

FIGURE 1: THE FLOW OF NATURAL CAPITAL TO ECOSYSTEM SERVICES



1.2 The State of Natural Capital and Ecosystem Services

"While living standards have generally improved over the past two centuries, human activity is putting such strain on nature that we are undermining the Earth's capacity to support current and future generations. We are living beyond our means: recent gains in quality of life have come at considerable cost to the natural systems on which we all depend. If we act now, we can avoid irreversible damage to ecosystems and human well-being. But this will require a sea-change in the way we think about and use natural resources."

— Millennium Ecosystem Assessment Toolkit, 2007

TO DATE, THE MILLENNIUM ECOSYSTEM ASSESSMENT is the most comprehensive investigation of the state of ecosystem services throughout the world. In the year 2000, the United Nations brought together hundreds of experts (1, 360 people from 95 countries) who sought to directly connect ecosystem changes with human well-being. Four years later, the Assessment concluded that we are living beyond our means. The study found that approximately 60 per cent of the ecosystem services examined are being degraded or used in ways that cannot be sustained. Furthermore, there is growing evidence that many ecosystems are at risk of reaching their "tipping point," where sudden and irreversible changes will have dire implications for human well-being. This situation can be avoided however. We possess the knowledge and technology to make changes that will protect ecosystems and human well-being. The 'sea-change' mentioned in the quote above begins with the recognition that ecosystem services are not free and limitless.

In British Columbia, only 14.4 per cent of its lands and less than one per cent of its waters are protected (B.C. Progress Board 2010). While B.C. can boast a higher percentage of protection than other Canadian provinces (ibid), there is general consensus in the scientific community that between 20 and 50 per cent of habitat requires some degree of protection to maintain ecological processes (Noss and Cooperrider, 1994; Clayoquot Sound Scientific Panel, 1995; Province of B.C., 1995; Noss, 1996c; Coast Information Team, 2004). Moreover, protected regions are already quite fragmented, restricting the movement and dispersal of animals and plants. In B.C., the distribution of intact[1] protected areas is skewed, with the majority in the northern half of the province where population pressures are low.

The B.C. Ministry of Environment tracks environmental health through its State of the Environment Reporting. The reports are released sporadically, which is a problem for highly threatened areas. For a period the reports were occurring every two years, but now they appear to have moved to five-year intervals. The most recent report, *Environmental Trends in British Columbia: 2007*, utilizes 44 indicators and over 25 supplementary measures to provide a picture of measurable pressures and environmental conditions in the province (MoE 2007). The report sounded alarm bells for large

There is growing evidence that many ecosystems are at risk of reaching their "tipping point," where sudden and irreversible changes will have dire implications for human well-being. This situation can be avoided.

1 'Intact' is defined as areas of at least 2,000 ha that are more than 5 km away from roads.

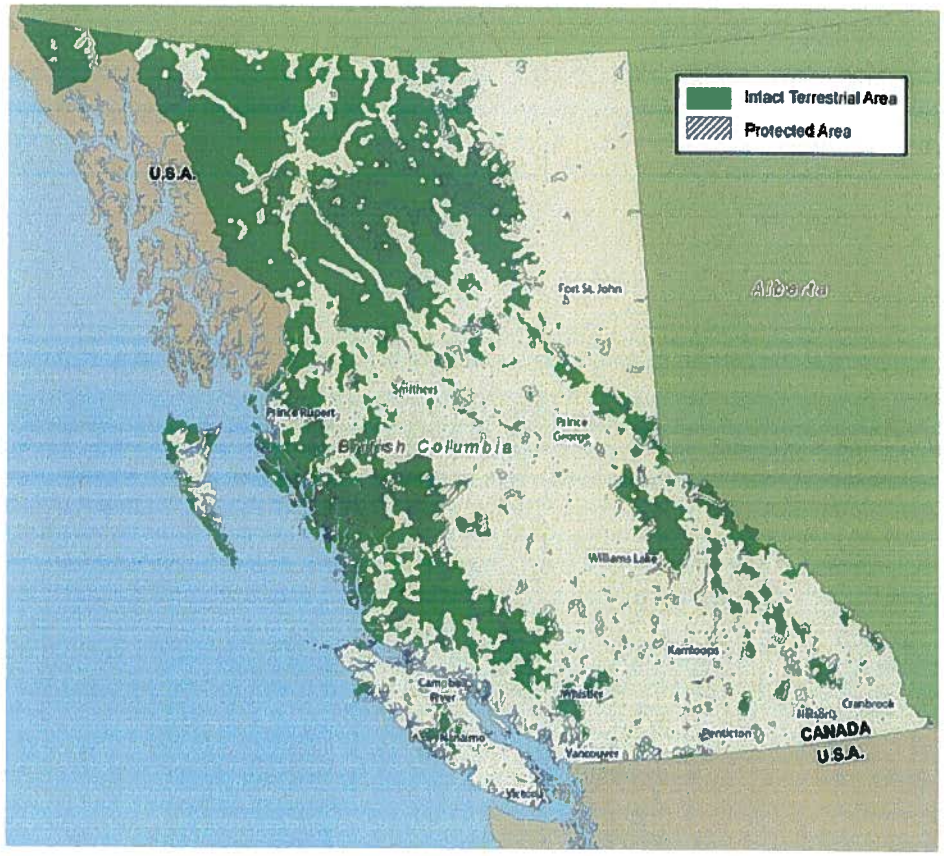
urban areas in the southern portion of the province, particularly Metro Vancouver, Southeastern Vancouver Island, and the South and Central Okanagan regional districts, where findings revealed:

- Rapid population growth, particularly in Metro Vancouver where population density doubled between 1976 and 2006;
- Heavily developed aquifers;
- More estuaries with economic tenures than conservation tenures (38 per cent versus 28 per cent);
- A significant increase in the length of roads (82 per cent from the period 1988 to 2005), especially within the Georgia Depression ecoprovince (which includes Vancouver) that has the most roads per square kilometre; and
- An increasing number of mammalian, freshwater fish, and plant species with "deteriorating" conservation status.

The University of British Columbia has also undertaken research on the province's "hot spots" (i.e. regions of B.C. that combine particularly high species richness, endemism, and threat). The results largely mirror the regions identified by the Ministry of Environment. Metro Vancouver, Southeastern Vancouver Island (including the Gulf Islands), and the Southern Okanagan were identified as regions

The strategy of fragmented protection offers limited protection of natural capital (and ecosystem services) due to the lack of connectivity for species.

FIGURE 2: INTACT ECOSYSTEMS AND PROTECTED AREAS IN BRITISH COLUMBIA

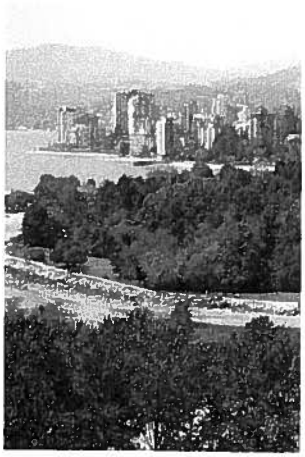


Source: Ministry of Environment (2007)

of high concern. The studies went on to examine the lack of correspondence between these hot spots and protected areas (Scudder 2003; Scudder 2004). While the authors conceded that park selection in the 1930s and 1940s was driven by tourism appeal, they anticipated a shift in park locations beginning in the 1980s when environmental considerations were added to selection criteria. This shift failed to materialize when biodiversity came to represent one value in a series of values to be considered in park selection. Feeling that there are few opportunities for adding additional protected areas in the hot spot regions, recommendations focused on "vest-pocket reserves," which are small reserves that are well suited to plant and invertebrates, and integrated conservation planning at the ecosystem level (Scudder 2003; Scudder 2004). Unfortunately this strategy of fragmented protection offers limited protection of natural capital (and ecosystem services) due to the lack of connectivity for species.

ECOSYSTEM SERVICES OF URBAN AREAS

It's common for people to think that nature has no role or only a very minor role in cities. We think of nature as something out there; that its utility in the city is generally confined to recreational pursuits. But there is much more to it than that. Below six local ecosystem services of relevance to cities and two ecosystem services of relevance to regional districts are discussed.



A recent review of natural capital in the Lower Mainland indicates that trees in the region remove about 100 kilograms of pollutants per hectare, and a total of 82.6 million kilograms per year.

AIR PURIFICATION

Air pollution caused by transportation and the heating of buildings, among other things, is a major environmental and health problem in cities. It is well documented that vegetation reduces air pollution by absorbing dissolved pollutants, filtering particulate matter, and releasing oxygen, but to what level generally depends on the local situation.

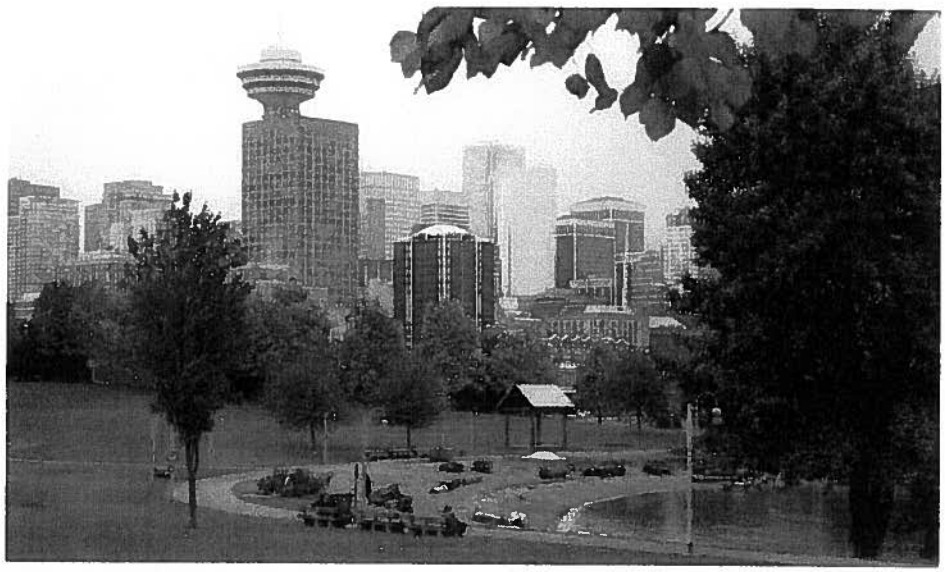
To provide some context, a recent review of natural capital in the Lower Mainland indicates that trees in the region remove about 100 kilograms of pollutants per hectare, and a total of 82.6 million kilograms per year. The annual minimum value of the removal of carbon monoxide, nitrogen dioxide, particulate matter and sulphur dioxide by trees is $409 million per year or $495 per hectare per year[2] (Wilson 2010).

In addition to conserving regional and urban forests, green infrastructure, such as green roofs, tree planting, and rain gardens improve air quality. A recent report coproduced by the Centre for Neighborhood Technology and Living Rivers (2010) provides guidance on how to estimate the value of green infrastructure. The report provides the following rough estimates of values related to air purification:

- GREEN ROOFS: A 464 square metre green roof would, on average, take up between 0.68 kg and 1.08 kg of NO2 annually, worth approximately $4.80 – $7.63/year[3].
- TREE PLANTING: 100 medium trees take up 28 kg of NO2 annually, worth approximately $200/year.

2 The externality costs used are reported by the United States Public Services Commission. An average of each state in the US is used and the dollar value conversion is $1 US = $1.11 CAN.

3 Values originally reported in US dollars ($5.01 – $7.98/yr), and have been converted to Canadian dollars at an exchange rate of $1.02 (average rate for the month of June 2011).



Studies have found that parks as small as a city block showed warmer temperatures in the winter and cooler in the summer. This is a key argument for the preservation of old parks and the creation of new ones in urban areas.

MICRO-CLIMATE REGULATION

Local climate and weather is affected by cities. It is generally warmer in the centre of the city and cooler as you move out to the suburbs, due to the change in surface materials. Studies have found that parks as small as a city block showed warmer temperatures in the winter and cooler in the summer. This is a key argument for the preservation of old parks and the creation of new ones in urban areas. All natural ecosystems in urban areas will help to reduce such differences. Water courses in the city will help even out temperature deviations both during summer and winter. Vegetation is also important (Bolund and Hunhammer 1999; Ball 2008).

The natural capital valuation of climate regulation in the Lower Mainland was calculated according to the carbon sequestration potential of forests. The total minimum value of $1.5 billion per year (or about $1, 780 per hectare per year) was based in the avoided social costs of carbon emitted to the atmosphere, as calculated by the Intergovernmental Panel on Climate Change (IPCC)[4] (Wilson 2010).

RAINWATER FLOW

The built-up infrastructure of cities, with buildings, concrete and asphalt covering much of the ground, results in alterations of water flow compared to an equivalent rural catchment area. A higher proportion of rainfall becomes surface-water run-off which results in increased peak flood flows and degraded water quality through the pick-up of urban street pollutants. The impervious surfaces and high extraction of water cause the groundwater level of many cities to decrease.

Vegetated areas contribute to solving this problem in several ways. The soft ground of vegetated areas allows water to seep through and the vegetation absorbs water and slowly releases it into the air or surrounding water bodies. In vegetated areas only 5 – 15 per cent of the rainwater runs off the ground, with the rest evaporating or infiltrating the ground. In urban areas about 60 per cent of the rainwater is instead discharged into storm water drains and local waterways. This affects both the local climate and the groundwater levels. Cities with a high risk of flooding will benefit more from naturalized areas that take up water than do other cities (Bolund and Hunhammer 1999).

4 A 2007 IPCC report estimates the average social cost (i.e. environmental, economic, and social) of carbon based on the impacts of climate change is $52 (2005 C$) per tonne of carbon.

Green infrastructure, such as green roofs, tree planting, bioretention& infiltration, permeable pavement, and water harvesting also assist with rainwater management. The aforementioned report coproduced by the Centre for Neighborhood Technology and Living Rivers (2010) provides the following estimates of the value of green infrastructure to reduce the impact and costs of stormwater runoff:

- GREEN ROOFS A 464 square meter green roof, using a 60 per cent retention rate will absorb a volume of 269, 143 litres annually, worth $6.24 in avoided treatment costs annually.
- TREE PLANTING 100 medium red oaks will absorb a volume of 427, 373 litres annually, worth $9.93 in avoided treatment costs annually.
- BIORETENTION AND INFILTRATION A site with an infiltration area of 185 square metres and a drainage area of 371 square metres, reduces the volume of runoff by 430, 628 liters annually. This is worth $9.99 in avoided treatment costs annually.
- PERMEABLE PAVEMENT An area of 464 square metres of permeable pavement, using an 80 per cent retention rate, will reduce a volume of 358, 857 liters annually. This equates to $8.33 in avoided treatment costs annually.
- WATER HARVESTING A water harvesting practice, using the rainfall data for Chicago will reduce a volume of 76,257 litres annually, worth $1.77 in avoided treatment costs annually.

WASTE TREATMENT

Wetland plants and animals can assimilate large amounts of nutrients and slow down the flow of sewage water, allowing particles to settle out on the bottom. Up to 96 per cent of the nitrogen and 97 per cent of the phosphorous can be retained in wetlands. Studies have demonstrated that wetland restorations have largely been successful in increasing biodiversity and substantially lowering costs of sewage treatment (Bolund and Hunhammer 1999).

The value of waste treatment by wetlands was estimated for the Lower Mainland (Wilson 2010). The total minimum value of $1, 347 per hectare per year was based upon the cost of removing nitrogen and phosphorus by waste treatment plants[5].

Wetland plants and animals can assimilate large amounts of nutrients and slow down the flow of sewage water, allowing particles to settle out on the bottom.

HAZARD MITIGATION

There are two possible paths to mitigating hazards: either by reducing vulnerability or by modifying, where possible, the hazard (e.g. through levies). There is a growing trend to reducing vulnerability through the preservation of ecosystems. Swamps, reservoirs, floodplains, and soil absorb and slowly release water, reducing the extremes of high and low water. Forests buffer high winds and temperatures and reduce soil drying, erosion, and slope failure. Buffering mechanisms are important information for land use planners concerned with natural hazards.

The David Suzuki Foundation's 2010 Natural Capital Valuation of the Lower Mainland estimates the value of water regulation by forests at a minimum of $1.2 billion or $1, 502 per hectare per year. This was based upon the replacement construction costs for water runoff control if forested areas were removed and converted for urban land use[6] (Wilson 2010).

5 Estimates of the savings in waste treatment are based on the costs of removing phosphorus ($21.85 – $61.20/kg) and nitrogen ($3.04 – $8.50/km) at Vancouver's primary and secondary waste treatment plants, as reported in 2004.

6 Estimates based on construction cost of $57 per cubic metre. Total cost savings are $3.4 billion. However, annualized savings are reported here, calculated over 20 years at 6 per cent interest by CITYgreen software.

CULTURAL AND RECREATIONAL

A city can be a stressful environment for residents. The overall speed and number of daily distractions result in hectic lifestyles with little room for rest and contemplation. The recreational aspects of all urban ecosystems, with possibilities to explore, play and rest, are perhaps the highest valued ecosystem service in cities. These natural urban also provide multiple health and psychological benefits for individuals, and at a community or regional scale help to attract and sustain a highly qualified workforce (Bolund and Hunhammer 1999).

The non-market benefits of recreation have been valued at a minimum of $298 per hectare per year (Wilson 2010). This value is an aggregate of:

- The value of nature-based recreation ($127 per hectare/year) based upon the economic value of nature for B.C.'s residents according to a 1996 national survey conducted by Environment Canada; and
- The value of farm-based recreation ($171 per hectare/year) based upon travel costs incurred for farm visits.

The recreational aspects of all urban ecosystems, with possibilities to explore, play and rest, are perhaps the highest valued ecosystem service in cities.

In addition to these services, there are also some key services at the regional level. Food provisioning and biodiversity are addressed below.

FOOD

The importance of food and the associated land and soil quality requires little explanation. Of obvious importance to human survival, the maintenance of productive farmland should be a common concern to all. With less than five per cent of the land in B.C. classified as suitable for farming, it should be of paramount concern in this province. The Agricultural Land Reserve (ALR) is one of B.C.'s solutions to its protection. Its merits are discussed further under section 2.2.2.

The non-market benefits of ecosystem services in food production were valued at a minimum of $382 per hectare per year in the Lower Mainland (Wilson 2010). This was based upon the estimated travel cost to farms, as well as the reported willingness to pay for locally grown food.

BIODIVERSITY

Biodiversity, or the variety of species and the habitat and natural processes that support them, act as a foundation for all of the goods and services provided by nature. Biodiversity provides numerous ecosystem services that are crucial to human well-being. By affecting the magnitude, pace, and temporal continuity by which energy and materials are circulated through ecosystems, biodiversity influences the provision of regulating services, such as pollination and seed dispersal, regulation of climate, the control of pests, invasive species and disease, and the regulation of human health. Also, biodiversity indirectly supports the production of food, fiber, potable water, shelter and medicines by affecting nutrient and water cycling, soil formation and fertility.

1.3 Drivers of Loss

DRIVERS ARE THE "NATURAL OR HUMAN-INDUCED FACTORS that directly or indirectly cause a change in ecosystems" (Rahl et al. 2007). There are two basic indirect drivers that affect ecosystem services (Heal et. al 2001). The first is that the scale of human enterprise is now so vast that humanity is radically changing natural ecosystems and their functioning. For millions of years, humanity had little impact on the character of ecosystems. But exponential growth in the world's population – from one billion people in 1800 to over six billion in 2008 (United Nations 2004) – and rapid advances in technology are now leaving an indelible imprint. Today, the impacts of humanity can be discerned in the most remote corners of the biosphere, outstripping natural biogeochemical and evolutionary processes. Moreover, many of these changes are irreversible, at least in the short term.

The second driver is our current economic models, which cause natural capital to be largely unrecognized in our market economy. Even in those instances where it is recognized, it tends to be neglected in policy because it is deemed virtually "free." While certain goods are explicitly accounted for in the market – goods that are perceived as important and in limited supply – the services underpinning the production of such goods are usually absent in the market. For example, food, fibre, and fuel have been valued in markets for centuries, whereas climate regulation, carbon sequestration, and oxygen production have failed to garner market signals that would alert society to changes in their supply or deterioration of the underlying ecosystems that support them. All too often, their value is only appreciated upon their degradation or scarcity.

In addition to these indirect drivers there are four direct drivers of ecosystem change, which can be identified based on broad ecosystem types (Rahl et al 2007). Terrestrial ecosystems have been altered by land cover change and overexploitation. Marine ecosystems have been altered by overfishing. Freshwater ecosystems have been altered by the modification of water regimes, invasive species, and pollution. And all ecosystems have been altered by climate change.

Turning our attention to B.C.'s hot spots, Olewiler (2004) identifies four major threats to natural capital (and by extension ecosystem services) in the Lower Fraser Valley. They include the construction of low-density suburban housing that consume large amounts of land; loss of forests, wetlands, and riparian habitat due to urbanization pressures, diking, and industrial agriculture; runoff from urban centres; and air and water pollution from urbanization and industrial agriculture. It is clear that the two overriding threats to natural capital are human activities and the invisibility of nature in the market.

Today, the impacts of humanity can be discerned in the most remote corners of the biosphere, outstripping natural biogeochemical and evolutionary processes. Moreover, many of these changes are irreversible, at least in the short term.

1.4 Role of Government

WHILE ALL SEGMENTS OF SOCIETY have a responsibility to protect natural capital, government must take the lead. There are two related reasons for this statement. First, the vast majority of landmass in Canada is publicly owned. Secondly, many ecosystem goods and services are classified as 'public goods', or goods that cannot be individually owned or used[7] (e.g. clean air). As such, we generally expect governments to manage public goods for the benefit of all.

In Canada, legislative responsibility for nature conservation is shared under the Constitution. The federal government is responsible for oceans and freshwater ecosystems, the continental shelf, migratory birds and the management of federal lands. They also carry fiduciary responsibility for First Nations lands south of the 60th parallel whose land claims are unsettled. Authority for the coastal zone is shared between the federal and provincial governments, and the territories. Provincial governments have responsibility for the majority of public lands; essentially all land classes and ecosystems not mentioned above. While the role of municipal governments is not explicitly acknowledged in the Constitution, it is this level of government that has arguably the greatest influence on the health of natural capital. As the level of government closest to its constituents and natural resources, local governments can promote the conservation of natural capital through planning decisions, infrastructure development, and local economic development (NRTEE 2003).

While the role of municipal governments is not explicitly acknowledged in the Constitution, it is this level of government that has arguably the greatest influence on the health of natural capital.

CHALLENGES AND OPPORTUNITIES FOR LOCAL GOVERNMENTS

Local governments have a critical role to play in the preservation of natural capital and ecosystem services. The reasons for this are twofold: the distribution of population growth and the downloading of provincial responsibilities onto local agencies.

Worldwide, population growth is sharply focused towards cities. Although occupying only two per cent of the world's land resources, cities are responsible for 75 per cent of our world's natural resources consumed and waste produced(Wackernagel et al. 2006). This trend is reflected in B.C., where 55 per cent of the provinces' population is located in the Lower Mainland. Currently this region holds over 2.5 million people and it is estimated to grow to over three million by year 2020, thus potentially placing enormous stress on the region's natural capital and ecosystem services.

The provincial downloading of responsibilities has left local governments with the burden of managing much of our threatened natural capital, often with scarce resources and little guidance on how to implement or enforce provincial mandates and policies. Moreover, citizens often look to their local governments before provincial governments for guidance on local resources. Citizens also don't generally have as much access or sway with provincial officials as they do with local mayors and councilors.

In order to provide policy recommendations of practical value to regional districts and municipalities, interview participants were asked to comment on what they perceive to be their greatest challenges and opportunities in preserving natural capital.

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7 Public goods are nonrival and non-excludable. That is, the consumption of a good by an individual does not reduce the availability of the good for consumption by another (nonrival), and no one can be effectively excluded from using the good (non-excludable).

CHALLENGES

The challenges of protecting and restoring natural capital at a local government level can be grouped into three broad categories: jurisdictional, economic, and ecological. Jurisdictional challenges relate to the ambiguous mandates of provincial, regional, and local governments. Economic challenges relate to limited government resources, as well as market forces at the local level. Ecological challenges relate to the level of knowledge surrounding ecosystems and their protection.

Jurisdictional challenges relate to conflicting, unclear or competing mandates between different levels of government, as well as the lack of effective enforcement mechanisms. When responsibilities are partitioned into silos, are unclear or overlapped across agencies, ministries or governments, efforts to manage natural capital are generally inconsistent and inefficiently or ineffectively implemented.

The lack of clear legislative direction from the provincial government was also a top concern of participants, particularly with respect to endangered species legislation. The need to develop provincial Species At-Risk legislation with a clear role for local governments was noted by each interviewee. With little to no provincial monitoring or enforcement, and no mandate for local governments to engage in environmental monitoring, there is a strong need for enabling mechanisms to protect habitat. One notable exception is the provincial approach to the protection of riparian areas. It should be modeled for other habitats as this regulatory structure motivated many municipalities to develop their own policies and processes on the protection of streamside areas.

> *Senior governments need to be proactive and assist local governments rather than being reactive (i.e. reviewing applications for approvals under provincial and federal legislation).* — expert interviewee

The challenges of protecting and restoring natural capital at a local government level can be grouped into three broad categories: jurisdictional, economic, and ecological.

Economic concerns were the second category of challenges facing local governments. Increasing responsibilities with no matching increase in revenue base and development pressures topped the list of concerns. Local governments have limited capacity to protect natural capital. While participants generally agreed on the effectiveness of incentives, they lacked the resources to independently implement them. Of equal concern is pressure from the business community to develop land that has more traditional economic worth as a subdivision than a park or natural area. Additionally, communities are often competing with one another to attract development, so policies that are overly restrictive to developers are unlikely to gain political support. That said, policies that provide greater long-term certainty to developers may be met with approval.

> *When we went through water course bylaw adoption we had huge pushback from the development community. Now, they thank us for the process. They know what the setback is that they have deal with. Certainty is highly valuable. The most valuable thing to a development community is certainty: clear objectives and criteria so they can evaluate in advance – they can't extricate once they are in it. It has to be clear.* — workshop participant

The final category of challenges relates to gaps in ecological knowledge of natural capital and ecosystem services, at both the local level and the broader academic level. There is currently a dearth of baseline studies of ecosystem health in the province. While many communities have completed mapping of their watercourses and sensitive areas, little ongoing work is underway to track changes in the quantity or quality of natural capital and ecosystem services. Furthermore, local governments lack the resources to acquire staff with the required expertise to track environmental health – a

much-needed prerequisite to effective conservation policies. Participants also struggled with how to identify and prioritize which natural capital assets should be protected within their community.

OPPORTUNITIES

There are many challenges to protecting and restoring natural capital in B.C. communities, however interview participants also discussed positive aspects of the changing landscape of local politics in the province. The emergence of local green leaders, innovative policies, successful partnerships, and an increasingly environmentally aware public all point to a paradigm shift in how urban governments view their relationship to natural capital.

The existence and influence of green political leaders in local government was discussed by several interview participants. Their ability to motivate others, their sheer passion, and drive has lead to incredible and inspiring changes. Green leaders from the community are also valuable in driving change by educating and motivating residents on environmental issues. For example, Squamish CAN (Climate Action Network) is a newly formed community group that has brought a large membership together. Their work initiated "Take back the tap," a policy banning bottled water in municipal facilities.

Municipalities and regional districts across B.C. are not afraid of trying out innovative new ideas. North Vancouver's district energy system, Saanich's carbon neutral reserve fund, and the Cowichan Valley Regional District's exploration of tax-shifting policies are all examples of progressive policy solutions to environmental issues. It is important for the provincial government to recognize the difficulty of being an early adopter. Those municipalities that implement new policies and procedures before they are mandated by provincial legislation require recognition and possibly compensation for the knowledge transfer their actions can provide.

The public has an increasing level of awareness of key environmental issues; from endangered species, to recycling waste and water conservation. The use of social networking tools has increased the profile of local concerns and allowed residents to become engaged in unprecedented ways.

Partnerships between various levels of government, non-governmental organizations and the private sector have been used by a number of communities and are growing in popularity. Partnerships have formed on multiple fronts, from mapping services, to stewardship of key resources, to cost sharing, and educational needs. This is a key tool for municipalities and regional districts that have limited staff or financial resources to carry out the long-term demands of natural capital policies.

Lastly, the public has an increasing level of awareness of key environmental issues; from endangered species, to recycling waste and water conservation. The use of social networking tools has increased the profile of local concerns and allowed residents to become engaged in unprecedented ways.

> *There are many examples of how quickly societies can change their lifestyles and develop new technologies in response to major challenges. There have been enormous societal changes in recent times, such as the pervasive implementation of recycling programs and conversion of our society from one of tolerance to smoking, to one of mostly non-smokers and the banning of smoking in public places. With increased awareness of climate change, issues of peak oil and other indicators, people are asking, 'What can I do to make a difference?'* — TEEB 2010

SECTION 2

Policy Tools to Protect Natural Capital

LOCAL GOVERNMENTS HAVE A VARIETY OF POLICY INSTRUMENTS related to the protection and restoration of natural capital. This study uses a three-part classification to organize policies: (1) public ownership, (2) regulation, and (3) market-based instruments. No single policy instrument – market-based or conventional – will be appropriate for all environmental problems. Which instrument, or combination of instruments, is best in any given situation depends upon characteristics of the specific environmental problem, and the sociopolitical, and economic context.

Which instrument, or combination of instruments, is best in any given situation depends upon characteristics of the specific environmental problem, and the sociopolitical, and economic context.

2.1 Public Ownership

The first broad category of policy instrument is public ownership and management. This refers to public acquisition of land for managing natural capital. Government control of land is often justified on the basis of the long-term benefits to the community. Permanent protection of ecologically valuable or sensitive lands is the most reliable method of protecting natural capital and associated ecosystem services, since it is not subject to short-term shifts in political priorities or resources. In British Columbia, municipalities and regional districts can secure parcels of land through the Free Crown Grant program, the Nominal Rent Tenure program, or through the outright purchase of property rights.

STRENGTHS

- Permanent protection for environmentally sensitive areas (ESAs);
- Monitoring can be undertaken by land trusts or community groups;
- Can be used for public education of natural capital and ecosystem services; and
- Establishes an economic value for habitat that supports ecosystem services.

WEAKNESSES

- Can be an expensive way to protect natural capital and ecosystem services;
- Violations to protected areas are difficult to enforce as infractions are usually dealt with through the courts; and
- Ongoing cost to maintain and manage land.

2.1.1 FREE CROWN GRANT PROGRAM

The province of British Columbia launched the Free Crown Grant program in 2004. It enables government to provide Crown land to local governments, public agencies, and community organizations to meet economic and social development goals. The Community and Institutional Program transfers parcels of Crown land for *"health, education, public safety, community infrastructure, and public facilities that benefit the public-at-large"*(MAL 2011, www.agf.gov.bc.ca/clad/tenure_programs/programs/community/index.html). Ministry sponsorship is required to record and track land value, and to ensure the proposed use of the land is consistent with provincial objectives. Granting decisions are based on a set of six weighted selection criteria: community priorities; economic benefits; health and social benefits; sustainable infrastructure; and environmental quality.

The province of British Columbia launched the Free Crown Grant program in 2004. It enables government to provide Crown land to local governments, public agencies, and community organizations to meet economic and social development goals.

While this program has been used most extensively by the Islands Trust, a federation of independent local governments of the southern Gulf Islands who have access to targeted funding for land preservation, it is open to both regional districts and municipalities. For example, in 2008, the province awarded Surrey 31 hectares of land worth a total of $7 million for public park purposes (http://www2.news.gov.bc.ca/news_releases_2005-2009/2008AL0017-000634.htm).

EFFECTIVENESS OF FREE CROWN GRANT PROGRAM: The program is the gold standard of natural capital protection. It provides certainty that natural capital and ecosystem services will be protected in perpetuity without the cost of purchasing the land. The effectiveness of the program is tempered by the arduous application process, which requires considerable staff capacity, as well as the need for ongoing technical and financial support to maintain the land.

2.1.2 PURCHASE OF PROPERTY RIGHTS

The purchase of property rights is one of the few options for protecting ecosystem services on private lands. While provincial and federal governments can provide tax incentives for the transfer of land through the Eco Gifts Program, local governments must buy land outright if they don't qualify under the Free Crown Grant Program.[8] This policy option provides a high level of certainty for the long-term protection of natural capital and ecosystem services, but it does come at a high expense. The outright purchase of land is not feasible on a broad scale. The initial purchase price, and the ongoing maintenance and monitoring costs can amount to a particularly expensive means to protect natural capital in relation to environmental regulation. As such, purchases should be targeted to tracts of

8 An additional option open to government is the Nominal Rent Tenure Program. While government doesn't own the land under this program, successful applicants are awarded 30-year leases. The application process is similar to the Free Crown Grant Program: www.al.gov.bc.ca/clad/tenure_programs/programs/community/index.html

land of heightened importance. In addition, a reliable stream of funding for locally managed lands should be available to local governments.

EFFECTIVENESS OF THE PURCHASE OF PROPERTY RIGHTS: The purchase of property rights provides certainty that natural capital and ecosystem services will be protected in perpetuity, but it can become counterproductive if the acquired land is poorly managed due to constrained resources. This option should be reserved for highly critical areas that are under threat.

CASE STUDY: **GAMBIER ISLAND GRANT**

In 2006 the Islands Trust Fund Board applied for a 107-hectare parcel on Gambier Island through the provincial Free Crown Grant program. Gambier Island Conservancy partnered with the Islands Trust Fund to raise $40,000 to cover the costs of surveying and the creation of a management plan for the reserve. This management plan defined short and long-term management goals for the new nature reserve, including conditions for public access.

MOUNT ARTABAN NATURE RESERVE **ISLANDTRUSTFUND.BC.CA PHOTO**

Mount Artaban Nature Preserve provides protection for ecosystems that provide excellent recreation opportunities and safeguards the region's habitat, drinking water, at-risk plant communities, and old growth trees.

The grant, worth over $1.1 million, was awarded in 2008. It provided the final piece of a protected areas network named the Mount Artaban Nature Reserve. When combined with neighbouring local, regional, and provincial parks, the total reserve area amounts to 525 hectares – 25 per cent larger than Vancouver's Stanley Park. It provides protection for ecosystems that provide excellent recreation opportunities and safeguards the region's habitat, drinking water, at-risk plant communities, and old growth trees.

Sources:

Island Trust Fund: Crown Land Acquisitions: www.islandstrustfund.bc.ca/crown.cfm

Ministry of Forests, Lands and Natural Resource Operations. Community and Institutional use of Crown Land: Free Crown Grants and Nominal Rent Tenures: www.al.gov.bc.ca/clad/tenure programs/programs/community/guide/apply nrt.html.

2.2 Regulatory Instruments

THE SECOND BROAD CATEGORY of public policy instruments are regulations. Government regulations attempt to produce outcomes that might not otherwise occur through the use of negative sanctions, or threats of sanctions. Regulations are most appropriate in situations where a high-risk activity could result in a substantial impact on the economy, environment, or specific groups or individuals. There are a number of taxonomies or classifications for regulatory instruments. For the purposes of this report, regulatory policies are grouped into:(1) planning documents; (2) zoning tools; (3) environmental bylaws; and (4) covenants.

2.2.1 PLANNING DOCUMENTS

Government regulations attempt to produce outcomes that might not otherwise occur through the use of negative sanctions, or threats of sanctions. Regulations are most appropriate in situations where a high-risk activity could result in a substantial impact on the economy, environment, or specific groups or individuals.

Planning documents are long-term policy directives prepared for a particular area. Together with the framework within which they are produced, they are extremely important. They are the means by which provincial, regional, and municipal policies are facilitated at the local level. Planning documents can include regional growth strategies (RGSs), official community plans (OCPs), watershed planning, and conservation planning.

Strengths:

- Create local or regional vision of community development;
- Foster greater discussion, collaboration and cooperation on a regional scale;
- Provide a mechanism to monitor change and the effectiveness of local policies;
- Inform the designation of greenways, developed areas, and protected areas; and
- Provide wider context for considering development proposals and associated applications for variance permits.

Weaknesses:

- Requirement for unanimous approval by member municipalities can lead to compromises that weaken social, economic, and environmental goals;
- Few effective enforcement mechanisms;
- Plans can generally be weakened through amendments; and
- Implementation can be slow if there are no or few related policies currently in place.

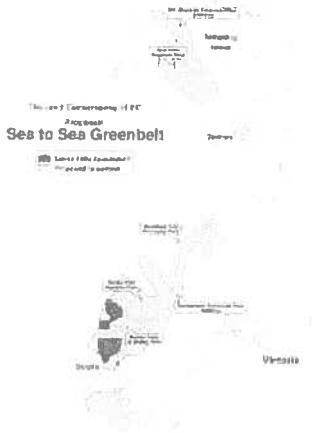
REGIONAL GROWTH STRATEGIES

Regional growth strategies (RGS) are an agreement between a regional district and its member municipalities about long-term social, economic, and environmental goals and policy directives. They provide a framework for making regional land use and transportation decisions by coordinating a variety of services such as housing, transportation, urban containment, green infrastructure, and economic development.

The *Local Government Act* states that a RGS must cover a period of at least 20 years and must include *"a comprehensive statement on the future of the region, including the social, economic and environmental objectives of the board in relation to the regional district"* (Section 849). The region proposing the RGS must provide opportunity for consultation with persons, organizations and authorities who will be affected. Once drafted, the RGS must be unanimously accepted by all member municipalities. Upon implementation, regional district bylaws and the OCPs of member municipalities must be consistent with its associated RGS. Each municipality internalizes a RGS by adopting a Regional Context Statement in its OCP. This Statement proposes how the municipality will meet the goals of the RGS by amending its policies and bylaws.

CASE STUDY: **CAPITAL REGIONAL DISTRICT GREEN/BLUE SPACES STRATEGY**

The Regional Green/Blue Spaces Strategy was approved by the Capital Region District (CRD) Board and the Provincial Capital Commission in November 1997. It is an ambitious plan that aims to create a corridor of protected wilderness and parkland stretching from Saanich Inlet in the east to the Sooke Basin in the southwest. The Strategy is unique in its ability to connect terrestrial and aquatic protection at a regional scale.



SOURCE: LAND CONSERVANCY OF B.C.

The CRD, in partnership with local municipalities, the Land Conservancy of B.C., Habitat Acquisition Trust, the Government of Canada, and the Province of B.C., aims to protect the entire Sea to Sea Greenbelt by the end of 2011, and complete all of its network trails by 2016. At this time, almost 90 per cent of the network protection goal of 11, 500 hectares has been secured through the designation of provincial, regional, and municipal parkland. These corridors of protected areas support a wide range of terrestrial and aquatic plant and animal species, as well as provide stunning settings for recreation and tourism experiences.

The Regional Growth Strategy has acted as the catalyst for bringing together multiple levels of government to fulfill the Greenbelt Strategy. At the local level, the CRD and member municipalities are developing programs aimed at protecting identified areas through regional context statements in their OCPs. Such programs may consist of policies, regulations, guidelines and incentives. At a broader level, the CRD is working alongside member municipalities and the provincial and federal government to complete a coastal zone management plan within five years of the adoption of the Regional Growth Strategy.

Source: Capital Regional District. Sea to SeaGreen Blue Belt:
www.crd.bc.ca/parks/reserves/seatosea.htm

EFFECTIVENESS OF RGSs: Regional Growth Strategies are valuable as a high-level policy document with the ability to mandate long-term policies that may be difficult to develop at a municipal level, such as acquiring environmentally sensitive areas as parkland and designating zoning for habitat corridors. Unfortunately, RGSs do not have the power to change the way in which regional districts and municipalities engage in land development. As such, there are no mechanisms to adjust existing municipal boundaries, to force municipalities to acknowledge adjacent OCPs in planning, or to oversee land use planning in unincorporated areas.

OFFICIAL COMMUNITY PLANS

The Local Government Act states that an Official Community Plan is "a statement of objectives and policies to guide decisions on planning and land use management, within the area covered by the plan, respecting the purposes of local government."

The *Local Government Act* states that an Official Community Plan (OCP) is *"a statement of objectives and policies to guide decisions on planning and land use management, within the area covered by the plan, respecting the purposes of local government"* (Section 875). OCPs provide the framework for growth management and conservation by articulating desired patterns of land use, as well as its policies to protect and restore sensitive environmental areas and biological diversity. OCPs may contain sub-plans such as neighbourhood plans, watershed plans, or conservation strategies.

OCPs are generally updated every five years. Upon drafting a new OCP, the local government must provide opportunities for consultation with persons, organizations, and authorities it deems will be affected. Once an OCP is in place, local government decisions to amend existing regulations and approval requirements must be consistent with the OCP.

EFFECTIVENESS OF OCPs: Similar to RGSs, OCPs are valuable as high-level policy documents. Yet several interview participants indicated that the goals and objectives of OCPs can easily fail in their transition to on-the-ground policies. Because OCPs do not directly regulate land use, it is up to local governments to amend existing regulations and approval requirements to align with the OCP.

ENVIRONMENTAL PLANNING

In addition to RGSs and OCPs, long-term planning can address specific ecosystems or environmental issues at both the regional and municipal levels. Watershed planning, conservation planning, rain-water management, and integrated flood management strategies are all examples of long-term environmental planning.

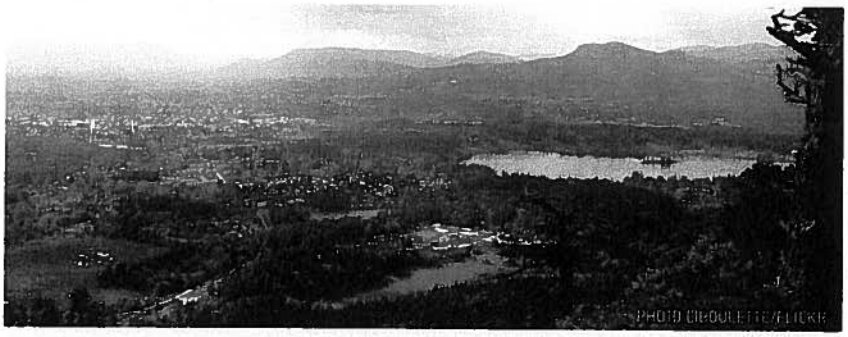
Long-term environmental plans should:

- Articulate ecological principles and conservation goals that aim to maintain and enhance the ecological integrity of natural capital assets;
- Establish a geographical framework for the strategy by identifying, mapping and analyzing habitat types, rare and significant species and ecosystems, and other biodiversity values;
- Be based on sound science, including tradition ecological knowledge;
- Consider and respond to trade-offs at multiple scales (e.g. ecological, social);
- Encourage participatory planning;
- Include measurable indicators to track effectiveness; and
- Include monitoring and enforcement mechanisms.

