IMPLEMENTING SUSTAINABILITY AT ALCAN PRIMARY METAL – BRITISH COLUMBIA

by

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ABSTRACT

This project is a strategic analysis of the environmentally driven pressures affecting Alcan Primary Metal – British Columbia (APM-BC), and its ability to be a sustainability driven company. The objective is to develop a set of recommended strategies that will bring both social and economic balance and create value by acting on the identified issues.

Using a stakeholder analysis and a modified PESTLE analysis, seven key components of APM-BC's value chain were analyzed to identify eighty-one key environmental issues. These issues were mapped according to business and environmental risk. Using a SWOT analysis, seventy-five strategies for managing the environmental issues while building value through incorporating stakeholder participation and creating economic opportunities for communities within APM-BC's sphere of influence were developed.

The set of recommendations provides an opportunity for further implementing sustainability into the company's business plan. This can be accomplished through eco-efficient strategies to improve operating margins, risk management strategies that create environmental awareness and strategies to build capacity with APM-BC's stakeholders.

DEDICATION

This paper is dedicated to my family (Karen, Tim, and Ann) for supporting me throughout the MBA program, and most of all, during the writing of this paper. I could not have completed this paper without your sacrifices.

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GLOSSARY

Anode	Positive electrode in an electric circuit.
Cathode	Negative electrode in an electric circuit.
CO2(e)	CO2(e) or Carbon Dioxide Equivalents is the total of all GHG contributing emissions converted to a standard carbon dioxide equivalent.
COSEWIC	Committee on the status of endangered wildlife in Canada (COSEWIC) is a committee of scientific experts that assess extinction risks to wildlife under the federal Species at Risk act (SARA).
Eco-efficient	An environmentally beneficial strategy that provides economic cost savings. For example, energy conservation to reduce greenhouse gas emissions is environmentally beneficial and provides cost savings through reduced energy expenditures.
Greenhouse gases	Greenhouse gases are defined as any six gases (Carbon Dioxide (CO_2), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs; both C_2F_6 and CF_4), Methane (CH_4), Nitrous Oxide (N_2O), and Sulphur Hexafluoride (SF_6) identified by the United Nations Intergovernmental Panel on Climate Change as contributing to climate change. These gases are generally measured in Metric Tonnes of Carbon Dioxide Equivalent (T CO_2e).
ISO 14001	International Standards Organization's framework for environmental risk management systems.
Lean-Sigma Six	A continuous improvement system that provides a set of analytical tools to streamline operations and remove waste so that the operation is faster and more cost efficient.
Life cycle	Life cycle is a measure of all the inputs and environmental emissions required to produce and use a product. The measures start from the extraction of raw materials and conclude with the end of the product's life. The end of life includes either the products ultimate disposal or recycling.
MWh	Mega Watt Hour (Unit of electrical energy consumption)
NPRI	National Pollutant Registry Index, a database run by Environment Canada for tracking polluting emissions from Canadian industries.
PAC	Public advisory committee (PAC) was established by APM-BC under Kitimat Works Pollution Prevention Program to provide input on Alcan related environmental concerns affecting the community and track the

	Kitimat Works' Pollution Prevention Program.
PAH	Polycyclic aromatic hydrocarbons (PAHs) are a group of aromatic hydrocarbons containing three or more closed hydrocarbon rings. Some specific PAHs are animal and/or human carcinogens.
Perfluorocarbons	Perfluorocarbons (PFCs) are compounds derived from hydrocarbons, where the hydrogen atoms have been replaced by fluorine atoms. PFCs are strong greenhouse gases, approximately 6000 times more effective than carbon dioxide for trapping radiant heat in the atmosphere.
Product life cycle	An inventory of all energy and raw materials used to fabricate a product and the environmental emissions generated during its manufacturing.
Reduction pot cell	Aluminum smelting cell which reduces aluminum oxide to metallic aluminum using Hall-Heroult reduction chemistry.
SPL	Spent potlining (SPL) is the used lining of the aluminum pot cell (cathode) after the cell has reached its life span. This material consists of refractory brick and carbon lining. The carbon lining is a hazardous waste from high levels of adsorbed fluoride and cyanide (developed through the carbon reacting with nitrogen). SPL is also highly reactive with water, generating potentially explosive gases and ammonia.
Sulphur Dioxide	Sulphur dioxide (SO_2) is an industrial emission gas produced by the combustion of sulphur containing fuels or carbon sources. SO_2 when released to the atmosphere can form sulphuric and sulphurous acids that then contribute to the acidification of soils and water.
VSS	Vertical Söderberg Stud (VSS) is a type of reduction technology for producing aluminum.

1 INTRODUCTION

Sustainability is a cornerstone of Alcan's business model, and in consequence is well promoted and implemented at the global corporate level. All business units within the Alcan family are required to support the corporate commitment to sustainability through putting sustainability into practice; a challenge in a commodity based industry. The objective of this paper is to develop a strategic implementation model for sustainability at the business unit level, specifically, at Alcan Primary Metals – British Columbia (APM-BC).

Sustainability is the challenging goal of balancing economic, social, and environmental objectives together for meeting present needs without compromising future generation needs.[i] For business, this is achieving continuation of the economic enterprise, while maintaining both a supportive stakeholder community and healthy environmental base. Addressing this balancing goal is challenging for business managers, especially in a commodity based industry that is striving for low cost production while maximising value. This is particularly true with APM-BC, a primary aluminum producer, challenged with ageing 50-year-old technology and situated in a very political and environmentally sensitive area.

This paper will recommend a pathway (road map) for implementing sustainability in APM-BC through developing a model to analyze internal and external pressures placed on the business from an environmental perspective. Recommendations for aligning or realigning the business unit's strategy will be provided as an outcome of the review and assessment of these pressures in terms of strategic vision, stakeholders, regulators, competitors, and market place forces. Through strategically aligning the business strategy with environmental pressures,

resources and investments can be directed to address the issues. This is approach to implementing a sustainability strategy is consistent with best practices for assessing material business risks affecting sustainability through:[ii]

- Economic issue identification
- Social issue identification
- Environmental issue identification
- Stakeholder involvement in issue identification and prioritization

The analysis will be completed in four steps. First step of the strategic analysis will focus externally on the global environment, economic, and social pressures affecting the entire industry. The second stage will examine the specific characteristics of Alcan Primary Metals Group (APMG)[1] and APM-BC that shape how the company can respond effectively to those external pressures. The third step will use a strategic analysis model to identify key environmental pressures and generate a table of those issues by priority. To conclude, the issues will be assessed by developing a set of cost efficient strategies that bring both stakeholder and economic opportunities into the solutions.

1.1 Alcan Inc. and the Alcan Primary Metal Group

Alcan Inc. is a globally integrated aluminum and packaging company with $19.5 billion annual sales, across 55 countries in all continents except Antarctica.[iii] Approximately, 70,000 people are employed by the company. Alcan Inc., is the corporate body managing all the business groups and is responsible for corporate governance, investor relations, business strategy, and developing consistent programs and global branding.

[1] Alcan Primary Metals Group is Alcan Inc.'s corporate group for managing Alcan's primary metal portfolio. APM-BC falls under the management of APMG.

The governing objective for Alcan Inc. is to maximize shareholder value. This objective is achieved through the Alcan Integrated Management System (AIMS) that is comprised of three components, value based management, environment, health and safety (EH&S) First, and continuous improvement. The goal of AIMS is to put Alcan in the best in class for maximizing shareholder value while building a sustainable future for all Alcan stakeholders.[iv] Value based management approach involves detailed strategic analyses of all potential opportunities to capitalize on ones that obtain maximum value and make best use of resources. EH&S First is an integrated environment, health and safety program that establishes a common set of practices, procedures, and mindsets to achieve best in class performance for the benefit of employees and communities in areas of operation. Continuous improvement targets maximizing opportunities through improving Alcan's competitiveness and efficiency through the systematic analytical process of Lean-Sigma Six[2].

Alcan is a vertically integrated company with four key business groups as shown in Table 1 below. Of interest to this paper is the Alcan Primary Metal Group (APMG), which represents 50 percent of Alcan's revenues. APMG's products include Aluminum ingot (sheet, extrusion billet, rod, foundry and remelt), smelter anodes, aluminum fluoride, smelting technology and equipment sales. Additionally in APMG are all of Alcan's power generation facilities. There are 24 smelters in the APMG global network with various degrees of ownership (Table 2). The smelters are separated into management groups based on both geographic and market location. APM-BC is in the Asia-Pacific group as the plant is isolated from the Alcan smelters in eastern Canada and the United States and APM-BC primarily serves the Asian market.

[2] A continuous improvement system that provides a set of analytical tools to streamline operations and remove waste so that the operation is faster and more cost efficient.

Table 1. Alcan Inc. Business Group Profiles[v]

Business Group	2004 Business Group Profit*	Number of Countries	Number of employees
Bauxite and Alumina	16%	12	5,000
Primary Metal	50%	15	20,000
Packaging	23%	26	34,000
Engineered Products	11%	36	12,000

*Excluding rolled products, which was spun-off to a separate company (Novelis Inc.) on January 6, 2005.

Source: table prepared by Author, based on data from Evans R., February 28, 2005. BMO Nesbit Burns Global Resource Conference

Table 2. APMG Smelting Capacity

Business Group	Ownership	Capacity (Tonnes)	Technology*
North America		**1293**	
Alma	100%	400	PFPB
Arvidia	100%	161	SWPB
Beauharnois	100%	50	HSS
Bécancour	25%	102	
Shawinigan	100%	91	HSS
Grand Baie	100%	196	PFPB
Aloutte	40%	97	
Sebree	100%	196	PFPB
Asia-Pacific		**597**	
Kitimat	100%	242	VSS
Oman	20%		PFPB
Qingtongxia	50%	75	PFPB
Tomago	51.5%	245	PFPB
Europe - Africa		**1127**	
Alucam	47%	45	SWPB
Dunkerque		245	PFPB
Isal	100%	172	PFPB
St-Jean-de-Maurienne		135	PFPB
Lannemezan		50	SWPB
Locharber		40	PFPB
Lynemouth		164	PFPB
PNL	85%	170	PFPB
Soral	50%	66	PFPB
Steg		40	PFPB

*Technology: PFPB = Point fed pre-bake, SWPB = Side worked pre-bake, HSS = Horizontal Stud Söderberg, VSS = Vertical Stud Söderberg.

Source: Table prepared by Author, data from Evans R., February 28, 2005. BMO Nesbit Burns Global Resource Conference

1.2 Alcan Primary Metal – British Columbia

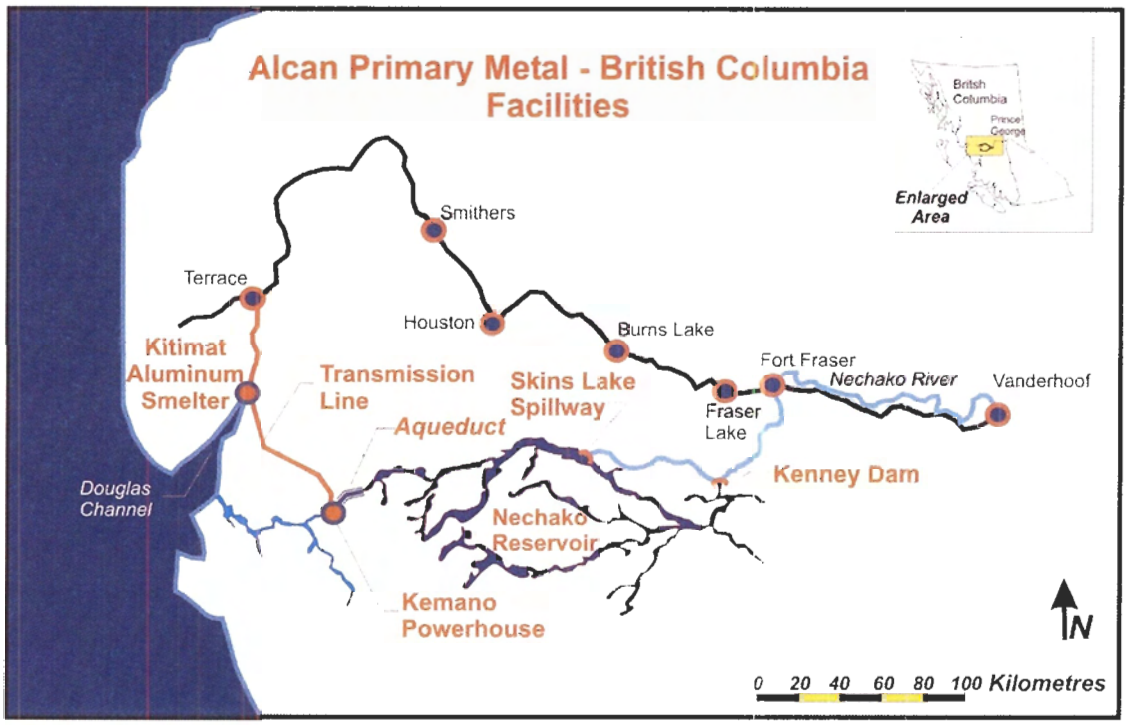
APM-BC is a primary aluminum smelting, casting and energy products business dominantly producing finished value added billet and sheet ingots primarily for the Asian market with a secondary product, electrical power for sale to the BC Hydro power grid. In addition to the value added aluminum products, "trilok" aluminum ingots are made for remelt or other casting facilities. Value is added to the aluminum through producing metal alloys to customer specifications, and high quality continuously cast sheet and billets. Key markets for APM-BC's aluminum products include Japan and Korea, with minor amounts sold in North America. Isolation from the key North American markets limits the ability to serve the domestic market. Up to 14 percent of revenues are generated from power sales to BC Hydro, excess power from the Smelter is used by BC Hydro to supply local power needs from Kitimat to Vanderhoof (refer to Figure 1).

1.2.1 APM-BC Operations Description

History and location play a key role in the environmental challenges faced by APM-BC today. For this reason, it is important to understand the origins, operational scope, and the environmental settings of APM-BC.

Alcan's presence in British Columbia began in 1951 with construction that lasted until 1954, when the operation was commissioned and the first ingot was cast. To date, APM-BC is the only aluminum smelter in British Columbia. The scope of the Alcan project was to build an aluminum smelter supported by a reservoir, hydroelectric generation facility, and a powerline; extent and location of the operations are shown on Figure 1.

Figure 1. Geographic Setting of Alcan Primary Metal – British Columbia



Source: Created by author.

The 277 tonne capacity Smelter was constructed on the southwest corner of the Kitimat River Estuary, covering approximately 115 ha. The smelter site, consists of a seaport, coke calciner, anode paste plant, 8 potlines with 912 reduction pot cells, two casting houses, and maintenance services supporting the key operations. The smelter was constructed at a time when there was little understanding about the environmental impacts from such an operation, and was operated for many years without most of the regulatory controls that are taken for granted today. This historical context has led to many unique environmental problems that have persisted for decades.[vi]

Water for the Kemano hydroelectric generation station is supplied from the 14,000 km^2 Nechako reservoir. This reservoir was built with a series of dams that diverted water in the Nechako River away from the Fraser River in the British Columbia interior and towards the Kemano by the pacific coast. Two key dams on the reservoir are the Kenney dam and the Skins Lake Spillway. The Kenney dam diverted the Nechako River, drying up an approximate 14 km section of the Nechako River. The Skins Lake Spillway discharges over flow from the reservoir and legally required flows to sustain downstream fish habitat. Water from the spillway flows through the Murray-Cheslatta system, rejoining the Neckako River (downstream of the dewatered section). The bulk of the Nechako Basin's water was diverted west from the Spillway to Tahtsa Lake, where a 16 km aqueduct tunneled through the Coast Mountains brings the water to the Kemano powerhouse.