EFFECTIVENESS OF ENVIRONMENTAL PLANNING: Environmental planning is more focused and in-depth than RGSs or OCPs, and can incorporate meaningful monitoring, allowing a community to focus on local or regional environmental issues of concern. The main drawbacks are that they take a long time to develop and are difficult to amend.

CASE STUDY: **COWICHAN VALLEY REGIONAL DISTRICT FLOOD PLANNING**

The Cowichan Valley Regional District (CVRD) is developing an Integrated Flood Management Plan for the long-term management of the lower Cowichan Flood plain. The management plan will be structured to meet the goal of reduced flood risk to the communities on the floodplain, while protecting aquatic and riparian habitat, as well as the cultural values of the rivers. The plan's commitment to ecosystem-based goals, diverse partnerships, and technological innovation has made it a model for other regions.



The CVRD's integrated flood management plan has included a diverse group of interests, including the Cowichan Tribes, City of Duncan, Municipality of North Cowichan, and CVRD. Support for the plan was provided by the Union of B.C. Municipalities Innovations Fund, Cowichan Tribes, and the B.C. Provincial Emergency Program, as well as in-kind contributions from local government organizations. Lastly, local universities, federal agencies, and regional organizations assisted with specific components of the plan, including the development and implementation of mapping scenarios, predictive hydrologic models, fisheries restoration plans, and stewardship activities.

The CVRD's desire to achieve more flood-resistant communities and a more natural, productive river system requires that floodwater and floodways be viewed as a resource to be enhanced, rather than something to be managed or mitigated. The integrated flood management plan was developed to with this in mind.

Sources:

Sustainable Cowichan: www.12things.ca/12things/12.php

Cowichan Valley Regional District. Lower Cowichan/Koksilah River Integrated Flood Management Plan. September 2009: www.cowichanwatershedboard.ca/sites/default/files/LowerCowichan-KoksilahRiverIntegratedFloodManagementPlan-FinalReport-Sept2009.pdf

2.2 2 ZONING TOOLS

Zoning allows local governments to control the use, density of use (e.g. number of residential units per lot allowed), as well as the siting of future development. Zoning bylaws can also regulate how far buildings and other amenities must be setback from environmentally sensitive areas.

Conservation zoning, in particular, is a straightforward way to keep development out of environmentally sensitive areas. It is often used to reinforce environmental protection goals and to correct outdated zoning that failed to consider sensitive areas. It is usually part of an application to rezone and subdivide a large parcel of land where there are plans for cluster development so as to allow a portion of land to be preserved as parkland. As long as zoning does not restrict public use of the land, local governments can enforce zoning for ecosystem protection

There are a number of zoning tools regional districts and municipalities can employ to protect natural capital. Four are discussed here: (1) development permit areas; (2) greenbelts; (3) urban containment boundaries; and (4) cluster zoning and development.

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Strengths:

- When used with other tools, zoning can be an effective way to protect environmentally sensitive areas and green infrastructure from development;
- Local governments do not have to pay compensation to landowners for changes in the value of land due to rezoning enacted in the public interest;
- Zoning is better received when it can be communicated as a tool to meet the goals of a community-wide planning process (e.g. OCP); and
- Enforcement mechanisms are available.

Weaknesses:

- May promote urban sprawl by pushing residential development and other activities to regions where there are fewer restrictions; and
- Can be politically unpopular because it can decrease the value of property by limiting its uses.

ENVIRONMENTAL DEVELOPMENT PERMIT AREAS

Environmental development permit areas (EPDAs) are among the strongest tools for shaping new development to ensure that it respects sensitive ecosystems. EDPAs allow local governments to create specific requirements for development in addition to basic zoning. When a municipality or regional district designates an EDPA, a permit must be obtained before a landowner may subdivide or alter land, or construct or alter a building. The permit must supply information about sensitive ecosystems on the parcel and describe how the development will impact that area. All development must be in accordance with the terms of the permit.

EDPAs can be designated by regional districts or municipal governments. They can be depicted on maps in an OCP or RGS or as written descriptions of sensitive areas in OCPs or RGSs. When an EDPA is established, the appropriate government must document the specific site conditions or objectives that justify the designation, and stipulate the guidelines to achieve those objectives. In instances where an EDPA is breached, local government can use the enforcement provisions of local bylaws to penalize landowners.

EFFECTIVENESS OF EDPAs: EDPAs are a highly effective tool to protect natural capital assets on private property when governments have adequately qualified staff to identify and assess the community's environmentally sensitive areas and monitor and enforce the provisions of the permits.

GREENBELTS

To maintain a high diversity of plants and animal species in urban areas requires the maintenance of corridors and connections to ecosystems surrounding the city. Small city parks and urban forests are often too small and fragmented to sustain a varied flora and fauna in isolation. Through the migration of organisms from larger core areas outside the city, the diversity in urban ecosystems can still be maintained (Bolund and Hunhammer 1999). Greenbelts serve this purpose, by providing a physical area of open space that surrounds a region and protects the ecosystems from urban growth.

B.C.'s most relevant version of a greenbelt is the Agriculture Land Reserve (ALR). Created in 1973, the ALR was a response to concerns that farmland in B.C. was being irretrievably lost to development. The ALR protects agriculture, and to a lesser extent natural heritage, tourism and recreation. It is administered by the Agricultural Land Commission (ALC), whose purpose is to encourage farming on agricultural land by promoting the adoption of local and provincial plans, bylaws, and policies that help to protect and enhance farming (Curran, 2005). The ALC was restructured in 2000, providing regional governments with greater authority to regulate permissible non-farm uses of agricultural land within the ALR. Each 3-person regional panel now has jurisdiction over decisions within their domain, which has diluted the provincial perspective. Since regional panels make decisions for the new commission and can include "community need" for development, there is concern about the undue influence of local economic interests (Carter-Whitney 2008).

Local governments play a vital role in land management affecting the ALR, as the first parties to see all applications to exclude or subdivide land from the ALR. These agencies can help protect the ALR by ensuring that all relevant bylaws and plans meet the requirements of the ALC Act (ALC, 2007a). For example, Surrey has an ALR exclusion policy, which specifies compensation for the removal of ALR land. Among the stipulations is the requirement to replace ALR land with an area that is at least twice as large as the area of land being excluded. 2 for 1 replacement of land. This has practically stopped ALR exclusion because it is almost impossible to meet this threshold.

EFFECTIVENESS OF THE ALR: While the ALR has met its objective of ensuring no net loss of agricultural land (from 1974 to 2003, B.C. experienced no net loss of farmland because the amount of land included and excluded from the ALR was roughly the same), the quality of land in the ALR has deteriorated. Many are concerned this trend will continue under its restructured form. ALRs are most effective when they are paired with relevant densification policies, such as urban containment boundaries.

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URBAN CONTAINMENT BOUNDARIES

Urban containment boundaries (UCB) strive to preserve green spaces and green infrastructure by coordinating key public facilities and infrastructure, with urban development pressures. UCBs are not a physical space, but a dividing line usually drawn at the margin of a municipality and a rural area. These boundary lines divide lands that are zoned to be developed from lands that are intended

CASE STUDY: **THE OKOTOKS LEGACY**

In 1998, Okotoks, Alberta became one of the first communities in Canada to base its growth on the environmental limits of its local watershed. Recognizing that continued growth would soon exceed the limits of its infrastructure, the town weighed the option of developing a larger, regional infrastructure system against the option of constricting growth to remain within the environmental limits of the region.

Okotoks reports bi-annually on sustainability targets with the use of a score card system. Throughout the planning process, the city has maintained a commitment to transparency and grass roots community support.

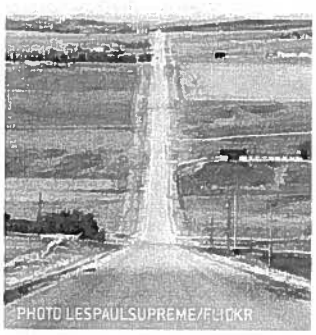
PHOTO LESPAULSUPREME/FLICKR

Extensive consultation with the community resulted in the decision to maintain quality of life and the environment by capping growth and setting an urban boundary to service a maximum 30,000 residents (the carrying capacity of the Sheep River Watershed) through the development of a sustainability framework, named 'The Legacy'.

Meeting the goals of the framework required drafting sustainable neighbourhood designs with the assistance of the University of Calgary's Faculty of Environmental Design, upgrading the municipal waste treatment system, and negotiating an inter-municipal development plan to ensure the protection of rural and urban transition zones, as well as natural and cultural areas.

Within a decade (2008) the community had reduced water use by 30 per cent, increased its commuter ratio from less than one per cent to 47 per cent, and secured 21 per cent of total land as open space. Furthermore, the conversion of its wastewater system into an Integrated Waste Water Treatment Plant saved $13 million compared to conventional methods and has decreased energy use by 30 per cent and greenhouse emissions by 28 per cent, and produced 4, 200 tonnes of compost. (Okotoks 2006f; EPCOR).

Okotoks reports bi-annually on sustainability targets with the use of a score card system. Throughout the planning process, the city has maintained a commitment to transparency and grass roots community support.

Sources:

Tools of Change: www.toolsofchange.com/en/case-studies/detail/149

Town of Okotoks. (2006b): www.okotoks.ca/sustainable/Water/initiatives.asp

for other non-development purposes, like agriculture, green space and rural. By protecting the lands outside the boundary from most forms of development, they tend to preserve environmental goods and services, minimize the costs of water, wastewater and public utilities, and provide certainty with respect to the location of future development. They are typically structured to accommodate growth over a set time period, but they can be reassessed and amended as needed.

UCBs can be used by regional governments through regional growth strategies, such as Metro Vancouver's Green Zone, and by municipal governments through OCPs, such as Saanich's UCB. They are designated in RGSs and OCPs and implemented through zoning bylaws. They are enforced through government refusal to extend services to regions outside of the UCB.

EFFECTIVENESS OF UCBs: Empirical analysis of the effectiveness of urban containment boundaries is mixed. However, relatively few studies have analyzed UCBs by comparing aspects of areas inside and outside of the boundary over sufficiently long periods. Gennaio, Hersperger, and Burgi (2004) evaluated the effectiveness of UCBs in Switzerland over a 30 year period, whereas Jun (2009) evaluated the effectiveness of Portland's UCB over a 20 year period. Both found that while UCBs restricted most development within the boundaries and promoted density in the building zones, the regions outside of UCBs experienced heightened development at lower densities. These results point to the need for greater inter-governmental cooperation to guide development outside of UCBs.

While there is a perception that UCBs limit land supply and therefore inflate property values, this has not been demonstrated in B.C. Users of UCBs have indicated that they assist with a number of planning goals, such as improved transit viability, protection of ecosystem services, maximizing the use of existing infrastructure, and providing certainty for developers. The benefits of UCBs are maximized when there is a strong commitment to densification policies to curb the flood of housing that would otherwise flow into the countryside.

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CLUSTER ZONING

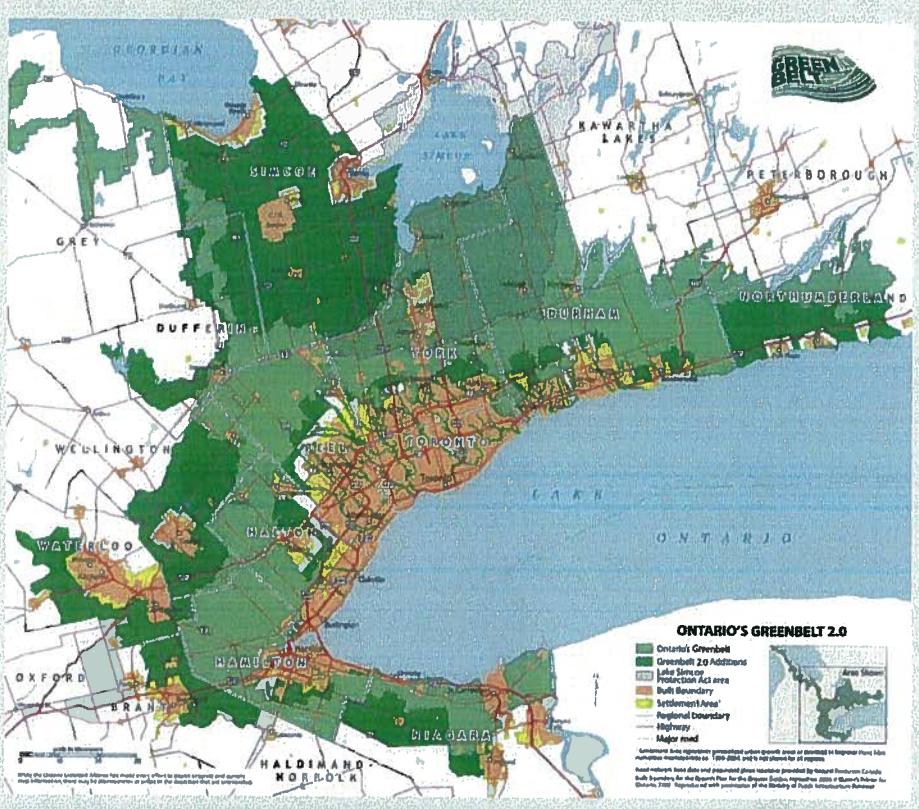
Cluster zoning involves rezoning and subdividing larger parcels of land so that a new development can be concentrated on a portion of the land, leaving the remaining area in undeveloped open space. The portion of undeveloped land will often contain environmentally sensitive areas, agriculture, greenways, or green infrastructure. This open space may be owned by the developer, a homeowner's association, local government, or a non-profit organization. The landowner can obtain a conservation covenant for the undeveloped portion to provide long-term protection to sensitive features. In some cases, incentives such as an amenity density bonus have been offered to developers to encourage cluster development.

EFFECTIVENESS OF CLUSTER ZONING: If local government has completed landscape mapping, cluster zoning can be an effective tool to protect small parcels of land, such as environmentally sensitive areas and green infrastructure. It is amenable to communities of all sizes, and attractive to conscientious developers. While cluster zoning is not used extensively in Canada, it has been used for decades in the United States.

An analysis of the effectiveness of cluster zoning for the preservation of farmland over a 20-year period in the town of Southampton, New York, concluded that cluster zoning should not be dismissed as a tool for the protection of small to moderate sized farmland. It does, however, stress the importance of complementary tools to address the larger issues of aggregate farmland protection and the distribution of new development. (Brabec 2001)

CASE STUDY: THE GREATER GOLDEN HORSESHOE GREENBELT

The Greater Golden Horseshoe is a densely populated and industrialized region centered around the Greater Toronto Area in Ontario. Currently housing nearly 26 per cent of all Canadians and 75 per cent of Ontarians, it is one of the fastest growing regions in North America, with population predicted to reach 13 million by 2030. The Ontario Greenbelt was created through provincial legislation in 2005 to ensure that the region's near-urban countryside and open spaces were not sacrificed to accommodate the needs of this expanding population.



SOURCE: GREENBELTALLIANCE.CA

At 1.8 million acres, the greenbelt is the largest and most diverse greenbelt in the world, providing permanent protection to agricultural lands, forests, fields and wetlands. Currently over 7,000 farms located within it generate an estimated $5.4 billion in revenue each year. In addition, the Greenbelt provides more than $2.6 billion in economic benefits per year through essential services such as filtering water and air. Approximately half of all people living in central Ontario engage in recreational and tourism opportunities in the greenbelt.

Sources:

The Friends of the Greenbelt Foundation website: www.greenbelt.ca/

Ontario Ministry of Municipal Affairs and Housing: Greenbelt. www.mah.gov.on.ca/Page7087.aspx

2.2.3 ENVIRONMENTAL BYLAWS

Environmental bylaws are a finer-scale approach to protecting natural capital. Bylaws are designed to regulate or prohibit certain activities and prescribe methods of carrying out activities. They can serve proactive or reactive purposes. Proactive bylaws generally require landowners to obtain permits before undertaking certain activities, whereas reactive bylaws permit government staff to enforce a bylaw after the offence has taken place.

With the exception of environmental impact assessments, specific types of environmental bylaws are not dealt with in this report, as comprehensive reviews are available elsewhere. For a comprehensive review of environmental bylaws see the Green Bylaws Toolkit: http://greenbylaws.ca/.

Strengths:

- Can set more stringent standards for individual ecological features;
- Opportunity for public education, particularly with proactive bylaws;
- Provides potential for rehabilitation;
- Can control pollution entering an ecosystem; and
- Provides opportunity to address incremental changes to ecosystems.

Weaknesses:

- Standards can be too stringent or costly to administer;
- Can create trade-offs (e.g. tree protection for dense development);
- Can be difficult to enforce without adequate resources (e.g. staff and training resources);
- Ongoing monitoring and enforcement needed;
- Requires landowners and developers to be aware of and understand bylaws and standards; and
- Standards could hinder innovation

Bylaws can serve proactive or reactive purposes. Proactive bylaws generally require landowners to obtain permits before undertaking certain activities, whereas reactive bylaws permit government staff to enforce a bylaw after the offence has taken place.

ENVIRONMENTAL BYLAWS

Regional districts and municipal governments employ a number of bylaws to protect and restore particular components of natural capital. Bylaws can encourage certain activities such as tree planting, and discourage others such as development near sensitive ecosystems. Study participants indicated a preference for proactive bylaws, such as the streamside protection regulations, due to its clear mandate and simpler enforcement. Reactive bylaws can be difficult to enforce, either because the damage is already done, or because the enforcements mechanisms and prescribed penalties are too difficult to enforce and collect. Small local governments often lack the resources to effectively enforce bylaws with such penalties.

The following types of bylaws are currently being used by regional districts and municipalities in B.C.

- Streamside protection regulation;
- Watercourse protection bylaws;
- Pesticide restriction bylaws;
- Tree protection bylaws;
- Soil deposit bylaws;

- Bylaw to control erosion and sediment flows;
- Idling bylaws;
- Hobby beekeeping bylaws;
- Electric vehicle bylaws; and
- Green building requirements for rezoning applications.

EFFECTIVENESS OF ENVIRONMENTAL BYLAWS: Bylaws are effective when they target environmental issues not addressed through planning or zoning, when they are well communicated to the public and developers, and when governments have sufficient resources to monitor and enforce their bylaws.

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessments (EIAs) provide the means for governments to make an informed decision about proposed development or activities. They are often seen as a leading policy mechanism to ensure that projects do not cause significant adverse environmental impacts. As such, they are reviewed here.

EIAs are designed to assess the effects of a new development on community goals and objectives, including environmentally sensitive areas.

EIAs are designed to assess the effects of a new development on community goals and objectives, including environmentally sensitive areas. Governments may specify particular areas (e.g. Environmentally Sensitive Areas) or situations (e.g. rezoning, development permits, and temporary commercial or industrial use) for which landowners must provide information on the anticipated impact of development. If information is required prior to development approval, the local government must enact a bylaw that outlines the required information and the procedures for obtaining it. This generally requires professional consultation and is the responsibility of the landowner or developer.

EFFECTIVENESS OF EIAs: EIAs can be effective when they are mandated through OCPs to occur prior to development and to provide alternatives to the proposed activities. In addition they contribute to the community's knowledge of local ecosystems and watersheds. Unfortunately, they are generally project driven and occur at the middle or end of a process rather than the beginning. It is widely acknowledged that EIAs rarely conform to the intended models of the process, offering more in theory then they do in practice (Cashmore et al., 2004; Noble, 2002; Dipper, 1998).

PERFORMANCE BONDS

In instances where performance bonds (or security requirements) are mandated, developers pay a fee to government as part of the approval process. This fee is held as a bond and is returned once the developer demonstrates that specific performance objectives have been met.

Performance bonds are contained in environmental bylaws and guidelines for development. They can be an effective incentive for developers to perform development activities properly in order to have the bond reimbursed, as well as to maintain good standing in the development community. In addition, they provide considerable reassurance to governments since remediation funds are provided up front.

EFFECTIVENESS OF PERFORMANCE BONDS: Performance bonds, if set at appropriate levels, are an effective tool for protecting natural capital. They are most useful when environmentally sensitive areas are known (through mapping) and when the region is a development hot spot. They are less useful to smaller municipalities that may be competing for development.

CASE STUDY: **WHISTLER GREEN BUILDING STANDARDS**

Buildings can be a key contributor to the ecological footprint of a region through inefficient material sourcing, wasteful resource use and disposal, and the clearing of natural areas. In response to this, a number of third party building certifications, such as Leadership in Energy and Environmental Design (LEED) and Built Green, have been developed to guide environmentally responsible construction. These standards are generally designed to reduce the overall impact of the built environment on natural areas, as well as on human health. They have resulted in significant savings in water and energy use, and reduced greenhouse gas emissions.

Recognizing a gap in standards for residential construction certification, as well as the prohibitive costs associated with green building certification, the Resort Municipality of Whistler developed *Whistler Green*, a green building standard and associated checklist for industrial, commercial, and residential construction. Whistler Green can be incorporated into new construction or renovation projects at any scale. Builders are provided with a project checklist, which contains required practices, as well as a number of optional practices that earn a set number of points toward the certification.

The standard promotes six broad objectives of green building (Green Building Policy, 2010):

- SITE/LANDSCAPE: Minimize disturbance to natural areas through careful location, design, construction practices and site rehabilitation;
- ENERGY: Decrease energy requirements and associated greenhouse gas emissions to move toward the target net zero energy consumption;
- WATER: Reduce the total volume of water used for buildings and associated landscaping;
- MATERIALS: Use less new material through efficient design and engineering, and increase the application of renewable, recycled and locally sourced materials;
- WASTE: Lower the total volume of waste sent to landfills during construction and occupancy; and
- INDOOR ENVIRONMENT: Minimize chemical emission from materials used in buildings.

The standard has gone through public review and is awaiting formal Council endorsement. It is anticipated that it will initially be voluntary, with the hope to move to mandatory compliance.

Sources:

Council green building policy: www.whistler2010.com/cms-assets/documents/4544-264247.greenbuildingpolicy.pdf

Resort municipality of Whistler: Whistler Green Guidelines Moving to the Next Step: www.whistler.ca/index.php?option=com_content&task=view&id=270&Itemid=529

2.2.4 PERFORMANCE BONDS AND COVENANTS

Performance bonds and covenants are proactive tools to prevent or remedy damage to natural capital from development. Performance bonds act as a security deposit that a municipality can use for habitat restoration if unintentional damage from development occurs. A conservation covenant identifies land or portions of land that development must preserve.

Strengths:

- Provides protection for sensitive land without the expense of purchasing it;
- Can be tailored to specific ecological features;
- Act as both a carrot and a stick, since the bond is returned if development preserves natural capital; and
- Conservation organizations can hold covenants and assume monitoring requirements.

Weaknesses:

- Remediation can be more costly than the performance bond;
- Covenants lack accessible enforcement mechanisms (court is generally the only option); and
- Covenants are perceived to decrease property values.

Typical covenants provisions include prohibitions on altering ecologically sensitive areas, limits on types of land use and land cover, distance between buildings, and where cattle are allowed to graze.

CONSERVATION COVENANTS

A conservation covenant is a legal agreement between a landowner and an organization (e.g. all levels of government, land trusts) that has been approved to hold covenants by the Surveyor General, Land Title & Survey Authority of B.C. The covenant is registered against title to the property under Section 219 of the *Land Title Act*. The register contains a summary of the physical description of the property and references a detailed baseline inventory (Land Trust Alliance of B.C. 2009).

A covenant may be applied to a whole property or just to specified portions of it. It helps to protect sensitive features, areas, or uses in perpetuity, since the covenant remains in effect after the land is sold or transferred. Typical covenants provisions include prohibitions on altering ecologically sensitive areas, limits on types of land use and land cover, distance between buildings, and where cattle are allowed to graze.

EFFECTIVENESS OF CONSERVATION COVENANTS: While the cost of acquiring and maintaining conservation covenants may be higher than other environmental policies, they are not vulnerable to changing political priorities and offer permanent protection of sensitive areas. Unfortunately, participation rates are low due to costs and restrictions. As such, the incentives for participating in conservation covenants should be expanded and strengthened.

CASE STUDY: **REGIONAL DISTRICT OF CENTRAL OKANAGAN PERFORMANCE BONDS**

A fundamental gap exists between the extractive value of natural capital and the full value of ecosystem services that come from natural capital. This gap often leads to incentives to overexploit the ecosystems that hold extractive value. Financial instruments can help narrow this gap by incentivizing environmental stewardship.

Performance bonds combine the "polluter pays" principle with the "precautionary principle," providing for internalization of costs where the potential of harm exists, but the extent of damages is uncertain. They are commonly used in resource extraction industries, such as mining, but infrequently in local government. The Regional District of the Central Okanagan is leading the way in this regard.

The Regional District of the Central Okanagan provides the opportunity for environmental bonds through professional reports for planning services. These reports are typically completed by Registered Professional Biologists and they are triggered at the time of neighbourhood planning, property rezoning, subdivision, or at the time of development permits to ensure that the land is suitable for the use intended. If development conditions require mitigation, restoration, maintenance or monitoring plans, the applicant is required to post a maintenance or monitoring bond. Performance bonds are set at 125 per cent of the estimated cost of the project, whereas maintenance bonds are set at 10 per cent of the performance bond.

Sources:

Regional District of Central Okanagan. Terms of Reference: Professional Reports for Planning Services: www.regionaldistrict.com/docs/planning/Handout%20TofR.pdf

Advanced conservation strategies: Environmental Performance Bonds – Insurance Contracts: www.advancedconservation.org/blog/?page_id=59

2.3 Market-based Tools

MARKET-BASED INSTRUMENTS are the third broad category of public policy instruments. These policies are often referred to as Environmental Pricing Reform (EPR), since they adjust market prices to account for environmental costs and benefits. EPR instruments have been used to stimulate the development of green technology, shift market demand, minimize pollution, and conserve and rehabilitate sensitive areas. As such, they represent a valuable opportunity for regional districts and municipalities. In some cases, EPR policies can generate revenue for local governments through the introduction of fees or tax shifting. In other cases they can bring about savings by encouraging conservative behaviours or activities. In the end, the appeal of EPR policies is that they often have the ability to do both (Calvert 2010).

Market tools to protect natural capital at the local level are grouped into four broad categories: environmental tax instruments; price signals; subsidy reform; and the creation of new markets.

In some cases, EPR policies can generate revenue for local governments through the introduction of fees or tax shifting. In other cases they can bring about savings by encouraging conservative behaviours or activities.

2.3.1 ENVIRONMENTAL TAX INSTRUMENTS

Environmental tax instruments aim to shift the tax burden from things that are socially desirable, such as employment, income, and investment, to things that are undesirable, like pollution, resource depletion, and waste. The goal is to help the environment and community health without hurting the economy. Environmental taxes can be structured to be revenue-neutral (i.e. total tax revenues remain unchanged), revenue-positive (i.e. total tax revenues increase) or revenue-negative (i.e. total tax revenues decrease), depending on how much tax revenue is recycled and public attitudes toward taxes.

Although there is a wide range of tax policies that regional and local governments can implement to protect natural capital, this section focuses on property tax instruments – the primary tax collected by local government – and provincial tax sharing opportunities.

Strengths:

- Helps government protect natural capital while also providing financial flexibility;
- Diversifies revenue stream; and
- Addresses social equity challenges (e.g. not asking everyone to pay into environmental challenges regardless of one's contribution to the problem or one's income level).

Weaknesses:

- Significant education required to overcome the public's dislike of taxes;
- The public is sensitive to increases in highly visible taxes (e.g. property taxes);
- Increased resources required for administration of policies; and
- Significant information required to set effective tax rate.

Recognizing that property taxes represent approximately half of total local government revenues, it seems prudent to employ them as a tool to protect natural capital.

PROPERTY TAXATION

Recognizing that property taxes represent approximately half of total local government revenues, it seems prudent to employ them as a tool to protect natural capital. There are a number of options available to local governments for restructuring property taxes to encourage the protection and restoration of natural capital.

- LAND VALUATION TAXATION: Reduces the portion of tax on building improvements while increasing the portion of tax on the value of the land. This provides an incentive to increase development density and repair old or damaged buildings. The drawback of this form of property taxation is the increase in housing prices in a region's core, which could promote sprawl. It is anticipated that this effect would only hold in the short-term, as market forces adjust over the medium-long term.
- PROPERTY TAX DIFFERENTIATION: Involves determining tax rates based upon the conservation of natural capital. The level of property tax is determined by a scoring system that assigns points to specific natural capital assets.
- DENSITY-BASED PROPERTY TAXATION: Removes the incentive to purchase single-family homes and by extension, reduces urban sprawl. Lowering taxes on multi-family dwellings recognizes that they have a smaller ecological and financial footprint (e.g. less land and infrastructure demands per person, lower household heating and cooling costs).
- IMPROVEMENT DISTRICTS: Provide a means of capturing increases in property values that result from public investment in an area. Local governments can recover a portion of the costs for various projects to protect natural capital (e.g. public transit improvements, brownfield remediation, parkland creation) in this way.

EFFECTIVENESS OF PROPERTY TAXATION FOR NATURAL CAPITAL: Canadian municipalities do not have enough experience with property tax reform to assess its effectiveness. However, given that the largest barrier to overcome with taxes is public acceptance, density based taxation is likely easier to justify than land valuation. In addition, it is administratively preferable to property tax differentiation (which requires the development of tax rates for various natural capital conservation activities), and doesn't require access to funding up front in the way that improvement districts do.

CASE STUDY: **ONTARIO'S ENVIRONMENTAL REMEDIATION AND SITE ENHANCEMENT (ERASE)**

The City of Hamilton, Ontario's Environmental Remediation and Site Enhancement (ERASE) program is a comprehensive framework containing a set of programs designed to improve economic opportunities and environmental conditions in the city's historically industrial and long neglected neighbourhoods.

The goals of the various ERASE programs have been to replace underutilized, contaminated, abandoned and blighted properties with productive land uses.

The goals of the various ERASE programs have been to replace underutilized, contaminated, abandoned and blighted properties with productive land uses.
This has included projects that will retain or increase employment opportunities, thus keeping businesses in the area and avoiding the high costs of urban sprawl and Greenfield development. The programs promote energy efficiency and sustainable building practices through the construction of Leadership in Energy and Environmental Design (LEED) standards and generally are intended to improve the physical, environmental and aesthetic qualities of the area.

Twenty projects have been awarded a total of approximately $9.5 million in ERASE Redevelopment Grant funding to date. It is expected that this investment will result in the remediation and redevelopment of 161 acres of formally vacant and underutilized brownfields. It will also have spurred construction expenditures in excess of $244 million and the creation of over 2 million square feet of industrial and commercial space, more than 100 new residential units, plus approximately 400 new full time jobs. All of this activity is expected to increase long-term property tax revenues by tens of millions of dollars per year.

Sources:

Hamilton Economic Development: Municipal Programs: www.investinhamilton.ca/incentive-programs/municipal-programs.html#Brownfields

CMHC: www.cmhc-schl.gc.ca/en/inpr/su/sucopl/upload/Brownfield-Redevelopment-for-Housing-in-Canada-Case-Studies-Environmental-Remediation-and-Site-Enhancement-ERASE-Community-Improvement-Plan-CIP-Initiative-Hamilton-Ontario.pdf

Resolutions requesting that money from B.C.'s carbon tax be directed towards local governments instead of individuals and businesses were passed at both the 2009 and 2010 Union of BC Municipalities conventions.

SHARING IN PROVINCIAL TAXES

Whereas other levels of government have a range of revenue streams, such as personal income taxes, resource royalties, and transfer payments, local governments rely heavily on property taxes. Property taxes represent the bulk of revenue for municipal governments, and unlike income and sales taxes they are not easy to increase. This is because property taxes are inelastic (i.e. property values do not grow as quickly as incomes and sales over a period of economic growth) so the local tax revenues generally lag behind other forms of government revenue. Consequently the need to diversify revenue streams is regarded by local governments as a key impediment to government action on natural capital.

One policy option that appears politically feasible in B.C. at this moment is for local government agencies to advocate for a share of B.C.'s carbon tax.

- B.C.'S CARBON TAX: B.C. introduced a carbon tax in 2008, which is applied to the vast majority of fossil fuels sold in the province. The rate is scheduled to increase from $10 to $30 per tonne by 2012. Although the tax is designed to be revenue neutral, resolutions requesting that money be directed towards local governments instead of individuals and businesses were passed at both the 2009 and 2010 Union of British Columbia Municipalities (UBCM) conventions.

EFFECTIVENESS OF SHARING IN PROVINCIAL TAXES: While these policy options do not promote direct behavioural changes, they can provide the funds necessary to protect and restore natural capital. Furthermore, the two opportunities highlighted above are likely politically feasible at this time.

2.3.2 BONUSES, FEES AND CHARGES

Correcting price signals can be a very effective tool to protect natural capital, since price is proven to be a strong motivator for behavioural change. Because participation is voluntary (i.e. you can chose not to purchase an item or develop in a particular location), there is generally less resistance to changes in price than equivalent changes in levels of taxation. In addition, fees and charges can bolster and diversify local government revenues. These tools are most effective when government staff is properly educated and enforcement mechanisms are well resourced.

Although fees, charges, and bonuses can be applied to a range of amenities and activities, three key ones are addressed here, including density bonuses, development cost charges, and volumetric pricing of utilities.

Strengths:

- Changes in prices usually invoke quick responses in behaviour;
- Changes culture of local government over time;
- Diversifies government revenues;
- Can be tailored to specific issues or ecological components; and
- Opportunity for public education.

Weaknesses:

- Instances of the rebound effect[9] could be observed;
- Few opportunities for local governments to control prices; and
- Considerable information needed about ecosystem services to set appropriate fees, charges, and subsidies.

DENSITY BONUSES

Local bylaws restrict the amount of floor space that a developer can build in a development. Density bonuses raise that amount in exchange for development that contributes to community priorities, such as affordable housing, transit shelters, and parkland. By shifting some conservation costs onto the development community, density bonuses send a price signal to the market, evoking developers to factor environmental and social values into their business considerations.

Density bonuses can prove to be an efficient use of government resources since they can acquire ecologically sensitive areas with little or no direct cash outlay. In addition they invite stakeholders to consider trade-offs between higher density and the preservation of nature, in effect adding an educational element to the process.

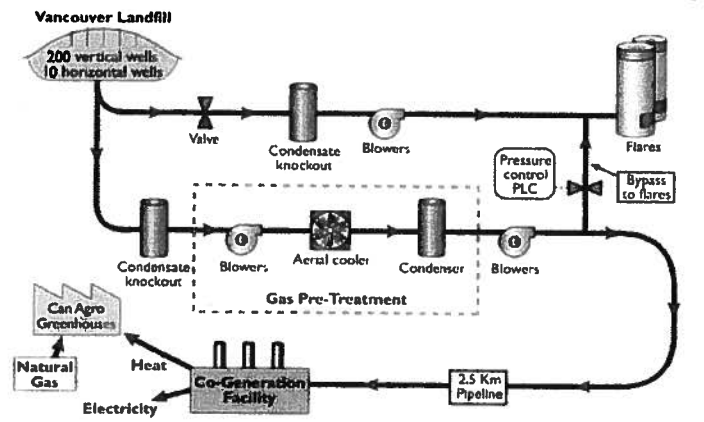
EFFECTIVENESS OF DENSITY BONUSES: Density bonuses have been used with success in urban areas of B.C. They have rarely been used in rural areas, where densification goals are not generally met with the same level of public approval. Favourable market conditions and community acceptance of higher development densities are necessary for a density bonusing system to be successful. As such, their use should be targeted to developers operating in suitable communities and promoted to residents in conjunction with educational programs.

9 The rebound effect refers to increased consumption that results from actions that increase efficiency and reduce consumer costs (UKERC 2007). For example, an improvement in a vehicle's fuel efficiency does not usually result in a proportional reduction in fuel use, because drivers of fuel efficient vehicles find that they can afford to drive more. As a result, they reinvest a portion of potential energy savings on comfort. The difference between the potential fuel savings and the actual savings is the Rebound Effect.

CASE STUDY: **CITY OF VANCOUVER – BURNS BOG LANDFILL GAS COLLECTION**

Landfills are potentially a significant source of greenhouse gas emissions since methane is a potent greenhouse gas, 21 times stronger than carbon dioxide. Collecting and burning landfill gases converts the methane to carbon dioxide, reducing greenhouse gas emissions, as well as minimizing odours. The City of Vancouver has operated a landfill gas collection and control system since 1990, in the southwest corner of Burns Bog, Delta.

Vancouver Landfill
Gas Collection and Beneficial Use



The Burns Bog landfill gas collection system was expanded in 2003, funded through a multi-million loan provided by the Green Municipal Fund. The expansion has resulted in the recovery of approximately 500,000 gigajoules of energy per year – equivalent to the total energy needs of 3,000 to 4,000 homes.

The Burns Bog landfill gas collection system was expanded in 2003, funded through a multi-million loan provided by the Green Municipal Fund. The expansion has resulted in the recovery of approximately 500,000 gigajoules of energy per year – equivalent to the total energy needs of 3,000 to 4,000 homes. This equates to the reduction of more than 230,000 tonnes of carbon dioxide equivalents per year; the annual emissions of approximately 45,000 automobiles.

In addition to the environmental benefits, there are significant monetary benefits for municipalities. The City of Vancouver will receive approximately $400,000 per year in revenues for 20 years, while Delta anticipates receiving between $80,000 and $110,000 per year in municipal tax revenues. Moreover, the supply of low-cost heat supports 300 greenhouse jobs in the region.

Sources:

Henderson et al., [date unknown]

Ministry of Community and Rural Development, 2009: www.waterbucket.ca/gi/sites/wbcgi/documents/media/268.pdf

DEVELOPMENT COST CHARGES

Development cost charges (DCCs) are fees imposed on developers to offset the cost of providing new infrastructure and services to new developments. For example, local government may need to build new streets, sewer lines, and plan for waste collection in new subdivisions or business parks. These fees can be waived or reduced for developments designed to have a low-environmental impact (Local Government Act, Section 933.1).

It is uncertain what can and should be included in the scope of DCCs. While it is clear that the capital costs of infrastructure and amenities require compensation, it is unclear if on-going operating costs can be accounted for or if environmental costs should be internalized in DCCs. The provincial government could assist local governments in this respect by providing greater flexibility, as well as guidance, on determining DCCs that reflect the true cost of development. In addition, DCCs could be used to compensate for impacts to natural capital.

Some workshop participants suggested that DCCs may spur urban sprawl since they are calculated on a per-unit or per-square-foot basis regardless of the location of the development. This could create a perverse incentive for local governments to approve development that would not otherwise be approved due to the revenues generated by DCCs. However, a recent survey of local government leaders (Fletcher and McArthur 2010), found that DCCs accounted for, on average, one per cent of total revenues.

While it is clear that the capital costs of infrastructure and amenities require compensation, it is unclear if on-going operating costs can be accounted for or if environmental costs should be internalized in DCCs.

EFFECTIVENESS OF DCCs: While workshop participants felt DCCs were not a preferable policy option for the protection or restoration of natural capital, they have proven effective in communities like Ottawa, where different rates are used inside and outside the regional greenbelt (Blais, 2010). In addition to the introduction of differentiated rates, a method of full cost accounting developed and mandated through the *Local Government Act* could increase the effectiveness of this policy.

VOLUMETRIC PRICING FOR UTILITIES

Volumetric pricing of utilities refers to charging for utilities based upon the amount used. Several options are available to structure pricing. Progressive rate structures are popular as they ensure low-income residents are not unfairly impacted. Pay as you throw systems have been implemented in over 200 communities across Canada for waste removal (Kelleher et al. 2005). B.C. Hydro employs a two-tiered rate structure, and metering is increasingly used in water pricing.

Price signals act as indicators of environmental impact and generate public awareness about the impacts of household consumption choices. And unlike most environmental policies, the significance of individual or household level actions is apparent.

Utility pricing can also be a much-needed source of additional revenues for local government. After property taxes, the sales of services (including utilities) are the next largest source of locally generated revenues for regional and municipal governments. Given that few utilities are priced in this manner, significant opportunities exist for increasing revenues by expanding this policy.

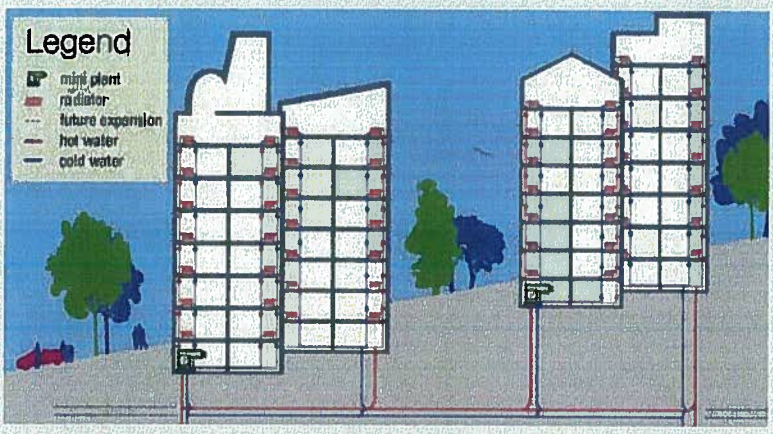
EFFECTIVENESS OF VOLUMETRIC PRICING OF UTILITIES: Volumetric pricing can be very effective. For example, a report by Environment Canada (2008) found that since 1991 residential water consumption has been consistently *"70 to 80 per cent higher nationally when under flat rates than under volume-based rates"* and pay-as-you-throw systems has reduced garbage volume by 8 to 38 per cent(Kelleher et al. 2005). However such policies can go even further by incorporating full cost accounting in order to recognize the full financial and environmental costs of service provision. Lastly, utility-pricing structures must ensure they do not disadvantage low-income residents.