An average 800 MW/hr of electrical power is produced in the Kemano powerhouse with the Nechako reservoir's water. This facility, built during the 'Cold War' was constructed 0.25 miles inside Mount Dubose to protect the powerhouse from bombardment. Water enters the powerhouse from the aqueduct where it drops 2600 ft in the powerhouse's penstocks to flow through the eight generators and then to the Kemano River. A 16 km road was built south from Kemano to the mouth of the Kemano River, where a causeway, jetty, and barge landing services were constructed. The Kemano town site was built to support powerhouse operations, which were later decommissioned (to a rotating crew level) when the powerhouse controls were partially upgraded to a remote control system.

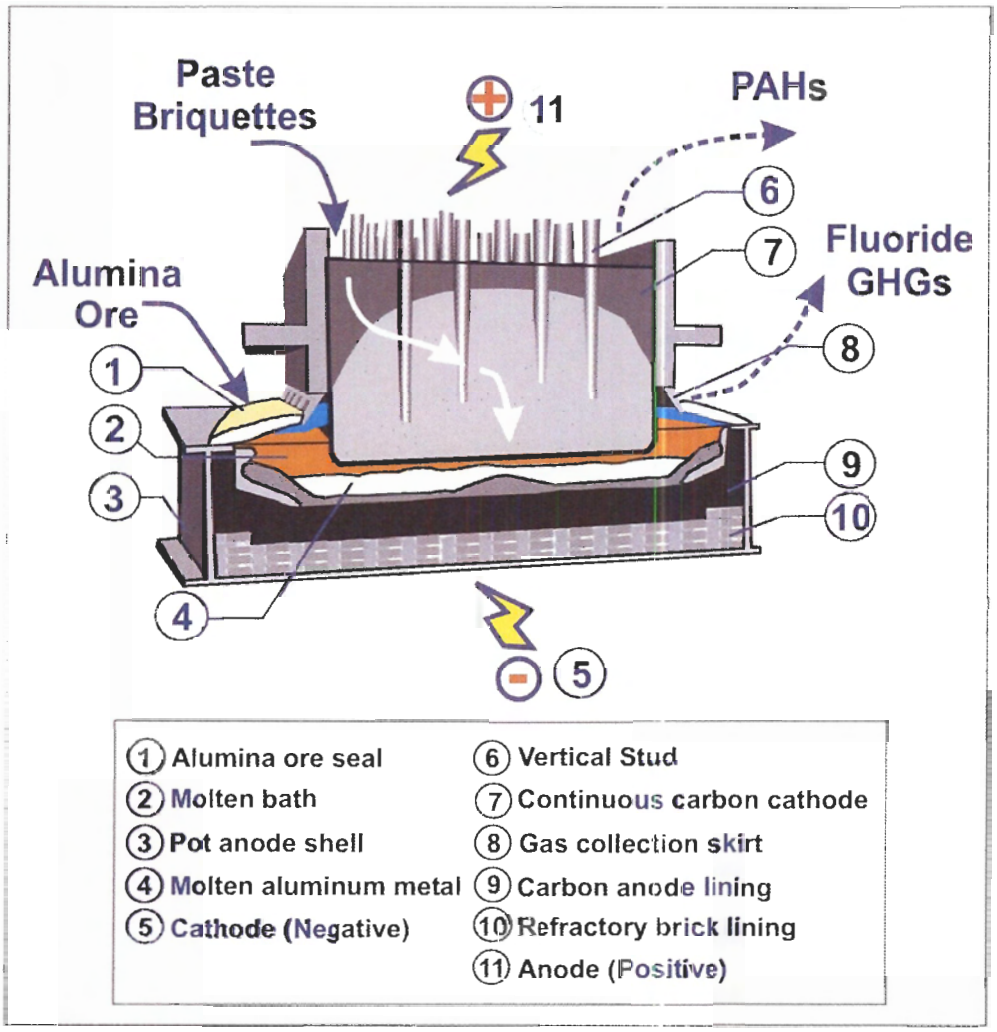
Electrical power is brought to the smelter over an 80 km power line constructed in remote environmentally sensitive areas, including river estuaries, alpine regions, and the Kildala and Kemano valleys. The power line is supported with two main camps in the Kildala and Kemano valleys and an access/maintenance road leading to most of the transmission line towers.

1.2.2 Reduction Process Technology at Kitimat Works

The technology at the Kitimat works smelter is vertical stud Söderberg (VSS) (Figure 2) technology developed in the 1920s, using the Hall-Heroult electrolytic reduction process to reduce aluminum oxide to metallic aluminum. At the time the smelter was constructed there was a choice between the Söderberg and pre-bake technology, and the Söderberg system was selected based on slightly higher efficiencies and metal purity, despite higher emissions than the pre-bake technology.

The reaction is controlled in a cell called a potshell that consists of a steel shell lined with refractory brick and carbon blocks. A molten bath of cryolite and aluminum fluoride is used to dissolve the aluminum oxide 'alumina ore'. Through electrolysis, oxygen is split from the aluminum oxide to form both metallic aluminum (that sinks to the bottom of the cell) and gaseous carbon oxides (that are released from the cell). A 5-volt electric potential is applied across the bath from a continuous carbon anode. The VSS anode is continuous as carbon paste briquettes are placed on top the anode, which melt and bake into a solid carbon block, replacing the carbon consumed at the bottom of the anode. The current is spread evenly across the anode through the steel vertical studs. Primary emissions from the process include polycyclic aromatic hydrocarbons (PAHs) from the anode, and fluoride and green house gases (carbon oxides from the consumption of the cathode, and perfluorocarbons formed from fluoride reactions with the carbon oxides). At the end of life of cell, the liner of the potshell is called spent potlining (or cathode waste). This waste is hazardous due to high concentrations of fluoride and cyanide in the carbon fraction of the waste (fluoride is adsorbed in the carbon, while cyanide forms high temperature reactions between carbon and atmospheric nitrogen).

Figure 2. Vertical Stud Söderberg (VSS) Reduction Cell



Source: Created by author.

1.2.3 Key Raw materials and Consumption

Aluminum production at Kitimat Works is dependent on the continual consumption of strategically important raw materials and natural resources. Both the supply continuity and quality consistency of each specific raw material or resource have significant impacts on the production efficiency and environmental performance of the Smelter. Key resources and raw

materials include water, electricity, alumina ore, green coke, liquid pitch, aluminum fluoride, and natural gas. Table 3, below, presents a summary of these key resources and raw materials consumed at APM-BC.

Table 3. Key Raw Materials and Consumption

Resource	Usage	Source	Origin
Water	Electrical Power Production	Nechako reservoir Watershed	Snow melt and rainfall
Water	Process cooling	Kitimat River and Anderson Creek	Glacial and precipitation
Alumina Ore	Smelting	Alcan Bauxite and Alumina - Gove, Australia	Bauxite mineral refined to aluminum oxide
Aluminum Fluoride	Smelting	Alcan Bauxite and Alumina – Vaudreuil, Canada	Alumina refinery and specialty chemicals
Green Coke	Anode Paste Production	Alaska, USA	Petroleum refinery waste product
Liquid Pitch	Anode Paste Production	Korea	Coal tar distillate
Natural Gas	Operation heat and energy supply	Pacific Northern Gas, - Alberta, Canada	Alberta gas fields
Wood	Pot poker poles,	Regional Sawmill	Regional forest

Source: Table by author.

1.2.4 Environmental Setting of APM-BC

Knowledge of the specific environmental setting is important to understand the performance and external pressures facing APM-BC. Due to the geographical extent of the company's assets across northern British Columbia (Figure 1) the company operates in very different environments.

1.2.4.1 Smelter Site Environmental Setting

The Smelter is located at the head of the Douglas Channel, between the Kitimat River estuary and mountains. Highly valued ecosystems in the estuary, intertidal zones around the plant, and two salmon creeks that flow through the smelter property surround Kitimat Works[3] and form the receiving environment for smelter emissions (Figure 3). The site is also located in a coastal temperate rain forest, that supports a number of valued flora and fauna, notably grizzly and black bears, moose, deer, herons, wolves, eulachon, and runs of both pink and coho salmon. The airshed surrounding the smeltersite is complex due to the terrain influences, but the mountains and coastal inflows and outflows generally direct the wind due north and south of the plant site. Prior to the development of the site, the Haisla First Nation used the surrounding area for traditional activities of hunting, fishing, and gathering of culturally important materials (such as cedar bark, medicines, herbs and berries)[vii].

[3] Kitimat Works is includes APM-BC's operations in Kitimat only.

Figure 3. Environmental Setting of the Kitimat Works Smelter

Source: Photo by author.

1.2.4.2 Transmission line and Power Production Environmental Setting

The power transmission line is 80 km and runs from Kemano to Kitimat, crossing several sensitive and geologically active environments. The power line originates in Kemano, and traverses north along the Kemano River to the Alpine Kildala Pass, where it crosses into the Kildala River valley. Both the Kildala and Kemano rivers are highly productive salmonid habitat and have culturally important eulachon fisheries (Haisla traditionally fishery). In addition to the sensitive fish habitat, the two valleys are home to dense grizzly bear and mountain goat populations. Recently, a provincial marine park was established at the mouth of the Kildala River and bordering the powerline for the protection of grizzly bears and marine life.

Geologically, both the Kemano and Kildala Valleys are active, with seasonal flooding, erosion, avalanches and landslides. The power transmission towers and service roads are frequently affected by erosion, requiring high expenditures to protect the assets. In addition to the costs, the erosion protection work impacts fish and wild life habitat through the construction, rock blasting, and rock placement in the river. Avalanches and landslides, though less frequent can damage transmission line towers.

The powerline was also constructed through territory claimed by the Haisla as traditional lands. The territory claimed by the Haisla include the Kitimat Valley, and lands south along the Douglas Channel, including the Kemano and Kildala Valleys. There are four small sections of Indian Reserve Land that the powerline crosses through which the company was given access to by a Federal Order in Council.

1.2.4.3 Nechako Reservoir Environmental Setting

The Nechako reservoir is an interesting watershed from both environmental and social historic perspectives. Many unique habitats and environmental challenges have been created from the development of the reservoir in the watershed and downstream of the dams. Social concerns that date from the 1950s development of the reservoir present a lasting legacy kept alive by the stakeholders affected by the reservoir.

Unique habitats have been created from the flooded forest in the reservoir. The reservoir was developed with the trees standing and remaining in place in the early 1950s, because at the time of the reservoir construction it would have taken over a decade to harvest all the trees using every single logger in British Columbia. The dead standing trees have created habitat favourable to Osprey, with the reservoir now hosting the world's densest nesting population. Although providing important habitat, the trees present nautical hazards to boat users on the reservoir.

Interestingly, the submerged trees have been preserved by the cold water, and are harvested. Some of the wood recovered at depth is very desirable for speciality markets, such as musical instruments.

The reservoir is host to a number of flora and fauna. Most notably, the fish species which consist of Kokanee (land locked Sockeye salmon), trout, and Dolly Varden. A healthy beaver population exists in the reservoir. The beavers have specially adapted to the fluctuating water levels of the reservoir by building oblong lodges that stretch from low to high water levels.

Downstream of the reservoir, the project has affected the Nechako, and Murray-Cheslatta River systems. The Murray-Cheslatta Rivers receive water from the Spillway with flows ranging from 30 to over 450 cubic meters per second. The high flows have caused erosion along the rivers, and sediment deposition in the Cheslatta Lake. The Nechako River was dewatered downstream of the dam for approximately 14km, where the Cheslatta River flows into the Nechako system. The Nechako River has all five salmon species and a variety of resident fish, including the endangered white sturgeon. To support salmon migration in the Nechako River, there is a legal obligation to release cooling water flows during migratory periods.

The reservoir was built over a number of areas that were previously inhabited by local residents and First Nations. The inhabitants were relocated by the Provincial and Federal governments to accommodate the project. This has created a lasting social legacy with the relocated groups and a strong association of socio-political aspects of the relocation legacy and environmental issues.

2 BUSINESS CASE FOR SUSTAINABILTY

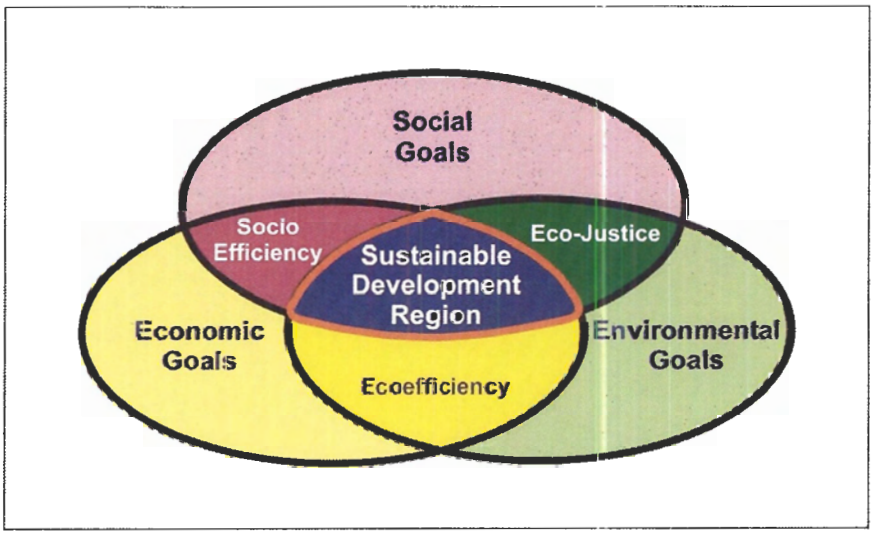
There is a general shift towards sustainable business practices in the aluminum industry. The business case for developing a sustainability driven business strategy lies largely with protecting long term shareholder value through risk management. Sustainable business practices push the industry competition frontier by raising expectations for environmental performance of what a good, desirable company and their products should be, while increasing the gap between the industry leaders and the laggards in sustainability. Environmental risks are managed and investment is promoted by reducing the environmental footprint of the company through sustainable business practices.

2.1 Definition of Sustainability

The World Commission on Environment and Development (WCED) in 1987 (with the Brundtland Commission) generated wide spread interest in sustainable development and the need for sustainable societies. The Brundtland Commission defined sustainable development as development that meets needs of the present without compromising the ability of future generations to meet their own needs. In essence, sustainable development recognizes that both the economy and society depend on the biosphere and the environmental pressures occurring within them.[viii] Additionally, the definition implies that there is a balance between how much development mankind can continue to engage in while still preserving the environment to the extent that it can at least sustain an acceptable quality of human life.[ix] Essentially, sustainable development balances our needs for continued access to clean air and water with our needs for both economic and social development.

Sustainability is the outcome of sustainable development. It is a tenuous balancing act of simultaneously achieving economic, social, and environmental goals. Figure 4 graphically demonstrates the union of these three goals. From the perspective of business, this union can be defined as the continuation of the economic enterprise, and the maintenance of a supportive stakeholder community and a healthy environmental base. According to Evans (2005), the business case for sustainability recognizes the intersection of a set of economic, environmental, and social linkages.[x]

Figure 4. Balancing Social, Economic, and Environmental Goals



Source: Created by author

Incorporating sustainable business practices into modern business is an important concept as value drivers within a company are affected by environmental and social interventions. Both stability and financial returns of value drivers reflect the risk levels poised by the business management decisions.