CASE STUDY: NORTH VANCOUVER DISTRICT ENERGY SYSTEM

In the early 1990s, the City of North Vancouver undertook an investigation of potential land use and energy planning. A feasibility study was completed in 1998, which recommended a system of interconnected mini-plants for district heating. Four million dollars in green municipal funding from the Federation of Canadian Municipalities and the establishment of a Hydronic Heat Energy Service Bylaw led to the establishment of the Lonsdale Energy Corporation in 2004. It is a utility company that is owned, governed, and regulated by the City of North Vancouver.

District energy is a technology for providing heating from a central plant to multiple users. Generally, such systems require large buildings to house large central boilers. The Lonsdale System is unique, employing a number of mini-plants that house high efficiency gas boilers. This technology is flexible, allowing for expansion as required. It is also cost-effective since developers don't need to devote building space for large electrical or boiler rooms.

The Lonsdale Energy Corporation, established in 2004, is a utility company owned, governed, and regulated by the City of North Vancouver.



SOURCE: CNV.ORG

After seven years, the results of the Lonsdale Energy Corporation are encouraging:

- The boilers are highly efficient, capturing 95 per cent of heat energy;
- The boilers are flexible, allowing for easy integration of alternative energies;
- Nitrous oxide emissions have decreased by 64 per cent and greenhouse gas emissions by 21 per cent relative to conventional heating systems; and
- The system has proven to be more reliable than conventional heating sources, since the malfunction of one plant doesn't interfere with the operation of other plants.

Sources:

B.C. Climate Action Toolkit: District Heating in North Vancouver: www.toolkit.bc.ca/success-stories/district-heating-north-vancouver

Canmet Energy Community Energy Case Studies: Lonsdale Energy Corporation: http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/fichier/81127/DE%2017%20Lonsdale%20energy%2Dcorp%20(ENG).pdf

2.3.3 SUBSIDY REFORM

Subsidies come in a variety of forms, including direct transfers of funds, income or price support, tax credits, exemptions and rebates, low-interest loans and guarantees, preferential treatment, and use of regulatory support mechanisms. Implicit income transfers occur when natural resources or services are not priced at full provisioning costs (TEEB 2010).

The removal of perverse subsidies can be a low-cost alternative for environmental and financial improvements. At the local government level, road construction and maintenance, subsidized by property taxes, represent what many consider the most significant subsidy. Restructuring this subsidy to increase the portion drivers pay towards road maintenance will provide a negative incentive for car travel. Such a change to road pricing could bring about large greenhouse gas reductions, lower demand for new road construction, and reinforce densification policies. Savings from the reduction of road subsidies can be reinvested into environmental programs. At the local level, subsidies to support public transit are greatly needed.

At the local government level, road construction and maintenance, subsidized by property taxes, represent what most consider the most significant subsidy.

EFFECTIVENESS OF SUBSIDY REFORM: Road and bridge tolls have met with mixed success. While they are politically unpopular, they appear to be effective at reducing traffic. For example, the London congestion charge, introduced in 2003 and extended in 2007, met with a 25 per cent reduction in traffic levels on the first day (Albalate and Bel, 2008). A 2007 follow-up report found traffic levels in the Zone were consistently 16 per cent lower in 2006 than pre-charge levels in 2002 (Transport for London, 2007).

2.3.4 CREATING MARKETS

The final group of policies to protect and restore natural capital and ecosystem services involve the creation of markets. The use of environmental taxes, charges, and subsidies assumes that governments have sufficient information to set an effective tax rate, which is exceedingly difficult with ecosystem services. These difficulties are heightened when differences in ecosystem services require governments to apply a different tax, fee, or subsidy at every site. Regulation faces similar problems, since governments need considerable information to design effective rules. In contrast, under certain conditions, creating markets for ecosystem services can improve societal well-being even under incomplete information.

Three market tools are viable at the local level: Valuation and payments for ecosystem services; tradable development credits; and labelling or certification schemes.

Strengths:

- Does not require perfect knowledge of natural capital and ecosystem services in a region;
- Promotes innovation; and
- A monetary value is established for natural capital and ecosystem services.

Weaknesses:

- Large transaction costs;
- Inefficient when there are few buyers and sellers;
- Unable to use when ownership cannot be defined and enforced; and
- Unable to use when there is uncertainty about the attributes of natural capital and ecosystem services.

PAYMENTS FOR ECOSYSTEM SERVICES

Valuing the environment in monetary terms is difficult and often controversial. Several reviews have examined different valuation methods and the limitations of their applications (Ledoux and Turner 2002, Farber et al. 2002). It has been argued, however, that these values are capable of highlighting the importance of natural capital and ecosystem services, provided they are placed in the appropriate context. When monetary valuations are coupled with qualitative descriptions and a clear articulation of the limitations of these studies, valuations can clearly provide a positive contribution to policy discussions. In the end, it must be kept in mind that they should be regarded as one tool among many that are available to decision makers.

At the federal level, the Alternative Land Use Services (ALUS) is a National Farm Stewardship program that provides financial assistance to farmers who implement management practices to protect ecosystem services. The financial incentives offered to farmers help to offset the costs of implementing the management practices. To qualify for the grant, farmers are required to have an Environmental Farm Plan in place and management practices must be approved by Agriculture and Agri-Food Canada. Pilots of the program have met with success. Ecologically valuable portions of land have been protected, such as riparian buffer zones, for a cost that was less than expected.

At the local level, payments for ecosystem services are uncommon but evidence shows that they may not be far away. A B.C. court ordered the municipality of Surrey to pay farmers close to $50 million when agricultural lands were flooded by runoff from urbanization (Curran, 2008).

EFFECTIVENESS OF VALUATION AND PAYMENTS FOR ECOSYSTEM SERVICES: While it is difficult to predict if payments for natural capital and ecosystem services will take root at the local level, the valuation of ecosystem services was overwhelmingly supported by interview and workshop participants. They expressed that valuations were needed to justify the preservation of natural capital to council.

TRADABLE OFFSETS: TRADABLE DEVELOPMENT CREDITS

Tradable development rights are another form of market creation that can be utilized to protect and restore natural capital and ecosystem services. In this case, a market is created that allows the sale and transfer of development rights from a particular parcel of land to other properties. Rights are sold from lands to be protected and bought for lands to be developed. Further use of the sold land is protected through conservation covenants or deeds prohibiting development.

Communities seeking to implement a Tradable Development Credit program will need to:

- Develop background studies that identify natural capital and ecosystem service areas of significance;
- Perform a real estate market assessment to determine how the credit market would interface with a local real estate market;
- Implement a standardized methodology at the regional level for such assessments;
- Develop an education program to engage local citizens; and
- Determine the number of permits to be allocated, whether the rights are held for a fixed period or in perpetuity, and what rules govern trade.

EFFECTIVENESS OF TRADABLE DEVELOPMENT CREDITS: Although Tradable Development Credit programs have been used extensively in the US with mixed results, there are no provinces with legislation that explicitly enables these programs. Early adopters will face some level of uncertainty. It is theorized that credit programs will work best in conjunction with zoning and other regulatory mechanisms to protect natural capital and ecosystem services.

CREATION OF NICHE MARKETS: LABELLING OR CERTIFICATION

Certification schemes have exploded in recent years, expanding from organic labelling to include items ranging from beauty products to carpeting. They have emerged as a significant and innovative venue for standard setting, environmental governance, and consumer education.

Green building is gaining popularity in Canada. In addition to environmental benefits such as reduced waste, storm water flow reduction, improvements in air quality, and reduction in urban heat island effect, green buildings make economic sense as well. These types of buildings have higher productivity, longer life cycles, lower long-term operating costs, and higher property values. These benefits often outweigh the additional costs incurred in the development and construction phases. As such, municipalities are beginning to implement policies to encourage green building practices and compliance with green building standards. For example, the district of Ucluelet offers developers a 5 per cent density bonus if they choose to build developments that comply with Leadership in Energy and Environmental Design (LEED).

EFFECTIVENESS OF CERTIFICATION SCHEMES: Certification schemes have become very popular. When certifications are backed by sound science and strong criteria they can be very effective in reducing damage to natural capital and ecosystem services, as well as educating the public. Drawbacks include green washing, the flooding of certification schemes causing public confusion, and high third party costs for certification. Innovative solutions are emerging to address these challenges however. For example, the 'Whistler Green' building policy was developed by drawing on LEED, while avoiding the third party costs of LEED.

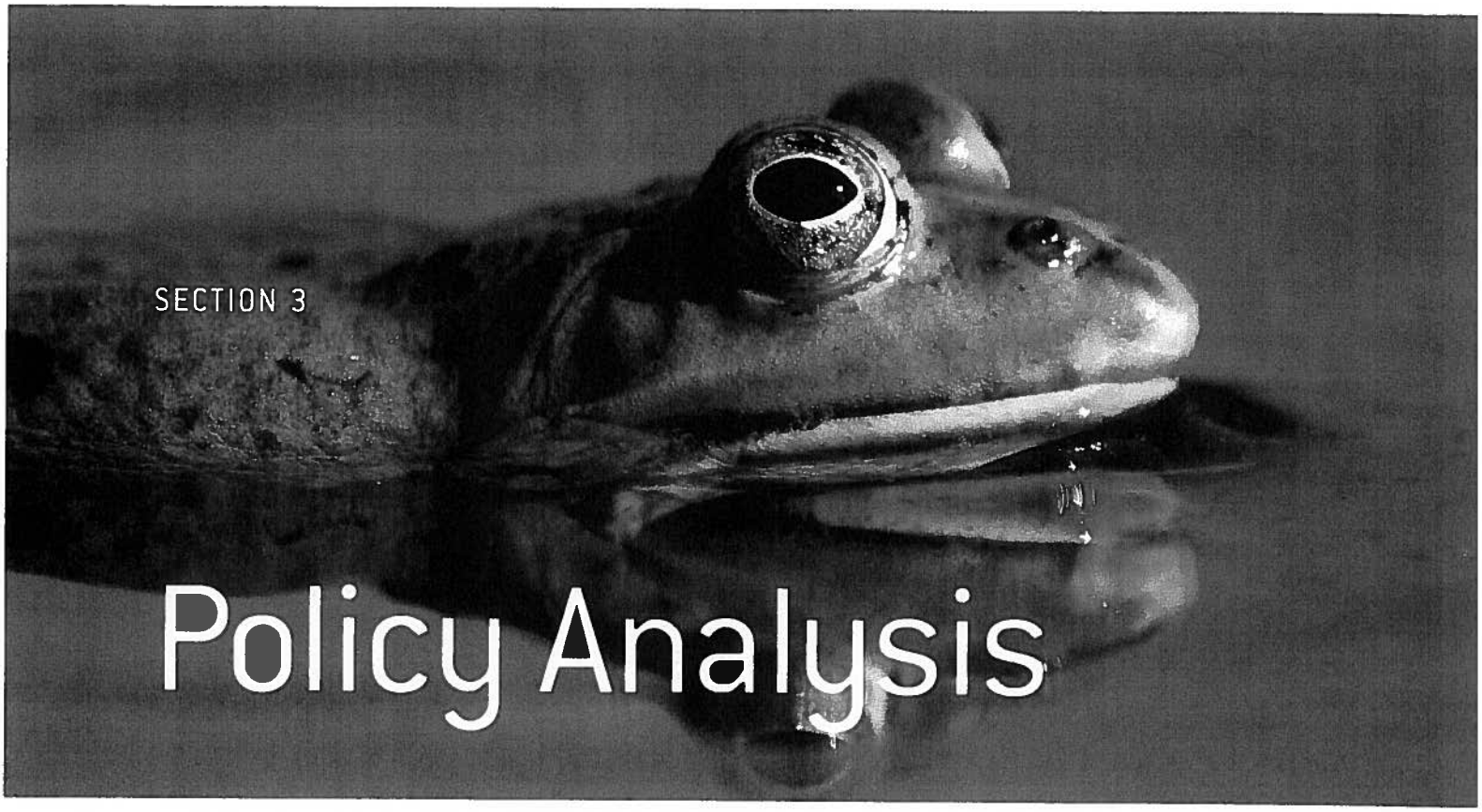
CASE STUDY: **SEATTLE'S TRANSFERABLE DEVELOPMENT RIGHTS PROGRAM**

Seattle, Washington's Transferable Development Rights Program was created in 1985. It is an initiative designed to preserve and rehabilitate affordable housing in the city's downtown core. The program allows the transfer of unused development rights from lower density low-income housing in the downtown area to proposed commercial projects located within targeted downtown zoning categories. The transfer allows the buyer to build at a floor area ratio above the maximum in that zone. In the process, funds are generated from the sale of development rights and are used to rehabilitate low-income housing, as well as support the construction of new affordable housing.

Since the inception of the program, 559 units in the downtown core have been preserved and/or rehabilitated, and the program has recently been reconfigured to create an additional 900 units. The city has generated $1.5 million from the sale of development rights. Development rights sold for $115 – $145 CAN per square meter in the 1990s.

Sources:

Canadian Mortgage and Housing Corporation: Retaining Affordable Housing: www.cmhc-schl.gc.ca/en/inpr/afhoce/tore/afhoid/pore/reafho/reafho_005.cfm#full



SECTION 3

Policy Analysis

TO AVOID IRREVERSIBLE DAMAGE TO ECOSYSTEMS and their associated services, we must change the way we use and think about them. Fortunately, we have the knowledge, technology, and tools to make such changes. We have an opportunity to develop the groundwork for policies and programs that strive to manage our ecosystems in a manner that fosters their resilience in the face of increasing pressures.

The following three policy options are derived from sections one and two. They strive to address the drivers of loss to ecosystems, the unique circumstances facing B.C. municipalities, and incorporate the most promising policy tools. Following the policy descriptions, the criteria for weighing the strength of each option is presented, accompanied by an explanation of how the criteria is measured. Next, the policy options are weighed against one another using the criteria. The section ends with a discussion of the results and recommendations.

We have an opportunity to develop the groundwork for policies and programs that strive to manage our ecosystems in a manner that fosters their resilience in the face of increasing pressures.

3.1 Policy Options

3.1.1 POLICY OPTION #1: NATURAL CAPITAL ACCOUNTS

This policy option represents the vital first step in managing natural capital – measuring it. Relative to other forms of capital, ecosystem capital is poorly understood, scarcely monitored, and in many cases undergoing rapid degradation and depletion. Decision-making that is based on an incomplete set of natural capital measures may lead to decisions that threaten a community's sustainability and ultimately, its well being. By taking stock of our resources and the services they provide, and by assigning them value, we can set the stage for an informed discussion about how to balance economic development with a healthy environment.

For any natural capital protection or restoration policy to be effective, we must first know where natural capital is located, how healthy it is, and how much of it requires protecting. While pieces of this are often in place at the municipal, regional, and provincial levels, they tend to be disjointed and lack the links connecting ecosystem health to societal well-being. The development of a regionally based system of natural capital indicators and targets that are flexible enough to be locally appropriate would provide the groundwork for:

- Identification of targeted protected areas, including corridors;
- Ecosystem monitoring;
- Natural capital policy assessments (to determine ecological, as well as cost effectiveness); and
- Valuation exercises of natural capital at the local level.

Key components of this option would include:

- Development of a multi-stakeholder task force to provide a manageable set of natural capital indicators and targets to track the health of ecosystem services and the progress on the governance and management of natural capital;
- Dedication of technical, fiscal and institutional resources from the provincial government;
- Incorporation of indicators and targets into RGS, OCPs, and other forms of community planning;
- Partnerships with relevant community groups to educate public on the importance of natural capital;
- Integration of ecosystem values into land management decisions; and
- Accounting that values the flow of ecosystem services, while costing out the depreciation of the under-lying assets, just as for physical capital.

For any natural capital protection or restoration policy to be effective, we must first know where natural capital is located, how healthy it is, and how much of it requires protecting.

POLICY MECHANISMS

- Data collection – Coordinated by Regional Districts in cooperation with stakeholders (e.g. municipal governments, academics, First Nations, Ministry of Environment, Ministry of Forests, Lands and Natural Resources, Ministry of Agriculture, NGOs, industry, public representatives);
- Ecosystem services modeling to inform target selection – Coordinated by Regional Districts in cooperation with regional colleges and universities;
- Amendments to *Local Government Act*– Lobbying to mandate ecosystem services considerations in OCPs and RGS. Coordinated by UBCM;
- Public workshops – Workshops should provide the connection between natural capital and ecosystem health with societal health. Coordinated by municipalities to account for particular community issues; and
- Pilot studies – To test model indicators and targets; to prepare recommendations on policy integration opportunities.

FUNDING MECHANISMS

- Share of provincial taxes;
- Provincial environmental grants; and
- Cost-sharing with industry and NGOs.

STAKEHOLDERS

- Local government (regional districts and municipalities);
- Provincial government departments;
- Union of B.C. Municipalities and Government Finance Officers Association of B.C.(GFOA);
- Industry;
- Conservation organizations;
- Research communities; and
- Residents.

Regional governments take the lead in developing natural capital indicators and targets to track the health of ecosystem services, as well as the effectiveness of policies geared toward the protection of natural capital.

TIMELINES

- Short-term (one to five years) – Task force to develop a short list of indicators in a framework that incorporates existing indicators currently in use by local governments and resource groups. Based upon baseline results, develop target ranges that can be fine-tuned at the community-levels. Run pilot studies in several municipalities.
- Long-term (five years plus) – Based on pilot results, extend the indicators and targets framework to regional districts and municipalities located within B.C.'s hot spots. Urge provincial government to make appropriate amendments to the *Local Government Act* to incorporate ecosystem services into community planning. Develop a number of natural capital valuation studies to justify further consideration of natural capital into local policies.

MEASURES OF SUCCESSFUL IMPLEMENTATION

- Development of regionally based indicators and targets for natural capital and ecosystem services;
- Public support of natural capital programs and policies;
- Amendments to the *Local Government Act;* and
- Implementation and analysis of pilot studies.

3.1 2 POLICY OPTION #2: CONNECTING OUR PROTECTED AREAS

Regional districts and municipalities in the provincial hot spots identified in this report must act quickly to secure their remaining natural capital and associated ecosystem services. Projected population growth and accompanying development pressures throughout the region reinforce the urgency of this message.

This policy option calls for regional governments to work with municipalities to develop a network of protected natural spaces and corridors around cities, while building or maintaining stocks of natural capital within cities (i.e. parks, rivers, wetlands, private gardens). The underlying goal of this option is to protect, restore and preserve the connections existing within and across ecosystems.

Key components of the regional protected areas strategy include:

- Identification of priority natural capital assets, ecosystem services, wildlife corridors, and associated land classes for protection (note: this should flow from policy option #1);
- Exploration of policy tools to promote linked networks of protected areas (as opposed to individual sites);
- Exploration of funding mechanisms for various components of the network, including Free Crown Grant program, market-based revenue alternatives, and continued UBCM pressure for share of Carbon Tax;
- Development and promotion of incentives for citizens to protect natural capital and ecosystem services on private land, including the creation of green spaces (e.g. rooftop gardens, water harvesting, community gardens); and
- Tap into existing partnerships with stewardship groups and nongovernmental organizations to educate public on the importance of natural capital and how they can support this initiative.

Regional districts and municipalities in the provincial hot spots identified in this report must act quickly to secure their remaining natural capital and associated ecosystem services.

POLICY MECHANISMS

- Data collection – Led by Protected Areas Coordinator (1 FTE/Regional District). Based upon results of policy option 1, gather and analyze information on priority areas of protection, policy options, legislative requirements, and funding mechanisms to implement a system of protected areas within the region;
- Report – Prepare a report of findings and recommendations to be presented to regional and municipal councils;
- Public outreach – Information sessions, social networking, and public events held to educate public on the connection between natural capital and societal health. Coordinated by municipalities to account for particular community issues;
- Expert and government workshops – Gather information as needed to build awareness and support amongst government agencies and various constituencies within their communities; and
- Lobby for Carbon Tax revenues be redirected toward local green initiatives.

FUNDING MECHANISMS

- Free Crown Grant program and/or Nominal Rent Tenure program;
- Subsidy reform; and
- Environmental taxes and/or volumetric pricing.

STAKEHOLDERS

- Local government (regional districts and municipalities);
- Union of B.C. Municipalities (UBCM) and Government Finance Officers Association (GFOA);
- Industry;
- Conservation organizations;
- Research communities;
- First Nations communities; and
- Local residents.

This policy option calls for regional governments to work with municipalities to develop a network of protected natural spaces and corridors around cities, while building or maintaining stocks of natural capital within cities (i.e. parks, rivers, wetlands, private gardens).

TIMELINES

- Short term (two to three years) – Research and develop strategy for protected areas network. Public engagement activities coordinated with stewardship groups, NGOs, stream-keepers, and volunteers. These activities should educate public on natural capital and protected areas, flesh out key concerns, and possibilities for public involvement.
- Long term (three plus years) – Strategy presented to local government councils and refined. Prepare for policy implementation, pursue funding mechanisms, and engage public support for Network.

MEASURES OF SUCCESSFUL IMPLEMENTATION

- Public engagement has translated into political support for Protected Areas Network;
- Strategy accepted by at least three municipal councils of B.C. hot spots;
- Funding mechanisms secured; and
- Plans in place for at least one Protected Areas Network to be complete within 10 years.

3.1.3 POLICY OPTION #3: MAINSTREAMING ECOSYSTEM SERVICES

The current infrastructure gap presents local governments with a significant opportunity to build communities that are greener and work better. Governments are now contemplating how to satisfy their community's infrastructure needs in ways that incur the least cost and provide the most benefits over time. They are also coping with how to protect and restore nature in their communities. Integrating the value of natural capital into decision-making related to these sorts of community development discussions is a prudent method to address many of the challenges municipalities are facing.

This policy options calls upon decision makers to deliberately take into account the connections between how they grow their community and the health of both the ecosystems and residents that call it home. This requires explicit accounting of the impact of proposed development strategies on the community's natural capital. Entry points for incorporating ecosystem services into existing processes occur at all levels of government, from procurement policies to land use planning.

Key components of this option include:

- Valuation of ecosystem services within the provinces' hot spots. Valuations need to be reviewed to isolate natural capital assets and provide monetary findings of relevance to each municipality.
- Development of new decision-making guidelines that incorporate full cost accounting into all land use decision making, such as, OCPs, and zoning bylaws. (This should include the monetary damage of the degradation of ecological services due to development.)
- Identification of policies that will be impacted by new development decision-making guidelines.
- Staff training on new decision-making guidelines and how to apply natural capital valuation to decision-making.
- Lobby for changes to environmental impact assessments (EIAs) to include an ecosystem services component that would assign dollar values to the benefits derived from these actions.

Governments are now contemplating how to satisfy their community's infrastructure needs in ways that incur the least cost and provide the most benefits over time.

POLICY MECHANISMS

- Data collection – Gather and analyze information on natural capital valuations (Tied into database developed in policy option #1).
- Preparation of revised guidance documents – Amend existing planning and accounting policies and documents to incorporate consideration for ecosystem services. Provide guidance on impacts this will have in terms of staffing expertise, time frames, and impacts upon related departments and policies (e.g. NC depreciation guidelines).
- Incentives for developers – Introduce incentives such as cluster zoning, performance bonds, and green building standards to generate support from the development community.
- Density-based property taxation – Would provide an incentive for residents and property managers to embrace compact communities.
- Adaptive management – Policy is reviewed every five years to incorporate new information, methodologies and procedures.

FUNDING MECHANISMS

- Density-based property taxation;
- Environmental taxes and/or volumetric pricing; and
- Provincial infrastructure grants.

STAKEHOLDERS

- Local government (regional districts and municipalities);
- Developers;
- UBCM;
- Local residents;
- Conservation organizations; and
- Research communities.

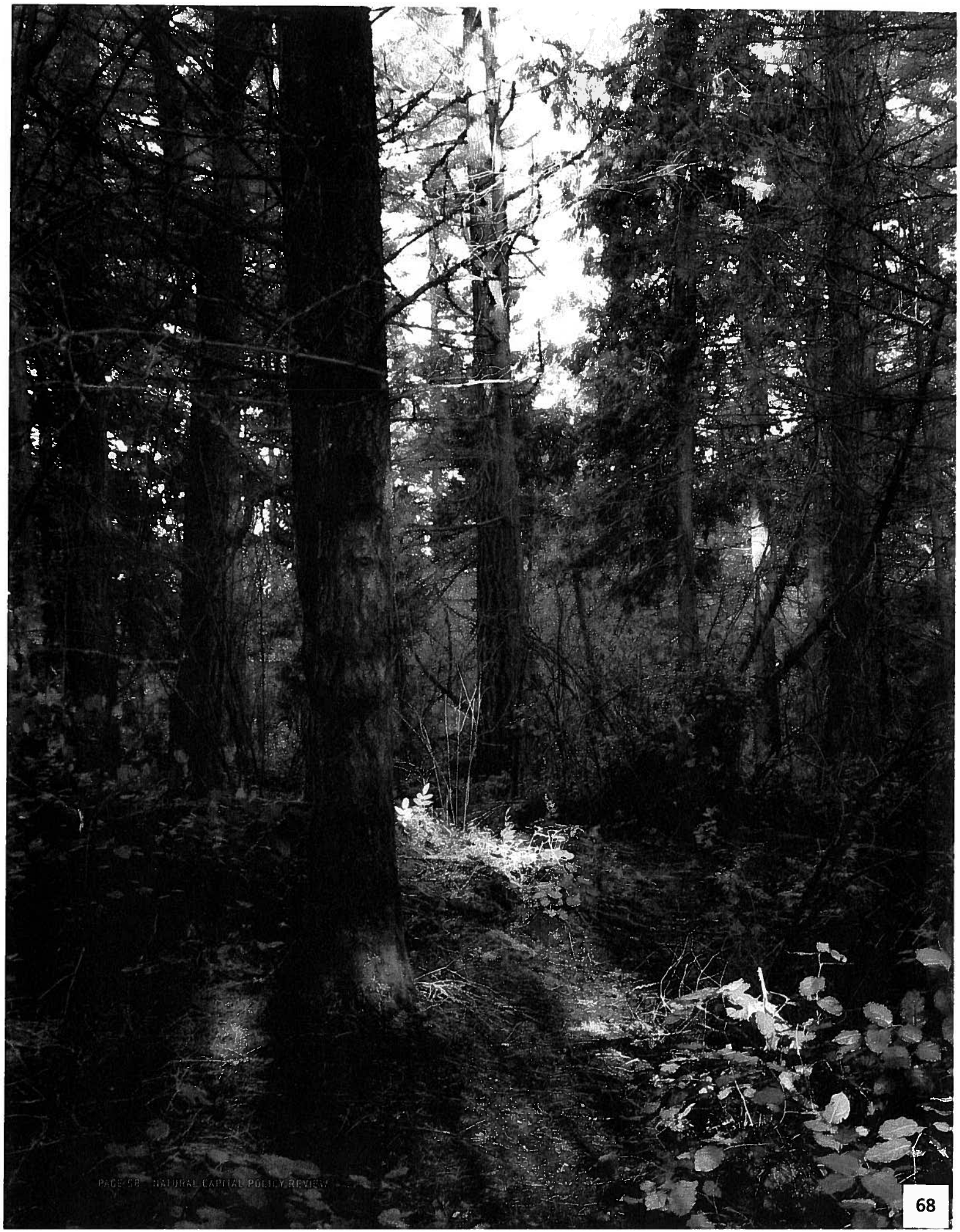
TIMELINES

- Short term (two to five years) – Within three years, municipalities obtain relevant staffing expertise to provide guidance of natural capital values for municipality and amend decision-making guidelines. They can also develop policy incentives for developers and residents. Within five years, municipalities can expect changes to EIAs due to coordinated lobbying efforts.
- Long term (five plus years) – Density-based property taxation can be introduced and an adaptation plan completed.

MEASURES OF SUCCESSFUL IMPLEMENTATION

- Full cost accounting adopted by municipal council;
- Increase in green infrastructure throughout city;
- Reduction in the infrastructure gap; and
- Developers understand and accept new decision-making guidelines.

Entry points for incorporating ecosystem services into existing processes occur at all levels of government, from procurement policies to land use planning.



3.2 Policy Criteria

The above policies will be assessed against the following criteria and measures:

TABLE 1: POLICY CRITERIA

Criteria	Considerations	Measure(s)
Political viability	Does the decision maker have the political capital to undertake a major initiative? Does the public understand the issue and support action to address it? What is the range of interests that would be affected?	High/medium/low Based on how easily policy option ties into mainstream issues (workshop feedback) and range of interests affected
Economic viability	Is the policy cost-effective for society as a whole? For those who must change their behaviour?	High/medium/low Based on relative cost of policy components
Effectiveness	Does the policy force action that is capable of modifying the direct and indirect drivers of ecosystem change? Is it possible to set an incentive such as a tax credit at the appropriate level to change behavior? Can the results of the policy be measured and used for accountability and to change course as appropriate?	High/medium/low Based on ability to address drivers of ecosystem change; availability of incentives; and degree of accountability
Equity	Is the outcome fair to all stakeholders? If there are "losers" under the policy, how will they be compensated?	High/medium/low Based on proportion of winners to losers, and availability of compensation options
Institutional capacity	Is adequate capacity and funding in government and other participating groups available to implement the policy? If the policy requires working across scales and/or sectors, is there a mechanism to do so, or can one be created?	High/medium/low Based on amount of resources required to carry out policy option (FTE staffing needs, funding), and level of inter-governmental work

Source: Adapted from World Resources Institute. Ecosystem Services: A Guide for Decision Makers

3.3 Policy Analysis

This section evaluates the policy options using the criteria developed above. Although it is common practice to evaluate policies against the status quo, or the general set of existing policies currently in place, that is not possible in this instance since there is no 'common set' of policies in place for the preservation of natural capital. Instead they are evaluated against one another using the scoring system below. Criteria are awarded equal weight.

Scoring:

1 = low
2 = medium/low
3 = medium
4 = medium/high
5 = high

TABLE 2: POLICY EVALUATION

Criteria	Option #1 – Regional Conservation Tracking	Option #2 – Development of Regional Protected Areas Strategies	Option #3 – Mainstream ES into economic and development planning
Political viability	Medium/High – (4) Provides for growing public recognition of NC Interests affected – low	Medium/High – (4) Public supportive of protected areas Interest affected – developers impacted, as well as municipalities losing out on property taxes	Medium/Low – (2) Public generally not aware of or interested in decision making criteria Interests affected – Developers impacted; local governments impacted
Economic viability	Medium – (3) Policy components – task force, development of database, upkeep of database, workshops*	Low – (1) Policy components – research, funds to purchase ESAs, funding for incentives, and public outreach* Note: costs could be mitigated if share of Carbon Tax is secured	Medium/High – (4) Policy components – research and data collection, funding for incentives, adaptive management plan
Effectiveness	High = (5) Drivers – addresses economic drivers, and sets the stage for addressing scale of human activities Incentives – none required Accountability – high since database is public	Medium/High = (4) Drivers – Doesn't address economic drivers but does address scale of human impacts Incentives – public incentives offered Accountability – medium (dependent upon protected areas management plan and how well plan is carried out)	High = (5) Drivers – Does address economic drivers, as well as human scale of activities Incentives – incentives offered Accountability – high

Criteria	Option #1 – Regional Conservation Tracking	Option #2 – Development of Regional Protected Areas Strategies	Option #3 – Mainstream ES into economic and development planning
Equity	High = (5) Ratio of W:L – few who lose with this option (municipalities who must change indicators) Compensation? – Not Applicable	Medium = (3) Ratio of W:L – development community lose in short-term, public and future generations win Compensation? – None	Medium/high = (4) Ratio of W:L – development community loses some opportunities; significant changes for municipal agencies but public and future generations win and government wins by being more cost effective Compensation? – yes for developers and public
Institutional capacity	Medium/Low = (2) Resources – high staffing and funding needs Levels of government involved – high (provincial/regional/ municipal)	Low (1) Resources – some staffing needs and high funding needs Levels of government involved – high (provincial/regional/ municipal)	Medium/high = (4) Resources – some staffing and funding needs Levels of government involved – medium (municipally focused but will draw in regional and provincial governments somewhat)
Total	19	13	19

* Can tap into partnerships to reduce policy costs

3.4 Recommendations and Conclusions

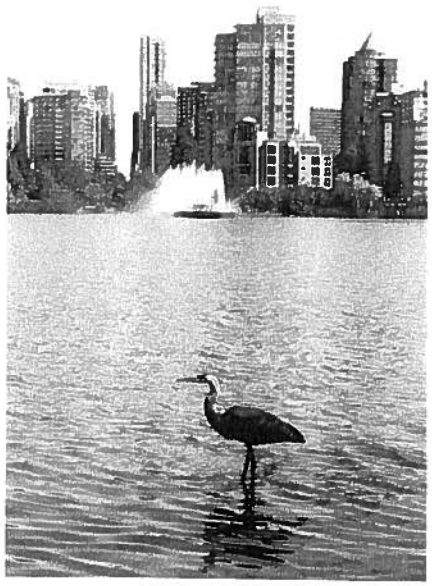
IN THE COURSE OF RESEARCHING THIS REPORT, it became apparent that there is no single policy or group of policies that will be a perfect fit for all of B.C.'s hot spot regions and municipalities. Communities displayed a considerable range of responses regarding threatened areas, public attitudes, government budget, capacity, and leadership. This is in addition to wide variances in the number and type of policies that have already been implemented to protect and restore natural capital. A number of policy gaps did emerge, however. The policy options were designed to address these.

- POLICY OPTION #1: Regional Conservation Tracking would address the most critical gap in local efforts to protect natural capital. The lack of knowledge regarding the extent and quality of our natural assets within each community is crippling the ability to respond effectively. This option scored high in the previous section (19 out of a possible 25 points). The biggest hurdle to implementation will be institutional capacity. Effort should be focused on building capacity within and across local governments to incorporate this option into existing mandates.

- POLICY OPTION #2: Development of a Regional Protected Areas Strategy would address the prominent coarse-scale issues that were identified in this report, particularly the need for governments to work together to incorporate connectivity into natural capital planning. While this option scored lowest in the assessment, due to the high costs associated with securing and maintaining protected areas, these costs can be offset by programs such as the Free Crown Grant program or by allocating monies from the provincial Carbon Tax.

- POLICY OPTION #3: Mainstreaming ecosystem services into economic and development planning would address finer scale issues that were identified through research. It ranked high on the policy assessment, together with option #1. The largest barrier identified was political viability, since it would require considerable thought and effort to effectively generate awareness and support for protecting and restoring natural capital. Framing would need to focus on the message that this is something that is coming at a large scale eventually, with local governments leading the way.

The ideal method for the implementation of these policies would likely differ with each community. Generally speaking, options one and three can quickly be operationalized, while option two would take more time to implement. The bottom line is that there are no easy policy solutions, particularly for B.C.'s hot spots. There are, however, a range of innovative policies and funding mechanisms to draw on.



The bottom line is that there are no easy policy solutions, particularly for B.C.'s hot spots. There are, however, a range of innovative policies and funding mechanisms to draw on.

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This report is the third in a series of David Suzuki Foundation publications examining the economic value of natural capital – forests, fields, wetlands and waterways – in and around Canada's urban areas and assessing the essential benefits that these ecosystems provide. The purpose of this report is to evaluate tools and policy options that B.C. local government agencies can use to protect and restore natural capital and ecosystem services. It reviews challenges and opportunities facing local governments and provides three promising policy options.

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2010 Annual Report

Vancouver Island Regional Drinking Water Team

Photo: Karst Formation, Atluck Creek, below Little Huson Lake, BC

September 2011

Vancouver Island Regional Drinking Water Team

2010 Annual Report

Document Purpose

In accordance with Section 6 of the Memorandum of Understanding Regarding Inter-Agency Accountability and Coordination on Drinking Water Protection (MOU), this annual report provides a summary of the Vancouver Island Regional Drinking Water Team's (RDWT) activities for the 2010 calendar year.

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1.0 Executive Summary

The Vancouver Island Watershed Protection Steering Committee (VIWPSC), aka Vancouver Island Regional Drinking Water Team operates under the "Memorandum of Understanding Regarding Inter-Agency Accountability and Coordination on Drinking Water Protection (2006)" The VIDWPSC includes representation from each provincial government agency that is signatory to the MOU and includes additional membership from local government, Health Canada, Islands Trust and the Private Managed Forest Land Council. The additional membership recognizes the essential role that other agencies have in delivering a drinking water protection mandate in this region, and in the case of local government participation, allows participation to those that have land use decision making authority at a more regional level. This committee met twice in the 2010 calendar year. As in previous years, there is continued support by Cowichan Valley and Nanaimo Regional Districts, while other regional districts are not active in the committee. Strong support was also provided by all provincial ministries with the exception of Energy, Mines and Petroleum Resources, and Community and Rural Development.

A number of successes were identified including:

- Completion of the Comprehensive Source to Tap Assessment Guideline by Ministry of Healthy Living and Sport, and presentations about the document given at the BC Water and Wastewater Association Annual Educational Conference and to this committee. The document is available for information and use on the Ministry of Health website at http://www.health.gov.bc.ca/protect/source.html

- Regional District of Nanaimo (RDN) and Ministry of Environment are partnering to increase the number of observation wells in the RDN area. RDN is also working on a number of projects related to water education and increasing baseline knowledge and data of water related issues.

- Cowichan Valley Regional District (CVRD) conducted integrated flood management and drought management planning. LIDAR mapping flight of the whole region will assist with these plans. ,

- South Cowichan project includes ongoing studies, groundwater mapping and water balance in partnership with VIU, surface water quality overview study, baseline water quality parameter benthic study in partnership with MOE, Shawningan Lake characterization and modelling of impacts of climate and landuse variability of water quality. Continued work with multi sectoral watershed management plan Board in the Cowichan Koksilah Watershed.

- Continued development of water quality objectives on an ecoregion basis for Comox and the Englishman River

- Development of a phosphorus guidance document for subdivision development

- MOE and partners have completed the DRASTIC mapping for Vancouver Island, with a focus on developed and developing areas.

Identified challenges included maintaining committee membership after reorganization of government ministries in October 2010. Ongoing is the need to develop a multi-agency approach for investigation, compliance and enforcement to deal with cross-jurisdictional issues, and provision of sufficient resources to effectively deal with the issues. There was also an identified challenge regarding the role of the committee and the level of support that it might offer the local regional scale technical drinking water teams. This is discussed in more detail in Section 3.2.

The priorities identified for the near future include increased consultation and referrals for projects that may impact water sheds or drinking water, increased partnerships to deal with population growth, climate change and storm water management strategies. With First Nations land claims in process, and settlements being reached, it is important that they be included as an active member of the Vancouver Island Watershed Protection Steering Committee.

2.0 Meetings and Membership

2.1 RDWT Meetings

Date	Location	Ministries in Attendance	Minutes Attached (y/n)
May 26, 2010	Duncan	VIHA,MOE, PROVINCIAL DWO, MHLS,HEALTH CANADA, RDN,MOFR, MOTI, ISLAND TIMBERLANDS, ILMB, COWICHAN VALLEY RD, CITY OF CAMPBELL RIVER	Yes, see appendix 8.1
September 22, 2010	Nanaimo	VIHA, MOE, MOTI, MHLS, RDN, ISLAND TIMBERLANDS, HEALTH CANADA – FNIHB, PROVINCIAL DWO	Yes

2.2 Changes in Membership

New members

Joanne Cyr, Ministry of Transportation and Infrastructure

See Appendix 8.2 for contact list.

2.3 Document Review

Member Name	Ministry

See Appendix 8.3

3.0 Key Successes, Challenges and Priorities

3.1 Successes

In 2010, MHLS completed the Comprehensive Source to Tap Assessment Guideline and presented the document at the BC Water and Wastewater Association Annual Conference and Trade Show. A presentation highlighting key points of the document was also made to the VIWPSC.

As part of its Drinking Water and Watershed Protection Action Plan, the RDN and MOE are working as partners to increase the number of observation wells in the RDN area. They are also working on a number of projects related to water education. WellSMART is an educational program for residential well owners focussing on well protection and water quality. The Watershed Snapshot Report is a process that solicited public and professional input on local watershed issues to develop baseline knowledge and data, and to prioritize actions in each watershed.

The Cowichan Valley Regional District (CVRD) conducted LIDAR mapping of the region to assist with assessing storm water implications, riparian function and identification of water courses in the region. This mapping will also assist in the integrated flood management and drought management planning. Other initiatives underway include slide maintenance and habitat restoration for the Cowichan River, development of a spatial tool for volumetric analysis in conjunction with VIU, water quantity studies with both water purveyors and private well owners, and various assessments of the effect of development on water quality, habitat and various species within the region.

The Ministry of Environment (Environmental Protections) has continued development of water quality objectives on an ecoregion basis for the Comox and the Englishman River. A phosphorus guidance document for subdivision development is underway. The Water Stewardship Division is working on First Nation treaty issues including water reserve applications. The water quality attainment report following up the Water Quality Objectives report for the Koksilah River was published in 2010. They are also involved in water planning initiatives with local governments.

Vancouver Island Health Authority (VIHA) has made some progress in reducing the number of systems on long term Boil Water Notices. This work will continue on an ongoing basis. Most of the systems on a long term BWN are small systems with issues with financial capacity and governance.

3.2 Challenges

Late in the year, government ministries underwent reorganization and the roles of each of the new or reorganized ministries have not been finalized. In order to maintain the inter-agency commitment to drinking water protection and bolster committee attendance, the Director's committee needs to ensure

that their respective agencies are represented at the RDWT meetings. There has been continued strong support for this committee by the CVRD and RDN, but other regional districts have not chosen to participate. This involvement from the other regional districts is necessary for an overall, regional and consistent approach to source water protection.

As raised previously, Regional Districts require input into provincially approved land use discussions. For example, the sale of privately managed forest lands for residential development often occurs in a watershed that is a community water source. Subdivision approval in unincorporated areas is given through the Ministry of Transportation and Infrastructure and the regional districts may have limited input into the decision process, especially if the area is not regulated by zoning bylaws or other mechanisms such as an Official Community Plan.