2.2 Value Drivers

Value drivers determine the creation of shareholder value. Business management needs to be cognizant that delivery of value to shareholders will be in part derived from diligent risk reduction and risk management. Ignoring or downgrading environmental risks to maximize short run economic value will not sustain the company in the long run. For instance, unmanaged risks at Union Carbide's plant in Bhopal, India led to a disaster in 1984 that killed and maimed thousands, and cost the company $470 million. While this is an extreme example, it demonstrates that sustainable business practices through environmental risk management and reduction are a driver for sustaining value. Alcoa's Baie-Comeau facility for example, is facing a $500 million class action lawsuit over PAH contamination of residential property in the St. Georges neighborhood of Baie Comeau, in addition to a minimum $3 million cleanup cost.[xi]

2.3 Sustainability, Financial Performance and Investment

Environmentally driven sustainability business strategies are about protecting value by aligning the business to the expected norms and constraints of society and by managing risks. It is important to note that not every environmental management act creates additional shareholder value, but in the long run sound environmental management will protect long term enterprise value.[xii] Environmental strategies that typically do create value are linked to eco-efficient strategies and:

- Are capital-extensive, relating to software rather than hardware (involving 'smarter', smaller, cheaper installations)
- Consume low amounts of material, reducing throughput (through lower purchase, storage and depreciation costs)
- Are sales boosting, increasing the benefit and attraction to customers (through the provision of more desirable products and services for more customers)
- Are margin-widening, increasing the benefit to customers and reducing the costs of producing products and services (fetching higher prices because of greater benefit and involving lower operating costs through improved operating efficiency)
- Safeguard the flow of finance, gaining the confidence of the capital market (involving lower and more unsystematic risks and 'winning' a 'green bonus')

- Enhance value over the long term in anticipation of future costs and earnings potential [xiii]

Environmental and social interventions can erode financial performance by attacking both operating margins and net income. An intervention is a step in a change process brought on by either regulatory or social response to a neglected issue. Operating costs can be increased through a number of venues such as unplanned environmental responses and mitigation, regulatory fines, permit driven environmental monitoring and management programs, and expenditures to cleanup past environmental liabilities. Environmental liabilities caused by site contamination are important to recognize as they can be significant to the point of limiting future business strategies and options. Net income is reduced from provisions resulting from environmental liabilities such as soil and groundwater contamination. With mitigation costs usually significantly lower than remediation costs, value is destroyed when mitigation is avoided and remediation is required.

Financial performance can be linked to environmental management. Wagner (2005) conducted an empirical analysis of companies with an environmental shareholder value orientated corporate strategy compared to companies with weak approaches to environmental management and strategy. Statistically, Wagner found that companies who employed market orientated environmental strategy had both stronger environmental and economic performance than those without. Investing in higher variable costs for environmental management resulted in lower variations in profitability. The relationship between environmental management and protection and economic performance, strongly depends on the factors internal to the company, especially, corporate environmental strategies that drive management activities at the business unit levels.[xiv] The evidence suggests that economic returns should be realized by employing an environmental management system, such as ISO 14001 which reduces and manages risks of both fixed and current investments and operational management.

Investing resources to manage environmental risks involves developing a competitive sustainability strategy. Such a strategy defensively protects margins and assets and leverages opportunities for productivity improvements. Additionally, the strategy provides for strategic investments in both innovations to sustain above average returns and growth opportunities for market development. The investment strategy is important for mapping out the approach to implement a sustainability driven business strategy.

2.4 Market Valuation of Sustainability Strategies

There is a clear interest in reducing risk to shareholders through diligent risk management at the corporate and business unit levels, and the market should recognize investments in sustainability and environmental management. However, despite Wagner's findings, the relationship between environmentally driven sustainability and investor premiums on share price is sometimes unseen. Travis Engen, Alcan's CEO has reported that:

"... the market doesn't fully appreciate the value of companies that make solid investments in sustainability."[xv]

From Mr. Engen's and other analysts[xvi] perspective there is a premium to be placed on companies who invest in environmental performance and sustainability. There is some empirical evidence supports this concept, but it is weak. Potash (2005) found that there is a general (but statistically weak) 15 percent rise in price to earnings (P/E) ratios for companies with sustainable strategies. This was an empirical statistical study on P/E ratios for the global top 100 sustainable firms compared to similar firms not on the list.

Traditional investors commonly view financial investments into environment and society as poor performers. These are seen as reducing financial returns in favor of benefits for environmental and socially conscientious stakeholders. However, there is a growing body of evidence that indicates that the traditional view is wrong, and that sustainable or "ethically" driven investments perform as well as or better than "non-ethical" investments.[xvii] CSR Europe, 2003 completed an empirical statistical study of ethical mutual funds (balanced, equity, fixed income, and global equity) and found that their 3 year performance was similar or higher than the benchmark non-ethically screened funds.

2.5 Promoting Investment

Another reason for implementing sustainability driven business strategies, beyond market performance, competitive advantages, and industry association commitments, is to increase access to investment capital. This is similar to promoting investment by reducing, but different, in that it opens the company to increased investments. There has been a steady growth in ethical institutional mutual funds that screen companies for suitable investment potential based not only on economic performance, but also on measures of both socioefficiency and ecoefficiency. These funds have grown by 240 percent between 1995 and 2003 and now represent $2.14 trillion in socially screened portfolios.[xviii] Additionally, non-traditional ethic funds are under increasing competitive pressure within the mutual fund market to provide ethical screening of their investments. Meeting screening criteria through published policy and a record of accomplishment will increase the investor base available to promote the company's share value.

Sustainability driven firms are appealing to superannuation investment funds that focus on long term value building for their investors. Companies strong in managing social, environmental and corporate governance risks are more likely to protect their asset base for long

term value creation.[xix] Emphasis on short-term strategies is more likely to erode shareholder value over the long term by failing to account for social and environmental considerations.

2.6 Competitive Advantages

There are competitive advantages to adopting sustainability driven business strategies, especially from either being the industry leader in sustainability or moving first on sustainability issues. For instance, Kärnä et al. (2003) found through empirical study that the forerunners of sustainable development are voluntarily ahead of governmental initiatives, allowing opportunities to gain competitive advantage through environmentally friendliness. Competitive advantages to moving first on environmentally driven sustainability range from gaining the "green" market share to influencing regulators and stakeholders on environmentally (and cost) beneficial positions of the company (often at the expense of competitors). Additionally, first movers raise social and investor expectations of acceptable industry standards, which raises entry barriers and forces competitors to react.

2.7 Aluminum Industry Wide Shift Towards Sustainability

From an industry wide perspective, there are aluminum associations both internationally (International Aluminum Association) and in each major market that promote the aluminum industry's needs. Some sustainability driven issues are recognized as industry wide threats and voluntary commitments are made by members to implement plans promoted by the industry association. For instance, global warming and green house gases are recognized as global threats to the aluminum industry. Action plans have been voluntarily developed to reduce greenhouse gas

emissions in advance of the Kyoto Protocol implementation in order to reduce the risk of carbon taxes.[xx] Additionally, the argument that aluminum has a beneficial life cycle[4] is a key industry strategy for promoting aluminum consumption and defending against threats from substitutes.

[4] Life cycle is a measure of all the inputs and environmental emissions required to produce and use a product. The measures start from the extraction of raw materials and conclude with the end of the product's life. The end of life includes either the products ultimate disposal or recycling.

3 THE GLOBAL ALUMINUM INDUSTRY AND SUSTAINABILITY

The global aluminum market place affects decisions of local business units. Because of this, the industry's dynamics and marketplace pressures must be understood, evaluated and their consequences formulated into local business strategies.

3.1 Industry Definition

The industry that is examined in this paper is vertically integrated primary aluminum production. The industry serves global markets in aluminum ingot intended for remelt, value added extrusion billet and rolling sheet. Vertical integration includes anode manufacturing, metal casting and the firm may or may not have their own electricity production. The primary aluminum products serve secondary manufacturing of aluminum cable, tubing, sheets, can stock, foils, and various other extruded products.

It should be noted that while over 50 percent of global aluminum production is represented by large highly vertically integrated companies and 20 percent of the global aluminum producing companies are involved in other metals,[xxi] neither activities upstream nor downstream of primary metal production, nor metal portfolios outside of aluminum are included in this analysis. Secondary aluminum (remelt and recycling), although a more favorable product in terms of sustainability is excluded from the analysis as those industries face significantly different social and environmental pressures than those faced by primary production. Although there are specific regional sub-markets for primary aluminum (largely defined by transportation considerations) the overall market is global, as primary aluminum product pricing is based on the daily LME base

aluminum price, which is affected by global supply and demand. Additionally, social and environmental issues are generally not contained by political boundaries. Incidental secondary products associated with primary aluminum production such as aluminum fluoride, energy, and anode sales are not included in the analysis.

3.2 Aluminum Industry Associations and Key Sustainability Challenges

Collectively, aluminum companies have formed industry associations in key production areas and globally under the International Aluminum Institute. Associations for the aluminum industry serve a number of functions. First, they market aluminum as a desirable value added product. For instance, every 1 kg of weight savings by using aluminum in a bus saves approximately 55 kg of CO2eq over the life of the bus.[xxii] Second, they develop and promote industry strategies for growth, health and competitive positioning of the industry. Industry health is often tracked through benchmarking surveys and monitoring global production by company and region. Lastly, and perhaps most importantly, the associations market the sustainable aspects of aluminum and develop industry wide strategies to implement sustainability within the industry itself. In this way, the industry creates a competitive stance against substitute products. The aluminum industry target is to be recognised by 2020 as a world leader in the provision of innovative material based solutions that are environmentally sustainable.[xxiii]

There are specific industry challenges to meet this target within the primary aluminum industry. These challenges are global in nature, but vary in significance by local regulations and social acceptance. Key sustainability challenges that face the industry are:

- Greenhouse gases and global warming
- Energy Conservation
- Water Conservation
- Fluoride Emissions
- Polycyclic Aromatic Hydrocarbon emissions
- Sulphur Dioxide Emissions
- Spent Potlining Waste Management
- Biodiversity protection

The following eight sections briefly describe these key sustainability challenges.

3.2.1 Greenhouse Gases and Global Warming

Greenhouse gases (GHGs) are the largest sustainability challenge to the primary aluminum industry. Threats to the industry arising from GHG emissions lie in proposed government regulations for carbon taxes and regulatory driven reduction targets put in place to meet Kyoto commitments. Additionally, industries promoting substitute materials can use this negative aspect of aluminum industry's value chain to further their market share. To mitigate GHG risks substantial reduction efforts have been employed globally to reduce GHG production and improve the monitoring of GHGs. Perfluorocarbons (PFCs) are strong greenhouse gases and are primarily generated during an anode effect[5]. The industry has collectively worked to reduce anode effects and limiting their duration (an anode effect length of time is proportionate to the amount of PFCs generated). This effort has led to a 73 percent reduction of PFCs between 1990

[5] Anode effect is a process disruption caused by the build-up of gas bubbles underneath the anode which increase the electrical resistance between the anode and the molten bath.

and 2003 and overall GHG production has declined globally throughout the industry by 71 percent.[xxiv] Despite the improvements continued work for monitoring, reducing and reporting on GHG production is required to mitigate this threat. Presently, global ranges for Söderberg GHG production ranges from a low of 6.5 to a high of 25.6 tonnes CO2(e) per tonne of aluminum.

3.2.2 Energy Consumption

Energy production contributes to GHG production by thermal power generation (natural gas and coal). For Alcan, this represents on average 40 percent of the total GHG production for APMG.[xxv] In addition to GHGs and their consequences, energy supplies are becoming tight in some production regions. Competing demands for limited supplies in some regions can bring into question the benefit of using the power for primary aluminum production versus a higher value activity. The competing demands for power and GHG regulatory protocols create a climate in which the aluminum industry must demonstrate the best use of power through obtaining the highest conversion efficiencies possible. Energy consumption by tonnage ranges from a high of over 20 MWh/tonne Al for Söderberg production to a best in class of less than 13 MWh/tonne Al for a modern prebake smelter. The benchmark of energy consumption is the theoretical minimum energy requirement to produce aluminum with Hall-Herroult process, which is 5.99 MWh/ tonne Al. The total energy for the Hall-Herroult process is 9.03MW/tonne Al, with 3.04MWh/tonne Al provided by the carbon consumption.[xxvi] These facts demonstrate that the best in-class smelters are 46 percent efficient in converting electricity to aluminum, while the worst in-class are only 30 percent efficient. The first Hall-Herroult process in the early 1900s was approximately 12 percent efficient but technological improvements since then, with the use of higher amperage processes and lower current density technologies, have provided today's 46 percent conversion efficiency.

Energy costs from 1999 to 2005 have increased by approximately 300 percent.[xxvii] This inflation of energy prices has pushed smelting operations to lower cost energy sources, such as

stranded energy supplies or government sponsored power projects in developing countries. Of interest in developing countries such as China where power supplies are costly, the operations are more efficient in electricity usage than in developed countries.

3.2.3 Water Consumption

The aluminum industry is dependent on the availability of fresh water. Water is used primarily for hydroelectricity, contact cooling in metal casting and anode production. Alcan, for instance, obtains 83 percent of its smelting electrical power from hydroelectricity.[xxviii] Dedicated hydroelectric power generation provides one of the cleanest and most efficient power sources for aluminum production. However, water is a passionate social issue. It must be considering that the primary cause of fresh water shortages and forecasted scarcity is directly related to poor governance.[xxix] Forecasts show that by 2025 40 percent of the world's population will live in water stressed areas. It is therefore essential that licenses to access water be protected through demonstrating best uses, conservation, and protection of water quality. Water management can also be linked to GHG production and climate warming in the future by predictions of a dryer world in 100 years. For the aluminum industry's longevity, industry wide efforts must be made to conserve and promote the conservation of water.

3.2.4 Fluoride Emissions

Fluoride emissions have impacts on areas in proximity to the source (localized impacts). Notable impacts include fluoride accumulation in vegetation and phytoxicity. Grazing mammals are sensitive to fluoride content in vegetation and may be at risk of fluorosis of the bones and teeth if they consume vegetation high in fluoride. Human health, similar to that of grazing mammals, can be affected and put at similar risk. Of important concern are the damaging effects of fluoride emissions on fruits and vegetables. Fluoride emissions tend to be a developed world

concern, driven by government regulations and social pressure. Typical fluoride emissions per tonne of production range from 0.1 to over 3.5 kg Fluoride per tonne aluminum produced[xxx]. Fluoride emissions also lead to the acidification of local rainfall, through combining with atmospheric water to form hydrofluoric acid. Depending on the production locations, it could also contribute to regional acidification.

3.2.5 Polycyclic Aromatic Hydrocarbon Emissions

Polycyclic aromatic hydrocarbons (PAH) emissions are associated with anode manufacturing (prebake) and anode consumption (Söderberg). Söderberg plants have the highest PAH emissions among the different aluminum reduction technologies. PAHs are a group of ringed hydrocarbons, some of which are known carcinogens that contribute particularly to bladder cancer. PAHs are hydrophobic and tend to bind with particulate and soil. Some PAHs are persistent contaminants and do not degrade in the environment. In the aquatic environment, PAHs are linked to liver lesions in flat fish and DNA damage. PAHs are generated on a global basis, but predominantly are a western world concern, which is a particularly strong threat to Söderberg plant viability. PAHs are also generated naturally in the environment, with forest fires emitting more PAHs than the combined primary aluminum industry in Canada.

3.2.6 Sulphur Dioxide Emissions

Acid rain is the key concern when considering the ramifications of sulphur dioxide emissions. The sulphur originating from anode production and consumption, can reduce current efficiency, increase anode effect frequency, and increase the consumption of steel anode studs through acidic corrosion. Sulphur dioxide emissions are mostly a western world concern despite being a global issue. The emissions have widespread regional and cross border impacts because of the acid rain formation and the subsequent associated ecological damage. In areas of high

sulphur dioxide sensitivity and concentrated sulphur dioxide emitters it will be challenging to maintain permit compliance given the increasing sulphur content in the coke supply. In the North American supply of green coke, there has been a 26.5 percent increase in sulphur content between 1997 and 2004.[xxxi] This trend is typical of the global coke supply and does not seem to be levelling off, making most Smelters susceptible to sulphur problems.

3.2.7 Spent Potlining Waste Management

Ultimate disposal and treatment of spent potlining (SPL) is an industry wide problem, and the method used for managing the waste presents a good indicator of a company's sustainability strategy. All aluminum production technologies produce SPL. The cathodes last between 3-5 years before requiring replacement and relining. The waste is considered hazardous due to its reactivity with moisture (producing methane and ammonia) as well as high fluoride and cyanide concentrations. Poor management of SPL can lead to methane gas explosions and soil and groundwater contamination. Poor handling practices of SPL have caused deaths by from explosions.