Multi-agency investigations involving a number of different government agencies require a process to ensure investigations are done in a collaborative and consistent manner. This issue has been raised with respect to waterfront properties and issues with squatters and uses contrary to the zoning of the area. If violations of legislation are discovered and are not enforced, this encourages disrespect for the legislation and the agency staff and allows uses which may be harmful to health or the environment. (Staples, 2008)[1]

The Regional Drinking Water Teams need to determine their role in supporting promotion of green infrastructure, water centric planning and water use conservation outside of funding supplied by the Ministry of Community and Rural Development.

There was also an identified challenge regarding the role of the committee and the level of support that it might offer the local regional scale technical drinking water teams for assistance in the development of watershed specific multi agency plans, analysis of the Chemainus River watershed at the request of the First Nations and support for a Shawinigan watershed plan. Limiting factors for this type of assistance is staff time and resources of the provincial and federal partners to the local groups.

3.3 Priorities

There is no change to the priorities of the previous report. This includes

- The Director's committee needs to ensure their agency has representation at meetings. There is also a need for two way communication with the committee.

- The process for multi-agency referrals for projects that may impact water sheds or drinking water needs to be formally recognized by the members of the VI RDWT, with all members participating in the consultation or referral process.

[1] A Handbook for Municipal Councils, Under the Community Charter and the Local Government Act November 2008 Lorena Staples, QC

- Population growth associated with urban and rural land development continues to put pressure on surface and ground water resources, including the need for source protection. Climate change may also impact surface and ground water resources. Climate change, especially with more extreme weather events will require more efforts focused on storm water management. Partnerships between local, provincial and federal governments are required to address these issues.

- There is a need for executive direction on assessing requests for Drinking Water Protection Plans and/or Water Management Plans under their respective legislation. There is a need for a mutually acceptable process for accepting proposals, assessing risk and supporting these requests.

- Support models for small water systems that have issues with financial viability are required to ensure small systems have the same level of protection as larger water systems in BC.

- First Nations need to be invited to participate in the RDWT.

4.0 Inter-agency Co-ordination and Co-operation

Through attendance at these meetings, relationships are being formed and information sharing is increasing although protection and/or provision of drinking water are still not always being recognized as an important attribute of development. There needs to be better coordination and cooperation between all levels and branches of government who have a role to play in protecting drinking water and ensuring sustainable development.

5.0 Co-ordination and Co-operation with Regional Government

Although local governments are an integral part of the RDWT, some regional districts do not attend the meetings. Efforts are being made to invite participation from all regional districts so this committee is truly representative of all of Vancouver Island. A challenge identified by local governments is the inability to have jurisdiction over, or sometimes even input into development or land use decisions made by more senior governments.

6.0 Directors' Committee

In December, Lynne Magee from Vancouver Island Health Authority made a presentation to the directors committee about the work done by the Vancouver Island Watershed Protection Steering Committee. The presentation was based on the 2009 annual report and included the history of the committee which predates the regional drinking water teams, the membership structure which includes representation from local governments and private forestry and the successes, challenges and issues of

the previous year. A case study of the ad hoc development at Hawes Bay on Cowichan Lake illustrated the need for all agencies to work together to uphold existing legislation and to ensure development occurs legally, in a sustainable manner and with as little impact to the natural environment as possible.

The reorganization of various government ministries in October of 2010 may impact the future direction of this committee. It is hoped that the important and ongoing relationships and partnerships developed between committee members will continue with the changes.

A process endorsed by the directors committee and implemented through each ministry is still needed for conducting multi-agency investigations and to ensure that issues are investigated in a collaborative and consistent manner, with appropriate resolution being reached. With the reorganization of the government ministries there is no timeline proposed for this process to be developed and the VIWPSC may wish to discuss and develop alternatives to this higher level process.

7.0 Additional Notes

8.0 Appendices

8.1 Meeting Minutes

VIWPSC Minutes May 26, 2010.pdf

VIWPSC Minutes Sept 22, 2010.pdf

8.2 Contact List

contact List Nov 1, 2010.doc

8.3 Document Review

Email requesting feedback on annual report sent to committee members on October 7, 2011. Comments were received at the meeting on November 17, 2011, and by email and incorporated into the draft. A final call for comments was sent to members on January 6, 2012.

CVRD

STAFF REPORT

ENVIRONMENT COMMISSION
OF JANUARY 19, 2012

DATE: January 11, 2012 **FILE NO:** 0810-00-GRE

FROM: Rachelle Rondeau, Planner I **BYLAW NO:**

SUBJECT: Private Sector Green Building Strategy

Recommendation/Action:
That this report be received for information, and that discussion and feedback from the Environment Commission regarding a private sector green building strategy for the CVRD be provided at a subsequent meeting.

Purpose:
To introduce several approaches to encourage green buildings within the private sector, and obtain feedback on the goals, and policies of a CVRD private sector green building strategy.

Relation to the Corporate Strategic Plan:
Under *Sustainable Land Use* and *Healthy Environment,* the CVRD Corporate Strategic Plan has identified the following strategic actions:

- Develop a green building strategy/policy that supports environmentally friendly building practices;
- Develop and implement a program to recognize examples of excellence in sustainable community development;
- Review existing CVRD Bylaws and make recommendations for incorporating sustainable elements, and where needed, create new standards.

Financial Impact:
The financial impact will vary depending on the scale, type of project, and the green building certification achieved. While green buildings may have higher initial capital costs, studies have shown that these costs can be reduced by designing buildings as integrated systems, and including the green elements as key features in the design (not as later add-on items).

With respect to a green building strategy that would target the private sector, financial impact to the CVRD will depend on the type of programming chosen. Limited to no additional resources would be required for policy development. However, research projects, education and outreach programs or incentive programs will require some financial commitment from the CVRD.

Under the current budget structure, any rebates on building permits would be lost income from the Building Inspection Division budget. However, the amount would depend on the uptake of the program and the level of rebate offered.

The financial impact to the developer or homeowner would be dependent on the green building techniques chosen, their familiarity with green building programs, and the scale/type of building.

Interdepartmental/Agency Implications:
The CVRD Board made the following resolution at their November 23, 2011 meeting:

"That, in consultation with the Environment and Economic Development Commissions, and a stakeholder committee, a private sector green building strategy be developed that would:

a) *provide financial incentives and recognition to builders/developers who build green, or establish a disincentive for non-green buildings, according to an established rating scheme or EnerGuide rating (e.g. 80 or above);*
b) *establish higher standards for proposed development through a rezoning policy and Official Community Plan policies;*
c) *continue integrating green building policies within planning documents."*

Feedback from the Environment and Economic Development Commissions is desired in order to provide input and feedback on the goals, priority areas, strategies, and possible certification requirements.

Input from a stakeholder or advisory committee will assist in providing feedback on the benefits and barriers to green building within the development industry, and best practices from other areas. As local government cannot impose additional regulations on buildings, voluntary measures need to be supported (e.g. through incentives/rebates), and green building policies should be included within planning documents to encourage new and redevelopment to build green.

The following sections of this report provide information regarding potential green building policy areas, and an overview of programs undertaken by other local governments for consideration.

As noted above, the three proposed mechanisms to encourage green buildings in the private sector are:

- financial incentives/disincentives;
- rezoning policy for new development;
- green building policies within planning documents such as Official Community Plans.

This report is being provided to introduce the topic of a private sector green building strategy for the Regional District, and targeted discussion regarding goals, targets and strategies will be required in order to inform development of the private sector green building strategy.

Staff are suggesting that the Environment Commission receive and review the attached information, and that a subsequent meeting be held to have a targeted discussion regarding the priority areas and targets.

Submitted by,

Rachelle Rondeau, Planner I
Development Services Division
Planning and Development Department

Reviewed by:
Division Manager:

Approved by:
General Manager:

Appendix A - Background:
The CVRD Corporate Strategic Plan identifies creation of a green building strategy as a strategic action supporting sustainable land use and a healthy environment.

A number of CVRD initiatives are already underway which support development of a green building strategy for the private sector:

- CVRD Corporate Strategic plan – overall direction for the CVRD, provides direction on strategic actions and work plans
- Regional Energy Plan – will establish targets for reduction in energy usage, renewable energy requirements
- Municipal Green Building Leaders[1]- work with other local governments to advance policies that would reduce greenhouse gas emissions in communities
- Environment Commission - 12 Big Ideas Outreach and Feedback Advertorials
- Sustainability Checklist – submitted with development applications to provide education on sustainable development and identify sustainable elements within their applications
- Integrated Regional Sustainability Plan – To be started shortly
- Sustainable Economic Development Strategy – Recently completed, now being implemented
- CVRD Bylaw No. 3422 – Building Regulation Bylaw (adopted September 14, 2011)

Green Building Policy Areas
The range of environmental impacts associated with new construction include the following:

- Building Energy Use;
- Transportation Energy Use;
- Water Consumption;
- Volume of Wastewater;
- Solid Waste;
- GHG Emissions; and
- Area of land converted to use for buildings (e.g. impervious surfaces, land clearing).

Certification or rating systems that verify a building as "green" identify points that can be achieved in each one of these areas (for reference, please see attached Appendix C LEED points checklist and BuiltGreen checklist).

The costs associated with obtaining points can vary from one area to the other.

A recent advertorial campaign done by the CVRD Environment Commission generated a number of ideas for green building including:

- A requirement for all new subdivisions to provide district heating;
- Energy audit requirements for dwellings up for sale;
- Increasing the energy efficiency standards for new construction;
- Mandatory green building materials (e.g. responsibly forested wood, recycled content);

[1] The CVRD, along with 11 other local governments, has partnered in the Municipal Green Building Leaders project of the Pembina Institute. www.greenbuildingleaders.ca

- Passive solar energy;
- Solar hot water; and
- That all new development be carbon neutral.

Local Government Tools

Without specific provincial approval to do so, local governments cannot adopt standards different or more restrictive than those within the BC Building Code. Therefore, the most readily available tools are land use planning and development tools, corporate policies, and programming opportunities.

Through participation in the Municipal Green Building Leaders program, it was found that adoption of an EnerGuide 85 standard for all new construction within the Electoral Areas would result in a reduction of greenhouse gas emissions of 5,064 tonnes CO_2e, and reduced energy consumption of 31,658 Mwh by 2020 from the business as usual scenario. Discussions about increasing the EnergGuide rating within the BC Building Code have established EnerGuide 80 as the next possible level.

To encourage higher standards of development than those within the BC Building Code, local governments can provide incentives or facilitate green buildings in private sector development by using policy tools such as rezoning policy to specify a certain standard (e.g BuiltGreen or EnerGuide 85), building permit rebates, and incentive programs.

Examples of strategies other jurisdictions have adopted include:

- District of Saanich – Green Home Building Rebate Program[2]
- Regional District of Nanaimo – Green Building Incentive programs[3]
- Bowen Island – Rezoning Policy
- City of Victoria – Green Building Policy Private Sector Development
- City of North Vancouver – Density bonusing for increased energy efficiency

Cost

Within the CVRD, the average building permit costs approximately $2,000 - $2,500 for a new home, which represents 1% of construction value based on fees of $100.00 per sq. ft, assuming an approximately 1,500 sq. ft home (plumbing permits etc. are added separately).

In order to construct a home that is certified BuiltGreen, for example, not all green elements are methods that are within the final product but can instead be services provided in how the development is completed, e.g. waste diversion on a construction site. The average expected cost increase is variable depending on the level of certification chosen, the techniques used to achieve BuiltGreen, and the developer/builder's familiarity with the system.

Incentives/Rebates

In order to offset the increased cost and encourage construction of green buildings generally, financial incentives in the form of lower building permit fees, new rebates and quicker permitting processes are strategies that have been adopted in other jurisdictions to encourage green

[2] Saanich offers building permit rebate levels depending on the standard of development achieved (e.g BuiltGreen Silver, Gold or Platinum or EnerGuide rating achieved.

[3] The Regional District of Nanaimo has developed a Sustainable Development Checklist for Residential, Commercial and Institutional Development that offers a series of rebates (ranging from $500-1,000) depending on the score achieved. http://www.rdn.bc.ca/cms.asp?wpID=2428

building. Alternatively, when new fee increases are considered for Building Permits, green buildings could remain at the regular rate to incentivize green buildings.

With regards to rebates, for example, the Regional District of Nanaimo has developed an optional Green Building checklist that provides a ranking for each project (Development Permit and Building Permit applications) and depending on the final score, offers rebates ranging from $500.00 - $1,000.00. The checklist is a series of 'yes' or 'no' answers, where a score is provided based on 1 point per question. As part of this program, the RDN provides advice to applicants through their Sustainability Coordinator who helps assist applicants to achieve a high sustainability rating.

Within the District of Saanich, rebates of up to 30% of the building permit value are provided for BuiltGreen Platinum, EnerGuide 80, and R-2000. An extra 20% for a total of 50% of the building permit is available for rebate on homes less than 2,000 sq. ft. For a BuiltGreen Gold home, a 20% rebate of the value of the building permit is offered (Please find attached sample information from other jurisdictions, as well as the LEED and BuiltGreen checklists).

To develop a similar program, this would involve establishing the rebate amount for certification levels achieved, developing communication materials, and a review by staff of the EnerGuide labels, BuiltGreen or R-2000 certification for applicants to receive the rebate.

Possible concerns with establishment of a rebate program are the lost revenue to the Building Inspection Division, and philosophically whether taxpayer funds should be distributed to individuals via incentive programs. Existing rebate programs offered by the CVRD include a woodstove exchange rebate, funded in large part through a Provincial grant and low flow toilet rebate.

Density Bonusing
Density bonusing is being used by the City of North Vancouver to encourage high energy efficiency in new buildings through their zoning and Official Community Plan policies. This program permits a base density in the form of allowable floor space ratio. A higher density is permitted when a minimum of EnerGuide 80 is attained, which for a single family dwelling will result in the homeowner being able to put in a secondary suite. The value of the suite is greater than the increased costs of building to a higher energy efficiency standard. The program requires a certified energy advisor to assess the final energy rating, and their involvement can also provide advice to homeowners on low cost options to improve the energy rating.

Rezoning Policy
When applications for rezoning are received, increased energy efficiency and greener buildings are sometimes negotiated on an application-by-application basis. However, development of a rezoning policy would communicate the importance of green buildings to achieving sustainable community development.

Direct support opportunities
As part of a private sector green building strategy, consideration could be given to the Regional District financing access to a Certified Energy Advisor for new construction and renovation projects. This resource person would introduce to the public the value and potential trade-offs in increasing energy performance over time versus potential capital cost. The District of Saanich offers a free one-hour consultation with a green building consultant and the RDN also offers appointments with their Sustainability Coordinator as part of these programs.

An additional opportunity that would require further research would be to identify a number of pre-approved technologies or solutions similar to that of the solar hot water regulation, in order to reduce engineering costs for homeowners wanting to build green[4].

Conclusion

To produce a high impact, the above-mentioned tools should be part of an overall green building/sustainable development strategy developed in consultation with the building industry, experts in the field, and local governments. Additionally, integration of green buildings with sustainable land use and transportation practices will result in larger benefits than a focus on buildings alone.

Green building policies are already, and should continue to be, integrated within planning documents (e.g. Bill 27 Green Communities legislation, low impact development/onsite rainwater management). A rezoning policy and other planning policies will communicate the importance of green building as a priority of the Regional District. In order to provide financial incentives to encourage homeowners/new developments to build green, a building permit rebate program for buildings that are verified BuiltGreen or Energuide 80 rating, or financial disincentives for non-green buildings, could also be established.

The CVRD Regional Energy Plan project being undertaken by the Regional Environmental Policy Division supports green building as it is intended to provide a series of policy tools and information that can guide and inform the development of the private sector green building strategy. Coordination between the Environmental Policy Division, who has been conducting research and developing tools, with the Planning and Development Department, who interfaces with the public and development industry, is recommended in order to produce a robust private sector green building strategy.

[4] An additional cost of building green or using methods not contained within the Building Code is that these need to be approved by an Engineer, which increases the costs of the permitting process to the homeowner.

Appendix B – Glossary of Terms

BuiltGreen
is a third-party certified green building rating system creating homes that are energy efficient, and environmentally responsible and includes the use of resource-efficient, environmentally friendly, construction practices and products. BuiltGreen Gold requires a minimum EnerGuide rating of 77 and 100 points from the checklist.

Integrated Design Process: a whole building-design approach. It uses a multi-disciplinary team of building professionals who work together from the pre-design phase through to post-occupancy to optimize the building's environmental sustainability, performance and cost savings. This design approach recognizes that a successful green building is best achieved by planning the site, structure, components and systems as interdependent parts.

LEED Green Building Rating System (LEED Canada Project checklist)
Leadership in Energy and Environmental Design (LEED) is a voluntary, consensus-based system for developing high performance, sustainable buildings. It was created by the United States Green Building Council (USGBC) in 1993 largely to stimulate green building market transformation. It is a recognizable "brand" that is also used to recognize industry leaders, and raise consumer awareness.

LEED Certification – different levels of green building certification are attainable in the LEED Green Building Rating system – certified, silver, gold, and platinum. They are awarded based on the total number of credits earned in the categories of sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. The certification is granted after a thorough review of the project characteristics by the CaGBC.

Life-cycle costing analysis
Is an evaluation tool that assesses the net present value of the design, construction and operational costs of a building. It can also include qualitative measures such as the health and productivity of occupants, cost of environmental impacts and costs of social impacts.

Appendix C – Rebate Program Samples, BuiltGreen and LEED Checklist.

How it works

1. Obtain a voucher for a free green building consultation. The green building consultant will guide you through any available programs and rebates available for renovators and new home builders.
2. For new homes, schedule a blueprint assessment with an EnerGuide Rating Service provider. They will provide you with a current and potential EnerGuide rating, and ways to upgrade the plans. Costs for this service vary.
3. Build or renovate the home.
4. Arrange for final testing of the home to receive an EnerGuide label.
5. For new homes, complete third party certification process.
6. Bring copies of EnerGuide labels and/or BuiltGreen, R-2000 or Power Smart certification to Saanich Inspections and receive your rebate for EnerGuide testing and/or building permit fees.

Fibreglass insulation

Solar panels

For more information

BuiltGreen BC
www.builtgreencanada.ca

Power Smart at Home
www.bchydro.com/powersmart
➢ Builders and developers

City Green
www.citygreen.ca

Saanich Green Building Rebate Program
www.saanich.ca
➢ Development

Oceanwood Built Green™ development, Saanich

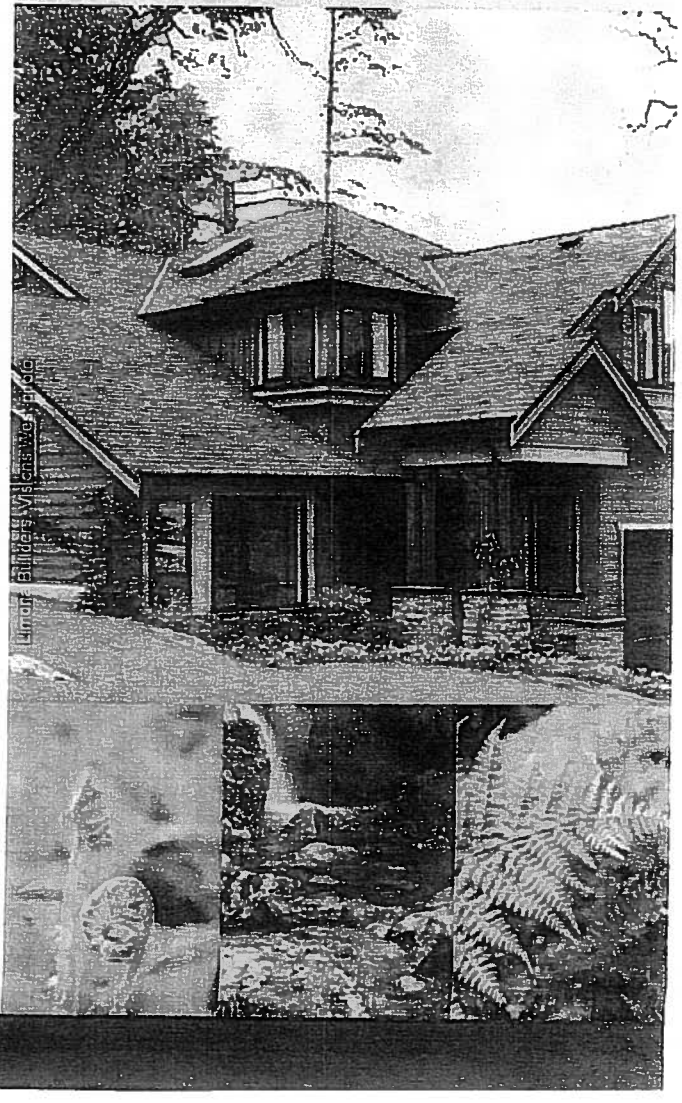
Contact us at:

Saanich
PLANNING AND INSTALLATIONS

Email: plansec@saanich.ca
www.saanich.ca
Phone: 250-475-5471

Sustainable Saanich

Green Building Rebate Program



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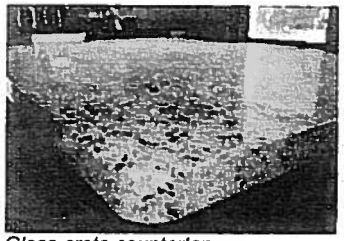
Saanich Green Building Rebate Program

Green buildings are designed and constructed to maximize efficiency and comfort, without sacrificing style and beauty. Green buildings reduce the need for resources such as energy and water, thus reducing the environmental impact of buildings overall. Healthier for the occupants and cheaper to maintain, green buildings are a community asset.

The District of Saanich offers free green building consultation and rebates for renovations and new homes built to certified energy efficiency standards.



Glass-crete countertop

Low VOC paint

Rainwater swale

Our Commitment

Saanich green builders will be eligible for the following benefits:

1. Free one-hour consultation with the Green building consultant.
2. No-fee plumbing permit for solar hot water installation.
3. Promotional assistance (if desired).
4. Eligibility for awards/recognition.
5. On completion and certification, rebates of up to 30% of the building permit value. Additional 20% (total 50%) for homes under 2000 ft².
6. Rebate on final retrofit or new home energy assessment ($150 value).

REBATES

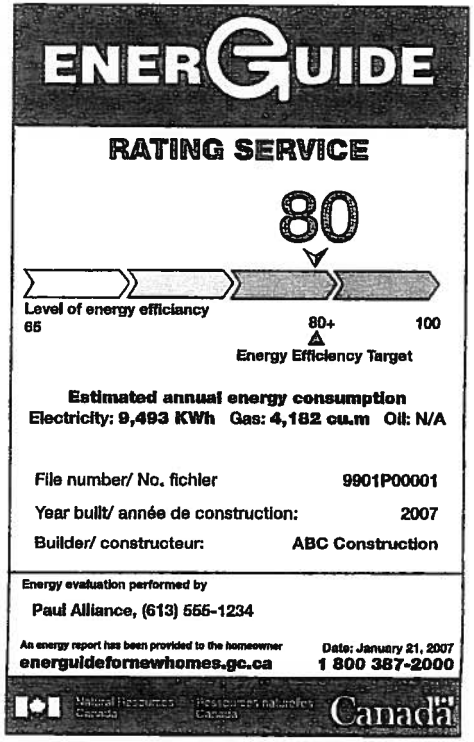
Rebate Level		EnerGuide Level
30%	Built Green Platinum	82
	Power Smart Gold	80
	Energuide 80	80
	R-2000	80
	*Gold Renovations	80
20%	Built Green Gold	77
	Power Smart Silver	77
	*Silver Renovations	77
10%	Built Green Silver	75
	*Bronze Renovations	75

*some conditions may apply

The EnerGuide Rating Service

An EnerGuide rating provides a standard measurement of a home's energy efficiency, on a scale from 0 to 100. EnerGuide ratings are calculated by a Certified Energy Advisor using information collected from the analysis of building plans and the results of a blower door test performed after the house has been built.

The EnerGuide rating is required for any Green Building Certification.



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BuiltGreen™ Checklist

Our checklist is a list of "green" criteria. It includes an energy efficiency requirement, and a menu of options in categories, addressing a range of "green" items from which the builder can select to meet the Bronze, Silver, Gold and Platinum achievement levels.

BuiltGreen™ Canada Members have the opportunity to submit requests for changes (additions, deletions, point value, etc.) to the BuiltGreen™ Checklist using the Checklist Change Request Form. The Checklist and the Checklist change requests are reviewed annually. The revised checklist is effective January 1 of each year.

Certification Levels

BuiltGreen recognizes its homes based on the criteria of the checklist described above, which will categorize its members into 4 levels of Green achievement: **Bronze, Silver, Gold** and **Platinum.**

BuiltGreen™ supports the use of lumber and gives a significant number of points for lumber use. Only products that have been submitted for verification can be approved, and are then certified by BuiltGreen Canada. To view a selection of products within the checklist categories below, view our Product Catalogue.

Checklist Categories	Bronze	Silver	Gold	Platinum
Energuide for New Houses Rating 2011	72pts	75pts	77pts	82pts
I. Operational Systems - Minimum 10/93				
II. Building Materials - Minimum 15/91				
III. Exterior and Interior Finished - Minimum 10/66	76pts	90pts	100pts	120pts
IV. Indoor Air Quality - Minimum 15/53				
V. Ventilation - Minimum 6/21				
VI. Waste Management - Minimum 7/32				
VII. Water Conservation - Minimum 7/48				
VIII. Business Practices - Minimum 6/31				

LEED Canada-NC 1.0 Project Checklist

Project Name

City, Province

Yes	?	No		
			Sustainable Sites	14 Points
Y			Prereq 1 **Erosion & Sedimentation Control**	Required
			Credit 1 **Site Selection**	1
			Credit 2 **Development Density**	1
			Credit 3 **Redevelopment of Contaminated Site**	1
			Credit 4.1 **Alternative Transportation**, Public Transportation Access	1
			Credit 4.2 **Alternative Transportation**, Bicycle Storage & Changing Rooms	1
			Credit 4.3 **Alternative Transportation**, Alternative Fuel Vehicles	1
			Credit 4.4 **Alternative Transportation**, Parking Capacity	1
			Credit 5.1 **Reduced Site Disturbance**, Protect or Restore Open Space	1
			Credit 5.2 **Reduced Site Disturbance**, Development Footprint	1
			Credit 6.1 **Stormwater Management**, Rate and Quantity	1
			Credit 6.2 **Stormwater Management**, Treatment	1
			Credit 7.1 **Heat Island Effect**, Non-Roof	1
			Credit 7.2 **Heat Island Effect**, Roof	1
			Credit 8 **Light Pollution Reduction**	1

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

Yes	?	No		
			Energy & Atmosphere	17 Points
Y			Prereq 1 **Fundamental Building Systems Commissioning**	Required
Y			Prereq 2 **Minimum Energy Performance**	Required
Y			Prereq 3 **CFC Reduction in HVAC&R Equipment**	Required
			Credit 1 **Optimize Energy Performance**	1 to 10

Yes	?	No			
			Credit 2.1	**Renewable Energy**, 5%	1
			Credit 2.2	**Renewable Energy**, 10%	1
			Credit 2.3	**Renewable Energy**, 20%	1
			Credit 3	**Best Practice Commissioning**	1
			Credit 4	**Ozone Protection**	1
			Credit 5	**Measurement & Verification**	1
			Credit 6	**Green Power**	1

Materials & Resources — 14 Points

Y					
			Prereq 1	**Storage & Collection of Recyclables**	Required
			Credit 1.1	**Building Reuse:** Maintain 75% of Existing Walls, Floors, and Roof	1
			Credit 1.2	**Building Reuse:** Maintain 95% of Existing Walls, Floors, and Roof	1
			Credit 1.3	**Building Reuse:** Maintain 50% of Interior Non-Structural Elements	1
			Credit 2.1	**Construction Waste Management:** Divert 50% from Landfill	1
			Credit 2.2	**Construction Waste Management:** Divert 75% from Landfill	1
			Credit 3.1	**Resource Reuse:** 5%	1
			Credit 3.2	**Resource Reuse:** 10%	1
			Credit 4.1	**Recycled Content:** 7.5% (post-consumer + ½ post-industrial)	1
			Credit 4.2	**Recycled Content:** 15% (post-consumer + ½ post-industrial)	1
			Credit 5.1	**Regional Materials:** 10% Extracted and Manufactured Regionally	1
			Credit 5.2	**Regional Materials:** 20% Extracted and Manufactured Regionally	1
			Credit 6	**Rapidly Renewable Materials**	1
			Credit 7	**Certified Wood**	1
			Credit 8	**Durable Building**	1

Yes ? No

Indoor Environmental Quality — 15 Points

Y					
Y					
			Prereq 1	**Minimum IAQ Performance**	Required
			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
			Credit 1	**Carbon Dioxide (CO_2) Monitoring**	1
			Credit 2	**Ventilation Effectiveness**	1
			Credit 3.1	**Construction IAQ Management Plan:** During Construction	1
			Credit 3.2	**Construction IAQ Management Plan:** Testing Before Occupancy	1
			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
			Credit 4.2	**Low-Emitting Materials:** Paints and Coating	1
			Credit 4.3	**Low-Emitting Materials:** Carpet	1
			Credit 4.4	**Low-Emitting Materials:** Composite Wood and Laminate Adhesives	1

			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
			Credit 6.1	**Controllability of Systems:** Perimeter Spaces	1
			Credit 6.2	**Controllability of Systems:** Non-Perimeter Spaces	1
			Credit 7.1	**Thermal Comfort:** Compliance	1
			Credit 7.2	**Thermal Comfort:** Monitoring	1
			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
			Credit 8.2	**Daylight & Views:** Views 90% of Spaces	1

Yes ? No

			Innovation & Design Process	5 Points

			Credit 1.1	**Innovation in Design**	1
			Credit 1.2	**Innovation in Design**	1
			Credit 1.3	**Innovation in Design**	1
			Credit 1.4	**Innovation in Design**	1
			Credit 2	**LEED® Accredited Professional**	1

Yes ? No

			Project Totals (pre-certification estimates)	70 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-70 points

C·V·R·D

STAFF REPORT

ENVIRONMENT COMMISSION MEETING
OF JANUARY 19, 2012

DATE: January 11, 2012 **FILE NO:**

FROM: Bob McDonald, Manager, Recycling and Waste Management

SUBJECT: Solid Waste Management Plan – Summary and Report on Implementation (2009-2012)

Recommendation: N/A

Purpose: To confirm staff activities are consistent with the CVRD Solid Waste Management Plan.

Financial Implications: As discussed.

Interdepartmental/Agency Implications: N/A

Background: The CVRD amended its regional Solid Waste Management Plan in 2006 with the Environment Commission reviewing the Plan and fulfilling its role as the public monitoring committee. As significant implementation of the Plan takes place, reports such as this are periodically provided to ensure the Commission is fully informed of activities and progress. An updated Plan Implementation Schedule has been provided (attached), while the discussion below provides an overview of new and recently completed initiatives.

Discussion: Some noteworthy developments over the past two years include the recent award of up to $950,000 in combined gas tax funding for upgrades to the Peerless Road Recycling Drop-off Depot near Ladysmith. Other capital works recently completed include the construction of a new operations building and expansion of the administrative centre at the Bings Creek Solid Waste Management Complex, along with improvements to the tipping floor at the Bings Creek transfer station (supported by Regionally Significant Project gas tax funds) and the recent introduction of indoor drop-off for commercial organics waste.

Although the recent attempt at developing a new recycling drop-off facility in south Cowichan was unsuccessful, high priority activities for 2012 will include a review of recycling options for the South Cowichan area, along with the resolution of outstanding Fisher Road area composting compliance issues. Other high priority activities will

collection at the Bings Creek transfer station; completion of remediation planning and closure of the Meade Creek ash landfill; and the development and promotion of a comprehensive Zero Waste education campaign.

Other projects planned for 2012 will include the continued exploration of long term disposal options for the region, the potential development of a backyard burning bylaw for applicable electoral areas, and the implementation of an air quality education campaign focused on backyard burning. In addition, staff will continue to work with product stewardship agencies, local industry and other stakeholders in order to ensure that a wide range of comprehensive recycling and diversion options are available within the region.

Submitted by,

Bob McDonald

Approved by:

Brian Dennison, General Manager, E&E Services

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Solid Waste Management Plan Amendment No. 3
Plan Implementation Schedule – Update 2010-2012

The following table provides an update to the Plan Implementation Schedule shown on page 33 of the CVRD's Solid Waste Management Plan. Status and comments sections have been added to show progress on the various initiatives.

Year*	Initiative	Status	Comments
2012	Internal review of Solid Waste Management Plan to identify new solid waste initiatives, programs and capital works to be implemented in 2012 – 2017 period	**In progress**	Internal review of disposal options, new programs and capital works will be completed in 2012 and will be incorporated with both 2012 and 2013 budgets and 5 year plans.
2011	Ongoing ash landfill closure and Recycling Drop-off Depot site development work	**In progress**	The CVRD is required by the BC Ministry of Environment to initiate closure planning at all incinerator ash landfills (Meade Creek, Peerless Road, and Koksilah Road). Closure of these sites is also a stated commitment of the CVRD's Solid Waste Management Plan. Closure of the Koksilah Road site was completed in 2011 (see below), while remediation planning for the Meade Creek site is underway, with works expected to be completed in 2012. Peerless Road remediation planning is expected to start in spring 2012.
2010	Ongoing ash landfill closure and Recycling Drop-off Depot site development work	**In progress**	As above.
2009	Planned upgrades to Meade Creek Recycling Drop-off Depot	**On hold**	Upgrades to the existing Meade Creek depot are not planned at this time pending completion of ash landfill remediation works on site, and potential relocation of the facility to more centralized area.
	Site upgrades to Bings Creek traffic routing	**Incomplete**	Changes to Bings Creek traffic routing are not planned at this time pending funding limitations and a focus on higher priority upgrades at satellite sites.
	Ongoing ash landfill closure	**In progress**	As above.
2008	Develop closure plan for Peerless Road ash landfill	**In progress**	Closure planning for the Peerless Road ash landfill is expected to begin in spring 2012, pending approval from the BC Ministry of Forests, Lands and Natural Resource Operations (site owners).
	Redevelop Peerless Road Recycling Drop-off Depot	**In Progress**	The CVRD was recently awarded up to $950,000 in combined gas tax funding for upgrades to the Peerless Road Recycling Drop-off facility.

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Solid Waste Management Plan Amendment No. 3
Plan Implementation Schedule – Update 2010-2012

Year*	Initiative	Status	Comments
			Preliminary planning and consultation for the project will be carried out during the spring and summer of 2012. Detailed design is anticipated to be carried out during the fall of 2012 pending all necessary approvals and permits.
	Evaluate feasibility of implementing Environmental Management System	**Delayed**	Low staffing levels have precluded the evaluation of an Environmental Management System at this time.
	Phase out Multi Bin program	**Delayed**	Phase out of Multi Bin program has been delayed pending further direction with regard to a south end recycling drop-off facility.
	Implement residential food waste collection service	**In progress**	Implementation of residential food waste collection service has been delayed due to complexities arising from inconsistent service levels across the region and subsequent cost impacts. It is expected that curbside collection models will be revisited during spring 2012 at the Engineering and Environmental Services Committee.
	Develop food waste tipping area at Bings Creek	**Complete**	A food waste tipping area for commercial trucks was developed within the existing Bings Creek transfer building during 2011. The work coincided with upgrades to the previously unfinished concrete floor within the transfer building. Works were supported in part by funding from the Gas Tax Regionally Significant Projects fund.
2007	Commission report on feasibility of employing new and emerging technology for residual waste stream	**Complete**	A report was jointly commissioned with the Regional District of Nanaimo in 2007.
	Redevelop west side of tipping area at Bings Creek to accommodate cardboard compactor, free store and hazardous materials	**Complete**	The new cardboard compactor was installed in 2007. Construction of a new building to accommodate an expanded free store and storage of household hazardous wastes was completed in 2009.
	Develop closure plan for Koksilah Road ash landfill	**Complete**	Closure of the ash landfill was completed in early 2011.
	Initiate development of South-end depot	**Unknown**	A referendum held on November 19, 2011 resulted in a 'no' vote for the

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Solid Waste Management Plan Amendment No. 3
Plan Implementation Schedule – Update 2010-2012

Year*	Initiative	Status	Comments
			development of recycling drop-off depot on Cameron Taggart Road in Shawnigan Lake. Future direction regarding development of a recycling drop-off facility in south Cowichan is unknown at this time.
	Initiate planning for upgrades to Peerless Road and Meade Creek depots	**Complete**	Planning for upgrades to Peerless Road depot has begun and funding secured (see above).
	Identify replacement disposal facility for Cache Creek landfill	**Complete**	A replacement disposal facility for the Cache Creek Landfill has been identified. The CVRD has been exporting waste to the Rabanco Landfill in Washington State since fall 2008. Staff will continue to investigate alternative means of regional waste disposal.

**Projected year for completion, as per SWMP A-3.*

Environment AECOM

Regional District of Nanaimo, Cowichan Valley Regional District and Capital Regional District

Tri-Regional District Solid Waste Study

Prepared by:

AECOM
3292 Production Way, Floor 4
Burnaby, BC, Canada V5A 4R4
www.aecom.com

604 444 6400 tel
604 294 8597 fax

Project Number:
60156649

Date:
May 2011

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The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

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- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
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- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
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AECOM
3292 Production Way, Floor 4
Burnaby, BC, Canada V5A 4R4
www.aecom.com

604 444 6400 tel
604 294 8597 fax

May 20, 2011

Dennis Trudeau
General Manager of Transportation & Solid Waste Services
Regional District of Nanaimo
6300 Hammond Bay Road
Nanaimo, BC V9T 6N2

Dear Dennis:

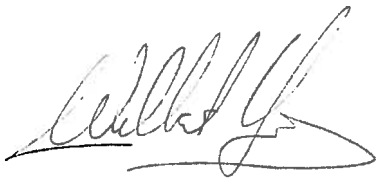
Project No: 60156649

Regarding: Tri-Regional District Solid Waste Study

We are pleased to present the report of the Tri-Regional District Solid Waste study for the combined regions of Nanaimo, Cowichan Valley and Capital Region. The report has been completed in accordance with comments received.

A copy of this report has simultaneously been sent to the CRD and CVRD. It has been a pleasure working with you and your colleagues and we thank you for the confidence placed in our team.

Sincerely,
AECOM Canada Ltd.



Wilbert Yang, P.Eng.
Senior Environmental Planner, Waste Services

WY:gc

CC: CRD, Larisa Hutcheson
CVRD, Bob McDonald

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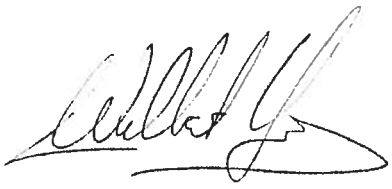
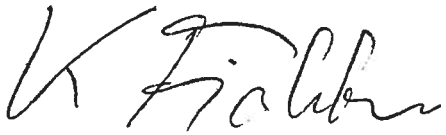


Wilbert Yang, P.Eng.
Senior Environmental Planner

Report Reviewed By:



Konrad Fichtner, P.Eng.
Senior Environmental Consultant

Report Reviewed By:

Robert C. Dickin, M.Sc., P.Geo.
Senior Hydrogeologist - Environment

Executive Summary

AECOM has assessed thermal treatment technologies for municipal solid waste (MSW) on behalf of three regional districts located in the southern portion of Vancouver Island (Tri-Regional District Solid Waste Study). This is an extension of two previous studies on the same subject conducted in 2006 for the Regional District of Nanaimo (RDN) and in 2008 for the RDN combined with the Cowichan Valley Regional District (CVRD).

This Tri-Regional District Study builds on the previous studies and now includes the Capital Regional District (CRD). In the expanded study, technologies are again reviewed in light of the larger volume of feedstock available and for the potential to accept dried biosolids as additional fuel. Four sites are reviewed, one in each of the participating regions and one in Gold River, BC. Costs are assessed as well as greenhouse gas implications.

Combining the solid waste that is expected to be generated in the CRD, CVRD and RDN after organics management and recycling have been maximized, still leaves about 225,000 tonnes per year that need to be treated and/or disposed. Waste-to-energy (WTE) technologies could conceivably treat about 200,000 tonnes per year and extract the remaining energy from this waste.

Technologies were assessed for 200,000 tonnes per year of feedstock, including biosolids. The technologies considered for further review and analysis were:

- mass burn;
- gasification; and
- plasma gasification.

Mass burn was confirmed as the most proven, reliable and lowest cost technology and the de-facto world standard for energy recovery from waste. A single WTE facility would have adequate economies of scale to employ mass-burn technology; however, it is still not at an optimum size from a pricing perspective, which would be about 3 times larger. The out of region WTE facility being offered in Gold River does fall into a desirable economy of scale range because it plans to accept waste from other regions. However, there is additional cost involved in getting the waste to Gold River.

Gasification and plasma gasification offer some process and environmental advantages, such as being able to make alternate fuels for combustion elsewhere or for use in vehicles, or by achieving higher overall electrical efficiencies. There is a greater technical and financial risk with gasification and plasma gasification than with mass burn, but select reference facilities are available in Japan, although none in Europe or North America. Gasification and plasma gasification could be included as options in a future selection processes.

Four siting options were reviewed as set in the scope of work:

- CRD – A site in the CRD;
- CVRD –Centroid of CVRD;
- RDN – A site in the RDN; and
- Out of region – private facility in Gold River.

These were used for demonstration and comparison only; this study was not conducted for the purpose of choosing a site. For each of the example sites, transportation options were analysed for costs, fuel usage and GHG emissions.

The site that is closest to where most of the waste is generated (i.e. in the CRD) offers the lowest transportation costs. Direct haul, transfer haul, rail haul and barging (for Gold River only) were considered. Transfer haul is the lowest cost option for all locations. It also offers the lowest fuel usage, lowest GHG emissions and most flexibility for backhauling.