Management of SPL can present a significant business cost and presently, there is no truly sustainable solution. Disposal options vary across the globe and usually according to the minimal regulatory driven standards. As shown in Table 4 these options range from ocean leaching (seashore deposit), landfilling, recycling into cement and brick, to stock piling. Globally, there is an estimated 644 kt/yr of SPL generation, with the two largest aluminum companies (Alcan and Alcoa) representing 27 percent of the global production. Since SPL presents a significant business costs and both stockpiles and landfills represent large liabilities, its management presents an interesting competitive frontier for influencing regulators to favour a particular company's strategy at the expense and detriment of their competitors.

Table 4. Global SPL Management Practices and Region

Region	Management Practice
North America	Storage, treatment and landfill
Europe and Australia	Seashore deposit, landfilling, treatment and recycling (Germany, Australia, Italy). Cement Industry (refractory brick fraction).
China	Landfilling and Burning
South America	Recycling (brick and cement).
Middle East	Landfill

Table by Author, data source: Alcan Inc., 2005.

Table 5. SPL Landfill Practices by Region

Region	Quantity generated	Percent Landfilled
China, Russia, Eastern Europe, Asia	278 kt	100%
North America	104 kt	78%
Europe	100 kt	42%
Middle-east and Africa		86%
South America		0%
Oceana		50%

Table by Author, data source Alcan Inc., 2005.

3.2.8 Biodiversity

Biodiversity refers to flora and fauna found in a particular environmental region. As a sustainability indicator, it is an excellent measurement of the health of the environment from the local to global levels. Biodiversity drivers in sustainability practices include the protection and promotion of living organisms (especially rare and endangered species) and ecosystems. Biodiverstity, although a true global issue, is predominantly a western world issue and little attention is paid to this issue in developing economies. In Canada for instance, the new Federal Species At Risk Act has wide sweeping powers to protect both species and communities deemed

to be at risk of expatriation or extinction. Additionally, the Act provides for input from NGO's at the local level.

3.3 Competitor Positioning

The aluminum industry is not concentrated, with 10 companies controlling 44 percent of the world's primary aluminum production. The largest three companies are Alcoa, Alcan, and Norsk Hydro collectively represents only 36 percent of the primary production. The largest production share lies with small independent national to regionally serving smelters situated across the globe. Many countries have started national or joint venture aluminum smelting companies to promote economic diversification and employment, such as with Mozal (Joint venture with BHP Billiton, Mitsubishi, and the government of Mozambique).

Between 1980 and 2004, as shown in Table 6, the competitive landscape has changed. Notably, there has been consolidation among the three largest leading a wave of mergers and acquisitions. At the same time, new entrants have arrived in the market place such as Chalco, Sual, RusAl, BHP Billiton (through political reforms in Russia and China, and new smelter capacity coming on line). Independent Chinese producers have increased their share from 2 percent to 19 percent of total global primary production (not including Chalco), and the other smelting companies have gained 4 percent of the production share. The Dow Jones HHI index shows the industry was moderately concentrated in 1980 (Table 7) and despite the recent industry consolidation there is no net increase in concentration. The industry remains fairly competitive.

Table 6. Global Primary Aluminum Production

	Percent Global Production			Percent Global Production	
Company / Region	**1980 16,131 kT**	**2004 29,798 kT**	**Company / Region**	**1980 16,131 kT**	**2004 29,798 kT**
Alcoa	14%	12%	Russian Aluminum	15%	
Alcan	11%	11%	Other China	2%	19%
Reynolds	8%	Alcoa	Alba + Dubal	1%	4%
Kaiser	8%	0%	Others	23%	27%
Pechiney	7%	Alcan	Norsk Hydro	-	5%
Alusuisse	4%	Alcan	BHP Billiton	-	4%
Alumax	3%	Alcoa	SUAL	-	3%
Comalco	2%	3%[6]	Chalco	-	3%
VAW	3%	Norsk Hydro	RusAl		8%

Source: Table by author, data from Evans, 2005 and Bergsdal et al., 2004.

Table 7. Primary Aluminum Industry Concentration

Concentration Index	1980	2004
6 Largest Companies (percent global production)	52%	44%
HHI (8)[7]	523	410

Source: Table by author, data from Evans, 2005.

[6] Comalco is a member of the Rio Tinto Group
[7] Dow Jones HHI Index

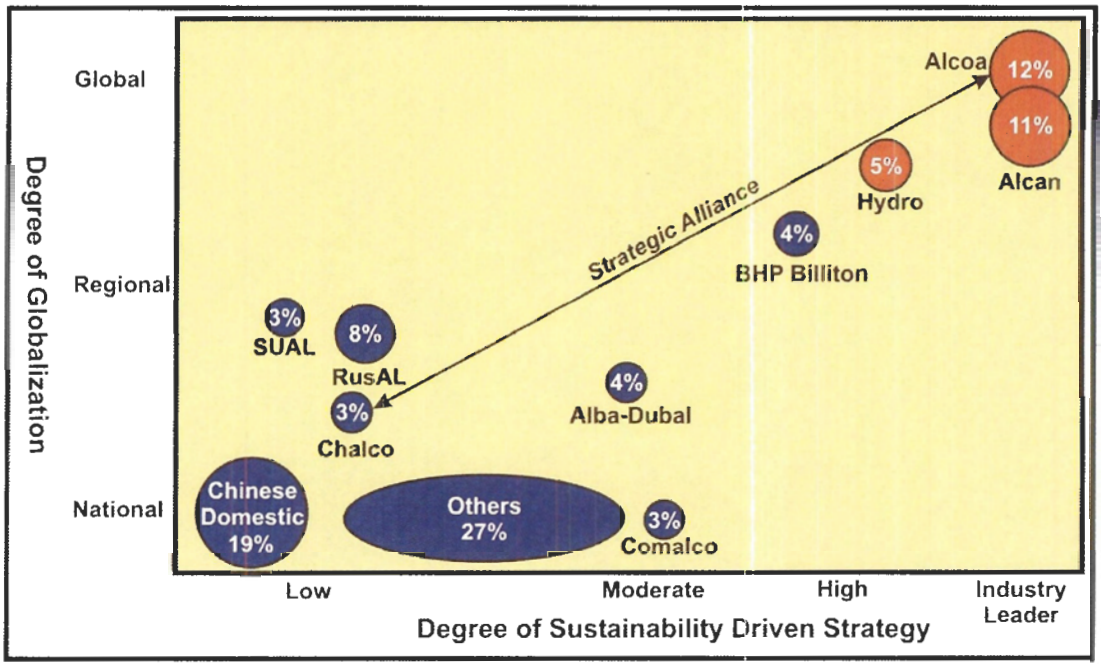
The industry is commodity price based with pricing defined daily on the London Metal Exchange (LME). As the LME price is affected by global production, inventories, demand and price pressures are developed collectively by the competitive production.

As the production base of the industry is spread throughout in many countries and regions of the world, degrees of sustainability implementation vary among the firms. Additionally their competitive influence on a sustainability basis varies from being an influencer to that of being pressured by companies who have adopted a sustainability-based strategy. Figure 5 presents a qualitative based strategic group map of the primary aluminum industry based on the degree of sustainability driven strategy employed by the firm, and the distribution of smelting assets around the world. The inferred degree of business strategy driven by sustainability objectives was assessed from a review of available literature, third party recognition, and information provided on the various companies' web site. Factoring into the assessment of the firm's strategy are key indicators of risk management systems (employing ISO 14001 standards) and degree that the firm addresses the industry's sustainability challenges. The degree of globalization is an indicator of a company's level of influence on the global market. The level of influence is determined by the following criteria: a national company being limited to one country, regional being clustered in 5 to 10 countries, while a global company has production on more than 2 continents.

The strategic positioning on this map is important as the leaders in sustainability have the power to influence regulatory agencies, market place expectations and industry association standards. Companies with leading positions have first mover advantage to influence the industry. For example, raising the minimum standards for other firms to meet in order to survive in the industry. This keeps the industry laggards at a cost disadvantage by keeping them in a responsive position. For the industry as a whole, this competitive strategy is beneficial because it pulls the entire industry to a more sustainable position. However, it is important to note that firms, which

do not operate on a sustainable basis, may have temporary cost advantages over sustainability driven companies or those that face tight environmental regulations. Therefore, it is advantageous for the industry leaders to influence the lagging firms into adopting best practices for the environment and community so that they are on an equal cost basis. Of importance to note is the influence from smaller firms that are not on the map, or are located on low to moderate scale of sustainability driven strategy. These firms can exert influence on the entire industry by developing new best practices that push the sustainability frontier and attract either regulatory, market, or stakeholder attention.

Figure 5. Strategic Group Map of Primary Aluminum Producing Firms by Sustainability Driven Strategy



Note: percentages shown in the bubbles represent global aluminum production share in 2004.

Source: Created by author.

3.3.1 Alcan

Alcan is a global firm and an industry leader in sustainability. The company is placed near the other leading aluminum firm, Alcoa, in terms of sustainability. A detailed discussion of Alcan and the company's positioning in terms of sustainability is presented in the following chapter.

3.3.2 Alcoa

Alcoa is a highly vertically integrated company operating on a global basis in 43 countries, with a recorded income from continuing operations of $1.4 billion US. Alcoa currently produces approximately 12 percent of the global primary aluminum supply. Alcoa has a clear sustainability strategy designed to align the company's values with society's values and provide long term value creation to Alcoa and its shareholders. The strategic sustainability goal is to provide long term net benefits to shareholders and stakeholders by simultaneously achieving financial, environmental and social responsibility performance.[xxxii] Alcoa has implemented strategic programs on climate change, stakeholder engagement, sustainability integration, sustainability measurement system, energy strategy, product life cycles, biodiversity, sustainable technology, and facility end of life management. Alcoa follows GRI[8] sustainability reporting guidelines and retains an independent auditor for verification. All of Alcoa's smelters are ISO 14001 certified. Alcoa has a AAA sustainability rating from Innovest Strategic Advisors and was named by the Corporate Knights and Innovest Strategic Advisors as one of the top three most

[8] Global Reporting Initiative (GRI) is a non-profit joint initiative between the U.S. based non-governmental organisation Coalition for Environmentally Responsible Economies (CERES) and the United Nations Environment Programme that develops global standards for sustainability reporting.

sustainable corporations in the world (topping the list of the worlds top 100 most sustainable corporations). Using GRI reporting standards as an indicator of sustainability, Alcoa was identified in 2003 to be a sustainability firm.[xxxiii] Interestingly, Alcoa is a member of the Dow Jones Sustainability Index, but ranks behind Alcan on the index (Alcan being recognized as the basic materials supersector leader on the index)[xxxiv]. Alcoa operates in markets at different states of development: from the western world to emerging markets in Africa, South America, and Asia. Alcoa uses its reputation and sustainability strategy in all markets to leverage ecoefficiency opportunities and influence competitor's positions on environmental strategies to the company's advantage. Alcoa typically landfills SPL. In North America, SPL is typically pre-treated before landfilling. While in Europe SPL is typically landfilled without pre-treatment. In Australia, Alcoa uses a vitrification process to stabilize the SPL.

3.3.3 Norsk Hydro

Norsk Hydro (Hydro) is the third largest global aluminum company, is highly vertically integrated, and operates in a number of different industry segments. Hydro is recognized for its sustainability strategy, being a member of the Dow Jones Sustainability index. However, although the company is one of the industry leaders for sustainability in primary aluminum production, it ranks behind Alcan on the DJSI and scores in the same range as Alcoa[xxxv]. Interestingly, Hydro was not recognized on the top 100 sustainable companies. Hydro's strategy is based on four phases. First reparation involving cleaning up legacy issues and addressing command and control situations. Second, prevention through the utilization of cleaner technology and developing operational excellence and eco-efficiency. Third, Norsk Hydro is focused on building business development opportunities and competitive advantages through environmental issues, and improving product life cycles. Lastly, sustainable conduct by bringing the three pillars of sustainability (environment, economic, and social responsibility) together.[xxxvi] Hydro in Europe

pre-treats SPL prior to landfilling and, additionally, practices seashore disposal. In other regions, SPL is landfilled without pre-treatment.

3.3.4 BHP Billiton

BHP Billiton (BHPB) is a vertically integrated aluminum producing company that operates a diversified portfolio of mining and mineral segments. BHPB's aluminum holdings include bauxite mining, alumina refining, and primary aluminum production. The company is not downstream vertically integrated. The company is a global entity, when all holdings in the various portfolios are considered together. The company has primary aluminum production facilities in South Africa, Brazil, and Mozambique. However, specifically the aluminum portfolio is operated on a regional basis. ISO 14001 certification has been obtained for 57 of BHPB's 90 sites. BHPB has developed an integrated sustainable business strategy with significant weight placed on community support and development, as a response to the locations that it primarily operates in (remote communities and developing countries). The company provided $42 million (US) in global community contributions in 2003. As to environmental questions BHPB has addressed them by developing plans for a 6 percent GHG reduction, implementing progressive water management plans, developing biodiversity plans and metrics for site closures, and lastly investing in hydrogen fluoride reductions from it's aluminum smelters. BHPB is behind Alcan, Alcoa, and Hydro in terms of sustainability in the primary aluminum industry, for example, its recent investments in slotted anode technology lags behind Alcan and Alcoa. Of interest, BHPB is not recognized on the World's top 100 sustainable companies list, but is listed on the Dow-Jones STOXX index as the basic materials supersector leader. SPL generated in by Mozal, is landfilled without treatment.

3.3.5 Comalco

Comalco is a member of the Rio Tinto group, which is similar in nature to BHPB, but lags behind BHPB in terms of primary aluminum production and sustainability. Comalco is on a national level, located in Australia, and is vertically integrated downstream into bauxite mining and alumina refining. Comalco is ISO 14001 certified, and endeavors to work as a sustainable company.[xxxvii]

3.3.6 SUAL

SUAL is a product of the collapse of Soviet Union. SUAL has operations in nine regions in Russia. The company has two divisions, upstream bauxite mining/aluminum refining and primary aluminum refining. Downstream the company's second division looks after semi-finished and finished aluminum products. The company mostly uses Söderberg technology, but it is presently investing in modernizing its plants with the installation of prebake technology to reduce emissions (hydrogen fluoride and greenhouse gases).[xxxviii] The company is more driven to the social aspects of sustainability than the environment pillar, largely due to the cultural heritage of the company and communities where it operates in. SPL is landfilled without treatment in SUAL's facilities.

3.3.7 RusAL

RusAL is similar to SUAL in origin. It is a regional company operating predominantly in Russia, but has interests in 11 countries, and provides a significant contribution to the global aluminum supply (8 percent). RusAl operates the world's largest aluminum smelter, which has a capacity of 900,000 tonnes. RusAl provides 75 percent of the Russian aluminum market, and 80 percent of the total primary metal production is with Söderberg technology. RusAl is working to

improve the environmental performance of its plants, and believes Söderberg technology has not reached its limits in terms of environmental performance.[xxxix] RusAL is in a similar position with sustainability as SUAL. SPL is landfilled without treatment in RusAl's facilities.

3.3.8 Alba

Alba was developed by the Bahrain government in 1971 to diversify the country's economic and employment base. It is 77 percent owned by the Government and 20 percent by SABIC Investments. The company has low vertically integration with petroleum coke calcining and primary aluminum production. The coke calcining facility is operated as an export business, selling 200,000 tonnes of coke annually on the global market. Alba is ISO 14001 certified and has invested in state of art sulphur dioxide scrubbing for the calciner. It also presently upgrading its gas fired power plant to reduce nitrous oxides emissions.[xl] The company is more focused on the social aspects of sustainability then the environmental, but investments are being made into emissions control. Alba is situated near main shipping routes and is strategically located to sell to the global market. Alba sends SPL directly to a landfill without treatment.

3.3.9 Dubal

Dubal is located in the United Arab Emirates and is a 540,000 tonne capacity prebake smelter. The site received ISO 14001 certification in 1999. Dubal has programs for GHG reduction and implements minimum environment, health, and safety performance standards on suppliers. Dubal, like Alba, is situated near main shipping routes and is strategically situated to sell on a global market. SPL is landfilled by Dubal without pretreatment.

3.3.10 Chalco

Chalco is an emerging vertically integrated aluminum company from China. Chalco is mostly upstream integrated in the Chinese bauxite mining and alumina production, controlling the country's bauxite and alumina markets. Chalco operates mostly modern prebake cost efficient smelters and has a strategic alliance with Alcoa (who purchased an 8 percent ownership in Chalco). Chalco is dominantly focused on economic growth and neither environment nor social aspects are prevalent in the company's strategy. SPL in China is typically burned or landfilled.

3.3.11 Other Chinese Domestic Producers

Other Chinese Domestic producers are an interesting fragmented collection of approximately 128 separate provincial governmentally owned enterprises that produce 19 percent of the global aluminum supply.[xli] This group of primary aluminum producers is not vertically integrated and their alumina supply is dependent on Chalco, short-term contracts, and the spot market. These smelters dominantly use Söderberg technology and operate in the upper cost quartile. Additionally, they are under pressure from the Central Government to close the polluting Söderberg potlines.[xlii] These independent producers may provide strategic growth opportunities to foreign aluminum firms, provided alumina and power supplies can be secured. Chinese producers will benefit from western influence, in terms of sustainability. For example, Alcan has invested in Qingtongxia and is influencing the environment, health, and safety strategies of the business. SPL in China is typically burned or landfilled.

3.3.12 Other Producers

The group of "Other Producers" on the strategic map of the primary aluminum industry is a variety of small, typically non-vertically integrated companies owned by families, governments, and corporations that are scattered across the globe. Technology employed by these producers

ranges from Söderbergs to various prebake systems. Commitments and integration of sustainability in their business strategy ranges widely between the enterprises. The North American producers have joined with Alcan and Alcoa in an industry wide partnership on environmentally driven sustainability initiatives of energy reduction, GHG reductions, and working collectively to improve environmental, health and safety performance.[xliii] Collectively, these producers contribute 27 percent of the global primary aluminum supply. SPL disposal practices for the smaller producers are varied depending on their local regulations. These practices range primarily from landfilling to recycling in brick and cement industries.

3.4 Aluminum and Substitute Product Positioning

The aluminum industry is positioning itself as a 'green' industry that provides an infinitely recyclable product with a net beneficial product life cycle. This positioning is targeted at leveraging opportunities with climate change, energy conservation, waste reduction and recycling, and low footprint product life cycles. Substitutes competing with aluminum vary, depending on use, but all are challenged to compete with the sustainability aspects of aluminum. Glass and plastic share the recycling market with Aluminum. Steel was the traditional metal of use in the automotive and transportation and industry, however, aluminum has made significant gains in those markets. Those gains were made largely through Alcan and Alcoa developing technology for fabricating and welding structural aluminum car frames and bodies. The competing advantage of aluminum in these markets is that the lighter weight car bodies and engines lead to fuel efficiency and GHG savings. Additionally, aluminum car bodies and engines are easier to recycle at the end of the product's life (a regulatory pressure developing in Europe). Competing materials often need to have new technologies developed to improve their traditional uses to maintain market share. This is especially true with steel in the transportation industry, where the steel industry had to develop new lightweight structural shapes to compete with

aluminum in cars. Aluminum is also entering the wine market by producing aluminum screw caps to replace dwindling cork supplies.

Table 8. Aluminum Products and Competing Substitute Materials (Select List)

Product/market	Substitute
Cans and bottles	PET plastic, glass, laminated paper
Wine bottle caps	Cork
Automobile and transportation industry	Steel, magnesium alloys
Architecture	Steel, composites, polyresins, wood,
Aerospace	Composites, polyresins
Packaging	Plastics, wood, paper, laminates

Source: Table by author.

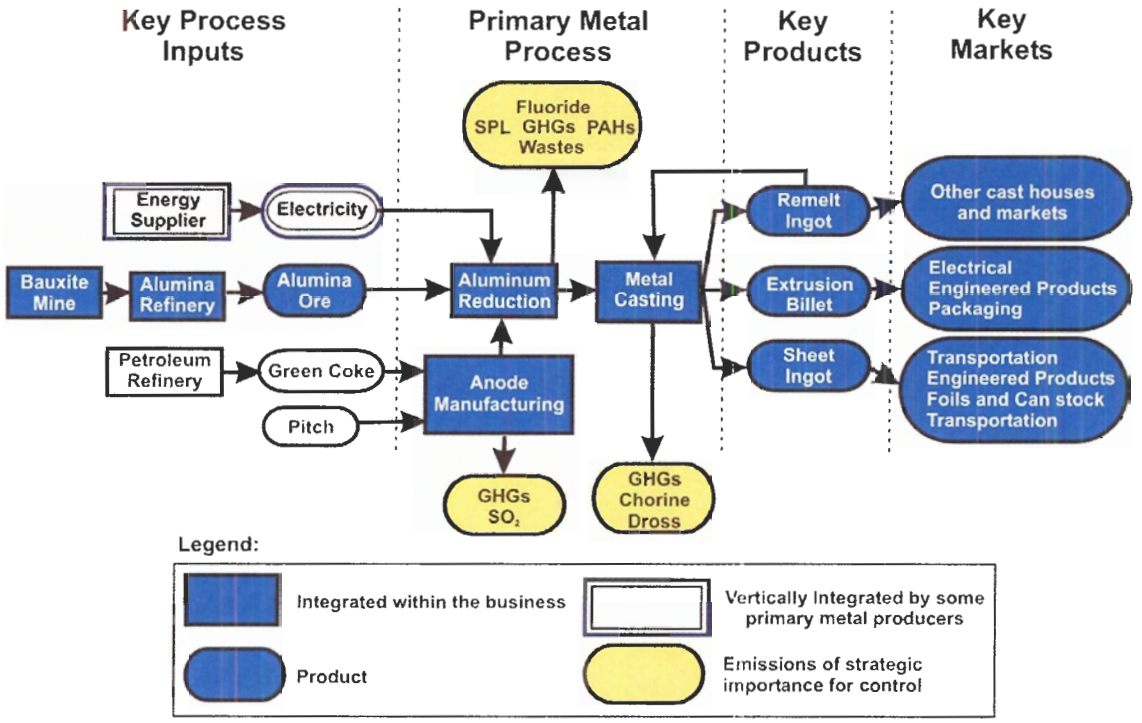
To mitigate substitute threats to its market share the aluminum industry promotes itself as the most environmentally favorable option because of its recyclability and overall low life cycle cost. This is important an important strategy as competing substitutes could turn the sustainability arguments against aluminum producers by focusing on the negative aspects of primary production.

3.5 Primary Aluminum Industry Supply Chain

The supply chain for primary aluminum production is similar across the industry. Upstream markets supply key materials of alumina ore, petroleum coke, and energy that are used to transform the alumina into primary aluminum for downstream markets.

Figure 6 schematically details this supply chain. The major aluminum companies have integrated their supply chain or various aspects of it, to mitigate supply chain pressures and promote growth in their core product.

Figure 6. Primary Aluminum Industry Supply Chain



Source: Created by author.

Bauxite mining and alumina refining are dominated by the major aluminum players, and are the first key strategic supply for the industry. Control of bauxite reserves and alumina production are of great strategic importance to the business models of the firms (guarantee supply, price, and quality). Consequently, the bauxite and alumina industry is more concentrated than the primary metal production, with six firms controlling 48 percent of the global bauxite production and 44 percent of the global alumina production (Table 9). Quality of alumina is important to primary aluminum production in regards to metal purity and environmental performance. Typical contaminants of alumina include silicon and iron, which is a notable concern with alumina produced from bauxite in China. Consumption rates of bauxite and alumina

to support primary metal production are substantial, with a ratio of approximately 4 tonnes of bauxite to make 2 tonnes of alumina to make 1 tonne of aluminum.

Table 9. Global Bauxite and Alumina Production

Company	Bauxite Global Market share	Alumina Global Market share
Alcoa	24%	22%
Alcan	10%	10%
Chalco	7%	10%
Comalco	7%	
BHP Billiton	5%	7%
RusAl	5%	5%
Glencore		5%
Others	42%	41%

Source: Table by author, data from Hanley, 2004.

Energy is a second key strategic input to primary aluminum production. The electrolytic process of reducing alumina to aluminum is extremely energy intensive, requiring between 13.8 to 16.1mW per tonne Aluminum[xliv]. Unless access to a stable long-term power supply is secured, an aluminum smelter will be at risk of production curtailment or stoppage. A recent example of this occurred in the 2000-2001 energy crisis in the western United States that led to the shut down of the aluminum smelters in the Washington and Oregon states.[xlv] For this reason, many primary smelters are either situated next to stranded energy supplies, government sponsored energy projects or have vertically integrate the power generation and transmission into the business.

Petroleum coke is the third key strategic supply for the primary aluminum industry. Coke is used in manufacture of anodes, either as prebaked anodes or as anode paste in the Söderberg process. Coke is essentially a waste product from the petroleum refinery industry, a residual product after the volatile fuels and oils have been distilled from crude oil. Although coke is a waste product, it provides some value to the refineries through its sales to other industries that

require carbon sources. The aluminum and steel industries are such markets. The aluminum industry is very sensitive to the quality of the coke used in the manufacture of anodes. Coke that is not high grade increases the risk of anode effects leading to higher GHG and fluoride emissions, and poorer current efficiency. Anode grade coke supplies are currently under tight pressure and are declining in quality due in part to an increasing trend in sulphur content. The predicted shortfall of suitable coke will be of concern due to higher coke prices, process instabilities and higher emissions (Fluoride, GHGs, and sulphur dioxide)[xlvi]. The sulphur content is increasing due to the declining availability of sweet crude oil and low sulphur fuel regulations. This increasing trend of sulphur content in coke results in higher sulphur dioxide emissions from the anode manufacturing process.

Pitch, produced from coal tar is used as a binder for the coke in the anodes. The quality of pitch is of particular concern for Söderberg plants due to polycyclic aromatic hydrocarbons (PAHs) emissions, some of which are identified carcinogens. PAH emissions in developed countries are concerning to regulators and are an added pressure to close Söderberg plants.

The anode manufacturing may be part of the reduction process (Söderberg plants) or a separate process for the prebake smelters. Prebake smelters may have the process integrated into the business, and may sell anodes to other plants. Additionally anode manufacturing may be a separate business unit serving a market place of prebake smelters.

The aluminum electrolytic reduction process is the core business of the primary aluminum industry. Electrical energy, alumina, and carbon are primarily used to form metallic aluminum in the reduction process. Hot metal from the aluminum pot cells is transferred to the cast house for purification and product casting. Key emissions from the process are gaseous hydrogen fluoride, PAHs (Söderberg plants), dissolved aluminum in effluents, GHGs and a variety of waste products. In particular, spent potlining and salt cake (prebake process) are included waste

products. The emissions and waste disposal present significant costs and liabilities to the business unit.

The last stage in the overall supply chain is metal casting. Metal casting is where the hot aluminum metal is purified, alloyed to customer specifications and formed into either value added extrusion billet, sheet ingots or remelt ingots. Finished metal is then shipped to customers. Of primary concern to the casting process are energy consumption, GHGs, chlorine, and dross management. GHG production and rising energy costs will drive the industry to increase the purity of metal supplied to the cast house, and also optimize the metal fluxing and alloying time. Dross is the skimmings from the casting furnace, and typically is high in chlorine salts and aluminum. The aluminum can be recycled at a recovery plant, but this is an added cost and can present concerns associated with managing the chloride salts.

3.6 Global Aluminum Industry Overview

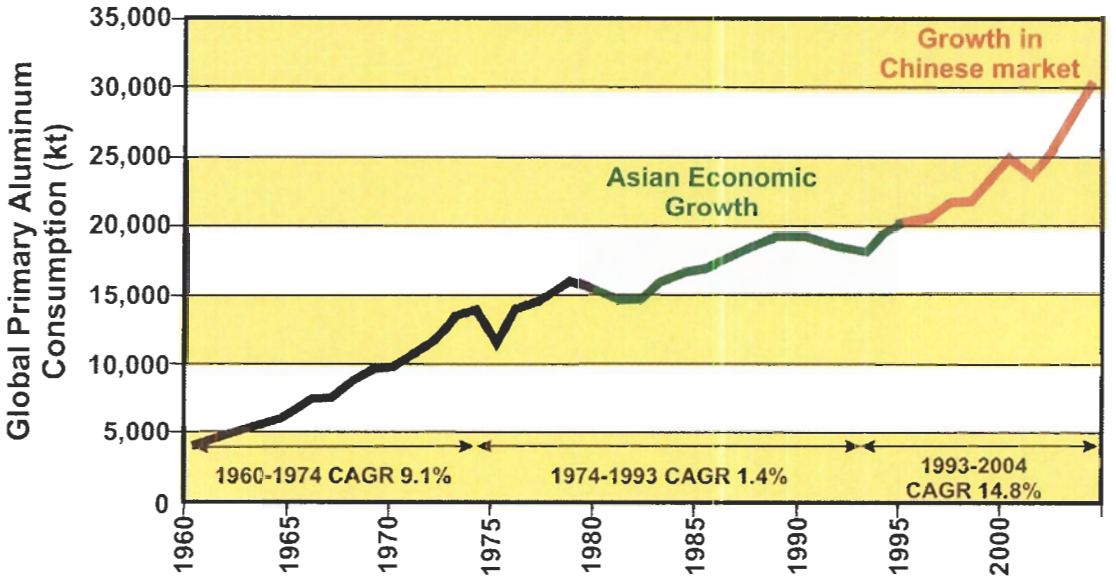
The aluminum industry is over 100 years old and is still growing, being fuelled by changing global economic cycles. Figure 7 shows the steady growth in global primary aluminum consumption from 1960 to 2004. Consumption in the first thirty years of the graph was lead by the American super-cycle in metals. This cycle slowed in the mid-1970s due to the energy crisis (1974 Middle East oil embargo). Consumption growth in the 1980s to early 1990s was predominantly fuelled by the strength in the Asian economy. From approximately 1995 to 2004, Chinese aluminum consumption was the primary contributor driving the growth in aluminum consumption. Alcan is forecasting continued long-term growth of the primary aluminum metal sector based on the assumption that there will be continued economic growth and development in

China, India, Malaysia, and Thailand. The demand for metal is forecast to be driven by needs in housing, transportation, electrical, and consumer goods.

Demand for primary aluminum in the automotive and transportation industry is expected to be supported by tighter emissions and GHG reduction regulations in response to climate warming and the Kyoto protocol as well as forecasted higher oil prices. Aluminum structures in cars can save up to 50 percent by weight which directly increases the fuel efficiency (10 percent weight reductions result in 5-10 percent fuel savings) of high aluminum content cars. Depending on the aluminum content of the car the life cycle savings of GHG emissions range from 2457 kg to 4950 kg. The energy and GHG savings are being recognised in the automotive industry. The average aluminum content in vehicles rose from 20kg in 1960 to 150kg in 2004[xlvii].

Additional demand support will be created by regulations on closed loop product life cycles such as those being created by the European Union. These regulations require recycling of the vehicle at the end of its life span. The recycling properties of aluminum and the technology being developed to segregate different aluminum alloys in the recycling process will make aluminum even more marketable to the automotive industry in the future. The aluminum industry is collectively marketing aluminum metal based on these green properties.