New transfer stations would be needed in all scenarios. If a WTE facility were built in the CRD, a new transfer station would be required in the Nanaimo area. If the WTE facility is located in RDN, then the CRD would require a new transfer station. If the waste goes to an out of region facility at Gold River, then both Nanaimo and CRD require new transfer stations. Existing transfer stations would continue to operate, except if the WTE facility were to be located in CVRD, in which case the local transfer station would be needed only for recycling and stewardship programs. If barging to Gold River is preferred, a special transfer station at the water front in the CRD would be required.

There is a fairly large variation in unit costs for the different technologies:

- mass burn would cost $84 to $98 per tonne (the latter without district heat);
- gasification to ethanol would be $136 per tonne;
- plasma gasification to electricity and district heat would be about $152 to $155 per tonne; and
- private facility mass burn in Gold River is estimated at $42 per tonne.

When transportation costs are incorporated, total unit costs are similar for all sites using the same technology. For example; mass burn costs range from $111 (Gold River) to $119 (CRD), with CVRD at $116 and RDN at $115 per tonne. A table presenting the different technology and transportation costs for the various technologies is shown below.

Option	Description	Capital Costs $ Million	Facility Cap and Operations $/T	Transportation Costs $/T	Total Costs $/T
1	**WTE in CRD**				
1a	Mass burn	$209 M	$98	$21	$119
1b	Gasification	$323 M	$136	$21	$156
1c	Plasma gasification	$292 M	$155	$21	$176
2	**WTE at CVRD**				
2a	Mass burn	$209 M	$84	$31	$116
2b	Gasification	$323 M	$136	$31	$167
2c	Plasma gasification	$292 M	$152	$31	$183
3	**WTE at RDN**				
3a	Mass burn	$209 M	$84	$30	$115
3b	Gasification	$323 M	$136	$30	$166
3c	Plasma gasification	$292 M	$152	$30	$182
4	**WTE at Gold River**				
	Mass burn	N/A	$42	$68	$111

It should also be noted that the CRD options analysis was undertaken with no potential for district heating. If a site with district heating opportunities was realized, the total unit cost could be reduced from $119 to $105 per tonne. This would make this option the most economical.

Small changes in capital costs, transportation costs, and energy recovery efficiency and markets can easily change the order of preference. Therefore, the selection of a site within the regions will depend more on other factors, such as:

- political and social preference/desire to host a facility by the community;
- availability of land under appropriate zoning;
- good transportation access;
- preferred form of energy recovery (electricity or fuel);
- ability to utilize district heat in the surrounding area; and
- minimizing transportation costs and GHG emissions.

Greater refinement of costs will require either a detailed study with actual technology selection, preliminary design and site selection, or a public proposal/tender process, or a combination of both.

The out-of-region WTE facility at Gold River benefits from greater economies of scale and thus can offer a substantially lower tipping fee than a constructed in-region facility. However, current calculations show that most of the lower tipping fee will be offset by higher transportation costs. For this option, further discussions with the proponent on how to optimize barging are recommended. These are contingent on the project proceeding based on the proponent having other key waste supply agreements in place.

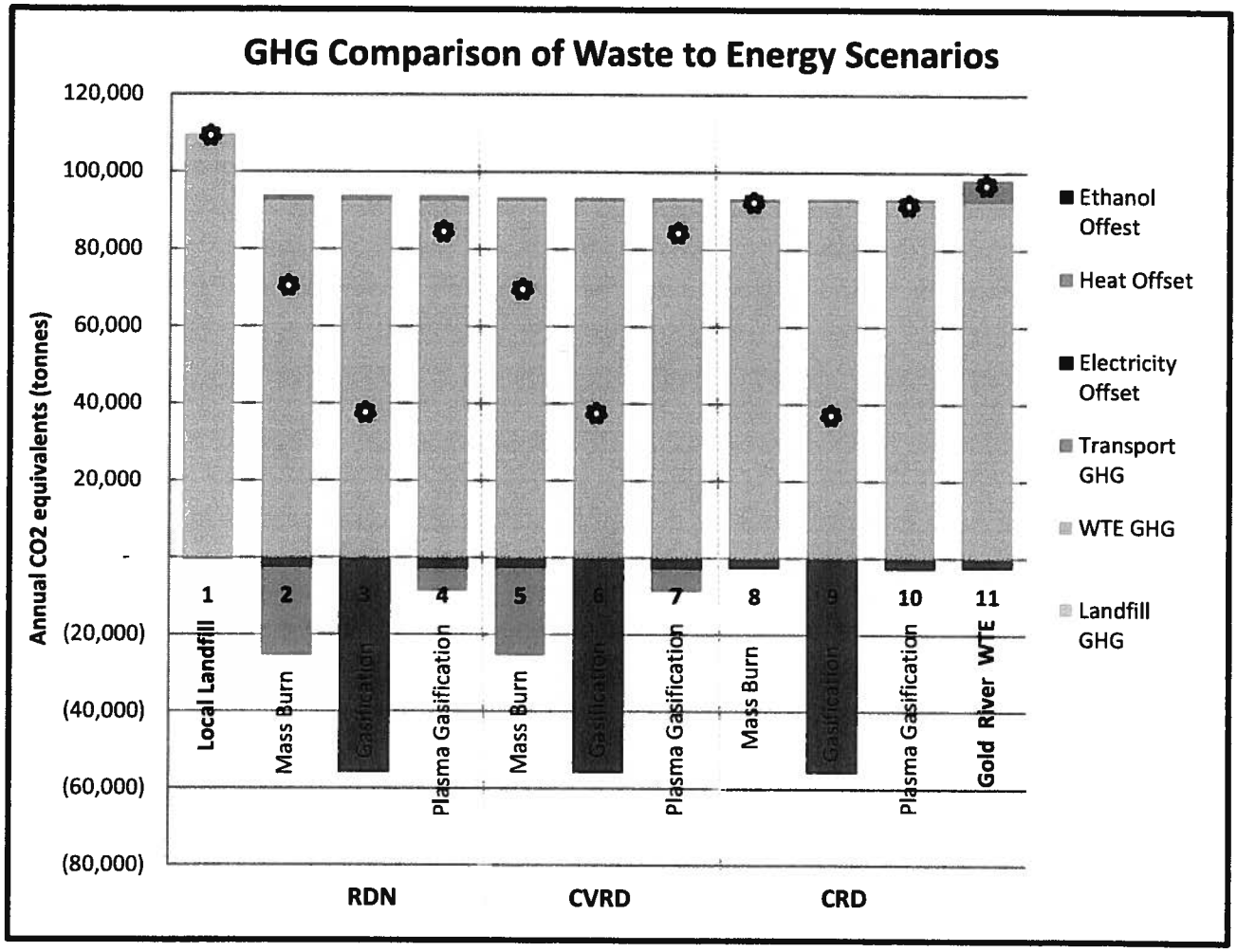
If the advantages of gasification and or plasma gasification are appealing, it will be necessary to decide what level of risk is acceptable to the three regions. Should the regions wish to pursue these technologies instead of mass burn, then it is recommended to confirm technology viability through further research and site visits of commercially operating plants before including them in a public selection process.

If in-region mass burn is seriously being considered, it is recommended that the three regional districts continue to cooperate in order to maintain the currently studied economies of scale. This would likely not be necessary if waste is shipped out of region to a private facility.

If an in-region WTE facility is preferred, it is recommended to give preference to a site in the RDN, since it offers the greatest potential for district heat. This is only essential in the case of combined heat and power technologies are selected. If ethanol production is preferred, then the CRD offers the preferred location due to lower transportation costs and should be considered.

Biosolids, provided they are dried adequately, should be welcomed as additional fuel, since they increase the biogenic portion in the feedstock and improve the overall GHG balance.

The GHG emissions and respective off-sets were compiled to assess the net GHG emissions for each option. These include a local landfill option, nine local WTE options and one out of region WTE option in Gold River, BC. The chart below summarizes the GHG emissions and the star on each bar graph represents the net GHG emission. In general, GHG emissions are lower with WTE than landfilling. GHG emissions are lowest where the waste is gasified and converted into fuels that offset fossil based fuels such as natural gas or diesel fuel. Both conventional and plasma gasification are capable of this, although in our example plasma gasification was, for comparative purposes, shown producing electricity and heat.


GHG Comparison of Waste to Energy Scenarios
Annual CO2 equivalents (tonnes)
120,000
100,000
80,000
60,000
40,000
20,000
-
(20,000)
(40,000)
(60,000)
(80,000)
1
2
3
4
5
6
7
8
9
10
11
Local Landfill
Mass Burn
Gasification
Plasma Gasification
Mass Burn
Gasification
Plasma Gasification
Mass Burn
Gasification
Plasma Gasification
Gold River WTE
RDN
CVRD
CRD
Ethanol Offest
Heat Offset
Electricity Offset
Transport GHG
WTE GHG
Landfill GHG

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Appendix A. Transportation Analysis Calculations

1. Introduction

AECOM has assessed thermal treatment technologies for municipal solid waste (MSW) on behalf of three regional districts located in the southern portion of Vancouver Island (Tri-Regional District Solid Waste Study). This is an extension of two previous studies on the same subject conducted in 2006 for the Regional District of Nanaimo (RDN) and in 2008 for the RDN combined with the Cowichan Valley Regional District (CVRD).

This Tri-Regional District Study builds on the previous studies and now includes the Capital Regional District (CRD). In the expanded study, technologies are again reviewed in light of the larger volume of feedstock available and for the potential to accept dried biosolids as additional fuel. Four sites are reviewed, one in each of the participating regions and one in Gold River, BC. Costs are assessed as well as greenhouse gas implications. Information from this study will help local governments make informed and defensible decisions on how to set the direction for solid waste treatment and disposal in the future.

1.1 Background

In 2008 AECOM (formerly Gartner Lee Limited) assessed thermal treatment technologies for MSW on behalf of the Regional District of Nanaimo (RDN) and the Cowichan Valley Regional District. This was a follow-up to a 2006 study for the RDN only and expanded the scope to include Cowichan Valley waste. In this study, traditional and new and emerging technologies were reviewed to determine their maturity and potential cost of implementation for the study area, with the purpose of extracting energy in the form of electricity and heat and extending the life of the RDN landfill.

For the CVRD which has no landfill and high disposal costs, the thermal treatment cost was competitive with long haul disposal. For the RDN which owns and operates its own landfill, thermal treatment costs are considerably higher than current landfill disposal costs; however, thermal treatment would extend the life of the landfill by twenty years. Nevertheless, the residual waste quantities from RDN and CVRD are not sufficient for a thermal process to be economically feasible without bringing in waste from other regions, or exporting the waste to a larger facility outside the region.

The advantages of thermal processing include reducing waste volumes thereby extending landfill life, recovering energy from waste, reducing GHG emissions, additional metal recycling and favourable processing costs if and when higher economies of scale can be achieved.

It was concluded that the greater volumes of waste from combining both regional districts did improve economics, but not adequately to compete with landfilling. Emerging technologies had not yet reached a maturity level acceptable to the risk criteria established for the study. It was recommended to monitor technology developments and costs every five years. It was further recommended to explore and consider working with private sector waste-to-energy firms offering the service outside of the study region.

Opportunities to include waste from other regions presented themselves when the Capital Regional District (CRD) started evaluating management options for organic waste. The purpose of that study was to identify a variety of technologies and options for processing source separated food organics from the solid waste stream and to compare them with options for managing biosolids from the liquid waste stream. Because a number of the scenarios that were evaluated included waste-to-energy as a disposal option for non-food and non-recyclable residuals, a solid waste study shared among the three regional districts was initiated to compare transportation, cost, GHG and landfill life implications for establishing a common waste-to-energy facility on southern Vancouver Island.

1.2 Project Approach

The study is based on recent and projected waste quantities that are provided by the regional districts. The waste quantities are projected over 30 years and take into account the planned diversion and organic programs in addition to volume estimates for biosolids. A baseline year was selected to analyze and compare the possible scenarios.

The transportation analysis is based on four possible locations for the waste-to-energy facility, one in each of the three regional districts and one outside the study area in Gold River, BC. Existing and new transfer facilities are assessed based on their capability to process future waste quantities, and capital and operating costs. The transportation assessment uses the quantities from the baseline year and compares transportation options (including direct haul, long haul, and rail haul) to determine fuel consumption, cost and GHG emissions. Barging is also assessed for the Gold River alternative.

Thermal technologies are evaluated based on the feedstock volumes from all three regions with the exception of the facility in Gold River, BC. Following a technology review process, the analysis examines one appropriate conventional technology in addition to looking at a gasification process and one using plasma gasification. Based on information in the public domain and typical industry values, the feasibility analysis estimates capital and operating costs, potential revenue from energy sales (steam, electricity, district heating and alternate fuels), and GHG generation.

2. Waste Quantities

2.1 Solid Waste Quantities

In 2009, the regional districts reported the following disposal rates in tonnes. As shown in the Table 1 below, the disposal rate for the three regional districts equates to 246,929 tonnes. The disposal per capita rates were calculated using the existing population for the regional districts.

Table 1. Disposal Rate for the Three Regional Districts

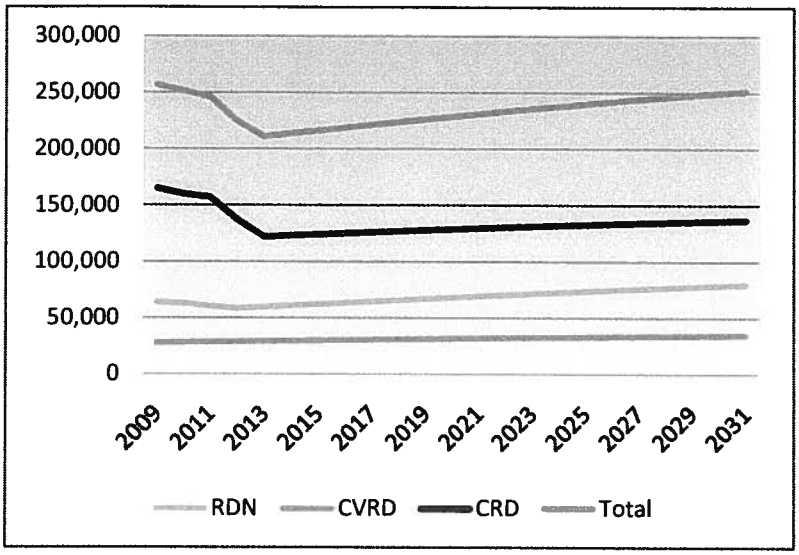
	RDN	CVRD	CRD	Total
2009 Disposal (tonnes)	63,529	27, 984	155,000	246,929
Disposal Per Capita (t/capita)	0.43	0.34	0.42	0.41

Over the next three years, the three regional districts have and will continue to ramp up organic waste diversion programs. The messaging that will be included to promote these programs should enhance existing recycling programs in addition to new Extended Producer Responsibility (EPR) programs and material disposal bans that will play a large role in decreasing per capita disposal rates. The regional districts have targeted the following disposal rates per capita.

- 0.36 t/c for RDN by 2012,
- 0.34 t/c for CVRD by 2013, and
- 0.32 t/c for CRD by 2013.

Population projections for the regional districts and the per capita disposal rates were used to project solid waste disposal demand. Figure 1 illustrates the estimated disposal rates over time. This suggests the required solid waste processing capacity for treatment and disposal will be between 210,000 and 250,000 tonnes per year. The waste-to-energy capacity used for planning purposes will be lower than the total expected volumes to allow for additional recycling and reduction efforts, as well as seasonal and economic fluctuations.

Figure 1. Solid Waste Disposal Projections



2.2 Biosolid Quantities

Biosolids from the liquid waste stream are identified as additional feedstock for the waste-to-energy facility. There are over twenty (20) wastewater treatment plants that are operated by the regional districts that vary in size from small neighbourhood facilities to large facilities that service several municipalities. The estimated biosolids disposal rates are estimated below.

	RDN	CVRD	CRD	Total
Biosolid Disposal (tonnes)	4,600	n/a	5,840	10,440

It is estimated that biosolids will add an additional 10,440 tonnes of material that the waste-to-energy would need to process. Population growth in the three regional districts is estimated to grow by 30% to 50% in the next 30 years. This suggests that biosolids disposal can increase to 15,000 tonnes per year by 2031.

2.3 Solid Waste Facilities and Waste Flows

The existing solid waste facilities in the Tri-Regional District study are summarized in Table 2 below.

Table 2. Existing Solid Waste Facilities

RDN	CVRD	CRD
Nanaimo Landfill – regional disposal site	Bings Creek Transfer Station (Duncan) – 100 tonnes per day facility that loads long-haul trailers.	Hartland Landfill – regional disposal site
Church Road Transfer Station (Parksville) – waste transferred to Nanaimo Landfill	Meade Creek Depot (Lake Cowichan) – waste residuals transferred to Bings Creek TS	
	Peerless Road Depot (Ladysmith) – waste residuals transferred to Bings Creek TS	

For RDN, waste is collected and delivered to one of two facilities, Nanaimo Landfill or Church Road Transfer Station (CRTS). Waste from CRTS is transferred to Nanaimo Landfill for final disposal. Of the 84,000 tonnes of waste that the RDN disposes each year, approximately 75% is directly hauled to Nanaimo Landfill and 25% is received at CRTS.

The CVRD waste is disposed at an out of region landfill in South Central Washington. Waste that is collected from residential or commercial sources is delivered to one of three facilities. The two smaller facilities (Meade Creek and Peerless Road Depots) transfer their waste to Bings Creek Transfer Station. This transfer station is the main transfer station that loads long-haul trailers to be disposed of at the South Central Washington Landfill. Of the 27,000 tonnes per year of waste that is collected in the regional district, 95% is received at Bings Creek, 1.5% at Meade Creek in Lake Cowichan and 3.5% at Peerless Road in Ladysmith.

In the CRD, the majority of the waste is directly hauled and disposed of at the Hartland Landfill. There are privately operated ICI transfer stations near the City of Victoria that transfer and dispose of their waste at the Hartland Landfill.

2.4 Solid Waste Disposal Costs

The waste disposal rates for each of the regional districts vary and depend on the system that is available to them. The two regional districts (RDN and CRD) that own and operate their own disposal system have lower tipping fees than the regional district that exports their waste outside the region. Table 3 below summarizes the tipping fees for the three regional districts. These tipping fees take into consideration other waste diversion programs.

Table 3. Existing Disposal Cost Summary

	RDN	CVRD	CRD
Tipping Fee	$107.00 /tonne	$135.00 /tonne	$100.00 /tonne
Land Disposal Cost	$50 /tonne	$115 /tonne	$37.00 /tonne

The disposal costs represent the actual cost for operating the disposal facilities which are considerably lower than the tipping fees. The tipping fees include waste diversion services such as operation of the recycling depots, public education and curb-side recycling programs (CVRD also uses some tax requisition to assist with financing of waste diversion). For the purpose of this report, it is the disposal costs that are relevant because thermal processing would impact the cost of disposal and would also add to potential revenue opportunities.

3. Transportation Analysis

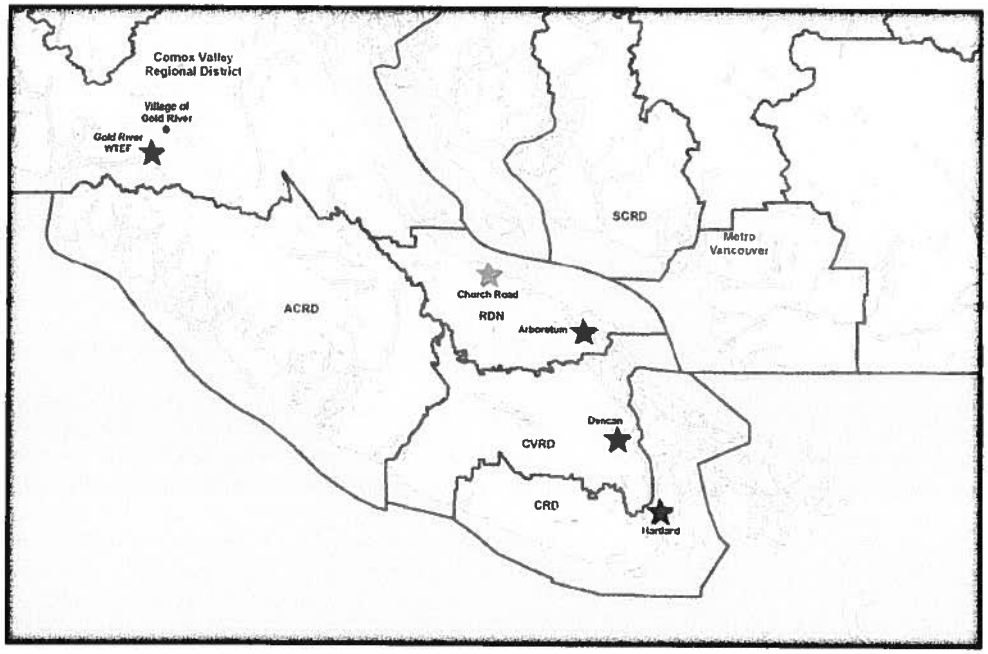
The transportation analysis examines the many different scenarios for transporting waste to the potential Waste-to-Energy (WTE) sites. The objective of this analysis is to determine the logistics of each transportation scenario and to compare each scenario. Topics that have been selected for comparison include:

- fuel consumption;
- GHG emissions;
- transfer facilities;
- backhaul opportunities; and
- transportation costs.

3.1 Facility Scenarios

Four potential WTE sites are identified in Figure 2 below. There is one site in each of the participating regional districts and one site outside the study area in Gold River, BC. The RDN site is a hypothetical location and would represent the most northerly of the in-region sites. The CRD site is hypothetical location that is assumed to be in the vicinity of the Hartland Landfill for simplicity and for calculation reasons. The CRD site is also a hypothetical and would represent the centroid for the three regional districts. The Gold River site is a proposed WTE site by the private sector. The proponent is hoping to accept waste from Metro Vancouver (following a public tender) and has expressed interest in accepting waste from communities on Vancouver Island as well.

Figure 2. Map of Potential Sites for a WTE Facility



3.1.1 Scenario 1 – RDN WTE

The RDN site would likely be located in the vicinity of the Nanaimo-Regional Landfill. Local RDN waste that normally goes to the landfill, including waste transferred from the Church Road Transfer Station, could be direct to this site.

Waste from the CVRD would be transported to this site via the existing network of transfer stations in the CVRD. The CRD would have to build a transfer station, to bring its wastes to this site.

3.1.2 Scenario 2 – CVRD WTE

The CVRD site represents the centroid of the three regional districts. The majority of the waste from the CVRD could be delivered directly to this site, possibly making the Bings Creek Transfer Station redundant. Waste from RDN and CRD would have to be transported to this site. For the RDN, the existing Church Road transfer station would continue to be used, and a new transfer station would need to be built to handle all of the materials that come to the landfill. The CRD would need to construct a transfer station for all of the waste currently going to the Hartland Landfill.

3.1.3 Scenario 3 – CRD WTE

Waste from the CRD would be directly hauled to this site. Waste from RDN and CVRD would be transported to this location. Transfer station facilities that are required for this scenario include the existing Church Road and Bings Creek transfer stations and a new transfer station in RDN, potentially near the existing landfill.

3.1.4 Scenario 4 – Gold River WTE

The Gold River WTE site has been proposed and permitted by the private sector. It is vying for Metro Vancouver waste as well as Island waste so that it can achieve economies of scale that make it highly competitive with landfilling or other WTE initiatives. Waste from the three regional districts could be transported to the Gold River site. Transfer stations that are required for this scenario includes the existing Church Road and Bings Creek transfer stations and two new transfer stations; one for RDN and one for CRD. For this scenario, a barging option was included as part of the transportation analysis.

3.1.5 Distance and Travel Summary

The transportation analysis is dependent on the how far waste needs to travel and the time required to travel that distance. This information was obtained using Mapquest and was to calculate fuel consumption and truck and driver costs. The distance and travel times between potential sites are summarized in Table 4 below. For study purposes, it has been assumed that any new transfer station in RDN would be located near the landfill, and in CRD it would be located at the Hartland Landfill. This is an assumption for comparative analysis only and not a designation of sites, which would have to be determined in a separate study when the concept of a centralized WTE facility is more advanced.

Table 4. Summary of Distance and Travel Times between Potential Sites

Site Scenario	Distance	Travel Time
Regional District of Nanaimo		
Church Rd. TS to RDN site	53 km	40 minutes
Bings Creek TS to RDN site	53 km	42 minutes
Hartland Landfill to RDN site	118 km	103 minutes
Cowichan Valley Regional District		
Church Rd TS to CVRD site	88 km	68 minutes
RDN TS to CVRD site	53 km	42 minutes
Hartland Landfill to CVRD site	60 km	56 minutes
Capital Regional District		
Church Rd TS to CRD site	148 km	124 minutes
RDN TS to CRD site	118 km	103 minutes
Bings Creek TS to CRD site	60 km	56 minutes
Gold River WTE Facility		
Church Rd. TS to Gold River WTE site	222 km	151 minutes
RDN TS to Gold River WTE site	275 km	191 minutes
Bings Creek TS to Gold River WTE site	310 km	219 minutes
Hartland Landfill to Gold River WTE site	370 km	275 minutes

3.2 Transportation Scenarios

The transportation options that were assessed include (1) direct haul using collection vehicles, (2) transfer haul using tractor trailers, and (3) rail haul. For the Gold River WTE scenario, a barge haul option was included as part of the assessment.

The transportation analysis focuses on the transportation logistics after the point from where it would normally go (i.e., transfer station or disposal site) to the potential WTE sites. For instance, CRD waste is collected and disposed at the Hartland Landfill. If a WTE facility were located in RDN or CVRD, the transportation analysis would begin from the Hartland Landfill and end at the WTE site. The waste collection aspects are not expected to change and are therefore not included in the analysis.

3.2.1 Direct Haul

Direct haul involves utilizing collection vehicles to transport the waste to one of the potential WTE sites. The benefit of this option is that no transfer station and waste reloading activity would be required. Factors to consider are collection vehicles typically carry loads that are four to six tonnes and fuel efficiency that is in the order of 0.7 km/L.

3.2.2 Transfer Haul

Transfer haul involves reloading waste from collection vehicles into larger tractor trailers units and hauling that waste to the potential WTE site. This transportation option requires transfer stations, front end loaders and labour to reload waste into tractor trailer units. Although there is a cost to transferring waste from smaller vehicles to a larger one, tractor trailers have a larger capacity (27 tonnes per load), better fuel efficiency (2.1 km/L) and require fewer trips.

3.2.3 Rail Haul

Rail haul is a transportation option that large communities, such as Seattle, Los Angeles and New York, use to transport waste considerable distances (typically in excess of 400 km). This method involves the following:

- transporting waste in intermodal containers (27 tonnes per container);
- loading of intermodal containers at transfer stations;
- intermodal yards at each end of the railway system;
- short hauls that move containers from transfer stations to intermodal yards and from intermodal yards to the disposal sites;
- railway agreements so that railcars are moved between intermodal yards; and
- return process that returns the empty containers back to the originating transfer stations.

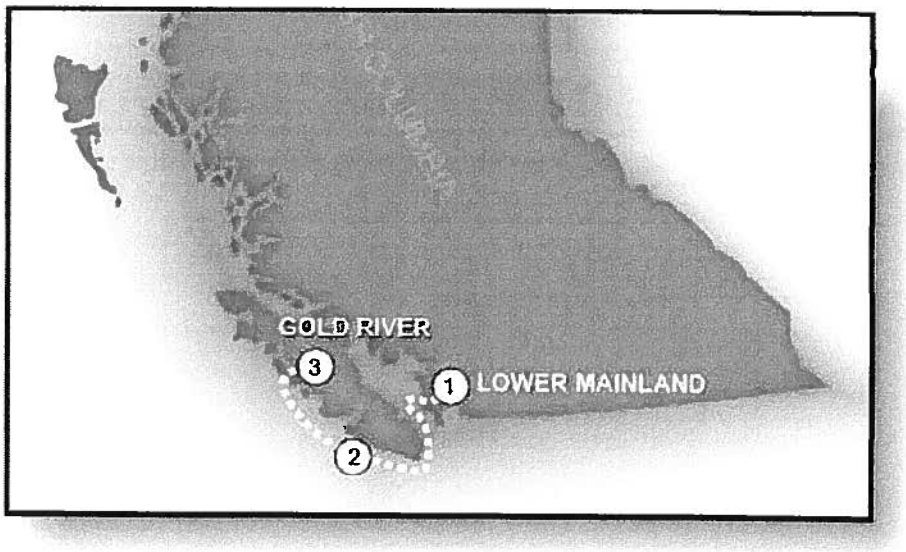
The railway system on Vancouver Island is managed by Southern Railway of Vancouver Island (SRVI) and runs between the Cities of Victoria and Courtney. There is also a section that runs between the Parksville and Port Alberni. SRVI is a bulk railway company that primarily moves goods on and off the island. As part of that service, SRVI also moves railcars up and down the island. Most of the commercial railway service on Vancouver Island is between Cowichan Valley and Nanaimo.

The rail haul analysis for this study is limited to Nanaimo and Victoria waste. Because the Bings Creek transfer station is approximately 53 km and 60 km away from either the RDN or CRD sites, it is not practical to rail haul the CVRD's waste. Waste from the Church Road Transfer Station would be transferred either to the RDN transfer station or to the intermodal yard that rail hauls to the Victoria intermodal site.

Rail hauling waste to Gold River WTE is limited because the railroad tracks end at Courtenay, BC, resulting in a long transfer haul between Courtenay and Gold River. The distance between Courtenay and the Gold River WTE site is approximately 160 kilometres and the estimated travel time is 110 minutes. For this scenario, to minimize railway stops along the railway corridor, all of the waste from RDN (which includes waste from Church Road Transfer Station and RDN Transfer Station) would be transfer hauled directly to the Gold River WTE site. Only CRD and CVRD waste would be rail hauled from an intermodal yard located between Bings Creek TS and Hartland Landfill to an intermodal yard in Courtenay, BC. The rail haul unit cost is also adjusted to reflect the additional cost for fuel.

3.2.4 Barge Haul

The barge haul option is based on the transportation system that is being considered by the Gold River proponent for Metro Vancouver's solid waste. It is a network of four or five barges and three tugboats that run continuously between Gold River and Metro Vancouver. The barging system would be owned and operated by the proponent. Their model is a "drop and go" approach where at each of the loading and unloading points, one barge would be dropped off and the other would be taken away. Therefore at a waste loading facility, an empty barge would be dropped off and a loaded barge



would be picked up and taken to the WTE facility in Gold River. It takes a tugboat and barge approximately 33 hours to travel from Metro Vancouver to Gold River. According to the proponent, the barging system could accommodate a loading facility near the Victoria/Esquimalt shoreline.

This barging scenario requires waste to be baled in plastic. Similar to the Metro Vancouver proposal, a transfer facility with baling capabilities would be required to be located along the waterfront for loading purposes. The waste would be loaded onto a barge immediately after it is baled to minimize double handling. This is the preferred approach as it prevents having to store and backhaul empty waste containers and to avoid the additional weight of the container itself which can add four to five tonnes per container.

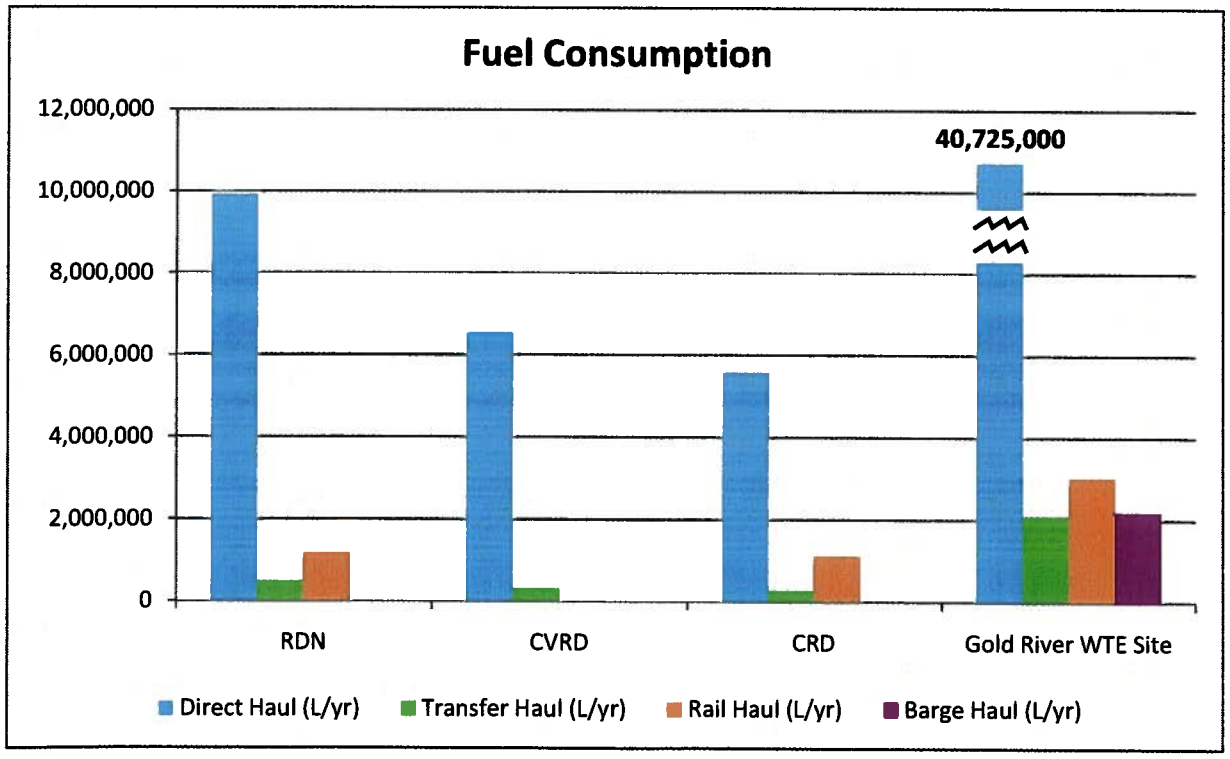
Barging waste in intermodal containers is not recommended as it increases the barging cost. The weight of the containers, handling to return the empty containers, storage space on the barge and loading facility, and loading of the empty containers on to trailers are considerations that would increase the cost.

Aspects that would be required to entertain this barging system are a waterfront loading facility in the southern point of Vancouver Island possibly along the Victoria/Esquimalt shoreline. This facility could replace the need to construct a transfer station on Hartland Landfill as waste collected from the CRD could be hauled directly to the barge loading facility. This facility would also need to be large enough such that RDN and CVRD waste could be transfer hauled to this facility for loading onto barges.

3.3 Fuel Consumption

Fuel consumption is a function of distance traveled, vehicle fuel efficiency and number of deliveries. Calculations for fuel consumption by facility and transportation scenario are included in Appendix A and summarized in Figure 3.

Figure 3. Graph Showing Fuel Consumption by Transportation Option and Destination



The direct haul option has the highest fuel consumption rate due primarily to poor fuel economy, smaller waste payloads of the waste collection vehicles and higher number of trips. While this was known at the beginning, the numbers have been left in the analysis for information and comparison only. The transfer haul option has significantly lower fuel consumption because the tractor trailer units have better fuel economy and larger payloads than waste collection vehicles.

Rail haul is optimized when the locomotive is hauling near its capacity. Train sets can haul between 12,000 and 18,000 tonnes per trip or a maximum of 120 to 140 railcars. For the waste from the three regional districts, the amount of waste that would be transported ranges from 250 to 600 tonnes per trip or five to ten railcars. The limited commercial rail hauling on Vancouver Island would also mean that trips between the three regional districts would likely be conducted alone. These considerations make this option inefficient as shown on the figure above.

In effect, the rail haul service would be an exclusive service for waste only. Therefore all of the fuel and time involved to move the train set up and down the southern portion of the island would contribute only to the waste being rail hauled. A locomotive's fuel consumption is about 750 litres per hour and each trip is estimated to take 2.5 hours. Therefore for a daily round trip, the fuel consumption would be approximately 3,750 litres per day. The number of railcars that would be pulled ranges from 5 to 10 railcars depending which RD the waste is coming from. The annual fuel consumption for the rail haul component only is nearly 1 M Litres of diesel per year. The rest of the fuel would be from the short hauls between the intermodal yard and the transfer stations and WTE facility, and the transfer haul from the CVRD.

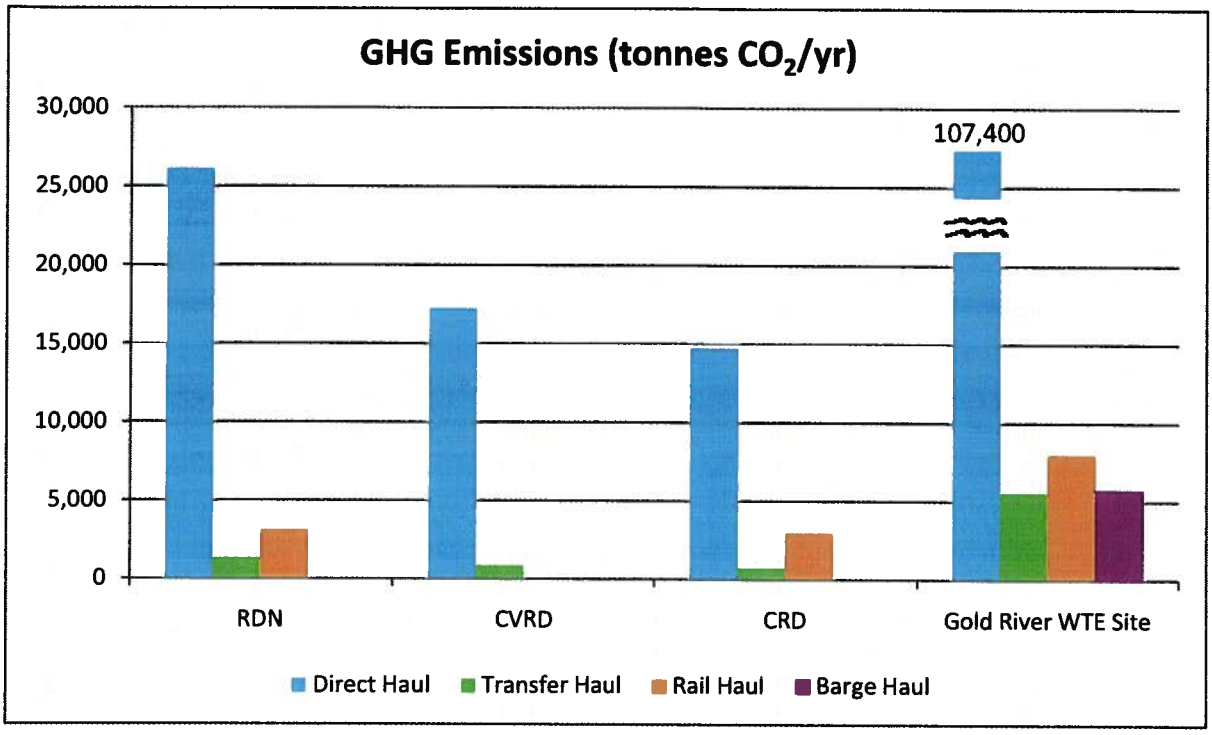
Transporting to Gold River's WTE facility is a completely different comparison. It is not within the boundaries of the three regional districts and is at least 300 km away from the centroid of the three regional districts. This additional distance is evident when comparing the amount of fuel being consumed. Generally, transporting waste to Gold River would increase the fuel consumption by four to seven times when comparing the transfer haul option and which RD the waste is coming from.

Barge hauling has concepts that are similar to rail hauling. Tugboats use diesel engines that are similar if not the same as those used in locomotives. Fuel consumption for each tugboat is also about 750 litres per hour. The travel time from the Victoria/Esquimalt loading facility to the Gold River WTE facility is about 24 hours (approx. 360 km away). The waste from the three RDs is also only part of a larger system thereby reducing the unit fuel consumption rate significantly. Because barge hauling depends on Metro Vancouver's waste, which accommodates about 70% of the waste being hauled, the overall fuel consumption for the three RDs is about 25% of the fuel consumption for the entire barging system. Because of these factors, barge hauling is almost equivalent to transfer hauling to Gold River.

3.4 GHG Emissions

GHG emissions were estimated based on transporting the waste to the potential WTE sites. These emissions are a function of the distance travelled and efficiency of the mode of transportation which results is the fuel consumed. The standards GHG emission rate for diesel fuel is 0.002637 tonnes CO_2 per litre. The GHG emissions for each of the scenarios are illustrated in Figure 4 below.

Figure 4. Summary of GHG Emissions for Each Site Scenario and Transportation Method



Similar to the Fuel Consumption chart, the transfer haul option has the lowest GHG emissions. Of the transfer haul options, having the WTE facility in the CRD area results in the least amount of fuel and GHG emissions. This is due to the least amount of waste requiring to be transported into the regional district.

3.5 Waste Transfer Facilities

The capital and operating costs for waste transfer facilities are important aspects for the transfer haul, rail haul and barge haul options. There are up to four locations for transfer stations, three locations for intermodal yards and one location for a barge loading facility. The subsections below discuss important considerations and estimated costs for the waste transfer facilities.

3.5.1 Transfer Stations

Transfer stations are required to reload waste from smaller and less efficient collection vehicles to larger and more fuel efficient tractor trailer units. Waste can be loaded into various lengths of trailers that range from 28 feet to 57 feet or intermodal containers that are typically 40 feet. The amount of waste that a tractor trailer unit or intermodal container holds is approximately 27 tonnes. Tandem units are able to hold 37 tonnes of waste. The number of transfer stations required depends on the location of the WTE facility and mode of transportation.

Up to four transfer stations are required to manage waste from the three regional districts. These include two existing transfer stations, Church Road Transfer Station (Parksville, BC) and Bings Creek Transfer Station (Duncan, BC), and two new facilities in the RDN and CRD.

The existing transfer stations do not appear to require significant capital upgrades. The processing capabilities of these two facilities should be sufficient to accommodate the 2030 solid waste projections. It may be prudent to allocate additional funds for possible facility upgrades and new assets such as tandem trailers with walking floors. A conservative estimate of $1.0 M is used to account for new trailers and possible facility upgrades. The unit operating cost for these smaller transfer stations is assumed to be $20 per tonne.