Figure 7. Global Aluminum Consumption Growth

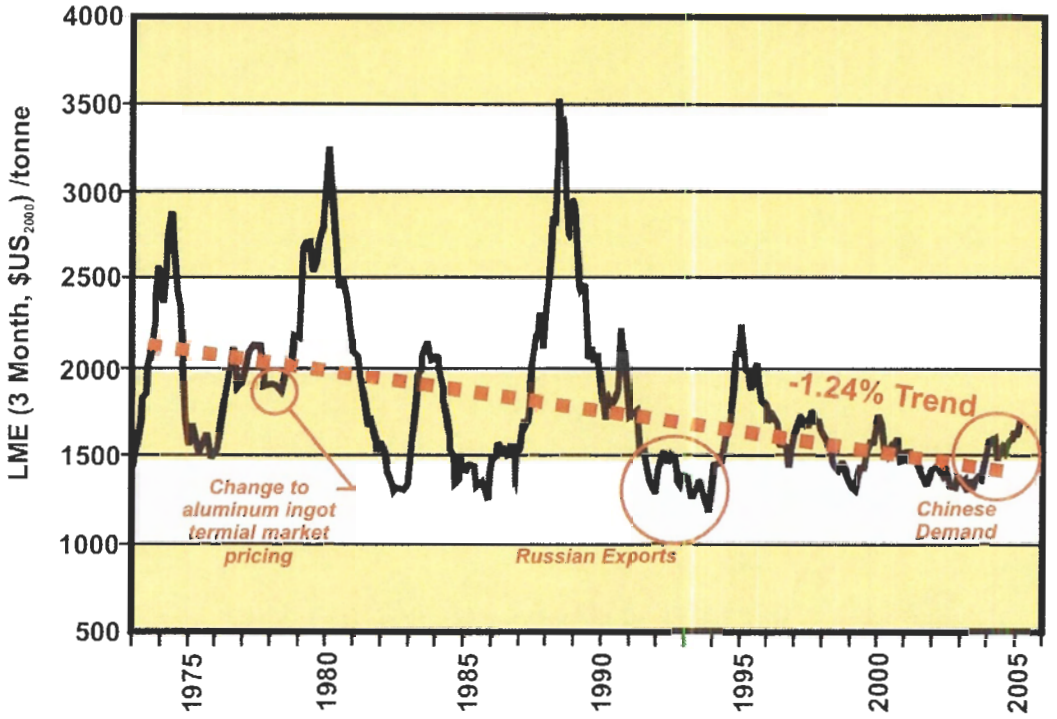


Source: Created by author, data by Evans, 2005

Despite the positive forecast for aluminum demand growth, continued supply challenges are expected. Primary aluminum is a commodity product that is under price pressure. The 30 year price trend (shown in Figure 8) has a declined by approximately 1.25 percent per year. The commodity pricing started in 1978 and marked the inception of commodity trading of alumimum ingot on the London Metal Exchange.[xlviii] This triggered a shift from producer pricing to terminal market pricing that initiated the breakup of the supply chain, economically separating upstream primary production from downstream fabrication. Additionally, the industry's low concentration of producers and publicly funded producers results in a historical lack of discipline balancing supply with demand. For instance, the 1992-1993 Russian aluminum exports to the western market, following the disintegration of the Soviet Union, flooded the global market place and collapsed the price of aluminum. Over one million tonnes of additional primary capacity are

being planned for 2008 that may dampen the price gains realized from the demand for primary aluminum in China.[xlix]

Figure 8. Long Term Decline in Aluminum Commodity Price

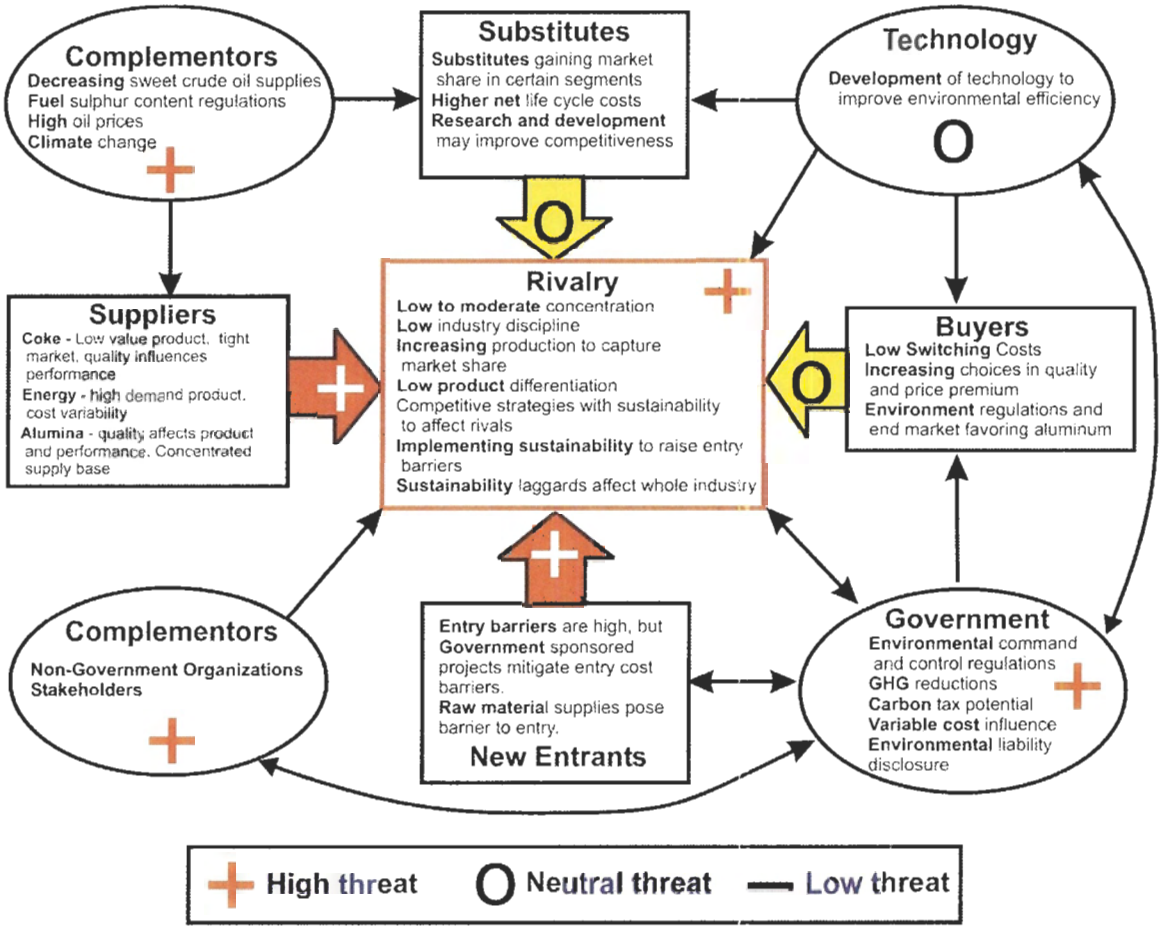


Source: Drawn by author, data from Evans, 2005 and Brooks, 2003.

3.7 Market Place Pressures

Based on an analysis of the market place pressures using an augmented Porter's Five Forces model, the primary aluminum industry faces high threats to profits that can the industry unattractive. The augmented Porter's Five Force analysis is based on analyzing the power of suppliers, threats of substitute products, threats of new entrants, buyer pressure, rivalry within the industry, complementary forces, technology, and governmental influence. Figure 9 presents the analysis of the influencing pressures on the industry.

Figure 9. Porter's Augmented Five Forces for the Primary Aluminum Industry



Source: Created by author.

Suppliers of strategic materials such as alumina, coke, and energy have high leverage over industry. The alumina industry is more concentrated than the primary aluminum industry, and the majority of global metallurgical grade alumina production is by the vertically integrated aluminum companies. Vertical integration to include alumina production is to offset supplier power, as alumina is a key resource input to the primary aluminum industry. Independent primary producers must negotiation largely on short to mid-term contracts or on spot market pricing for alumina. The industry has low to moderate power over the quality of the alumina ore, which can

affect production and environmental emissions. Coke producers have very high power over the industry as anode grade coke is a very tight market and the coke is a low value product to the petroleum refineries. Controlling quality in terms of bulk density, size gradation, ash and sulphur content can affect the over distillation process and tie up refinery resources. Additionally, the refineries are increasing the sour crude oil content in their production as sweet crude oil is decreasing in supply. This results in an overall increase trend of sulphur content of the coke supplied to the industry that degrades the environmental performance of the industry by increasing sulphur dioxide and GHG emissions. Tight energy supplies are a threat to the industry in some regions of the world. The aluminum industry is energy intensive and high electrical costs can decrease the profit margin on the aluminum ingot. A single power producer typically supplies smelters and switching to another power producer is highly difficult. Additionally, shortages can shut down production.

Substitute products have gained market share in certain segments by competing with the positive life cycle qualities of aluminum but this force remains neutral. PET plastics have gained significant market share in the bottling industry. PET plastics compete with cans in the 250-755 ml size range. Steel is aluminum's rival in the transportation industry, although aluminum has been gaining increasing market share since the 1960s. Magnesium alloys are another substitute risk to aluminum. The degree of threat poised by the substitute alloys depends greatly on the LME price of aluminum, with higher prices increasing the attractiveness of the substitute alloys; however, switching costs can be high for some products. Complementing substitute forces are high oil prices and increasing sulphur contents in oils, as these tend to offset substitute advantages. High oil prices negatively affect PET plastic production and higher sulphur content in crude oils affect the environmental performance of the steel industry.

Threat from buyers is neutral as buyers can have high switching costs to move from aluminum, however, nearer the end market, buyers have lower switching costs when replacing aluminum. Buyers of primary aluminum metal typically include:

- Rolling companies (purchase value added sheet ingots) that produce aluminum plates, sheets, foils, and can stock.
- Foundries (purchase value added ingots and remelt) that produce cast aluminum products.
- Extruding firms (purchase value added billet ingot) that produce extruded aluminum profiles.
- Cable companies that purchase rod stock.

End markets for aluminum are comprised of transportation (30%), building and construction (18%), consumer durables (6%), machinery & equipment (8%), electrical (9%), cans (12%), other packaging (6%), other uses (12%)[1]

LME pricing trends affect the attractiveness of substitute materials. Within the industry, buyers have low switching costs to move from one aluminum producer another. There are increasing choices in qualities and premiums available, especially with the availability of extrusion products being supplied by China. Environmental regulations and end market consumers place positive pressures on the buyers to favor the positive life cycle costs of aluminum.

Entry barriers to the industry are high due to costs and raw material supplies. Costs to enter the primary aluminum industry are prohibitively high, with a modest sized smelter (250 kT capacity) costing over a billion dollars to construct. Small or mini-mills such as in the steel industry are not cost efficient in the aluminum industry due to the requirements for casting the value added products (such as sheet ingot). Raw materials supplies pose a second entry barrier as smelters require stable and large supplies of refined bauxite (alumina) and low cost electricity. Unless long term stable supplies of alumina are secured, the incumbent will be forced to procure the alumina on the spot market which can be an average 50 percent above the long term contract

price. Electricity is another critical supply issue for an incumbent, as a smelter requires stable large supply of electricity, often a dedicated supply. The energy supply is limits where a smelter can be located. Unless the incumbent is able to secure long term alumina contracts and low cost energy supplies, the incumbent would be operating at a competitive disadvantage.

Despite the high entry barriers, governments that sponsor primary aluminum projects for economic development will substantially mitigate the entry barriers. This effect of government sponsored projects on the aluminum industry is demonstrated in Table 6 and Table 7 where there has been no concentration in the primary aluminum industry despite a series of large mergers and acquisitions within the industry. Emerging markets are following a similar development plan that occurred in the US Pacific Northwest, whereby hydro-electric power stations were developed to entice large industries to setup and take advantage of low cost energy. The Mozal smelter project is an example of this kind of development.

Government sponsored new entrants to the industry pose a high threat that can negatively affect the overall industry. This is because many government sponsored projects are not sensitive to competitive market place pressures and receive subsidies. These projects often lack market place constraints and discipline.[li] For instance, many provincial governments in China operate highly inefficient smelters that purchase alumina on the spot market and collectively occupy 19% of the global market place (Figure 5). Additionally, the changing political landscape has allowed both government and formally state owned producers to enter the global market. For instance, Chinese and Russian producers have entered the global market and caused an upset in overall inventories.

Rivalry is high within the aluminum industry. High rivalry is a characteristic of low-moderate concentrated industries. Financially, firms compete primarily on operating margins and premiums of value added products (alloyed metals). Other modes of competition are product

branding, quality control and technical support. Industry rivalry is demonstrated by the industry's lack of discipline in maintaining a balance between inventory and demand. Overall, the producers are compelled to increase production to win market share. Leading companies are implementing competitive sustainability strategies to:

- improve the positioning of their product
- raise entry barriers
- increase industry and government expectations on companies without sustainable business approaches
- to pressure competing businesses on the environmental front

Technology is a competitive force used by the industry often in response to governmental influence to develop eco-efficient technologies. Additionally, it is used to influence rivals to compete in developing similar applications or expend resources to defend their existing applications. The industry is also using technology to compete with substitutes and develop new markets for aluminum. Conversely, technology is being used by substitute based industries to improve the life cycle competitiveness of their products. Technology is a complementary and neutral force on the industry.

Government is a very powerful influence on the aluminum industry. Governments control the licenses to operate. They also enact command and control regulations that influence both environmental performance and operating costs. This influence can be a key factor in either locating production to a region or shifting away from high operating cost areas. Key areas of global influence from regulators lie with the GHG reduction and potential carbon taxes. Until the primary aluminum industry is able to move away from the Hall-Heroult process with non-consumable anodes the government pressure for the GHG emissions reduction will be a strong influence in the cost positioning of the industry. The Government of Canada, for instance, is proposing that 700 large final emitting industries in Canada cut their GHG emissions by 15 percent in 2010 or it will impose high compliance fees and regulatory fines for missing the

targets.[lii] It is important to note that each major region has an aluminum association that collectively voices and lobbies for industry concerns. The associations also develop initiatives to mitigate governmental pressures. The Canadian Aluminum industry, for example, is trying to improve the position of the Canadian primary aluminum industry in relation to GHG emission regulations of the Federal Canadian government. Internationally the American Sarbanes-Oxley Act will affect all companies that have equity listings in the United States through its financial liability disclosure rules.[liii]

Non-governmental organizations (NGOs) and stakeholders are complementary to government and can influence government regulatory forces and industry rivalry. NGOs can exert political pressure through lobbying and swaying public opinion. For instance, the David Suzuki Foundation released a critical environmental performance report ranking Canada as the 28th out of 30 countries of the Organization Economic Co-operation and development.[liv] Carbon monoxide (a gas that oxidizes to CO2) was singled out as a pollutant that is poorly managed by the Government of Canada. If the pressure and criticisms spur Canada to regulate carbon monoxide emissions and GHG reductions then this would affect aluminum companies, in particular Alcan which has 40 percent of its production in Canada and the majority of it's emissions are GHG's. Additionally, Pollutionwatch (a joint organization of the Environmental Defense and the Canadian Environmental Law Association) released a report that obtained national news coverage which identified Alcan as a member of the "Dirty Dozen" the top twelve polluting companies in Canada in terms of overall emissions.[lv] Negative publicity such as this can influence not only regulatory opinion but also stakeholders such as shareholders.

3.8 Primary Aluminum Industry Dynamics

The aluminum industry has evolved dynamically over the past 30 years and will continue to grow and change into the future as political, economic, social and technological changes are encountered. The industry has become highly vertically integrated and has encountered two new global players (Russia and China) as a result of changing political landscapes and ideologies. Recently, the three largest firms (Alcoa, Alcan, and Norsk Hydro) consolidated the industry through a series of acquisitions. Despite the acquisitions, they did not increase the overall concentration of the primary producers because new firms have entered the industry and Russia and China have opened up. The growth forecast in primary aluminum demand is positive with the expectation of continued development in the Asian emerging markets. The margins on the primary metal will likely be lower, however, due to increased production to meet demand and competition in providing value added products. The tightening of margins may reshuffle production to lower cost countries and higher efficiency smelters. Over all, these may have a net benefit by bringing best EH&S practices to countries that would not be otherwise exposed to them.

Government regulations play a key role in shaping and industry. Global concern over climate change will affect the primary aluminum industry. If proposed regulations come into effect for energy conservation and GHG reduction there will be increased demand for the beneficial life cycle properties of aluminum across the transportation industry. This may create growth opportunities similar to those seen in the automotive industry (there is growing use of aluminum in cars and strategic alliances to meet the demand). Environmental regulations on GHG will affect aluminum production, as GHGs are one of the main emissions from aluminum

smelting. If potential carbon taxes are introduced in conjunction with carbon trading it may change the industry dynamics and potentially the production base.

Government pressures are also affecting Söderberg production plants in favour of the less polluting pre-bake smelters. In China, the Central Government wants to shut down the all environmentally unacceptable Söderberg plants by 2007 (approximately 900,000 tonnes of production).[lvi] Alcan Inc. has committed to closing down its Söderberg plants in Quebec due to environmental problems (primarily PAHs) and costs.

The supply base for the industry is also changing, notably the coke supplies and energy. The increasing sulphur content in coke will be of strategic concern to smelters across the globe in the near future. Mainly due to the increasing sulphur content in coke, firms may find difficulties in meeting permitted sulphur dioxide emission levels. The same factors may also increase the frequency of anode problems and fugitive emissions.

4 ALCAN AND SUSTAINABILITY

Alcan has made sustainability a company wide priority, and is positioning the company into a global leadership position within the aluminium industry. According to Travis Engen, Alcan Inc.'s president and CEO:

"Sustainability is one of the most pressing and complex issues facing contemporary businesses and societies around the world. At Alcan, we realize sustainability is a continuing journey, requiring unwavering commitment, effort and focus. And just as we demand excellence in meeting our production objectives, we will accept nothing less in our journey towards corporate sustainability."[lvii]

By integrating environmental, economic and social factors in to the company's strategy, Alcan is positioning itself as a long-term successful business enterprise. The company's industry leadership in sustainability is dependent on the success of its strategies and ability to implement them across its numerous business units and facilities. The Author's interpretation of the company's strategy is based on understanding three components, first its vision of a sustainable company. Second, its strategies to posture the company into a leadership position in the global aluminum industry. Lastly, the financial returns that supports the business case for sustainability. From understanding Alcan's strategy, one can comprehend how the corporate strategy affects the business units, particularly AMP-BC.

4.1 Alcan Inc. and Sustainability Vision

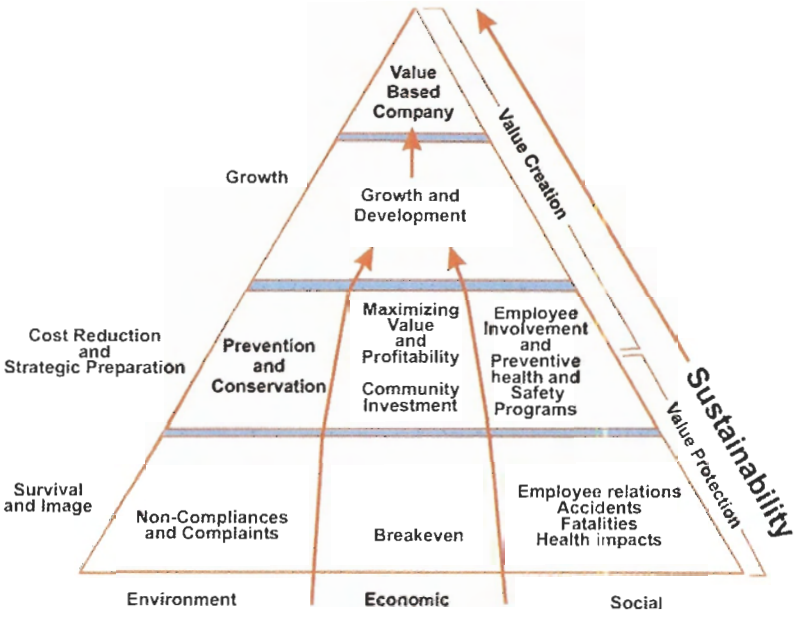
Alcan is globally positioning itself as a leading sustainability driven company, by creating shareholder value while continuing to meet the long-term needs of the company's stakeholders. This is a new frontier for the company to compete on and to become more attractive to customers, regulators, communities, and shareholders.[lviii] Corporate governance and the implementation of the Alcan Integrated Management System (AIMS) serve as the platform for Alcan's sustainable business model.[lix]

As previously mentioned, AIMS provides the platform of the company's sustainability strategy. Corporate governance ensures the best financial, strategic and management integrity of the company. AIMS is based on value based management, EH&S First, and continuous improvement. The value based management system provides a rigorous financial analysis of opportunities to ensure the best use of resources can be made. EH&S First provides a common set of practices that all business groups must comply with for environment, health and safety aspects of the business.

Alcan's vision for a sustainable company is to create a true value based company.[lx] This is a broadened concept of value, introduced in 2001, with the company's governing objective of maximizing value; a value definition that includes environment, social and economic aspects. The path to this vision is based on the sustainability triangle shown in Figure 10. This model is a simplified version of the model developed by Alcan. The base of the triangle is built on the company's core values and policies. The core values influence the way the company interfaces with customers, invests in management systems and manages stakeholders. In these ways the company will perceive the environment, realize financial performance and interact with both stakeholders and the community (the three pillars of sustainability). The first of the four levels of the triangle represents the basic level needed to maintain the license to operate. The second level

focuses on managing risks and investing in opportunities that create value. Once the base for value creation is established the company can build on opportunities that truly create value and sustained growth in the third and fourth tiers of the sustainability model.

Figure 10. Sustainability Triangle



Source: Created by author, data from Alcan, 2005

4.2 Alcan Inc. Sustainability Driven Strategy

Alcan Inc.'s global strategy is to be a low cost producer for bauxite, alumina and aluminum while being a leader in high margin engineered products and packaging.[lxi] Sustainability is a core aspect of the strategy. To develop the strategy, seven key areas have been acted on to implement AIMS. These key areas include instituting an EH&S policy, establishing an EH&S First Management system, developing a stakeholder engagement policy, optimizing

production assets, corporate involvement and seeking recognition, corporate reporting, and most importantly, the promotion of positive life cycle aspects of aluminum products.

4.2.1 Environment Health & Safety Policy

Alcan Inc. has a combined environment, health and safety policy that governs excellence and leadership in all three areas. This policy was developed in 2002. An outcome of the Policy is building sustainability by protecting and promoting the environment, health and safety of employees and communities. The Policy is based on nine guiding principles that all business units are expected to integrate into their daily business management. The following seven principles from the Policy provide governance over the environmental aspects of the business:[lxii]

- Integrate EHS as an essential part of Alcan's management and decision making process.
- Demonstrate leadership in EHS to reflect the superior and life-enhancing characteristics of our products for the benefit of all society.
- Minimize any adverse environmental impact from operations and business practices, and use natural resources and energy more efficiently through effective use of management systems that continually improve EHS performance.
- Consider and establish appropriate EHS requirements when selecting business partners and contractors.
- Audit business units and operations at regular intervals to assess EHS performance and compliance.
- Comply with legal requirements and Alcan's internal standards.
- Engage in open and transparent communication with stakeholders to achieve greater environment, health and safety understanding and to improve performance.

4.2.2 EH&S First Management System

The EH&S First Management system was rolled out in 2003 and is designed to drive EH&S performance to an industry leadership standard. As part of the EH&S First strategy Alcan Inc. issued six environmental directives (Table 10) that focus on risk management and strategic preparation for long term business growth and development. Each directive is linked to key

industry sustainability challenges and all business units are expected to fully comply and implement all directives. In addition to the directives, all facilities must be ISO 14 001 certified.

Table 10. EH&S First Directives and Sustainability Links

Directive	Scope	Link to Key industry Sustainability Issues
GHG Management	Requirement for measurement, monitoring, and reporting of GHG emissions. Establishment of Performance reduction targets by the business units.	• Climate change
Management of Environmental Releases	Establishes minimum requirements for managing environmental releases to air and water at all Alcan sites. The objective is to minimize potential environmental impacts, material losses and operational costs.	• Protection of water • Fluoride emissions • Polycyclic aromatic hydrocarbon emissions, • Sulphur dioxide emissions, • Spent Potlining • Waste Management
Resource Management	Establish a systematic approach in resource management to improve the efficiency in the use of resources and material recycling. Resources include energy, raw materials, and water.	• Natural resource conservation (water, energy, and raw materials) • Climate change - GHG emissions reduction through energy conservation
Soil and Groundwater Protection	Protection of soil and groundwater quality where business units have influence over. Assessment of potential areas of risk, development of management plans (including remediation) for all sites of risk.	• Biodiversity protection • Water conservation
Spill Containment and Counter Measures	Objective to minimize the risk of releases of hazardous chemicals to the water and soil environmental media. Establishes minimum standards for fluid storage tanks, hazardous chemical transportation and transfer.	• Biodiversity protection • Water conservation
Waste Management	Establishes minimum requirements for managing all waste streams by Alcan sites. Promotes a systematic approach in waste management to improve efficiency and minimization of waste generation.	• Water conservation • Spent potlining waste management, and • Biodiversity protection

4.2.3 Stakeholder Engagement

Stakeholder engagement and partnering is seen as a key link to value creation.[lxiii] Alcan practices proactive engagement and dialogue with stakeholders. This is accomplished through gestures of goodwill and political willingness, understanding the company's impacts, exchange of best practices, seeking cooperation and partnerships, lastly, developing and implementing action plans. [lxiv] The multi-stakeholder networks that develop through these processes fit within the second tier of the sustainability triangle. The networks strategically prepare for and lead to the third tier in the sustainability model of growth and business development through formation of partnerships.

Stakeholder engagement needs to be practiced, supported and managed by the individual business units and facilities as 'grass roots' organizations can bring local issues to national or global attention.

4.2.4 Asset Optimization

Asset optimization focuses on improving economic returns by improving production efficiency. Although asset optimzation is primarily economically driven it is important to discuss and consider the challenges that this poses to environmental goals and vice versa when coupled with the constraints posed by the environment and society. For instance, all business units have been assessed for asset optimization potential and assigned improvement targets. Through this strategy, metal production across APMG has been increased by 230,000 tonnes from 1999 to 2004.[lxv] This increase has largely been achieved through minimizing anode effects, improving current efficiency, and increasing current amperage. Reduction in anode effects reduces GHG and fluoride emissions while conserving energy. Improving current amperage could lead to higher fluoride emissions. While asset optimization improves the economic performance, the

environmental challenges may present barriers to realizing the full potential of the strategic options. Additionally, the tradeoffs of current efficiency, resource management, and environmental performance must be managed carefully.

4.2.5 Corporate Involvement and Recognition in Sustainability

Developing and maintaining a leadership position in the global community requires active participation in and promotion of sustainability issues. For this reason, Alcan Inc. is involved in a variety of multi-stakeholder and industry associations and initiatives.[lxvi] For example, the Alcan sustainability prize awards $1 million annually to NGOs involved in sustainability work. Alcan's sustainability work and company involvement in issues has received recognition from the financial investor community. For instance, Dow-Jones sustainability index uses Alcan as one of the index's supersector leaders. Involvement in the community on sustainability initiatives by the business units is encouraged by the corporate office, which promotes the initiatives in the annual sustainability report. An example of promotion is with Kitimat Work's community involvement on pollution prevention that was highlighted by the 2004 sustainability report.[lxvii]

Involvement in multi-stakeholder groups is another method that Alcan can use to exert its voice in larger socio-environmental issues and policies. For instance, recently Alcan was named to the Business Environmental Leadership Council (BELC) (a part of the PEW Center on Global Climate Change) which is focused on formulating public policy around the world to reduce GHG emissions.[lxviii]

4.2.6 Corporate Reporting

Sustainability reports are an essential tool for externally communicating the sustainability strategy and position of the company. The reports also help obtain recognition for improvements made by the company. Research companies, investors and NGO's use the sustainability reports to evaluate material risks and the ethical nature of the company. Reporting was initiated in 2002, after APM-BC issued a triple bottom line report in 2001. The first report did not use GRI standards, which may be why the Matthews et al. study ranked Alcan with a lagging sustainability score.[lxix] More recently, the reports for the 2003 and 2004 calendar years use the GRI reporting criteria and reporting metrics that have been developed based on GRI core performance metrics.

Alcan tracks approximately 38 environmental performance indicators (out of total of about 70 that include economic and social indicators) that are used in the sustainability report. The business units and facilities are expected to report on these metrics on a monthly to quarterly basis. Data is collected on a web based performance data management (PDM) system. The IAI has about 17 metrics, while the European Aluminum Association (EAA) has around 40 performance metrics.[lxx] Alcan's metrics is above both industry associations reporting standards. Both the IAI and EAA are tailored more towards bauxite mining, alumina refining, and primary metal production than Alcan's metrics, which are more inclusive of a vertically integrated company. However, removing the upstream and downstream components from primary production, the reporting metrics is significantly more involved than the associations'.

Although this high level of performance information provides the important function of externally communicating the company's sustainability performance, the PDM system and

internal reporting requirements to support the sustainability modeling and reporting will increase the reporting burden of the business units.

4.2.7 Promotion of Sustainability and Positive Life Cycle Aspects of Aluminum Products

Promotion of both the positive life cycle aspects of aluminum and product stewardship are priorities identified in the company's sustainability strategy.[lxxi] This effort is not only a defense against claims focusing on the negative aspects of aluminum's life cycle but a proactive assertion of the net life cycle benefits of Alcan aluminum products. Compared to the manufacturing of finished aluminum products and post consumer aluminum recycling, the activity of aluminum smelting has a net negative life cycle cost. Energy and water consumption, and both emissions and effluents drive the negative life cycle cost. Steel, plastics, and other competing materials can capitalize on this negative aspect of the aluminum value chain. A holistic presentation of the full life cycle of Alcan's products helps protects the company's market share.[lxxii] This is done through demonstrating that the full life cycle of aluminum is positive despite the negative life cycle cost of the primary aluminum production. However, a more applied aspect of product life cycle management is that the company can use it to communicate through life cycle metrics that it is essentially self-regulating with respect to the reduction of environmental emissions, impacts, and risk. Reductions in GHGs and achievements in energy and water conservation targets for instance reflect positively in a product's life cycle analysis. These analyses can be used by customers who seek materials from companies that improve their product's life cycle or by customers that are ethically driven to purchase products with the lowest environmental cost.

While the promotion of the product's life cycle helps maintain Alcan's visibility and position as an industry leader in sustainability, it also affects the management of the product's life cycle. Management of the life cycle pressures the business units and facilities to establish emissions reduction and resource conservation targets and delivers them. Further, it increases the burden for timely and detailed reporting on the environmental aspects of the business.

4.3 Alcan Inc. Sustainability Driven Competitive Positioning

As briefly described in section 3.3 Alcan is in an industry leadership position in terms of sustainability. The position of Alcan relative to other primary aluminum companies is determined through interpreting the company's actions on the key sustainability industry issues, external perception and recognition of the company's positions.