The solid waste projections for 2030 show that the RDN and CRD transfer stations should be designed to accommodate a minimum of 80,000 per year and 140,000 tonnes per year, respectively. The estimated capital costs for facilities of this size are $15 M and $20 M. These figures are based on construction costs for a transfer station in Metro Vancouver and appropriate cost escalations. The unit operating costs for facilities of this size are $10 to $15 per tonne, respectively.

A summary of capital and operating costs for the four transfer station facilities are included in Table 5 below.

Table 5. Transfer Station Capital and Operating Cost Summary

Transfer Station Facility	Waste Transferred (t/yr)	Average Daily Capacity (t/d)	Capital Cost ($)	Amortized Annual Capital Cost ($/yr)	Unit Operating Cost ($/t)	Unit Transfer Station Cost ($/t)
Church Road	20,000	100	$1.0 M	$80,000	20	23.9
RDN	42,062	150	$15 M	$1,200,000	15	43.1
Bings Creek	30,119	100	$1.0 M	$80,000	20	22.6
CRD	124,123	400	$20 M	$1,600,000	10	22.7

3.5.2 Rail Haul Facilities

In addition to the transfer stations, the rail hauling option also requires intermodal yards to load and unload intermodal containers onto flatbed railcars and trailer frames. Discussions with Southern Railway of Vancouver Island (SRVI) revealed that there are no intermodal yards between Nanaimo and Victoria, and that SRVI own no assets (i.e., flatbed railcars, intermodal property, and container loaders) that the three regional districts could use.

In order for this option to be pursued, the regional district would have to acquire at least three properties in close proximity to the railroad track for intermodal facilities, flatbed railcars, intermodal containers with trailers and two container loaders. Locations for intermodal yards are Victoria, Nanaimo and Courtenay, BC. These properties must also be large enough to store containers (up to 20) and to allow tractor trailers to manoeuvre to pick up and drop off containers. The minimum size for an intermodal yard is one hectare.

Costs for flatbed railcars, intermodal containers and container loaders were obtained from vendors. The number of components required depends on the location of the WTE facility and frequency of trips on the railway system. For this analysis, it is estimated that that the waste is rail hauled five times per week. The considerations for rail haul are summarized in Table 6 below.

Table 6. Rail Haul Considerations

WTE Site	Transfer Stations	Intermodal Yards	Intermodal Containers	Railcars	Container Loaders	Yard Operating Cost
RDN	CRTS BCTS CRD TS	Nanaimo Victoria	18	10	2	$200,000 per site
CRD	CRTS BCTS RDN TS	Nanaimo Victoria	10	5	2	$200,000 per site
Gold River	CRTS BCTS RDN TS CRD TS	Victoria/Duncan Courtenay	22	11	2	$200,000 per site

3.5.3 Barging Facility

The barging facility applies to transporting waste to the Gold River WTEF. This facility requires enough storage capacity to accommodate waste from the three regional districts (over 200,000 tonnes per year). Possible location for this facility is along the Victoria/Esquimalt shoreline. This barging facility could also act as a transfer station for CRD instead of building a transfer station on Hartland Landfill.

The other transfer stations required include CRTS, RDN TS and Bings Creek TS. Waste would be transferred from these locations using tractor trailers with walking floors and unloaded into a tipping area. Similar to the Metro Vancouver proposal, the waste would be baled and wrapped in plastic before being loaded onto the barge.

The capital cost for the barging facility on solid ground could range from $20-$25 M, not including property cost. Soft soil which is typical of shoreline properties may require significant foundation support such as piling to stabilize the structures. Operating cost should be similar to a transfer station of this size ($10/tonne). Loading the waste onto the barge has been estimated to be about $2 per tonne. The property would likely need to be at least four hectares is size.

3.6 Backhaul Opportunities

Backhauling is a means to optimize the transportation system so that vehicle and trailers are not moving around empty thereby consuming fuel, costing money and emitting GHG's. Metro Vancouver applies this principle when they transport waste to Cache Creek Landfill backhaul woodchips from the interior. This has significant savings on transportation cost which in turn lowers the allocated fuel consumption and GHG emissions for the waste disposed at Cache Creek. To realize backhaul opportunities, there must be the vehicle and flexibility that allows others to use this system. This section rates backhaul opportunities for the various transportations options and rates them based on high, moderate and low.

Intermodal Containers
40 feet container is 8 feet wide and 8.5-9.5 feet high. Volume is about 67.5 m^3.

Semi-Trailers
Range in is size from 28', 45', 48', 53' and 57' long and are 8' wide by 9' high. Volumes are about 2,016, 3,240, 3,456, 3,744 and 4,104 cubic feet, respectively.

3.6.1 Direct Haul

Direct haul uses waste collection vehicles to transport garbage. These vehicles are made to haul garbage, recyclables and organic waste such as food and yard waste. Commodities that could be transported in a collection vehicle cannot be fragile, since the compactor may crush the contents in the vehicle. In addition, loading materials into the collection vehicles can be challenging. From these perspectives, backhauling opportunities with waste collection vehicles are low.

3.6.2 Transfer Haul

Transfer haul uses tractor trailers to move waste from a transfer station to a WTE facility. The loading capacity is typically limited by the gross vehicle weight that the trailers are allowed to carry on the road. Trailers come in a number of sizes that range from 28 feet to 57 feet. Trailers can have open tops or walking floors that allow materials to be loaded and unloaded with relative ease. Tractor trailers have flexibility in where they can travel and can transport materials between the transfer station and the WTE facility. Therefore, the backhaul opportunities for the transfer haul option are high.

3.6.3 Rail Haul

Rail haul is limited by the railway system and the schedule it needs to follow. Intermodal containers are a standard 40 feet and can be loaded after waste is emptied. Utilizing rail haul system for back hauling is better suited for long distance transport. Therefore, the backhaul opportunities for the rail haul option are low to moderate.

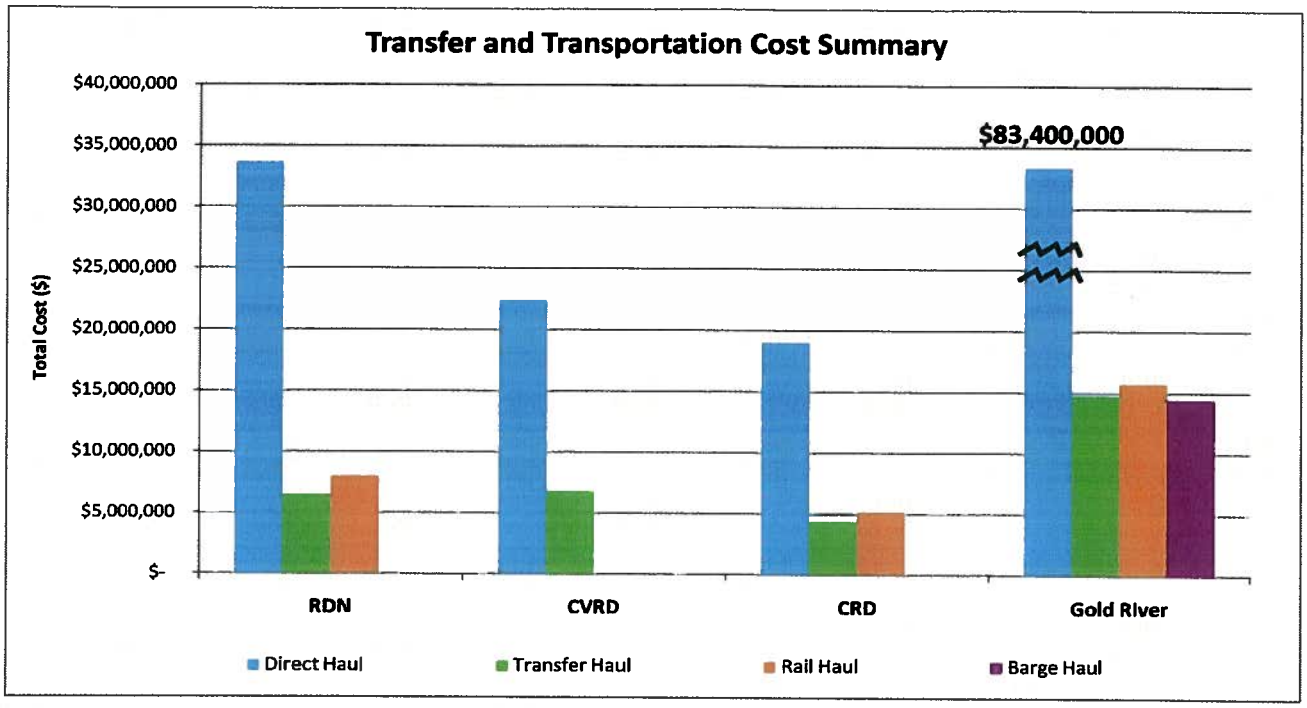
3.6.4 Barge Haul

Barge hauling system would be operated by Covanta. Their priority is to move waste to the Gold River WTEF. Utilizing bales means the barge will be empty when heading back to Metro Vancouver or the barge loading facility near Victoria/Esquimalt. This transportation system has the potential to transport forestry products from Gold River to Victoria or Vancouver. Other options to explore include backhauling ash from Gold River for disposal at the existing Hartland landfill. This could save Covanta the need to build an ash monofill and provide revenue for continued operations of the Hartland landfill. Therefore, the backhaul opportunities for the barge haul option are moderate to high.

3.7 Transportation Costs

Transportation costs were calculated based on a driver and truck cost of $100 per hour and fuel cost of $1.20 per litre diesel fuel. These rates are subject to change but are used to provide a realistic comparison of the transportation options. Figure 5 is a summary of the transfer and transportation costs for each location.

Figure 5. Summary of Transfer and Transportation Cost for Each Scenario



3.7.1 Direct Haul

Distances are such that direct haul using collection vehicle is not economical. The smaller loads and poorer fuel economy means there will be additional trips that add to fuel consumption and cost. The assumptions and calculations for the direct haul option are included in Appendix A.

The results of the direct haul option were rounded off to the nearest hundred. It also does not take into consideration the fleet size that would be required for the municipality or regional district.

Besides cost and fuel consumption, other considerations that make this option unfeasible include the following:

- longer lag times when collection vehicles are unable to collect waste travelling to unload waste;
- increases the wear and tear on collection vehicles; and
- need for larger vehicle fleet.

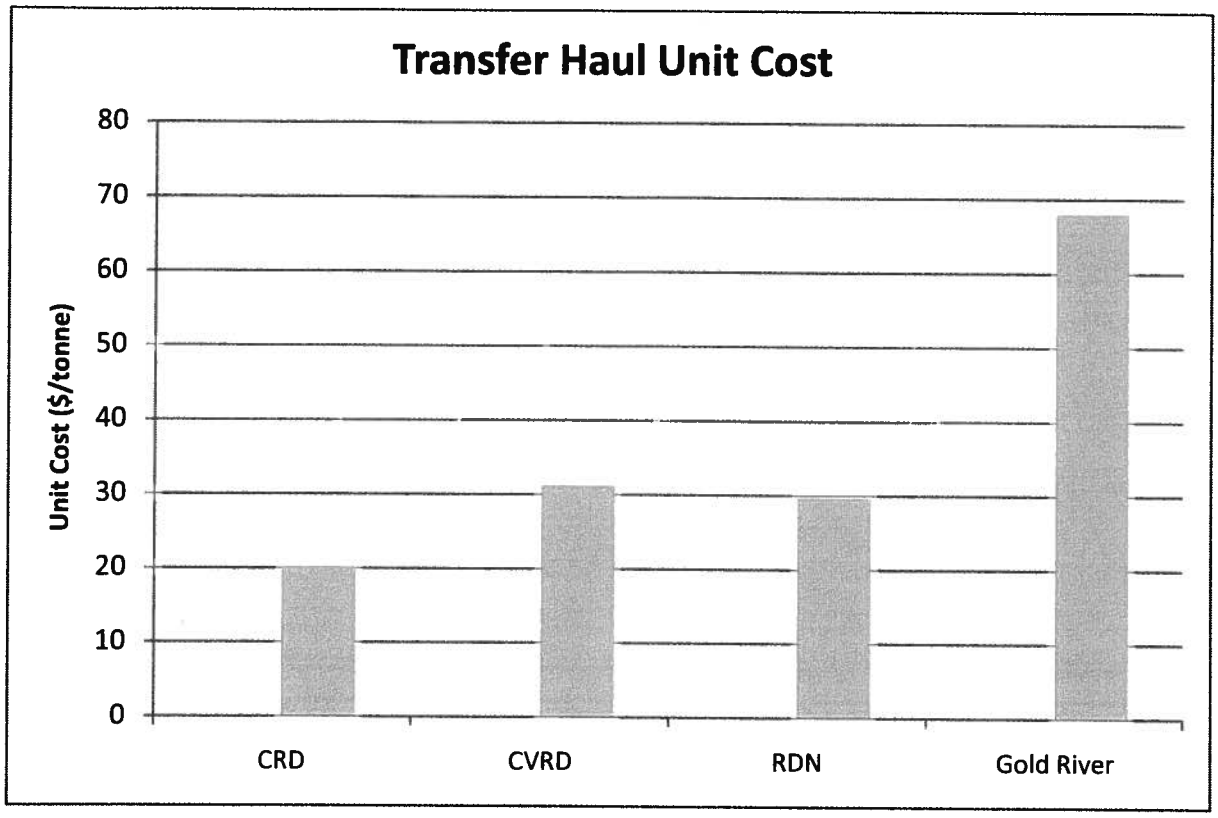
3.7.2 Transfer Haul

The transfer haul scenario represents the most economical option. The payloads are at least five times larger which means there will be four times fewer trips. In addition, the better fuel economy of the tractor trailers will further reduce fuel and fuel costs. The trade off with this transportation scenario is that transfer stations are required to reload the waste into the larger tractor trailer units. Even with the additional transfer activity, the transfer haul option is three to five times less costly than direct haul.

The comparison charts show that the least expensive transportation scenario is locating the WTE site in the regional district that generates the most waste. This lowers the transportation cost by having fewer trucks delivering waste

and not having to build the largest transfer station of the three regional districts. Therefore, from a total cost perspective, the lowest cost option is locating the WTEF in the CRD area. From a unit cost comparison perspective, as shown in Figure 6 below, transporting to CVRD or the RDN adds about $10 per tonne and transporting to Gold River adds about $38 to $48 per tonne.

Figure 6. Comparison of Transfer Haul Unit Costs for Each WTE Site



Sending waste outside the three regional districts is an added cost. Gold River is approximately 300 km away from the centroid of the three regional districts which is a significant expense. 300 km means the tractor trailers would on average need to drive a whole day to deliver the waste and to drive back to the starting location. This option also requires that a transfer station would be required in each regional district. In short, the increased cost can be attributed to the extra transfer station, extra distance and extra travel time to transfer waste from the three regional districts to Gold River.

3.7.3 Rail Haul

Other rail haul and transfer haul comparison studies have shown that transfer hauling is typically more economical than rail haul when the travel distance is less than 400 km. This finding is consistent with the cost analysis for the Tri-Regional District study. This is especially the case because of the following:

- commercial rail system is very small and only railcars that would be pulled are the waste from the three regional districts;
- rail system is only pulling 5% of its capacity which means it is very far from running at an optimal level;

- separate intermodal yards would need to be established by the regional district at a significant cost as industrial land on Vancouver Island is at a premium (>$1 M/acre);
- having to load and unload intermodal containers at the intermodal yards is an extra cost; and
- maximum distance between the three regional districts is about 150 km which is not sufficient to make rail haul more economical than transfer haul.

Rail hauling to Gold River is also difficult because the tracks only go to Courtenay, BC and an additional 160 km of transfer haul is required to bring the waste to the Gold River WTE site. There are no economies to scale that would warrant utilizing the island's railway system.

3.7.4 Barge Haul

Barge haul is an option that seems comparable to transfer haul provided the three regional districts can utilize the system that was developed for Metro Vancouver. Without the economies of scale from Metro Vancouver's waste, the barging haul costs are estimated to increase by 10%-15%, which includes the cost of transferring and hauling waste from RDN and CVRD to the waterfront at CRD. Hauling by barge could be a viable transportation option provided the following are undertaken:

- Metro Vancouver needs a contract with the Gold River WTE facility;
- Covanta then needs to build the WTE facility;
- capacity needs to be available for the three regional districts;
- Covanta and three regional districts need to develop a contract;
- barge loading facility needs to be acquired/built in Victoria/Esquimalt;
- waste will be baled at the loading facility before loading onto the barge;
- plastic will wrap the garbage; and
- utilizing intermodal containers to deliver waste is not practical because of additional handling costs.

3.8 Transportation Analysis Summary

The transportation analysis shows that the three regional districts are close enough to one another that there are economical benefits to establishing a WTE facility within their geographic area. It also shows that the most economical approach is to locate a WTE facility in the regional district where most of the waste is generated. That way the additional transportation required is minimized and the need for a new large transfer station does not arise because the WTE facility would be located there.

Rail haul is not economical on Vancouver Island. The amount of waste being moved in only about 5% of the rail system's hauling capacity. Therefore, the benefits of hauling the waste by rail are not realized. Rail haul is also limited because there are no tracks between Courtney and Gold River.

Of the transportation options analyzed, the transfer haul option is by far the most economical and emits the least amount of GHG. It also allows for better flexibility and opportunities for backhauling commodities within the three regional districts.

Transporting waste to Gold River will have a noticeable increase in cost, fuel consumption and GHG emissions. That added cost must be balanced against the potentially lower tipping fees from a larger WTE facility at Gold River compared to a smaller facility built within the regions.

4. Thermal Technology Review

4.1 Previous Studies

Previous studies examined conventional direct combustion (mass burn and controlled air) and gasification/ pyrolysis/plasma technologies. The two studies that are referenced for this report are:

- Assessment of New Treatment Technologies; prepared for Regional District of Nanaimo and Cowichan Valley Regional District by Gartner Lee Ltd, December 2008.
- Management of Municipal Solid Waste in Metro Vancouver – A Comparative Analysis of Options for Management of Waste after recycling; prepared by AECOM in June 2009.

Both of these reports provide extensive analysis and references on the various types of technologies available to thermally recover the energy from municipal solid waste. A third report was recently prepared for the CRD and presented to CRD committees in draft form. It includes some updates to the above reports and this updated information is also used for this report.

For brevity, the content of these reports will not be repeated here. Table 7 provides a summary of key attributes of the various technologies under consideration. In the following subsections, each category is updated with the most recent information and advantages and disadvantages of this category of technology are presented.

Upon review, it was found that when excluding the pilot and bench scale conversion technologies that are still under development, the following categories emerge for further discussion and consideration:

- Conventional combustion with mass burn. This is the most proven technology with over 800 plants world wide.
- Gasification using Thermoselect technology. This is technically proven in Germany and Japan, provides an alternative to mass burn combustion, but is more costly.
- Plasma gasification, which has two operating plants in Japan (Alter NRG technology), and full scale demonstration facility in Canada (Plasco) which is not operating full time yet.

Table 7 provides a summary comparison of the thermal treatment technologies described in the referenced reports.

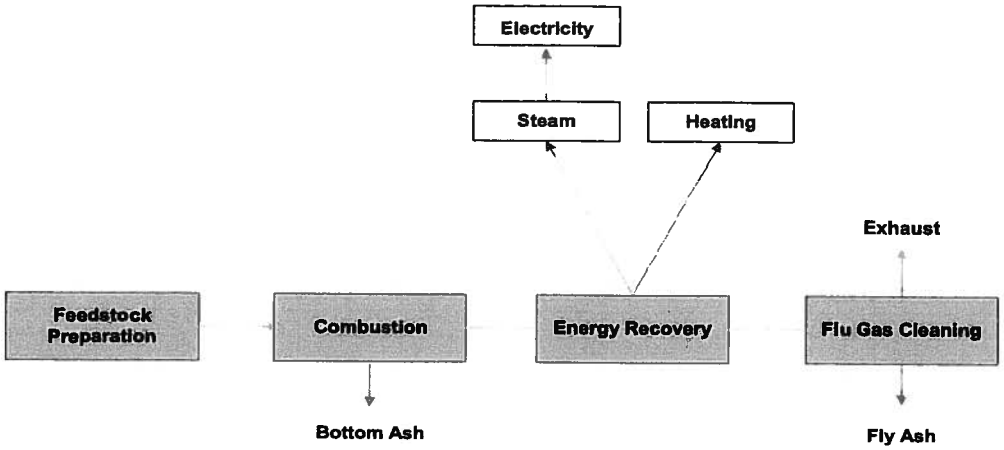
Table 7. Technology Summary

	Mass Burn	Controlled Air	Gasification	Pyrolysis	Plasma/Gasification
Vendor Names (examples only)	Von Roll, Martin, Keppel-Seghers	Consultech Systems, NCE Crawford Emcoteck	Thermoselect, Enerkem, Nexterra	WasteGen UK	Plasco, Alter NRG
Commercially Proven with North American Waste	Yes	Yes	No	No	No
Proven Processing Capacities	90Kt-1Mt/yr	30Kt-180Kt/yr	10Kt/yr-225Kt/yr	50Kt/yr	8Kt/yr-60Kt/yr (Alter NRG)
Waste Feedstock	Residential MSW Commercial waste Bulky waste Sewage sludge	Residential MSW Commercial waste Bulky waste Sewage sludge	Residential MSW Commercial waste Bulky waste Sewage sludge	Residential MSW Commercial waste Bulky waste Sewage sludge	Residential MSW Commercial waste Bulky waste Sewage sludge
Capital Cost	Moderate	Moderate	High	High	High
Operating Cost	Moderate	Moderate	High	High	High
Process Risk	Low	Low	Moderate	Moderate	Moderate
Carbon Footprint	Moderate	Moderate	Small, if fuels made	Moderate	Small, if fuels made
Meets Canadian Emission Criteria	Yes	Yes	Yes	Yes	Yes
Energy Recovery Efficiency (combined heat and power %)	25% electricity only. Over 90% with district heating	20% electricity only. Over 80% with district heating	25% conventional steam cycle. Over 40% with combined cycle operations Over 80% with district heating	Unknown, reference facility in Germany has low efficiency but built for demonstration only	25% conventional steam cycle. Over 40% with combined cycle operations Over 80% with district heating
Additional Processing	Minimal pre-processing	Minimal pre-processing	High degree of pre-processing to size and moisture specifications and recovery recyclable material	High degree of pre-processing to size and moisture specifications and recovery recyclable material	High degree of pre-processing to size and moisture specifications and recovery recyclable material
Residuals (% mass of incoming waste)	5% if bottom ash is recycled, otherwise >20%, including fly ash	5% if bottom ash is recycled, otherwise >20%, including fly ash	<1% if ash is vitrified, otherwise >20%	Unknown, but >30% if residue not treated	<1% if ash is vitrified, otherwise >20%
Level of Maturity/ Implementation	Highly mature. Hundreds of plants in operation in North America and Europe	Mature with 3 facilities in Canada (Brampton, Ont.; Charlottetown, PEI; and Wainright, Alta)	Thermoselect is mature with seven plants in Japan. 225 Kt/yr Thermoselect facility in Germany closed due to high operating costs. Other vendors not well proven	36Kt/yr plant operating in Burgau, Germany since 1987	Two facilities (similar to Alter NRG) operating in Japan (Mihama-Mikata and Utashinai) since 2002 and 2003, respectively.
Operational Complexity	Routine – Operational procedures well understood and established	Simple– Operational procedures well understood and established	Complex process – requires additional operational experience and maintenance skills	Complex process – requires additional operational experience and maintenance skills	Complex process – requires additional operational experience and maintenance skills. Special challenges from ultra high temperatures

4.2 Conventional Combustion Update

By conventional combustion we understand the direct firing of waste or "burning" under highly controlled conditions, with subsequent clean-up of flue gases. Conventional combustion includes the technologies called mass burn, fluidized bed, controlled air and rotary kiln. For smaller systems, batch technologies sometimes referred to as batch oxidation systems also fall into this category. The schematic in Figure 7 demonstrates the major components and process sequence in conventional combustion.

Figure 7. Schematic of Conventional Combustion



Following some form of feedstock preparation, the combustion process is used to release the heat, which is then converted to steam or hot water. The steam in turn can be converted to electricity or used in industrial processes. The gases, after the heat has been extracted, are then cleaned before being vented to the atmosphere. Two forms of ash come from the process: bottom ash from the actual burning of the feedstock, and fly ash from the flue gas cleaning process.

Most bottom ash from WTE facilities burning MSW can be landfilled, or processed for other uses. The only WTE plant operating in BC is located in Burnaby and is owned by Metro Vancouver. Bottom ash is used at the Vancouver landfill as daily cover and roadbed material. Fly ash, which is considered hazardous, is stabilized with cement and disposed at the Cache Creek landfill. Metal is recovered after the combustion process and is sold to a local metal recycler. The only other mass burn facility in Canada is in Quebec City. Controlled air systems are in operation in Peel, Ontario, in PEI and Wainwright, Alberta.

Air emissions from modern WTE facilities can meet the most stringent guidelines in existence anywhere in the world today. The study for Metro Vancouver includes extensive research into the potential emissions from WTE and also potential health effects. Regarding health effects, it is quoted from a 2004, United Kingdom Department for Environment, Food and Rural Affairs (DEFRA) comprehensive report on the potential for health effects associated with the management of MSW. Based on a review of over 600 publications, no link was discovered between living close to a modern thermal treatment facility and adverse health impacts, including cancer and respiratory problems. The study concluded that:

> *"If the operation of these facilities does have any effect on the health outcomes which have been investigated, any effect is very small – smaller than many other influences on these health outcomes."*

Furthermore, as part of the same study, the (UK) government's independent expert advisory Committee on the Carcinogenicity of Chemicals in Food, Consumer Products and the Environment concluded that:

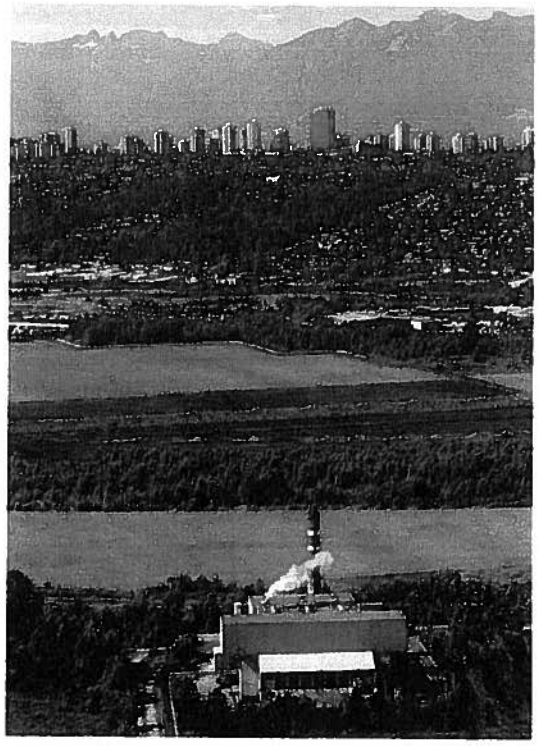
> *"any potential risk of cancer due to residency (for periods in excess of ten years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern techniques."*

GHG emissions from combustion facilities will vary depending on the biogenic component of the waste stream. Whether a WTE facility is GHG neutral, positive or negative depends also on the offsets that can be achieved. In most parts of the world, where a portion of the electricity is generated by fossil fuels, WTE is generally in a GHG favourable position.

In BC, studies have shown that if WTE is used for the generation of electricity only, then the GHG balance is not so favourable. This is because our electricity in BC is mostly from hydro power, so there is a very low carbon density. Offsetting relatively low carbon electricity with WTE generated electricity has a negative effect on the carbon balance. However, if WTE is also used for district and industrial process heat (offsetting natural gas use), then WTE can be preferable to landfilling from a GHG perspective. It should be noted that recycling from a GHG perspective is in most cases preferable to both landfilling and WTE. When looking at GHG scenarios involving WTE (of the residuals that cannot be recycled), other factors such as transportation need to be taken into account.

A photo of a mass burn facility with a capacity of 280,000 tonnes per year is shown in Figure 8. This facility operates three separate lines that each process approximately 93,000 tonnes of waste per year.

Figure 8. Metro Vancouver Waste-to-Energy Facility



Conventional, direct fired combustion systems are the predominant technology chosen for the recovery of energy from municipal solid waste today. This is due to the technology's ability to handle the varying waste stream with little or no pre-processing, the simplicity of the process overall, the development and integration of sophisticated air pollution control systems and the overall thermal efficiency of the process. Conventional combustion technologies that lend themselves to the volumes and types of waste identified in this study are mass burn (predominantly) and to a lesser degree controlled air combustion. There have been no major technology changes since the referenced reports were issued, however thermal efficiencies and emissions are being continuously improved.

There is considerable technical and emotional debate about the advantages and risks of conventional combustion systems. Experience from the past, before modern emission standards and controls were in place, has caused waste incineration to receive a poor public perception. In Europe, modern WTE in conjunction with recycling is generally regarded as the most cost-effective and environmentally friendly method of managing waste without creating future liabilities and a legacy for future generations. In Europe, WTE is often employed as a means of reducing GHG compared to landfilling.

Advantages of conventional combustion systems:

- the technology for MSW it is well established worldwide. More than 36 million people in 29 countries dispose of their MSW at 800 waste-to-energy facilities;
- there are many examples of well-operated waste-to-energy facilities in the developed world. Modern WTE facilities have no significant impact on the environment and generally a positive greenhouse gas balance;
- conventional combustion is relatively simple and costs less to build and operate than most advanced systems, such as gasification and pyrolysis;
- other wastes, such as biosolids and biomedical materials can be destroyed; and
- the technology is reliable.

Disadvantages of conventional waste-to-energy systems:

- public perception and opposition can be significant when burning MSW or refuse derived fuel made from MSW;
- it does not represent an advanced form of energy recovery, but is rather one of the traditional technologies available,
- fly ash may be hazardous when combusting MSW, which requires some form of treatment or stabilization before disposal; and
- economies of scale suffer as the units get smaller, so that WTE is often uncompetitive with landfilling in smaller communities where the waste volumes are below 300,000 tonnes per year

4.2.1 Capital Costs vs. Annual Throughput

Costs are a function of size, and a report issued by the Municipal Waste Integration Council (MWIN) in 2007 provided the following graph (Figure 9) showing how economies of scale affect costs.

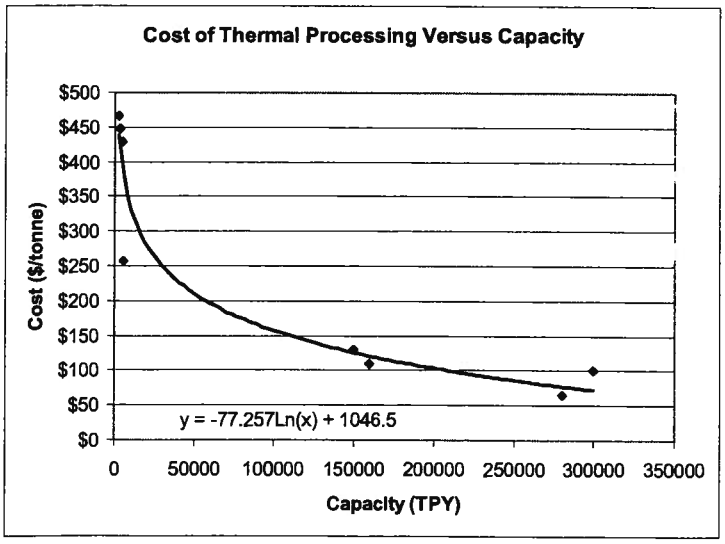


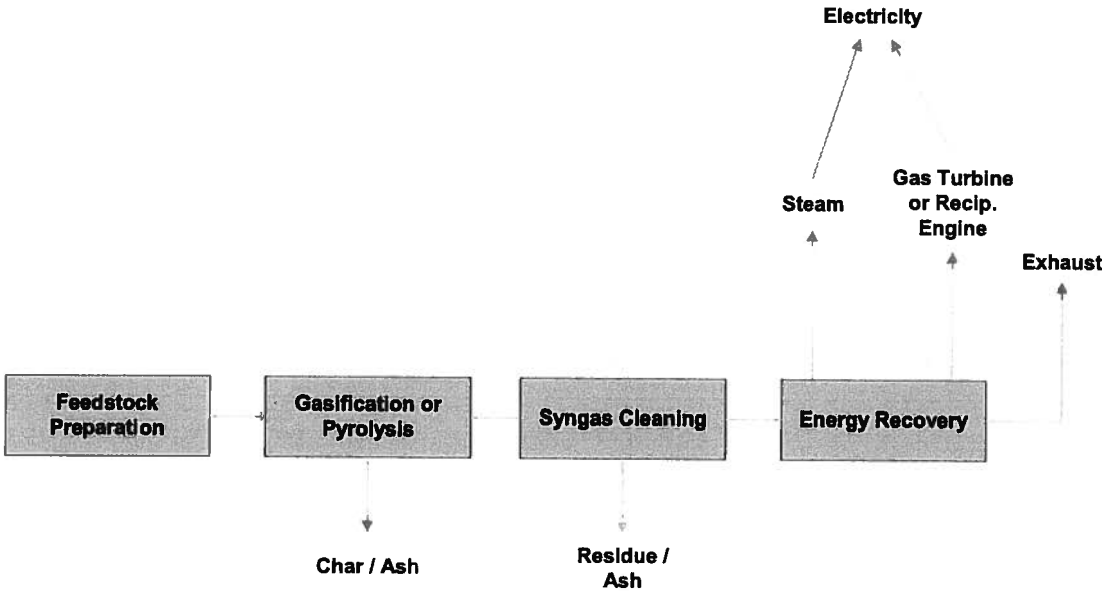
Figure 9. Incineration Costs as a Function of Annual Capacity (MWIN 2007)

Assuming that a WTE facility has a capacity of about 200,000 tonnes of waste throughput per year, then the cost would likely be above $100 per tonne (not including revenue from the sale of energy).

4.3 Gasification, Pyrolysis and Plasma Systems (Advanced Thermal Processes)

Pyrolysis and gasification, as well as ultra high temperature gasification using plasma are often called advanced thermal processes. After extensive pre-processing, thermal energy is used to create a synthetic gas (syngas) and char or bio-oil. Syngas is chemically cleaned before it is burned so that complex post combustion air pollution control is minimized, or not needed at all. Syngas and bio-oil can be upgraded as feedstock for other processes or burned to produce heat and/or power. Figure 10 illustrates a typical gasification or pyrolysis process.

Figure 10. Main Components of a Gasification or Pyrolysis System



The major differences between these so called "advanced" systems and conventional combustion systems are as follows:

Feedstock Preparation

For conventional combustion, especially mass burn, this is very simple and at most a coarse size reduction and removal of large undesirable items. For many advanced technologies, waste must be extensively prepared by shredding, drying and classifying. This adds to the cost and complexity of the system.

Gasification or Pyrolysis

In the advanced systems, energy is released by adding heat to the waste in the absence of oxygen (without allowing it to burn as in conventional combustion). This creates a synthetic gas, consisting of CO, some hydrogen, CO_2, nitrogen and contaminants. With gasification, there is still an ash, as with combustion, and with pyrolysis there is a carbon rich char that requires further processing. Heating the waste, if done by combustion, also creates some emissions which must be cleaned before being released to the atmosphere. Some plasma systems heat the waste using a plasma torch, which requires a large electrical input.

Syngas Cleaning

Syngas coming from the advanced technology is contaminated with tars, metals and particulates. If it is to be used in internal combustion engines or as a feedstock for other processes, it needs to be cleaned and purified. This is a chemical process that results in residues that need to be managed/disposed. Some processes, such as the Plasco technology, use hot plasma to clean the syngas of organic contaminants. If the syngas is well cleaned, then there is generally no or very little post combustion air pollution control needed (as in conventional combustion).

Energy Recovery

This is where advanced technologies convert the recovered gas into energy. If it is a thermal process, the gas is burned on-site to make electricity and heat in a reciprocating engine (similar to a landfill gas application), gas turbine, or it is made into a liquid fuel or pipeline quality gas that can be moved and burned elsewhere. In any case, the product will ultimately be burned (if there is to be energy recovery) which will produce GHG emissions, and other air emissions similar to what can be expected from natural gas combustion.

Advantages and disadvantages of advanced thermal processes are discussed in a recent Juniper publication that was prepared for Improvement and Efficiency South East, UK. Juniper Consultancy Services are a recognized leader in the assessment and evaluation of thermal technologies in solid waste management. This report was released in 2008 and is a public document. Advantages and disadvantages from previous studies and from the Juniper report are summarized below:

Advantages of Advanced Thermal Processes:

- Most of the basic technologies (gasification, pyrolysis) have been proven in industrial applications with specific materials.
- Potential for better lower carbon emissions than convention combustion through higher energy recovery efficiencies when using combined heat and power for electricity production.
- Potential to displace fossil fuels when using cleaned syngas as an intermediate in the manufacture of other fuels and chemicals.
- Syngas cleaning takes less space than flue gas cleaning in a conventional WTE plant.
- The recovered energy can be utilized/burned in a different location than where it was extracted.
- Advanced thermal processes have a better public image than conventional combustion and may be easier to site and to get public approvals.
- Module sizes are generally smaller than mass burn systems, so overall plant sizes can be smaller.

Disadvantages of Advanced Thermal Processes

- Few full scale technologies have been proven, and the only successful plants are operating in Japan.
- Technologies are generally more complex than mass burn, and costs are generally higher.
- Syngas cleaning to a level that enables combined cycle gas turbine applications is not well proven.
- Many technologies are only proven on a pilot or demonstration level in Europe.
- None of these technologies are currently commercially operating in North America.

4.4 Gasification Update

Gasification is the general term used to describe the process of partial combustion in which a fuel is combusted with a quantity of air that is deliberately set to be below what is required for complete combustion. It is an alternate technique to direct combustion for reducing the volume of MSW and for the recovery of energy. The process involves the partial combustion of carbonaceous fuel to generate a combustible syngas that can be burned at a later

time (after cleaning) in an internal combustion engine, gas turbine, or boiler under excess-air conditions. The generated syngas has an energy content about one third that of natural gas if air is used as the oxidant. Use of pure oxygen can yield gases with higher energy content. Gasifiers have the potential to achieve low air pollution emissions with simplified air pollution control devices. The emissions can be comparable to or less than those from mass burn systems employing far more complex emission control systems. Gasification systems typically require homogeneous feedstock and therefore extensive front-end processing is generally required.

Gasifiers have been used since the 19th century for coal and wood. By the early 1900s gasifier technology had advanced and was used on certain industrial waste streams to produce 'synthetic' natural gas fuel for stationary and portable internal combustion engines. Fuel shortages of World War II resulted in the further development of gasifier technology. However, with the return of relatively cheap and plentiful oil after the end of World War II, gasifier technology was no longer employed. In recent years, gasification technology has been developed for MSW as an alternative to conventional mass burn combustion.

Any solid material being combusted goes through a gasification stage. Some companies argue that if the gas is burned in a separate vessel, then it is a gasification system. However, the difference between a close coupled gasification system where the synthetic gas is immediately burned in a subsequent vessel, and an incineration facility where burning takes place in the same vessel, is minimal. For the purpose of this study, gasification will be defined as a process where the synthetic gas is cleaned and then used for some other process (which might be a chemical process for making methanol, or thermal process to make electricity in an internal combustion engine or gas turbine).

The syngas created by gasification can be used in many of the same ways as natural gas. Syngas can be burned in a conventional boiler to produce steam to drive a steam turbine generator to produce electricity. Cleaned syngas can also be used in:

- reciprocating engines to produce electricity and heat;
- combined cycle gas turbine power plants to produce electricity and heat; or
- fuel cells.

The efficiencies of gasification and pyrolysis when the syngas is converted to electricity using a steam boiler and turbine are up to 25%. This does not provide any advantage over mass burn systems, which typically reach up to 27% and can be optimized to achieve 30%. However, if the syngas is burned in a reciprocating engine, efficiencies increase to over 30% and in a combined cycle gas turbine, they can be as high as 40%. Since there is no known commercial scale applications of combined cycle gas turbines using syngas produced from MSW, or of ethanol produced from MSW, the actual efficiency of these systems is not known.

Gasification facilities are usually built with a fixed capacity. Module sizes range from less than 40,000 tonnes per year to about 100,000 tonnes per year. Due to their potential for smaller sized units, gasification facilities can be sited close to the feedstock source, i.e., decentralized applications. However, there are economies of scale to be achieved by building larger centralized facilities.

Companies such as Enerkem and Fulcrum BioEnergy are starting up new plants to produce ethanol from MSW however these techniques have yet to be proven over years of continuous operation. Enerkem claims that approximately 37.8 million litres (ten million gallons) of ethanol can be produced from 200,000 tonnes of MSW. Markets prices for ethanol are almost $2 per gallon which could possibly net $20 M/yr.

North American communities that are pursuing gasification technologies include:

- Edmonton, Alberta;
- City of Taunton, Massachusetts; and
- Pontotoc, Mississippi.

The projects mentioned above are planning to process the syngas into ethanol in addition to utilizing any thermal recovery. The Edmonton and Pontotoc projects are expected to be operational in 2011 and 2012, respectively.

Gasification – Conventional

There are few full-scale plants in continuous operation outside of Japan. A company named Energos claims to have eight gasification plants in operation in Norway and Germany. These are grate gasifiers that would be classified as controlled air combustion units in North America. The only true large scale commercially operating gasification plant in Europe was in Karlsruhe, Germany, using technology from a company called Thermoselect and there are seven plants with this technology operating in Japan.

The THERMOSELECT process converts mixed waste to clean synthetic gases and recoverable metals and minerals. High temperatures (2,000°C) and oxygen concentrations are used in the gasification stage. Subsequent rapid cooling is used to prevent formation/reformation of trace organic contaminants in the synthetic gas. A 225,000 tonnes per year "THERMOSELECT" plant in Karlsruhe, Germany was operated for some time but was recently shut down due to high costs compared to conventional mass burn WTE technology. The "THERMOSELECT" technology did not yield significant improvements in air emissions over state-of-the-art conventional incineration. In Japan, it does offer the benefit, at a significant cost premium – of vitrifying the residue char to meet Japanese ash standards.

The City of Taunton has chosen the Thermoselect process as the preferred technology for its energy recovery facility and estimates start-up sometime in 2014.

Plasma Arc Gasification

Plasma arc gasification processes use extremely high temperatures in an oxygen-starved environment to gasify waste into simple molecules. In essence, it is a conventional gasification system where the heat is supplied by a high temperature plasma field.

A thermal plasma field is created by directing an electric current through a low pressure gas stream, thereby creating a stream of plasma at temperatures from 5,000 to 15,000°C. The products of the process are slag and combustible gases.

Plasma arc technology is not new. Industrial applications include electric arc furnaces used in the steel industry and arc welding units used in the construction industry. Plasma technology is also used for treating hazardous waste. The technology involves relatively high capital and operating costs. However, because of extremely high operating temperatures and the resultant production of a vitrified inert ash that will not leach metals or other contaminants into the environment, plasma technology has environmental advantages in certain applications. The environmental advantages include the 'ultimate destruction' of highly problematic hazardous organic materials such as PCBs and complex stable volatile organic compounds.

In principle, plasma arc has the same attributes, advantages and disadvantages as conventional gasification, with the added benefit of much higher heat that destroys all organic contaminants and vitrifies the slag into a reusable aggregate-like substance. This aggregate would need to be ground into a marketable commodity and compete with traditional aggregates on price. The major disadvantages are the higher energy requirements to create and maintain

the plasma, the heat losses associated with high heat conditions, and the technical complexity and material challenges that come from managing such high temperatures.

Despite considerable research into the application of plasma technology for MSW, the technology is still at the developmental stage. Currently, there are no commercial scale units managing MSW in North America or Europe, and only two plants in Japan. There are, however, a number of different patented plasma arc systems being proposed for the treatment of MSW and undergoing pilot tests. Two well known Canadian examples are Alter NRG, based in Calgary, Alberta, and Plasco in Ottawa. These are described briefly below.

Alter NRG

Alter NRG is selling a design based on using plasma technology from Westinghouse Plasma Corporation (WPC), an industry leader in the design and supply of plasma torch technology, which is now owned by Alter NRG. Their plasma torches have been in operation since 1989 and have logged over 500,000 hours of commercial use. Although this key component of plasma arc gasification is considered proven, the design, construction and operation of a solid waste facility that uses this technology has not been commercially applied in North America. There are currently two facilities have been operational in Japan since 2003. The specifics of these facilities are summarized below.

Location	Duty	Plant Capacity	Treatment Capacity	Start-up
Utashinai, Japan	Plasma gasification: - 50% MSW & - 50% auto shredder residue	180 tonnes per day	49,500 tonnes per year	2003
Mihama-Mikata, Japan	Plasma gasification: - 80% MSW & - 20% dried sewage sludge	22 tonnes per day	6,600 tonnes per year	2003

The first North American plasma arc gasification facility using Alter NRG's technology is being proposed in St. Lucie County, Florida. Geoplasma St. Lucie LLC was issued an air pollution permit from the Florida Department of Environmental Protection to build this facility on June 16, 2010. This plant will be designed to produce a gross 24 MW of power and process 622 tonnes per day (193,000 tonnes per year) of garbage, tires, metallurgical coke and other waste. Alter NRG is supplying the plasma torches and the plant is expected to be operational by 2013.

Plasco Process Description

Plasco Energy Corp. (Plasco) utilizes a more traditional approach to gasification. MSW is pre-selected and is fed into a gasification chamber where a portion is combusted to create the necessary heat for the gasification process to occur. Plasma torches are applied in the flue gas stream to clean up organic contaminants (also called syngas polishing) and in the slag area to create the vitrified residue. After passing through the plasma area, the syngas is cooled and passed through a cleaning system to remove metals, sulphur, and the remaining particulates. .

Plasco operates a demonstration facility in Ottawa with a permitted capacity of 27,000 tonnes per year. Plasco financed the construction and operation of the plant, and the City of Ottawa provided the site for the facility and is paying a tipping fee of $40/tonne. The facility is permitted to process up to 75 tonnes of MSW per day and ten tonnes per day of high carbon wastes (plastics 3-7 and tires). The high carbon wastes are added to reduce fluctuations in the energy content of MSW and to increase the heating value of the feedstock. The Plasco technology was designed primarily for mixed MSW, with the high temperatures of the plasma arc used to remove contaminants in the flu gas and vitrify the ash. Plasco is currently negotiating a contract for all of the residential waste with the City

of Ottawa. Plasco is also in advanced stages of implementing a new facility in Red Deer, Alberta, which should be in construction later in 2011.

4.5 Pyrolysis Update

There are no known pyrolysis facilities that have been recently built for MSW in Europe or Japan, or planned in North America, with the exception of one facility in Germany, which creates a syngas that is fired without cleaning in an adjacent coal fired boiler for making electricity.

4.6 Summary

Conventional combustion technologies remain the benchmark for energy recovery with over 800 facilities worldwide. There are many examples of well-operated waste-to-energy facilities in the developed world, the closest being in Burnaby, BC. Modern WTE facilities are considered to have no significant impact on the environment and generally a positive greenhouse gas balance. Conventional combustion systems are relatively simple and cost less to build and operate than most advanced systems, and have been proven to extract energy from and destroy other wastes, such as biosolids and biomedical materials. Most importantly, the conventional combustion is reliable, proven, with many qualified firms offering equipment and services.

Advanced thermal technologies such as gasification and plasma arc gasification offer some advantages over conventional combustion. They have the ability to create an intermediary product, namely syngas, which can be used for the manufacturing of fuels and chemicals. If fuels are made, such as synthetic natural gas or ethanol, they will still be combusted with resulting GHG emissions, but they do not need to be combusted where they are made. Advanced thermal technologies also offer the promise of higher efficiency in the production of electricity, if syngas can be cleaned adequately for use in gas engines or in a combined cycle power plant, although the latter has yet to be proven.

The gasification technologies that are reasonably proven are generally more expensive than conventional combustion, and due to their limited application with MSW, carry a higher degree of technical and financial risk. This must be weighed against the environmental benefits that the technologies offer.

5. Financial Analysis

Facilities were sized according to the twenty year solid waste projections for the three regional districts in Section 2. The solid waste disposal rate for the baseline year (2015) is estimated to be 215,000 tonnes per year and that is expected to grow to 250,000 tonnes per year by 2030. Similarly, the biosolids generation rate is expected to grow from 10,000 to 15,000 tonnes per year by the year 2030. A reasonable annual processing capacity for a WTE facility is 225,000 tonnes per year. These estimates assume recycling and organics recovery programs will be implemented as planned.

In order to account for seasonal variations in the generation of waste, and to allow for even more aggressive and currently unscheduled additional recycling and waste reduction, it is suggested that the WTE facility be sized for not more than 200,000 tonnes per year. This would also enable the facility to continuously operate at 100% of capacity, which is necessary for efficient operation of most thermal technologies.

5.1 Facility Cost

Costs were developed based on information in the public domain. Since there are no known publications in North America that keep statistics on the cost of new WTE facilities, and no facilities have actually been built in the past 15 years, cost information must be obtained from a variety of sources. These include published reports and studies conducted by other engineering companies in North America, published tender results for WTE facilities where these are in planning, industry guides that are used internally by WTE developers when assessing WTE potential, and experience by AECOM staff from working in this field for many years. These numbers have been processed and modified for the proposed systems to be compared based on our professional judgment and experience.

The following assumptions were applied to each of the WTE technology options:

- amortization period 25 years;
- interest rate is 6%;
- electricity price is $100/MWh which is based on BC Hydro's last call for power plus the expectation of higher prices in future calls;
- Natural Gas rate is $6/GJ which is based on natural gas price forecasts submitted by BC Hydro in its most recent Long Term Acquisition Plan;
- district heating value is 70% of natural gas value which is based on heat generated by a WTE facility and can be sold to a district heating system;
- uptake of district heat is estimated at 90% of heat output of which 50% is conservatively taken up; and
- waste contains 11.5 GJ of energy per tonne.

5.1.1 Conventional Systems – Mass Burn

The most recent published cost estimates for a mass burn facility is for the proposed Durham-York WTE facility. The capital cost is estimated at $235M at the initial processing capacity of 140,000 tonnes per year (Phase 1). This facility is designed to be expandable to 250,000 tonnes per year (Phase 2) and to a final capacity of 400,000 tonnes per year (Phase 3). The utilities will be designed to accommodate the final processing capacity. Staff reports indicate that additional processing buildings and stack are not required until the facility is expanded to the final processing capacity.

Based on Durham-York's design approach, the capital costs were adjusted to reflect the 250,000 tonne per year capacity that is built into the proposed design. This equates to a unit capital cost of $1,044 per tonne of installed annual capacity.

Other aspects that have been reported by Durham-York include the following:

Operating Cost:	$14.7M/yr
Energy Generation:	667 kWh per tonne net (electricity) and 7.2 GJ per tonne (heat)
Facility Availability:	90%
Electricity Revenue:	$8.6 M
Metal Revenue:	$80 per tonne (based on MV WTE metals recovery rate)
Residuals (by wt):	21 percent of plant capacity

The capital cost, operating cost and energy revenues were estimated based on specifications for the Durham-York WTE facility. Table 8 below takes into consideration annualized costs, disposal cost and local electricity and potential district heating revenue.

Table 8. Mass Burn Capital and Operating Cost Estimate

Description			Comments
Plant Capacity	200,000	tonnes per year	
Chute to stack equipment with building	$208,888,889	$1,044	per tonne of installed capacity
Land costs	$0		Land already owned by District
Site work	$4,177,778	2%	of plant cost
Permits and approvals	$2,088,889	1%	of plant cost
Total capital cost	$215,155,556		
Assumed average cost of capital	6	6%	interest rate
Amortization period	25	25	years
Annual capital costs	$16,975,773		
Annual operation and maintenance costs	$13,040,000	$65.20	per tonne
Residue disposal (21% of feedstock)	$2,100,000	$50	per tonne
Revenue from steam sales			
Revenue from electrical energy	($12,006,000)	$100	per MWh (90% efficiency for electricity)
Revenue from district heating sales	($2,721,600)	$6	per GJ (assume 50% of heat sold)
Revenue from sale of metals	($500,000)	$80	Scrap metal price per tonne
Net annual cost	$16,888,173		
Cost per tonne	$84.44	$98.05	without district heating

The identified costs are without contingency and provision for profits. They also represent a conservative approach for estimating the capital cost for a waste-to-energy facility and the estimated tipping fees to balance costs (break-even tipping fees). These costs estimates are consistent with the cost estimates that were recently reported by Stantec, in a report entitled "Waste to Energy – A Technical Review of Municipal Solid Waste Thermal Treatment Practices", dated August 27, 2010.

If district heat markets are not available, then the break-even tipping fee rises by about 15%.

5.1.2 Gasification System – Thermoselect

The City of Taunton, Massachusetts recently completed a Request for Proposal for alternative waste conversion technologies. The preferred proponent is Interstate Waste Technologies (IWT) that utilizes the Thermoselect process. The capital cost is estimated at $600 M with a processing capacity of 500,000 tonnes per year. The unit capital cost for this facility is calculated to be $1,205 per tonne. Revenue from this facility would come from the production and sale of 34 million gallons of ethanol per year.

There are no published costs for gasification systems, since there are no commercially operating gasification units in North America. The tender documents from Taunton, Massachusetts offers likely the most up to date capital cost figures. The Taunton facility is more than double the size for the three regional districts. It is reasonable that the unit capital cost would be about 30% higher ($1,566 per tonne of installed annual capacity) than the Taunton proposal.

Operating costs for a Thermoselect process are also documented in a City of Los Angeles' Evaluation of Alternative Solid Waste Processing Technologies report. Operating costs ranged from $65 per tonne for a 340,000 tonne per year facility and $120 per tonne for a 90,000 tonne per year facility. The prorated operating cost for a 200,000 tonne per year facility is estimated to be $93 per tonne.

Energy revenue comes from ethanol. The Taunton proposal projects an ethanol production rate of 34 million gallons per year and 10 to 20% of that ethanol would likely be used to provide heat for the gasification process. For conservative purposes assume 80% of the ethanol produced is available for sale. This equates to 205 litres of ethanol per tonne of waste which is equivalent to 5.1 GJ per tonne.

The largest single use of ethanol is a fuel or fuel additive. The United States has used ethanol and gasoline blends (E85) up to 85% ethanol and 15% gasoline. The ethanol produced could be used to fuel the collection and transfer vehicles and the portion of ethanol used would not be subject to the carbon tax. The energy content of ethanol is approximately 60% that of diesel. Market rate for ethanol is approximately $0.529 per litre ($2 per gallon).

Other considerations include the following:

Facility Availability: 90%
Metal Revenue: $500 K
Residuals (by wt): 21% of plant capacity

Table 9 list the cost estimates for a gasification facility.

Table 9. Gasification Capital and Operating Cost Estimate

Description			Comments
Plant capacity	200,000	tonnes per year	
Chute to stack equipment with building	$313,207,573	$1,566	per tonne of installed capacity
Land costs	$0		Land already owned by District
Site work	$6,264,151	2%	of plant cost
Permits and approvals	$3,132,076	1%	of plant cost
Total capital cost	$322,603,801		
Assumed average cost of capital	6	6%	interest rate
Amortization period	25	25	years
Annual capital costs	$25,453,440		
Annual operation and maintenance costs	$18,645,069	$93	per tonne
Residue disposal (20% of feedstock)	$2,000,000	$50	per tonne
Revenue from ethanol production (~43.7 ML/yr)	($18,435,650)	$0.53	per litre
Revenue from electrical energy	$0	$0	per MWh (90% efficiency for electricity)
Revenue from district heating sales	$0	$0	per GJ (assume 50% of heat sold)
Revenue from sale of metals	($500,000)		
Net annual cost	$27,162,859		
Cost per tonne	$135.81		

These parameters have been selected because they are conservative. There is a reasonable chance that the market could respond with lower cost alternatives than are available in the literature, or that financial parameters might change. This is certainly the case with the market price for ethanol which fluctuates with gasoline prices.

5.1.3 Plasma Arc Gasification Systems – Alter NRG

There are no published costs for plasma arc gasification systems, since there are no commercially operating gasification units in North America. The City of Marion, Iowa, recently completed an economic feasibility study for a plasma arc gasification plant. The study examined and compared the capital and operating cost relative to a conventional mass burn WTE facility. The study findings include a capital cost that is 35.6% higher than a mass burn WTE facility and an operating cost that is $107 per tonne.

An ideal application for gasification technologies would be the use of the syngas as a natural gas (fossil fuel) substitute in a combined cycle power plant or reciprocating engines. These applications benefit from the high energy efficiencies which are in the order of 40% for reciprocating engines and over 50% for combined cycle gas plants. By comparison, mass burn is currently at 27% energy efficiency for a modern facility.

Combined cycle gas technology offers the highest energy recovery efficiency for electricity production, however, there are two factors which make it not suitable at this time: 1. The minimum practical size for combined cycle gas plants is in the 200 to 250 MW range, and the waste in the three regions is only enough for about one tenth of that; and 2. Gas turbines are extremely sensitive to contaminants in the gas, and there are no known facilities currently achieving the necessary level of gas cleaning from MSW derived syngas which are firing a gas turbine.

Reciprocating engines offer good efficiencies for electricity production and are less complex that steam cycles, which are necessary with mass burn technologies. Therefore, reciprocating engine technology has been chosen for this gasification option to demonstrate the potential of this technology. The City of Los Angeles Evaluation of Alternative Solid Waste Processing Technologies documents energy potential from syngas used to power a reciprocating engine to range from 838 to 875 kWh per tonne of MSW. For this financial analysis 850 kWh is used. There is also residual heat that can be used for district heating. Similar to the Mass Burn analysis, it is assumed that 50% of the heat can be taken up.

Option parameters are assumed as follows:

Energy Generation:	850 kWh per tonne (electricity) and 7.2 GJ per tonne (heat)
Facility Availability:	85%
Metal Revenue:	$500 K
Residuals (by wt):	2% of plant capacity for disposal; (vitrified slag used for construction purposes at zero cost and zero revenue)

Table 10 is a summary of a capital and operating cost for a plasma arc gasification facility.

Table 10. Plasma Arc Gasification Capital and Operating Cost Estimate

Description			Comments
Plant capacity	200,000	tonnes per year	
Chute to stack equipment with building	$283,253,333	$1,416	per tonne of installed capacity
Land costs	$0		Land already owned by District
Site work	$5,665,067	2%	of plant cost
Permits and approvals	$2,832,533	1%	of plant cost
Total capital cost	$291,750,933		
Assumed average cost of capital	6	6%	interest rate
Amortization period	25	25	years
Annual capital costs	$23,019,149		
Annual operation and maintenance costs	$21,350,821	$107	per tonne
Residue disposal (2% of feedstock)	$200,000	$50	per tonne
Revenue from syngas production		0	
Revenue (electricity) from reciprocating engines fueled by syngas	($13,005,000)	$100	per MWh (85% availability for reciprocating engine)
Revenue from district heating sales	($714,000)	$6	per GJ (assume 50% of heat is sold)
Revenue from sale of metals	($500,000)		
Net annual cost	$30,350,970		
Cost per tonne	$151.75	$155.32	without district heating

5.1.4 Gold River Waste-to-Energy Facility

The Gold River WTE facility is proposed to be built, operated and financed by Covanta Energy. This facility would be constructed after securing waste from Metro Vancouver or from other sources. The minimum quantity available from Metro Vancouver is 500,000 tonnes per year. The additional waste from the three regional districts would bring the total processing capacity to 700,000 tonnes per year.

Covanta plans to build a 750,000 tonne per year WTE facility for $500M. These capital costs are based on articles summarizing the Gold River project which are also consistent with another WTE project that Covanta is planning in the United Kingdom. Electricity will be the only source of revenue. Operating costs are expected to be $40 per tonne. Based on these published figures for the Gold River project, the break-even tip fee is calculated to be $42 per tonne. This break-even tip fee does not take into consideration any profit margin mark up.

5.2 Potential Energy Users

Each technology produces different products. These products may include syngas, steam, heat, electricity or ethanol. These products may be used by industries located in the vicinity of the WTE facility. Industrial users and their long term plans tend to adapt to economic conditions. Energy costs have risen significantly over the past several years, and are likely to keep rising. Interest in heat or steam recovered from waste is anticipated to grow as costs increase. The following subsections identify potential energy uses for each site.

5.2.1 RDN

The Harmac pulp mill is now owned and operated by Nanaimo Forest Products (a group of mill managers, workers, and three private investors) who was awarded possession in July 2008. The mill has been back in production since early 2009, with 300 employees. Nanaimo Forest Products president, Levi Sampson, expressed interest in opportunities that would enhance industrial activity in the area. Nanaimo Forest Products owns over 500 acres of industrial land in the surrounding area and would consider establishing a utility to supply steam, electricity, syngas and district heating. They are also exploring opportunities such as district heating for a proposed community development at Cable Bay, just south of the Harmac pulp mill.

Western Forest Products operates a sawmill just south of the Duke Point Ferry Terminal. That operation may expand as negotiations are underway to move Western Forest Products' Nanaimo sawmill to the Harmac site. Western Forest Products could potentially purchase electricity, heat and steam for the sawmill operation.

Nexen Chemicals produces sodium chlorate, which is used by pulp mills. Nexen purchases steam from the Harmac mill to produce sodium chlorate.

BC Hydro issues long term contracts to buy electricity that is incorporated into the grid. According to BC Hydro's last call for power, the estimated price for electricity is $100 per MWh.

5.2.2 CVRD

The majority of the residents in the CVRD reside around Duncan. The community is primarily residential with some light industrial and commercial operations. Opportunities for energy revenue include electricity sales to BC Hydro and potentially some residential district heating.

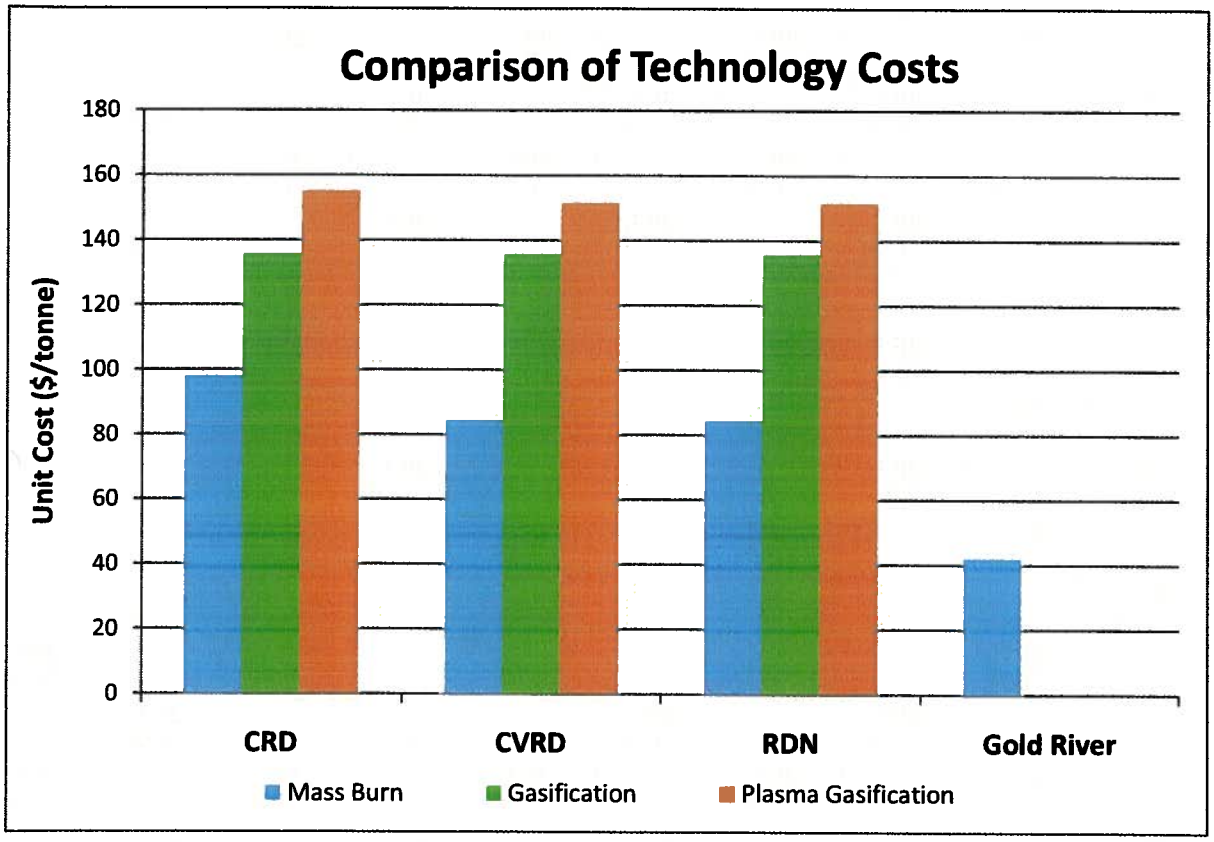
5.2.3 CRD

No specific site has been identified for a future waste-to-energy facility in the CRD. Sites throughout the region may offer a range from very limited to excellent opportunities for use of district heat and steam. To reflect a conservative analysis, the report considers having no users for heat and steam as a base case. Therefore, energy recovery opportunities would include electricity, which could be sold to BC Hydro, and fuel production such as ethanol, that would be produced from technologies that have that capability.

5.3 Financial Summary

The greatest difference in cost comes from the choice of technology, except for Option 4 (out of region mass burn), where economies of scale make a big difference. The actual technology cost between using mass burn, gasification and plasma gasification can be compared in Figure 11. These costs show net of revenue break even tipping fees, assuming 100% of the excess electricity generated can be sold, 100% of the ethanol can be sold, and 50% of the district heat energy can be sold (RDN and CVRD locations only). Having local markets for district heat helps economics from the revenue perspective.

Figure 11. Comparison of Technology Costs



The above analysis shows the basic costs and revenues for each technology. These must be combined with site specific factors, such as ability to sell heat at some locations, plus the cost to transport feedstock to the facilities. Together, these costs will indicate the actual break-even tipping fee required for a particular option.

Although this study only deals with four options, we need to consider the implications of technology and heat markets at each location. This effectively expands the number of options to ten. However, it also allows the assessment of technology and market implications. Costs are summarized in Table 11.

Table 11. Summary of Options

Option	Description	Capital Costs $Million	Facility Cap and Operations $/T	Transportation Costs $/T	Total Costs $/T
1	**WTE at CRD**				
1a	Mass burn	$209 M	$98.05	$20.57	$118.62
1b	Gasification	$323 M	$135.81	$20.57	$156.38
1c	Plasma gasification	$292 M	$155.32	$20.57	$175.89
2	**WTE at CVRD**				
2a	Mass burn	$209 M	$84.44	$31.45	$115.89
2b	Gasification	$323 M	$135.81	$31.45	$167.26
2c	Plasma gasification	$292 M	$151.75	$31.45	$183.20
3	**WTE at RDN**				
3a	Mass burn	$209 M	$84.44	$30.09	$114.53
3b	Gasification	$323 M	$135.81	$30.09	$165.90
3c	Plasma gasification	$292 M	$151.75	$30.09	$181.84
4	**WTE at Gold River**				
	Mass burn	N/A	$42.12	$68.42	$110.54

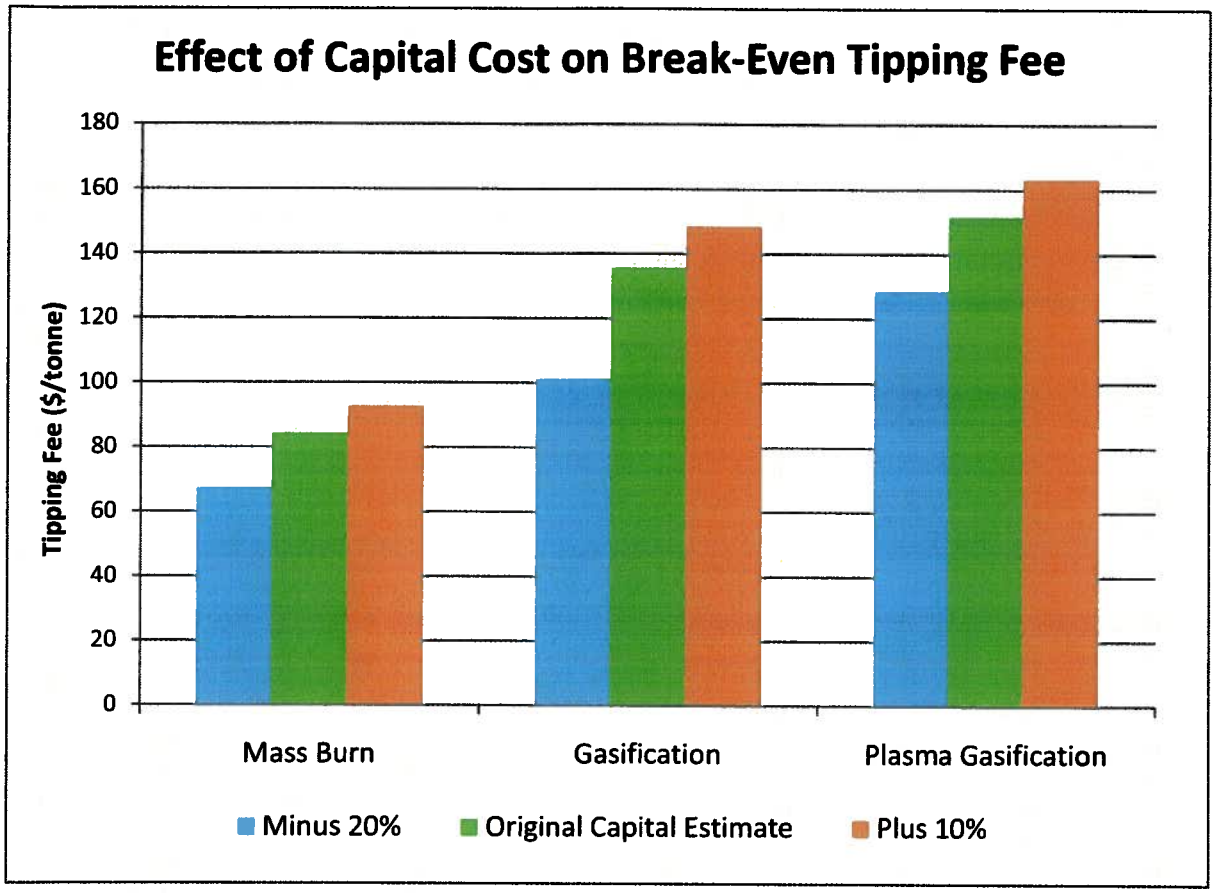
Transportation is the equalizing factor among the option locations. When the same technology is used, the difference after transportation is factored in, is less than 9% for mass burn (for example). This is well within the study's tolerance of cost estimating and could make any of the options attractive in a competitive situation. Further, small variances in the amount or cost of capital, revenues from sale of heat, or competitive transportation arrangements could change rankings and favour one option over another. These variances can only be determined through more advanced study, or proceeding with a tendering process.

For example, district heating revenue is conservatively estimated at 50% uptake for the RDN and CVRD sites. The potential heat and steam market at the RDN are very favourable and could reasonably achieve 80% uptake. This could lower the facility capital and operating unit cost by about $8, shifting the rating of the RDN site to a much more favourable position.

It should also be noted that the CRD options analysis was undertaken with no potential for district heating. If a site with district heating opportunities was realized, the total unit cost could be reduced from $118.62 to $105.01 per tonne. This would make this option the more economical than sending waste to Gold River.

One of the largest factors in overall feasibility is capital costs. To demonstrate the difference this makes, they were varied +10% and -20% for all of the scenarios. The results are shown in Figure 12 below.

Figure 12. Effect of Capital Costs on Break-Even Tipping Fees



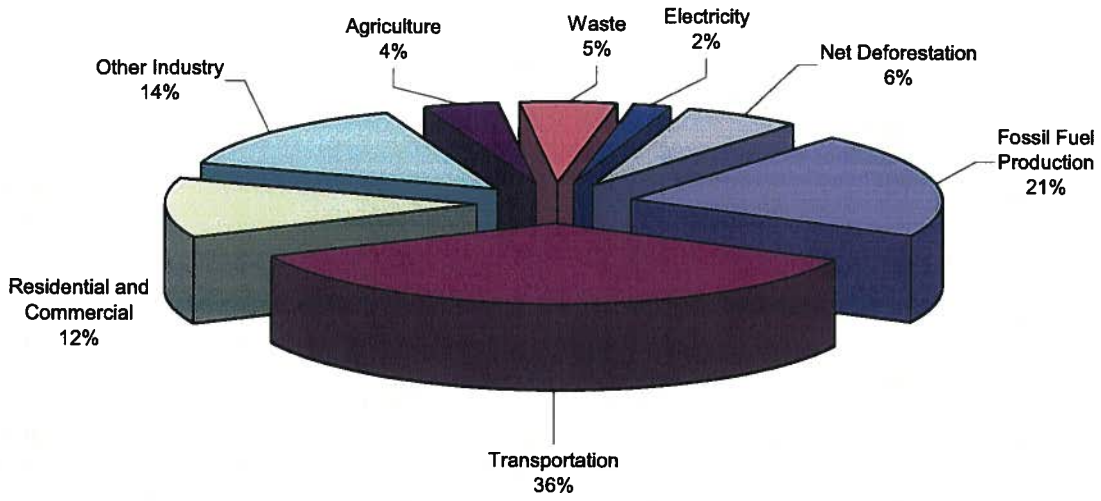
This comparison shows that with a 20% reduction in capital costs, plasma gasification could be less costly than conventional gasification (if no capital reduction can be achieved). The capital costs of gasification and plasma gasification would have to drop by much more than 20% in order to make them competitive with mass bum technology.

6. Greenhouse Gas Emissions

Waste management contributes to global climate change through the release of greenhouse gases (GHG). The most common GHG is carbon dioxide; emissions of all other GHG compounds are typically expressed in terms of carbon dioxide equivalents (CO_2e).

Provincially, the waste sector contributes 5% of the total GHG emissions. A breakdown of GHG emissions by sector for BC in 2006 is illustrated in Figure 13. Within the waste sector, 95% of the emissions are from landfills, with 2% from waste incineration and 3% from wastewater management. The statistics do not include the GHG resulting from the transportation of waste in these numbers.

Figure 13. Sectoral Breakdown of BC's GHG Emissions, 2006[1]



For the purposes of GHG inventories, it is important to distinguish between "fossil" and "biogenic" carbon in wastes. Fossil carbon is found in waste that is derived from fossil fuels (e.g., coal, oil, natural gas) that are processed into a variety of wastes (notably plastics). Biogenic carbon is in waste that has "recently" been alive (such as wood, paper, plants, food waste, rubber products). When conducting GHG inventories, the release of biogenic carbon to the atmosphere (as carbon dioxide) is not considered a GHG emission, because this carbon dioxide is simply returning to the atmosphere from where it was "recently" removed by the growth of organic matter. Biogenic waste can create a GHG emission if its treatment or disposal generates methane (for example in a landfill) or nitrous oxide (via combustion). These two gases are respectively 21 and 310 times more potent, than carbon dioxide. Therefore, the biogenic carbon is being returned to the atmosphere in a more potent form than it would have under natural conditions.

Emissions of carbon dioxide from the burning of biogenic waste are not included in the waste management section of a GHG inventory. Carbon dioxide from the burning of wastes of a fossil carbon origin is counted in the waste management portion of an inventory. It is therefore important to have an accurate estimate of the proportion of biogenic carbon in the waste stream so that estimates can be made about the climate-relevant emissions associated with thermal treatment. Methods are available to achieve this. Before a WTE facility is built, a waste analysis can accurately reveal the split between biogenic and fossil carbon. During WTE facility operation, there is instrumentation available that can measure the fossil portion of the emissions in real time. Generally, the biogenic portion of the municipal solid waste stream is in the 50 to 60% range, depending on the degree of organic material removal (i.e., kitchen wastes). If biosolids are added to the WTE feedstock, then that increases the biogenic portion.

GHG emissions originating in landfills are from the release of landfill gas (LFG) generated by the anaerobic decomposition of organic (i.e., biogenic) waste in landfills. LFG is primarily carbon dioxide and methane. As noted previously, methane has a higher global warming potential than carbon dioxide (21 times higher than CO2), and therefore is of great concern in MSW management. Landfills also have the potential to act as carbon "sinks", storing carbon underground rather than emitting it into the atmosphere. Only the fraction of the biogenic waste that does not decompose into carbon dioxide or methane is stored. Landfilling fossil-based carbon (e.g., plastic wastes) does not count as carbon storage, as that carbon has not "recently" been in the atmosphere.

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1 British Columbia. (2008). *BC Climate Action Plan.* Accessed August 8, 2008. http://www.livesmartbc.ca/attachments/climateaction_plan_web.pdf.

BC Climate Action Plan

The Province of BC is taking a leadership role in reducing emissions of greenhouse gases (GHG). The Province released a Climate Action Plan in June 2008, followed by a series of recommendations from the Climate Action Team in August 2008.

The Climate Action Plan outlines a series of initiatives that the provincial government commits to undertaking to reduce GHG emissions. The Plan also includes an overall reduction target of 33% for GHG emissions by 2020. A number of supporting pieces of legislation were also passed to enable the following actions to be achieved:

- implementation of a cap and trade system in conjunction with regional partners;
- implementation of a revenue-neutral carbon tax;
- adoption of vehicle emissions standards that will increase automobile fuel efficiency;
- regulation of LFG;
- development of more low-carbon energy generation projects;
- development of renewable forms of energy and decrease the carbon content of fuels;
- development of more sustainable, healthy communities; and
- low-carbon economic development.

The most relevant of these actions to waste management is the Landfill Gas Regulation, which was passed in December 2008.[2] The Regulation covers landfills that accept waste after January 1, 2009 and that have more than 100,000 tonnes of municipal solid waste in place, or that receive more than 10,000 tonnes of municipal solid waste per year.

Every landfill covered by the Regulation must complete a LFG generation assessment, based on the quantity of municipal solid waste received (historic and projected). Initial reports are due by January 1, 2011. If the assessment indicates that more than 1,000 tonnes of methane will be released, then a design plan for LFG management must be prepared for the site. The plan must be prepared within one year of the assessment and submitted to the Ministry of Environment. Once the design plan is approved by the Ministry of Environment, LFG management facilities and processes must be installed and implemented within four years of the approval. Landfill gas must be flared or used for a purpose that reduces the methane emissions by an amount equivalent to the reduction that would be achieved by flaring.

The recommendations from the Climate Action Team include interim CO_2 emissions reduction targets of 5-7% below 2007 levels by 2012, and 15-16% below 2007 levels by 2016. The recommendations also provide strategies related to a number of sectors, including solid waste, as noted at the beginning of this section. Although the strategy is not yet specified, the recommendation document mentions diverting organics from landfill, extended producer responsibility, expanded composting, and strict standards for air quality, energy efficiency for waste-to-energy facilities, and residuals management.

BC Energy Plan

The BC Energy Plan was released in February 2007. This plan notes that British Columbia is currently dependent on other jurisdictions to supply up to 10% of our electricity, and that forecasts from BC Hydro show that electricity

[2] British Columbia Ministry of Environment. (2008). *Landfill Gas Management Regulation.* Accessed January 5, 2009. http://www.env.gov.bc.ca/epd/codes/landfill_gas/pdf/lg-reg-12-08.pdf

demand may grow by up to 45% over the next 20 years. Within this context, the Plan sets a goal of achieving energy self-sufficiency by 2016.[3]

The new electricity generating capacity that will be required to meet the goal of energy self-sufficiency should comply with the following policies.[4]

- all new electricity generation projects will have zero net GHG emissions;
- zero net GHG emissions means that facilities that emit GHG will be required to purchase carbon offsets from other activities in British Columbia;
- zero GHG emissions means that the project itself must not generate any GHG emissions. This can be accomplished by sequestering (storing) carbon that is generated;
- clean or renewable resources include sources of energy that are constantly renewed by natural processes, such as water power, solar energy, wind energy, tidal energy, geothermal energy, geoexchange, wood residue energy, and energy from organic municipal waste;[5]
- zero net GHG emissions from existing thermal generation power plants by 2016;
- zero GHG emissions from coal thermal facilities;
- ensure clean or renewable electricity generation continues to account for at least 90% of total generation (Currently in BC, 90% of electricity is from clean or renewable resources); and
- no nuclear power.

Achieving these goals will be difficult, and implementation details have not yet been provided.

The plan further notes the potential for biomass to generate energy (bioenergy). Wood residue, agricultural waste, municipal solid waste and other biomass may be considered a carbon-neutral form of energy because the carbon dioxide released by the biomass when converted to energy is equivalent to the amount absorbed during its lifetime. This type of energy is considered firm, and the plan estimates the cost of additional biomass-based electricity capacity at $75 – $91/MWh.[6]

The BC Bioenergy Strategy is the supporting document to the BC Energy Plan.[7] This strategy provides detail on how municipal solid waste could potentially provide energy to BC. The case studies provided in the strategy focus on the capture and use of LFG (at Hartland Landfill , and at the Vancouver Landfill in Delta) and the WTE facility in Burnaby. The strategy earmarks municipal solid waste as a source of green energy with "endless potential". The "next step" identified in the report is for the development of requirements for methane capture at landfills (which has been mandated under the recently enacted Landfill Gas Regulation).

It is our interpretation that the BC Bioenergy Strategy only considers the biogenic portion of the solid waste stream as having potential to generate green electricity. Therefore, any WTE system will need to determine what portion of the MSW is from fossil based sources and find carbon offsets for the electricity produced by this waste. In the case of district heating, this is fairly easy to do, since a lot of natural gas use would be displaced by the district heat, resulting in carbon credits. If Electricity only is produced, then carbon offsets may have to be purchased to make the

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3 British Columbia Ministry of Energy, Mines and Petroleum Resources. (2008). *The BC Energy Plan: A Vision for Clean Energy Leadership.* Accessed August 24, 2008. http://www.energyplan.gov.bc.ca/

4 British Columbia Ministry of Energy, Mines and Petroleum Resources. (2008). *The BC Energy Plan: A Vision for Clean Energy Leadership.* Accessed August 24, 2008. http://www.energyplan.gov.bc.ca/

5 British Columbia Ministry of Energy, Mines and Petroleum Resources. (2008). *The BC Energy Plan: A Vision for Clean Energy Leadership.* Accessed August 24, 2008. http://www.energyplan.gov.bc.ca/

6 British Columbia Ministry of Energy, Mines and Petroleum Resources. (2008). *The BC Energy Plan: A Vision for Clean Energy Leadership.* Accessed August 24, 2008. http://www.energyplan.gov.bc.ca/

7 British Columbia Ministry of Energy, Mines and Petroleum Resources. (2008). *BC Bioenergy Strategy Growing Our Natural Energy Advantage.* Accessed August 24, 2008. http://www.energyplan.gov.bc.ca/bioenergy/

electricity generation GHG neutral. This interpretation is only an opinion and needs to be verified with the Ministry of Environment in the case that WTE is pursued.

It should also be mentioned that WTE directly reduces GHG emissions from landfills by removing the source of the landfill gas emissions. This is taken into account in the GHG balances presented in this report; however it is not clear at this time how the MOE would calculate these GHG reductions.

Internationally, WTE is generally considered to be GHG neutral provided minimum electrical and heat recovery efficiencies are achieved. This differs in each jurisdiction depending on local conditions and legislation. In the USA for example, the federal EPA considers WTE to provide clean, renewable energy, and almost half of all US states do the same.

GHG Emissions from Tri-Regional District MSW

Waste management activities currently contribute about 5% to BC's GHG emissions, and un-captured landfill gas is by far the greatest source of GHG emissions coming from waste management activities. WTE can substantially reduce the amount of landfill gas produced.

As an energy producer, WTE will likely be judged on the amount of renewable energy it can produce, i.e., from biogenic carbon. If kitchen organics are removed and biosolids added to the WTE feedstock, then the biogenic portion can be expected to be in the 60% range. The carbon produced by making electricity from the fossil fuel portion of the waste stream may have to be offset by displacing natural gas use for heating or by buying carbon credits. A formal policy on this from the Provincial Government is not yet known and needs to be confirmed in the future.

The nature of GHG emissions from MSW is dependent on the carbon origin of the waste, i.e., carbon from fossil fuel origins versus carbon of biogenic origin. For WTE, the GHG emissions are related to the amount of fossil carbon in the waste from materials derived from geologic reserves of carbon like coal, natural gas, or petroleum, which is primarily found as plastics. For landfills, the GHG content is related to the amount of biogenic carbon from materials derived from "recently grown" biological sources, which includes paper, lumber, food scraps, and yard waste.

GHG Emissions from WTE

The GHG emissions from thermal process were estimated based on the amount of fossil and biogenic carbon in the MSW from waste composition studies and current total CO_2 emissions from Metro Vancouver's WTE facility.

Emissions from Metro Vancouver's WTE facility is determined through an analysis of the stack gas CO_2 content and the flow rates through each of the three lines. 2005 data waste used and indicated a total carbon dioxide emission rate of 1,157 kg per tonne of MSW. As indicated above, the biogenic portion of the waste is expected to be in the 60% range and the fossil carbon portion is estimated to be 40%. Therefore, the carbon dioxide emission for the fossil carbon portion of the MSW is 463 kg per tonne.

GHG Emissions from Landfilling

The anaerobic decomposition of organic matter generates landfill gas (LFG). LFG comprises of two greenhouse gases (methane and carbon dioxide). The rate and quantity of LFG generation is a function of many factors including the moisture content of the waste, the composition of the waste, the landfill conditions (pH, temperature, moisture content, compaction, etc.) and other factors. Evaluating the gas generation based on these factors is an on-going area of research.

For this study the LFG emissions were estimated using a computational model developed by the U.S. EPA called LandGEM (Landfill Gas Emissions Model) Version 3.02.[8] The LandGEM model is a spreadsheet-based tool that generates a forecast of LFG emissions based on inputs of waste deposition and defined model parameters.

There are two key parameters of the LandGEM model: k and L_0. The rate at which LFG is generated (i.e., the lag between waste deposition and gas generation) is described by k. The value of k does not affect the total amount of LFG estimated by the model, and is therefore not critical to the results of the greenhouse gas emission analysis since the objective is to determine the total quantity of methane and carbon dioxide generated from a tonne of MSW, and not the quantity generated in a specific year.

The second key parameter of this model is L_0, the methane gas generation potential. This parameter indicates the ultimate methane generation possible from the waste (units of methane production in m^3 per mass of waste). The U.S. EPA recommended figure for a traditional landfill in a wet region (such as on Vancouver Island) is 100 m^3 methane per tonne MSW. Based on the waste composition and previous studies for Metro Vancouver, an L_0 value of 98 m^3 of methane per tonne MSW was calculated and used in this study.

LFG is nominally composed of 50% methane and 50% carbon dioxide. There are many other contaminants associated with LFG and the LandGEM model includes standard concentrations of 48 other compounds. These have been included at their default concentrations.

To obtain an "apples to apples" comparison, we assumed that a new landfill with a disposal rate of 200,000 tonnes per year that commences operating in 2015 and operates for 25 years. If the existing two landfills were taken into consideration for this analysis, the GHG emission would be considerably higher (approximately 50% higher) primarily because of the previously deposited waste that is continuing to decompose.

It was also assumed that the new landfill would have a 75% LFG capture rate which is typical of newly designed bioreactor landfills. This is consistent with the recent environmental assessment completed for the proposed landfill at Logan Lake (or Highland Valley Copper) which predicts a 75% capture rate. The Vancouver Landfill has been modeled as achieving an average 75% average capture rate for LFG from now until closure. A recent study conducted by CH2M Hill on behalf of the City of Vancouver estimated a capture rate in the range of 65 to 90%.[9] A recent U.S. EPA report suggested 75% as an average value.[10] A 75% capture rate means that 25% of the LFG is not captured.

For this analysis, carbon storage in landfills is not included (i.e., carbon storage is set to 0 kg CO_2e per tonne of MSW), since even hard to decompose materials would be expected to undergo some degradation.[11] The US EPA is currently studying this issue, but has not yet officially recognized the potential for carbon storage. The IPCC's 2006 Guidelines include carbon storage as an "informational item", meaning that the data can be collected but does not form part of the inventory.[12]

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8 U.S. EPA (2005). LandGEM Model V3.02, *posted to EPA software download site (http://www.epa.gov/ttn/catc/software) 5-12-05. Downloaded May 2006. User's Guide (EPA-600/R-05/047) downloaded May 2005.*

9 CH2M Hill. (2009). *Comparison of Greenhouse Gas Emissions from Waste-to-Energy Facilities and the Vancouver Landfill.* Prepared for the City of Vancouver.

10 Background Information Document for Updating AP42 Section 2.4 for Estimating Emissions from Municipal Solid Waste Landfills", EPA/600/R-08-116, September 2008 on page 7 (http://www.epa.gov/ttn/chief/ap42/ch02/draft/db02s04.pdf)

11 *Note that although fossil carbon in MSW is not released, this does not constitute a sequestration activity. Sequestration occurs when atmospheric carbon is removed from the atmosphere and kept from being released back into circulation. The creation of plastics and other MSW from fossil carbon has not removed carbon from the atmosphere; the carbon in these materials has been transported from one reserve (petroleum reservoir) to another (landfill)."*

12 Intergovernmental Panel on Climate Change (IPCC). (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5 – Waste, Chapter 2 – Waste Generation, Composition and Management Data.* Accessed August 26, 2008. http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf

The expected change in future LFG generation due to the implementation of source segregated organics programs that reduce the quantity of gas generating putrescibles from entering the landfill has been accounted for in the calculations and estimates.

Captured LFG is assumed to be burned in an internal combustion engine (similar to that used at the Vancouver Landfill) to generate electricity. It is also assumed that the heat is not recovered. This analysis assumed best case conditions where 90% of the captured landfill gas is combusted in an internal combustion engine and 10% is flared. The GHG emissions rate for a 200,000 tonne per year landfill is calculated to be 549 kg CO_2 equivalents per tonne MSW.

GHG Emissions from Transportation

Transportation is not a substantial source of GHG emissions in any scenario. This is because the fossil fuel consumption for transportation is relatively low. Only the Gold River scenario has a notable GHG emission. The GHG emissions from the transportation of MSW are based on figures from the transportation analysis in Section 3. The GHG emission levels are also based on the transfer haul option and dependent on the location of the WTE facility.

Avoided Greenhouse Gas Emissions

In addition to calculating the direct GHG emissions resulting from landfilling or WTE, it is also necessary to account for emissions that are avoided elsewhere as a result of the energy that is recovered. Avoided greenhouse gas emissions represent energy outputs that displace or replace the need to use energy from coal, natural gas, oil, hydro or nuclear sources. The carbon dioxide emissions that are avoided vary depending on the type of energy being displaced and the local area. The GHG emission displacement by energy source is summarized in Table 12 below.

Table 12. Greenhouse Gas Emission Factors

Energy Source	Emission Factor	Units
Electricity (hydro-electric in BC)	0.022	Kg CO_2e per kWh
Heating (natural gas combustion)	50.3	Kg CO_2e per GJ
Ethanol combustion	1.66	Kg CO_2e per litre
Diesel combustion	2.73	Kg CO_2e per litre

The relatively low emission factor for electricity is based on the present GHG intensity of electricity generated in BC, which uses limited amounts of fossil fuel. In Alberta where electricity comes from coal fired power plants, the emission factor is much higher. The higher avoided GHG emissions come from the avoided emissions from district heating, which is assumed to offset a combination of natural gas fired boilers and electric heat. Ethanol can be utilized as a vehicle fuel and replace diesel. The energy content of ethanol is about 61% of diesel.

Summary of Greenhouse Gas Emissions

The GHG emissions and respective off-sets were compiled to assess the net GHG emission for each option. The options include a local landfill that has the same capacity as the proposed WTE facilities, nine local WTE options and one out of region WTE option in Gold River, BC. Figure 14 summarizes the GHG emissions and the star on each bar graph represents the net GHG emission. It should be noted that landfill gas captured for the local landfill scenario is utilized to generate electricity and is accounted for in the electricity off-set.

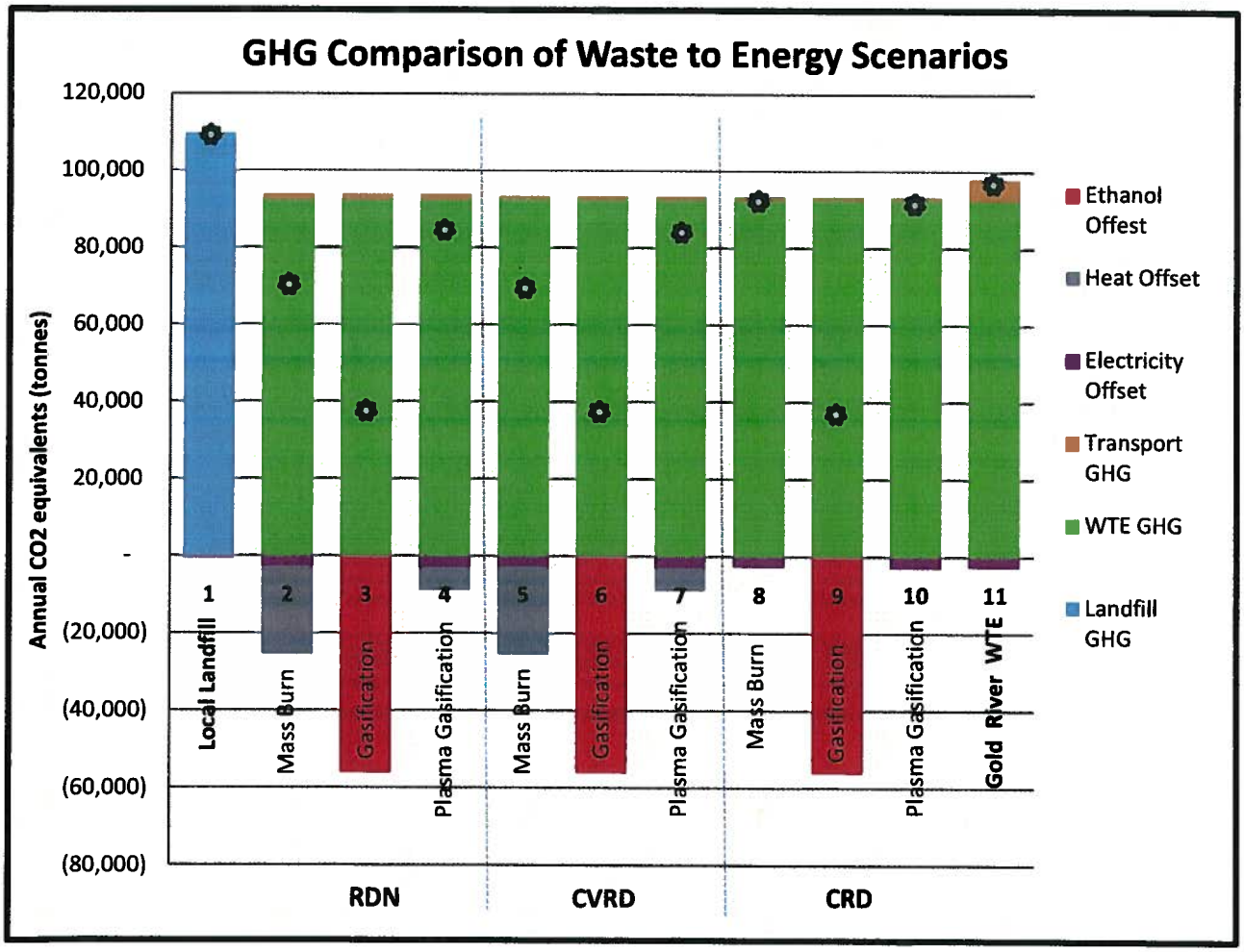
The conclusion is that landfilling, even with landfill gas recovery and utilization, produces more GHG than WTE. Under the WTE options, the technologies that generate fuels used to offset fossil based natural gas or diesel has the

greatest benefits. BC's electricity has such a low carbon density that there are few carbon offsets that can be achieved from new electricity generation.

For this analysis, and to demonstrate a variance in the options, conventional gasification was shown as converting syngas to liquid fuel, and plasma gasification, due to its higher temperatures and claimed gas cleaning characteristics of the plasma, was shown producing electricity with a high efficiency. Plasma gasification systems are equally suitable for creating syngas that can be converted into fuel, thus they could achieve the same GHG levels as conventional gasification systems.

It should also be noted that the Gold River option is based on electricity production only. The proponent of the Gold River facility has indicated that there may be the possibility in the future of also providing steam to industrial users in the vicinity of the plant. If that becomes reality, then the GHG values for the Gold River option would improve, and likely be similar to the options that produce electricity and district using mass burn WTE.

Figure 14. GHG Emissions Scenarios



7. Summary and Conclusions

Combining the solid waste that is expected to be generated in the CRD, CVRD and RDN after organics and recycling have been maximized, leaves about 225,000 tonnes per year that need to be treated and/or disposed. WTE could conceivably treat about 200,000 tonnes per year and extract the energy from this waste.

Technologies were assessed for 200,000 tonnes per year of feedstock, including dried biosolids. The technologies considered for further review and analysis were:

- mass burn;
- gasification; and
- plasma gasification.

Four locations that could possibly host a WTE facility were also reviewed:

- CRD;
- CVRD;
- RDN; and
- out of region – private facility in Gold River.

A single WTE facility would have adequate economies of scale to employ the most proven combustion technology – mass burn. However, it is still not at an optimum size from a pricing perspective, which would be about three times larger. The out of region WTE facility being offered in Gold River falls into a desirable economy of scale range because it also plans to accept waste from other regions. However, there is additional cost involved in getting the waste to Gold River.

Mass burn is the technology that is most proven and can be used to generate electricity and supply district heat to potential users. It has been agreed that mass burn would provide electricity and district heat at the RDN and CVRD locations, otherwise only electricity at CRD and Gold River.

Gasification and plasma gasification offer alternate technologies that create a syngas that can be cleaned and used as raw material:

- combusted in reciprocating engines to achieve higher electrical efficiency, plus district heat where markets exist; and
- converted to ethanol and sold on the open market.

From a transportation perspective, the site closest to where most of the waste is generated (i.e., CRD area) offers the lowest transportation costs. Transfer haul is the lowest cost form of transporting waste for all options (compared to direct haul, rail haul, and barge transport). Transfer haul also has the lowest fuel consumption, produces the least GHG emissions and the most flexibility for backhauling. *Note: Barge haul numbers may change if more precise data becomes available after release of this draft report.*

New transfer stations would be needed for all scenarios, and this has been factored into the review. Existing transfer stations would continue to operate, except if the facility were to be located in Duncan, in which case the local transfer station would be needed only for recycling and stewardship programs.

There is a fairly large variation in unit costs for the different technologies. Break-even tipping fees for the thermal technologies and out of region option could be summarized in the following manner:

- mass burn $84 to $98 per tonne (the latter without district heat);
- gasification to ethanol $136 per tonne;

- plasma gasification to electricity and district heat $152 to $155 per tonne; and
- private mass burn facility in Gold River $42 per tonne.

When transportation costs are taken into consideration, the total unit costs are similar for all sites using the same technology. For example; mass burn costs range from $111 (Gold River) to $119 (CRD), with CVRD at $116 and RDN at $115 per tonne. Small changes in capital costs, transportation costs, energy recovery efficiency and markets can easily change the order of costs.

It should also be noted that locating a WTE in the CRD that has heat and steam recovery opportunities could reduce the total unit cost by $14 per tonne. At initial glance, this would make this option the lowest cost option at $105.

To determine the most suitable technology and location, it would be prudent to either conduct a very detailed study that selects technology, site and conducts conceptual designs and equipment selection, or a competitive process that refines capital costs, operating costs and revenues.

8. Recommendations

Mass burn is the proven technology and gasification is somewhat proven, but still carries some financial and technical risk with implementation. It will be necessary to decide what level of risk is acceptable to the three regions if the advantages of gasification and or plasma gasification are appealing. It is recommended to verify the appetite for risk, and to further research, review and to visit existing gasification and plasma gasification facilities operating commercially before including them in a public selection process.

If mass burn is seriously being considered, it is recommended that the three regional districts continue to cooperate to maintain the current economies of scale. This would likely not be necessary if waste is shipped out of region to a private facility.

Out of region WTE may, in a public competitive process, be very attractive. It should be considered that the out of region WTE facility will only be built if other sources of waste are available, i.e., the availability of this option is dependent on events out of the regions' control.

The out of region WTE option may also become more attractive financially if barging costs can be more closely defined. It is recommended to conduct further research in co-operation with the proponent into barging costs, understanding that this option is only viable if other contracts (i.e., with Metro Vancouver) are in place.

If an in-region WTE facility is preferred, it is recommended to give preference to a site that offers the greatest potential for district heat. This is essential in the case of combined heat and power technologies. If ethanol production is preferred (only possible with gasification or plasma gasification), then the CRD area offers the preferred location and should be considered.

Biosolids, provided they are dried adequately, should be considered as additional fuel, since it increases the biogenic content in the feedstock and improve the overall GHG balance.

AECOM

Appendix A

Transportation Analysis Calculations

Transportation Analysis Calculations

Evaluation of these transportation options:

Transportation Option	Transportation Description
Direct Haul	Use of collection truck to transport MSW to potential WTE sites (smaller loads, less fuel efficient and higher operating costs)
Transfer Haul	Use of tractor trailers to transport MSW from a central collection point (i.e., transfer station) to potential WTE sites
Rail Haul	Use of the railway system to transport MSW to a potential WTE site
Barge Haul	Use of a barging system to transport MSW to a potential WTE site

The road distances and travel times for each site scenario can be summarized in the following manner.

WTE Site Scenario	Distance	Travel Time
Regional District of Nanaimo		
Church Rd. TS to WTE site	53 km	40 minutes
Duncan to WTE site	53 km	42 minutes
CRD TS to WTE site	118 km	103 minutes
Cowichan Valley Regional District		
Church Rd TS to WTE site	88 km	68 minutes
RDN TS to WTE site	53 km	42 minutes
CRD TS to WTE site	60 km	56 minutes
Capital Regional District		
Church Rd TS to WTE site	148 km	124 minutes
RDN TS to WTE site	118 km	103 minutes
Bings Creek TS to WTE site	60 km	56 minutes
Gold River WTE Facility		
Church Rd. TS to Gold River WTE site	222 km	151 minutes
RDN TS to Gold River WTE site	275 km	191 minutes
Bings Creek TS to Gold River WTE site	310 km	219 minutes
CRD TS to Gold River WTE site	370 km	275 minutes

The railway system on Vancouver Island is managed by Southern Railway of Vancouver Island (SRVI) and runs between the Cities of Victoria and Courtney. There is also a section that runs between the Parksville and Port Alberni. The railway company's primarily business is to move goods on and off the island. As part of that service, SRVI also moves railcars up and down the island. Most of the commercial railway service on Vancouver Island is between Cowichan Valley and Nanaimo.

The barge haul option is based on the transportation system that the Gold River proponent is proposing for Metro Vancouver's solid waste. It is a network of barges and tugboats that run continuously between Gold River and Metro Vancouver. The barging system would be owned and operated by the Gold River proponent. It is approximately 360 km and takes a tugboat and barge approximately 24 hours to travel from the Victoria/Esquimalt shoreline to Gold River.

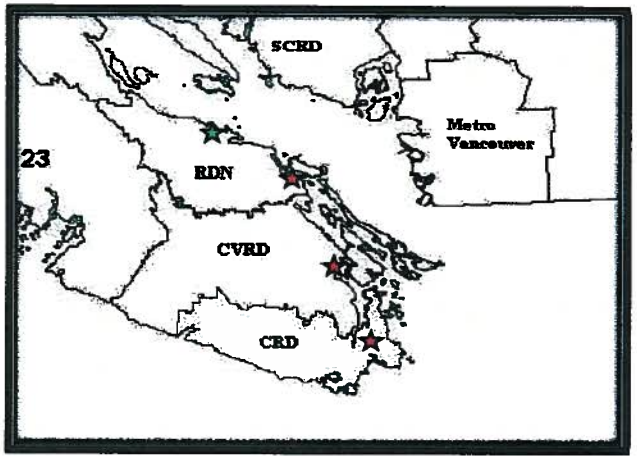
Direct Haul Analysis

Assumptions:

Collection routes not included in the transportation analysis.
Transportation analysis starts from where waste is typcially dropped off (i.e. TS or Landfill)
Vehicles used are deisel trucks and unit price for deisel is $1.20 per Litre
Collection trucks have an average load size of 5 tonnes per load
Average fuel economy of collection trucks is 0.7 km/L (~1.86 mpg)
Unit operating cost for a driver and collection truck is $100/hr
Waste transfer volumes to be provided by RD staff

Waste quantities collected from the local areas where potential site would be located is assumed to require no additional transporation.

Factors for Calculation		
Collection Truck Average Load Size:	5	tonnes/load
Unit Operating Cost (Truck and Driver):	$ 100.00	per hour
Collection Truck Fuel Economy:	0.7	km/L
Diesel Fuel Cost:	$ 1.20	per litre



	Distance (mi)	Distance (km)	Travel Time	Waste transferred (t/yr)	Truck Loads to travel (# truck/yr)	Fuel Use (L/yr)	Annual Operating cost (Truck and Driver)	Annual Fuel cost	Annual Fuel and Operating Cost ($/yr)	Transport cost per tonne	System Wide Unit Cost
Capital Regional District											
Duncan to Hartland Landfill	36.5 miles	61 km	56 minutes	30,119	6,024	1,046,986.04	$ 1,124,434.32	$ 1,256,383.24	$ 2,380,817.56	$ 79.05	
Nanaimo to Hartland Landfill	71 miles	118 km	103 minutes	42,062	8,412	2,844,188.69	$ 2,888,253.58	$ 3,413,026.43	$ 6,301,280.01	$ 149.81	
Church Rd TS to Hartland Landfill	89 miles	148 km	124 minutes	20,000	4,000	1,695,238.10	$ 1,653,333.33	$ 2,034,285.71	$ 3,687,619.05	$ 184.38	
TOTAL = Operating and Fuel Cost				92,181		5,586,412.82	$ 12,369,716.62	$ 6,703,695.39	$ 19,073,412.01	$ 206.91	$ 88.18
Cowichan Valley Regional District											
Church Rd TS to Duncan	53 miles	88 km	68 minutes	20,000	4,000	1,009,523.81	$ 906,666.67	$ 1,211,428.57	$ 2,118,095.24	$ 105.90	
Nanaimo to Duncan	32 miles	53 km	42 minutes	42,062	8,412	1,281,887.86	$ 1,177,734.47	$ 1,538,265.43	$ 2,715,999.90	$ 64.57	
Victoria to Duncan	36 miles	60 km	56 minutes	124,123	24,825	4,255,630.55	$ 4,633,908.83	$ 5,106,756.67	$ 9,740,665.49	$ 78.48	
TOTAL = Operating and Fuel Cost				186,185		6,547,042.22	$ 14,574,760.63	$ 7,856,450.67	$ 22,431,211.30	$ 120.48	$ 103.70
Regional District of Nanaimo											
Church Rd TS to Duke Point	32 miles	53 km	40 minutes	20,000	4,000	609,523.81	$ 533,333.33	$ 731,428.57	$ 1,264,761.90	$ 63.24	
Victoria to Duke Point	71 miles	118 km	103 minutes	124,123	24,825	8,393,049.15	$ 8,523,082.31	$ 10,071,658.98	$ 18,594,741.29	$ 149.81	
Duncan to Duke Point	32 miles	53 km	42 minutes	30,119	6,024	917,905.57	$ 843,325.74	$ 1,101,486.68	$ 1,944,812.42	$ 64.57	
TOTAL = Operating and Fuel Cost				174,241		9,920,478.53	$ 21,804,315.61	$ 11,904,574.23	$ 33,708,889.84	$ 193.46	$ 155.84
Gold River WTE Site									$ -		
Church Rd to Gold River		222 km	151 minutes	20,000	4,000	2,537,142.86	$ 2,013,333.33	$ 3,044,571.43	$ 5,057,904.76	$ 252.90	
Arboretum to Gold river		275 km	191 minutes	42,062	8,412	6,609,734.28	$ 5,355,887.71	$ 7,931,681.13	$ 13,287,568.85	$ 315.90	
Duncan to Gold River		310 km	219 minutes	30,119	6,024	5,335,326.11	$ 4,397,341.36	$ 6,402,391.33	$ 10,799,732.68	$ 358.57	
Hartland landfill to Gold River		370 km	275 minutes	124,123	24,825	26,243,055.09	$ 22,755,802.27	$ 31,491,666.11	$ 54,247,468.38	$ 437.05	
TOTAL = Operating and Fuel Cost				216,303		40,725,258.33	$ 34,522,364.68	$ 48,870,309.99	$ 83,392,674.67	$ 385.54	$ 385.54

Truck Transfer Haul Analysis

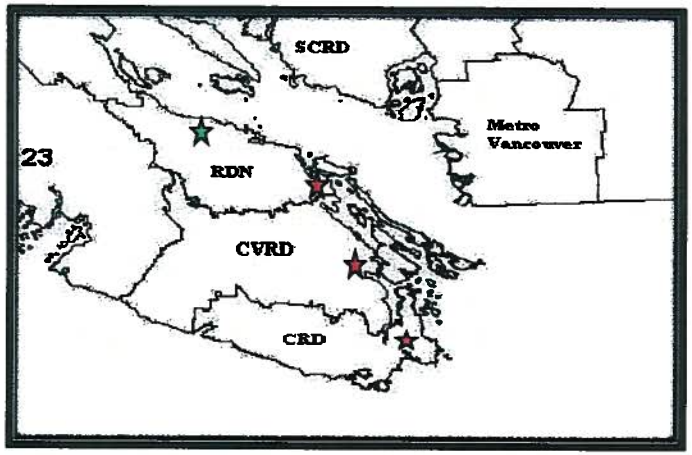
Assumptions:

Collection routes not included in the transportation analysis.
Transportation analysis starts from where waste is typcially dropped off (i.e. TS or Landfill)
Transfer vehicles are deisel trucks and unit price for deisel i
Transportation analysis starts from where waste is typcially dropped off (i.e. TS or Landfill)
Average fuel economy of tranfer trucks is 2.5 km/L (~5.86 mpg)
Unit operating cost for a driver and truck is $100/hr
Waste transfer volumes to be provided by RD staff

Waste quantities collected from the local areas where potential site would be located is assumed to require no additional transporation.

CRD transfer station is assumed to be located at Hartland Landfill
(although a TS near the city would have savings).

Backhaul opportunities not taken into consideration.



Factors for Calculation	
Collection Truck Average Load Size:	27 tonnes/load
Unit Operating Cost (Truck and Driver):	$ 100.00 per hour
Transfer Truck Fuel Economy:	2.5 km/L
Diesel Fuel Cost:	$ 1.20 per litre

	Distance (mi)	Distance (km)	Travel Time	Waste transferred (t/yr)	Truck Loads to travel (# truck/yr)	Fuel Use (L/yr)	Annual Operating Cost (Truck, Driver and Fuel)	Unit Transport Cost ($/t)	Unit Transfer Station Cost ($/t)	Total Transfer Haul Unit Cost ($/t)	Total Transfer Haul Cost ($)	System Wide Unit Cost ($/t)
Capital Regional District											-	
Duncan to Hartland Landfill	36 miles	60 km	56 minutes	30,119	1116	53,544	$ 272,482	$ 9.05	$ 22.62	$ 31.67	953,756.91	
Nanaimo to Hartland Landfill	71 miles	118 km	103 minutes	42,062	1558	147,476	$ 711,834	$ 16.92	$ 43.14	$ 60.06	2,526,261.16	
Church Rd TS to Hartland Landfill	89 miles	148 km	124 minutes	20,000	741	87,901	$ 411,654	$ 20.58	$ 23.95	$ 44.53	890,554.32	
TOTAL = Operating and Fuel Cost				92,181		288,922	$ 1,396,106	$ 15.14	$ 32.27	$ 47.41	4,370,572.39	$ 20.21
Cowichan Valley Regional District											-	
Church Rd TS to Duncan	53 miles	88 km	68 minutes	20,000	741	52,346	$ 230,716	$ 11.54	$ 23.95	$ 35.48	709,616.05	
Nanaimo to Duncan	32 miles	53 km	42 minutes	42,062	1558	66,468	$ 297,861	$ 7.08	$ 43.14	$ 50.22	2,112,288.53	
Victoria to Duncan	36 miles	60 km	56 minutes	124,123	4597	220,662	$ 1,122,926	$ 9.05	$ 22.71	$ 31.76	3,942,146.01	
TOTAL = Operating and Fuel Cost				186,185		339,476	$ 1,651,620	$ 8.87	$ 27.46	36.33	6,764,050.59	$ 31.27
Regional District of Nanaimo											-	
Church Rd. TS to Duke Point	32 miles	53 km	40 minutes	20,000	741	31,605	$ 136,691	$ 6.83	$ 23.95	$ 30.78	615,591.36	
Victoria to Duke Point	71 miles	118 km	103 minutes	124,123	4597	435,195	$ 2,100,583	$ 16.92	$ 22.71	$ 39.64	4,919,802.70	
Duncan to Duke Point	32 miles	53 km	42 minutes	30,119	1116	47,595	$ 213,286	$ 7.08	$ 22.62	$ 29.70	894,560.50	
TOTAL = Operating and Fuel Cost				174,241		514,395	$ 2,450,660	$ 14.06	$ 22.84	36.90	6,429,954.56	$ 29.73
Gold River WTE Site											-	
Church Rd to Gold River		222 km	151 minutes	20,000	741	131,556	$ 530,706	$ 26.54	$ 23.95	$ 50.48	1,009,606.17	
Arboretum to Gold river		275 km	191 minutes	42,062	1558	342,727	$ 1,403,103	$ 33.36	$ 43.14	$ 76.50	3,217,531.06	
Duncan to Gold River		310 km	219 minutes	30,119	1116	276,647	$ 1,146,298	$ 38.06	$ 22.62	$ 60.68	1,827,573.26	
Hartland landfill to Gold River		370 km	275 minutes	124,123	4597	1,360,751	$ 5,846,939	$ 47.11	$ 22.71	$ 69.82	8,666,158.62	
				216,303		2,111,680	$ 8,927,047	$ 41.27	$ 26.79	68.06	14,720,869.11	$ 68.06

Rail Haul Analysis

Assumptions:

1. Waste is shipped by intermodal containers
2. Intermodal containers are double stacked on flatbed railcars
3. Some transfer stations will need to be retrofitted with compactors
4. CRD needs to build a TS at the Hartland Landfill and waste delivereed to an intermodal yard
5. Intermodal transport only apply from RDN to CRD sites.
6. Assume Arboretum is about 8 km from an intermodal yard with a rail spur.
7. Intermondal containers hold 27 tonnes of waste
8. CVRD waste is transfer hauled directly because of proximity to RDN or CRD site (50-60 km)
9. Waste quantities based on 2015 projections.
10. Fuel and operating cost from CVRD to WTE site included in rail haul assessment.
11. For Gold River option, railway only runs up to Courtenay, BC (therefore need to transfer haul 160 km to Gold River|

Rail haul about 120 km between Victoria and Arboretum and at an average speed of 50 km/hr. Hence, round trip travel about 5 hours. Fuel consumption based on locomotive consumption rate of 200 gallons per hour. Therefore, round trip travel consumes 1000 gallons or 3780 litres of deisel fuel.

Fuel consumption:	3,780 L/trip

Railcars transported ranges from 9 to 18 per day, and operates 5 days per week. This is well below the capacity of the locomotive.

Annual Rail Fuel Consumption:	982,800 L/yr

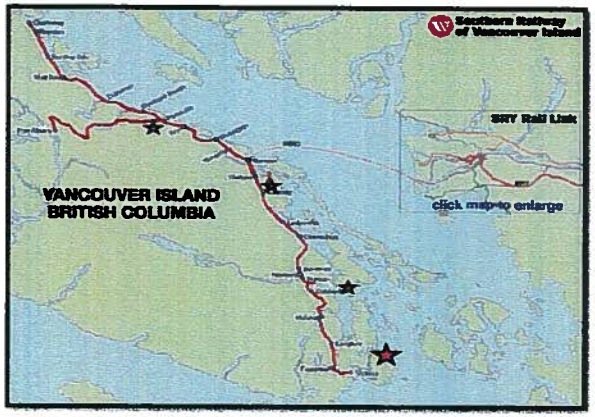
Rail haul delivery cost (by SRY Rail) estiamted at $1050 per railcar. Each railcar holds about 54 tonnes.

Unit Rail Delivery Cost:	$ 19.44 per tonne

Loading and Unloading containers at intermodal yard estimated to cost $1.50 per tonne for each side.

Rail haul to Courtenay about 190 km from Victoria and at an average speed of 50 km/hr. Therfore, round trip travel under 8 hours. Fuel consumption based on locomotive consumption rate of 200 gallons per hour. Therefore, round trip travel consumes 1520 gallons or 5745 litres of deisel fuel.

Fuel consumption:	5,745 L/trip	or	1,493,700 L/yr



Factors for Calculation		
Collection Truck Average Load Size:	27	tonnes/load
Unit Operating Cost (Truck and Driver):	$ 100.00	per hour
Collection Truck Fuel Economy:	2.1	km/L
Diesel Fuel Cost:	$ 1.20	per litre

	Distance (mi)	Distance (km)	Travel Time	Waste transferred (t/yr)	Intermodal containers to move	Annual fuel consumed to deliver containers (L/yr)	Unit cost to deliver to Intermodal Yard and load ($/t)	Railway cost from Pt. A to Pt. B ($/t)	Unit cost to deliver from intermodal to WtEF and unload ($/t)	Annual fuel consumption to deliver from intermodal yard to WTE site (L/yr)	Ammortized Intermodal Yard cost ($)	Unit cost for railcars ($/t)	Transfer Station Unit Cost ($/t)	Total Cost per Tonne	System Wide Unit Cost ($/tonne)
Capital Regional District						FUEL				FUEL					
Duncan to Hartland Landfill	36 miles	60 km	50 minutes	30,119	1,116	63,743.4	$ 8.71						$ 22.62	$ 31.33	
Arboretum to Intermodal Yard	0 miles	8 km	10 minutes	42,062	1,558	11,869.3	$ 3.07	$ 19.44	$ 5.43	29,673.33	473,400.00	$ 1.91	$ 43.14	$ 73.00	
Church Rd TS to Intermodal Yard	32 miles	53 km	40 minutes	20,000	741	37,389.8	$ 7.18	$ 19.44	$ 5.43	14,109.35	473,400.00	$ 1.91	$ 23.95	$ 57.91	
TOTAL = Operating and Fuel Cost				92,181	3,414	113,002.5				43,782.68	946,800.00			$ 66.38	$ 28.29
Cowichan Valley Regional District															
Church Rd TS to Duncan	53 miles	88 km	68 minutes	20,000	741										
Nanaimo to Duncan	32 miles	53 km	42 minutes	42,062	1,558										
Victoria to Duncan	36 miles	60 km	56 minutes	124,123	4,597										
TOTAL = Operating and Fuel Cost				186,185											
Regional District of Nanaimo															
Church Rd. TS to Arboretum	32 miles	53 km	40 minutes	20,000	741	37,624.9	$ 7.20						$ 23.95	$ 31.14	
Hartland landfill to Victoria intermodal yard	12 miles	20 km	25 minutes	124,123	4,597	87,564.4	$ 5.43	$ 19.44	$ 3.07	35,025.77	946,800.00	$ 1.72	$ 22.71	$ 52.38	
Duncan to Arboretum	32 miles	53 km	40 minutes	30,119	1,116	56,660.8	$ 7.20						$ 22.62	$ 29.82	
TOTAL = Operating and Fuel Cost				174,241	6,453	181,850.18				35,025.77	946,800.00			$ 51.48	$ 41.47
Gold River WTE Site															
Church Rd to Gold River		222 km	151 minutes	20,000	741	156,613.8	$ 28.04						$ 23.95	$ 51.98	
Arboretum to Gold River		275 km	191 minutes	42,062	1,558	408,008.3	$ 35.22						$ 43.14	$ 78.36	
Duncan to Victoria Intermodal yard		25 km	25 minutes	30,119	1,116	26,559.8	$ 5.64	$ 22.36	$ 21.85	169,982.51	473,400.00	$ 1.69	$ 22.62	$ 74.16	
Hartland landfill to Victoria Intermodal yard		20 km	25 minutes	124,123	4,597	87,564.4	$ 5.43	22.36	$ 21.85	700,515.32	236,700.00	1.69	$ 22.71	$ 74.04	
				216,303	8,011	678,746.2				870,497.83	710,100.00			$ 76.14	$ 76.14

Estimation for Transfer Station Costs

Transfer Stations		Annual Design Capacity (t/yr)	Daily Design Capacity (t/d)	Capital Cost ($M)	Annual Amortized Cost (over 25 years)	Unit Catipal Cost ($/t)	Unit Operating Cost ($/t)	Unit Transfer Station Cost ($/t)
	Church Road	20,000	100	1.0	$ 78,900	3.9	20	23.9
	Arboretum	42,062	150	15.0	$ 1,183,500	28.1	15	43.1
	Bings Creek	30,119	100	1.0	$ 78,900	2.6	20	22.6
	Hartland Landfill	124,123	400	20.0	$ 1,578,000	12.7	10	22.7
	Barge Loading TS	216,300	750	45.0	$ 3,550,500	16.4	12	28.4

Note: At 6% interest, the annual payments for every $1M borrowed (over a 25 year amortization period) is $78,900.
Barge loading transfer station includes $15M for waterfront industrial property and $30M for TS building.
Assume barge loading TS unit operating cost is $10/t plus $2/t for barge loading and wrapping.

Intermodal Yards		Facility Size (Ha)	Unit Property Price ($M/ha)	Property Price ($M)	Site Improvements ($M)	Annual Amortized Cost (over 25 years)	Property Cost ($)
	Nanaimo	1	4	4.0	2.00	$ 473,400.00	$ 6,000,000.00
	Victoria	1	4	4.0	2.00	$ 473,400.00	$ 6,000,000.00
	Courtenay	2	1	2.0	1.00	$ 236,700.00	$ 3,000,000.00

Barge Haul Analysis

Barge travel from Metro Vancouver to Gold River ~ 500 km
Barge travel from Victoria to Gold River ~ 360 km

Tug boat and barge speed ~ 15 km/hr
Tugboat fuel consumption ~ 200 GHP

Travel time:

Gold River to Metro Vancouver	33.3	hrs	(~1.5 days)
Gold River to Victoria Habour:	24	hrs	(1 day)

Tugboat Fuel Consumption (diesel):

Gold River to Metro Vancouver	25,200 L/trip	2,620,800	L/yr/tug
Gold River to Victoria Habour:	18,144 L/trip	1,886,976	L/yr/tug

Round-Trip Tugboat Cost (assume $4000/hr)

Gold River to Arboretum:	$ 266,667 /trip	$ 13,866,666.67	/yr
Gold River to Victoria Habour:	$ 192,000 /trip	$ 9,984,000.00	/yr

Total Fuel Consumption (annual):

Tug and Barge Fuel Consumption:	1,886,976	24% of total
Transfer trailer fuel consmption:	308,298.36	
	2,195,274	L/year

Total annual operating cost:

Tug and Barge Annual Cost:	$ 3,095,600.00	30% of total
Transporation and Loading:	$ 8,058,134.27	
Truck and Fuel Cost:	$ 2,634,329.23	
	$ 13,788,063.50	per year

Staffing on Tugboat:	5	crew member
Shifts per tugboat:	2	shifts
Crew Salary:	$ 80,000.00	per year
Number of Tugboats:	3	
Crew Operating Cost:	$ 2,400,000.00	per year
Tugboat & Barge Cost:	$ 18,000,000.00	
Annual Amortization Cost:	$ 4,266,000.00	
Estimated Tugboats & Barges Cost:	**$ 9,286,800.00**	
Unit Cost for MV:	$ 18.57	

Factors for Calculation		
Collection Truck Average Load Size:	27	tonnes/load
Unit Operating Cost (Truck and Driver):	$ 100.00	per hour
Tractor Fuel Economy:	2.5	km/L
Diesel Fuel Cost:	$ 1.20	per litre

Barges in BC can hold upto 168 containers (max capacity of 4200 tons or 3810 tonnes)
assuming 27 tonnes/container, barge capacity would be exceeded (i.e. 4536 tonnes)
Therfore, barge can hold 141 containers of waste.

	Distance (mi)	Distance (km)	Travel Time	Waste transferred (t/yr)	Loads to Deliver	Fuel Used (L/yr)	Unit Hauling Cost ($/t)	Transfer Station Unit Cost ($/t)	Total Unit Cost ($/t)
Gold River WTE Site									
Church Rd to Victoria Harbour		150 km	130 minutes	20,000	741	88,888.89	$ 21.38	$ 23.95	$ 45.33
Arboretum to Victoria Harbour		118 km	103 minutes	42,062	1,558	147,476.45	$ 16.92	$ 43.14	$ 60.06
Duncan to Victoria Harbour		60 km	56 minutes	30,119	1,116	53,544.49	$ 9.05	$ 22.62	$ 31.67
Barge Loading Facility (Victoria Harbour)		5 km	8 minutes	124,123	4,597	18,388.53	$ 1.17	$ 28.41	$ 29.58
Total				216,303	7,270	308,298.36			$ 37.25

		Wt	Distance	t-Km	%
Metro Vancouver	500000 t/yr	70%	500	250000000	76%
TRI-RD	216000 t/yr	30%	360	77760000	24%
Total	716000			327760000	