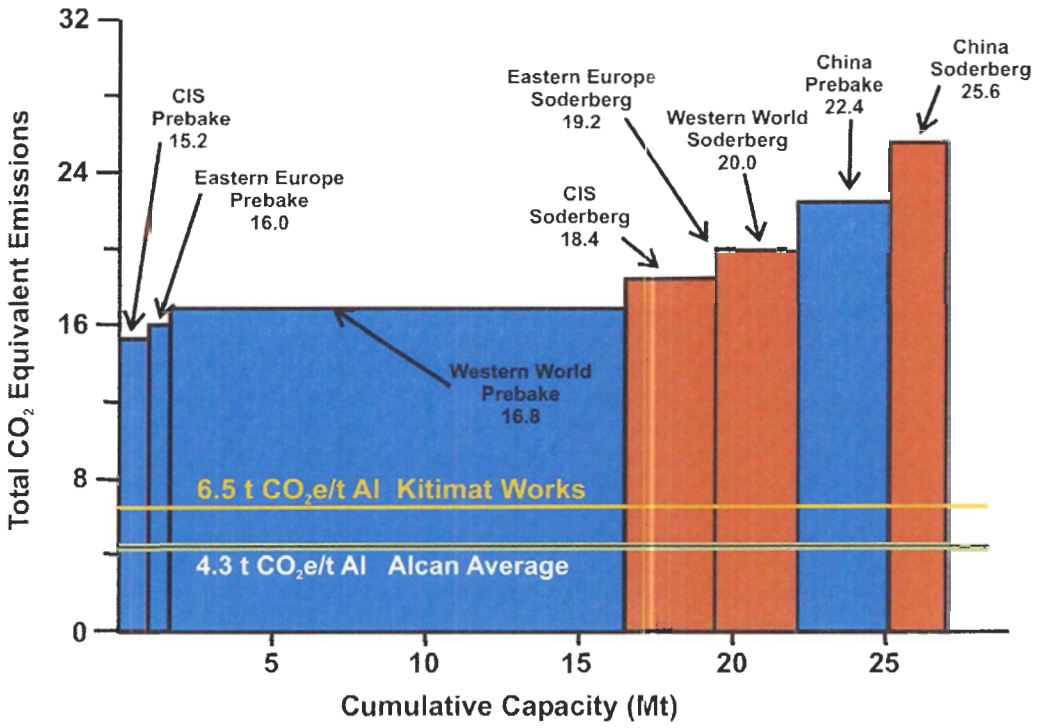
4.3.1 Alcan's Position on Key Sustainability Challenges to the Aluminum Industry

Actions and positions on the key sustainability challenges of GHG emissions, energy conservation, emissions, SPL management, resource conservation and biodiversity by Alcan are described below.

To manage GHG emissions Alcan has established the TARGET program and created a specific EH&S directive on GHG emissions. Under the TARGET program created in 2000, a reduction objective of 575,000 tonnes of GHGs was surpassed by an actual reduction of 2.9 million tonnes.[lxxiii] PFC emissions were reduced by 64 percent from (5.1 to 1.8 tonnes per tonne of aluminum) over the five year tracking period. The results driven TARGET program has given the company international recognition for the achievements and inventory of carbon emissions.[lxxiv] Additionally, Alcan has been included in the Carbon Disclosure Project's (CDP) 2005 Climate Leadership World Index [lxxv]. As can be seen in Figure 11 Alcan is in a global

leadership position in GHG management with an average GHG emission rate of 4.3 t CO2e/t Al (the western world prebake is 16.8 t CO2e/t Al.)

Figure 11. Greenhouse Gas Benchmarking



Source: Drawn by author, data from Evans, 2003.

Energy conservation is a challenge for Alcan with an average 14.9 kWh/kg Al.[lxxvi] The best in class producer requires less than 13 kWh/kg Al and the theoretical conversion requirements are 5.99 kWh/kg. These figures show there are continuing opportunities to improve energy conversion and consumption efficiency.

Fluoride and PAH emissions are managed under the EH&S Directive for environmental releases. Fluoride emissions have remained largely unchanged from 2002 to 2004, however, PAH emissions have decreased by 7.3 percent. Sulphur dioxide emissions are approximately 21 tonnes

per day and will be a growing concern due to the increasing sulphur content in the global coke supply.

Alcan is moving in to a leadership position on SPL management by developing a treatment technology (LCLL process) in Canada and researching alternatives to landfilling. SPL that is landfilled is pre-treated to stablize the hazardous waste.

Alcan manages water consumption, raw materials and energy under the EH&S Resource Management directive. Water is a high sustainability priority for the company as 83 percent of its electrical power for primary aluminum is from hydropower generation. To manage the water issue, Alcan Inc. is involved in a number of multi-stakeholder and industry organizations; in particular, Alcan co-chairs the World Economic Forum's Water Initiative. All business units are expected to support the water initiative by assessing water consumption and developing a baseline, on which they can build and develop reduction targets.

Biodiversity is a growing concern and opportunity for the company. Alcan operates in a number of areas of high-biodiversity. The issue is managed through development of an understanding of the company's environmental footprint and impacts on sensitive areas. Reporting on biodiversity is largely made through the GRI Principle number eight on initiatives to promote greater environmental responsibility. The company is also seeking opportunities for biodiversity management through community initiatives, land rehabilitation, and land management. Many of these opportunities arise from local facilities and business groups.

4.3.2 External Recognition of Alcan's Position Within the Global Aluminum Industry

Alcan is recognized for its CO2 inventory and comprehensive GHG strategy across its business units.[lxxvii] Alcan has received recognition from external analysts. They consider the company a leading benchmark for comparison by investor analysts. Alcan is also included among the top sustainable companies in Canada and the world.

According to SAM Research Inc. Alcan is a leading Aluminum company on the Dow-Jones Sustainability Index with an overall sustainability score of approximately 85 percent. The industry average in overall sustainability is scored at about 65 percent. Alcan leads on all three sustainability dimensions: the economic dimension (90 percent vs. industry average of 65 percent), environmental dimension (~88 percent vs. industry average of <65 percent), and lastly, the social dimension (75 percent vs. industry average of ~62 percent).[lxxviii]

The environmental dimension is measured against environmental policy, climate strategy, environmental performance, and biodiversity. Alcan excels in two of the four metrics. Alcan's strength is in its environmental policy (100 percent vs. industry average of 75 percent), however, the environmental performance score of 70 percent lags behind the leading score of 85 percent (industry average is 60 percent). Alcan is a leader in climate strategy with a score of 95 percent compared to the industry average of 62 percent. Alcan is above the industry average (65 percent) on biodiversity with a score of around 85 percent, however, the company lags behind the leading score of 95 percent.[lxxix]

The Corporate Knights rank Alcan in the top 50 sustainable Canadian companies. Interestingly, Alcan dropped from 3rd position in 2004 to the 50th position the 2005 ranking. [lxxx]

This change in position is largely due to a change in the ranking method. More weighting is now placed on financial management (taxes, CEO pay, and pension shortfalls) as opposed to environmental management. On a global scale, the Corporate Knights include Alcan in the list of the top 100 companies.[lxxxi]

Alcan's position with respect to competitors is similar to Alcoa on the sustainability driven strategic group map of primary aluminum producers (Figure 5). Alcoa and Norsk Hydro are Alcan's two main competitors. According to SAM Research all three companies are similar in score on their environmental performance but Alcan has stronger performance on the social and economic dimensions.[lxxxii] Alcoa has, however, received a leadership ranking from Innovest Strategic Advisors and the Corporate Knights.[lxxxiii] Alcan is also the Dow-Jones supersector sustainability leader for basic materials and is in competition with BHP-Billiton who is a suspersector sustainability leader for STOXX index (European sustainability index).[lxxxiv]

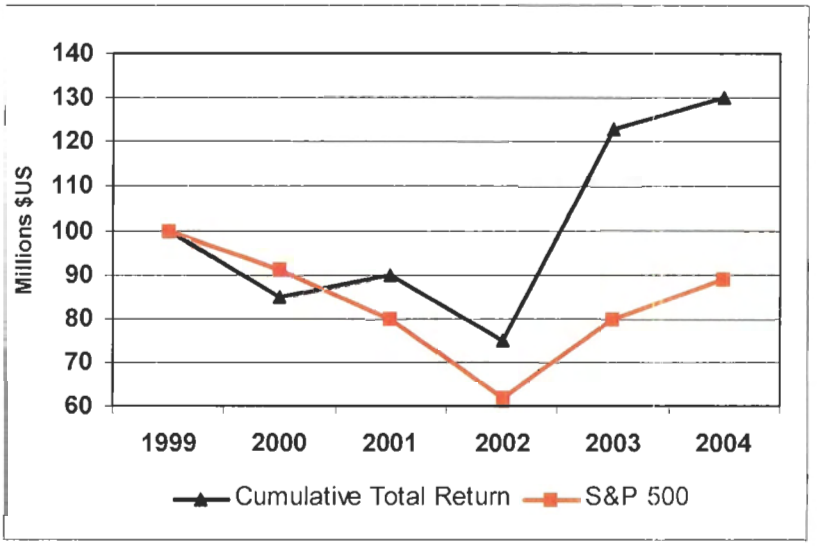
4.4 Alcan Financial Performance and Sustainability

Alcan has undergone significant recent changes that present challenges to the sustainability implementation of financial performance. Since 2001, the company has acquired two competitors, Aluswisse and Pechiney (among a number of acquisitions across the business groups) while, at the same time divesting the rolling products. Over this period share prices have steadily declined despite increasing LME Aluminum prices.

The four-year period may not be sufficient time on which to judge the financial results of the sustainability driven strategy. Sustainability is well suited to the primary metal industry as it drives forward strategic thinking on complex long-term issues such as global warming, resource conservation and energy conservation. Acting on these issues provides long term financial security and near term efficiency gains.

Figure 12 shows Alcan's performance in comparison to the Standard and Poors 500 Index (S&P 500). Between 1999 and 2004 Alcan has out performed the S&P 500 by approximately 45 percent. From 1999 to 2002 Alcan's trend follows the S&P 500 in a decline, but rebounds in 2003 by approximately 64 percent. The growth follows the jump in capital employed (Figure 13). A jump of $10 billion in capital employed can be seen. This increase in working capital is related to acquisitions in 2003 of VAW Flexpac, Baltec, Uniwood/Fome Cor and most notably Pechiney. There was also a 50 percent joint venture in the Qingtongxia prebake line that was initiated in 2003.[lxxxv] Returns on capital employed (ROCE) and on equity (ROE) do not follow the same trend as the overall financial performance as the returns are affected by business operating environment. The most notable investment return was in 2001, when they (ROCE, ROE, and ROA) declined to between zero and 1 percent. In 2001, there was a strong negative business environment with a decline in LME aluminum prices (Figure 8) and a 6 percent decline in global aluminum consumption (Figure 7). The company also incurred restructuring and impairment charges in that year. A significant added cost of $167 million in environmental provisions to cover liabilities associated with SPL storage in Canada and disposal of red mud in Canada and the United Kingdom was incurred.[lxxxvi]

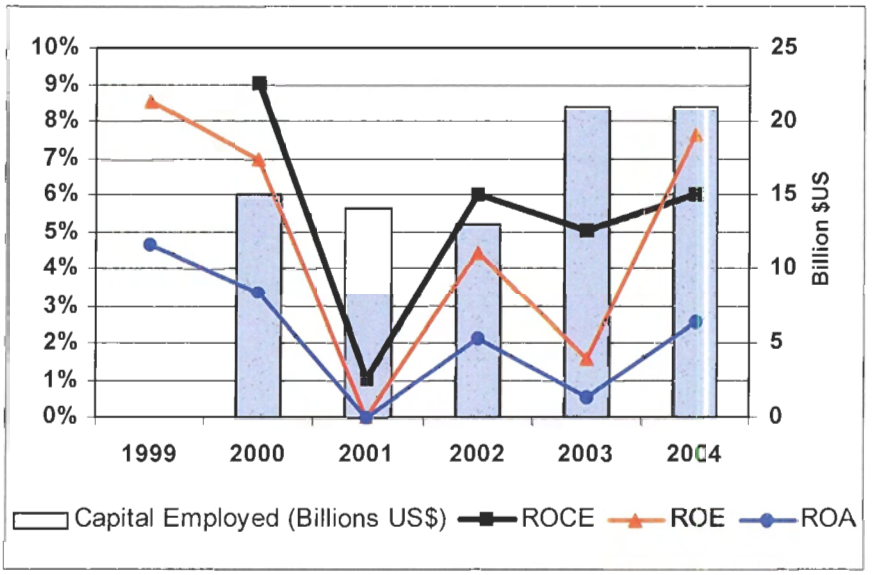
Figure 12. Alcan Financial Performance Compared to S&P 500



Assumes $ 100 million original investment with dividends reinvested.

Source: Created by author, data from Alcan Inc. 2004 Sustainability Report.

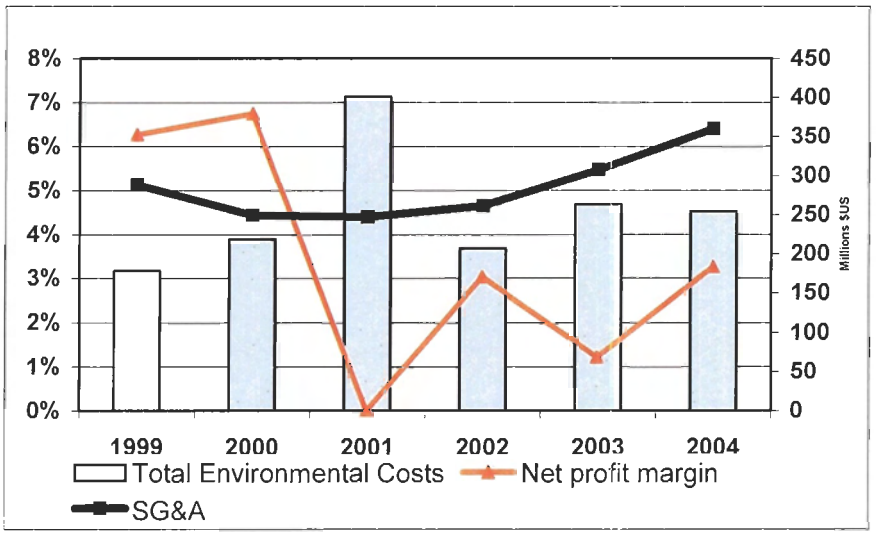
Figure 13. Alcan Inc. Capital Employed and Financial Return Performance



Source: Created by author, from Alcan Annual Financial Reports for 2002. 2003, and 2004, and Alcan Inc. 2004 Sustainability Report.

The effect of the environmental provisions of 2001 can be seen in the jump in total environmental cost trend in Figure 14. Between 1999 and 2004, there is a general increasing trend in environmental costs. The trend follows a increase in operating costs (2 percent increase from 1999 to 2004) but has a poor relation to net profit margin except in 2001 where there was a one time significant environmental charge. It is of importance to note that the increase in operating costs correlates to the rollout of the EH&S policy in 2002 and rollout of the EH&S directives in 2003. Unfortunately, it is too early to link EH&S expenditures and performance to the overall company financial performance and ability to provide investor returns.

Figure 14. Alcan Inc. Total Environmental Costs, Sales and Administration Costs Related Profit Margin



Source: Created by author, data from Alcan Annual Financial Reports for 2002. 2003, and 2004, and Alcan Inc. 2004 Sustainability Report.

The long term downward trend in LME aluminum prices and shift to lower cost production will challenge sustainability implementation and investments for environmental improvement. To remain an industry leader Alcan will have to find the balance between production and environmental performance.

Alcan is competitively positioned on the global aluminum market with an average hot metal cost of $1157/tonne, which is 7.5 percent below the world average of $1250/tonne.[lxxxvii] This places Alcan production in the middle of the second quartile of global production. An essential driver in the cost advantage is the company's position in the energy sector. Owning 62 percent of energy sources for the smelters helps push this driver. Specific advantages lie with the low cost hydroelectric supplies in North America, however, this advantage increases the importance of the global water sustainability issue.

5 APM-BC AND SUSTAINABILITY

APM-BC has a value chain that is widely distributed geographically. It occupies over 14,000km^2 and crosses over many sensitive environments. This creates a highly complex web of inter-linked environmental and stakeholder issues that affect both the individual value chain components and the overall business. Due to the issues involved with managing the business, APM-BC has become a leader in environmentally driven sustainability issues for APMG. Although APM-BC has had many successful cases of implementing sustainability initiatives there is room for improvement and optimization of the efforts and resources that are invested into managing the environmental issues. To build on the sustainability successes and develop a sustainable business strategy a review of APM-BC history in regards to sustainability issues and current business strategy is needed. Then the history must be assessed from the viewpoints of the value chain and the stakeholders to provide the foundation for developing an effective sustainability driven business strategy.

5.1 APM-BC Encounters with Environmental and Social Interventions

The Alcan Project in British Columbia was conceived and constructed at a time (1950s) when economic development was considered the equivalent equated to society building while environmental issues were marginalized. Changes in cultural and environmental awareness led to a series of social and environmental challenges in the 1990s and to the realization of the need for a sustainable business approach at APM-BC became clear. Key social issues related to the 1950s culture and to the construction of the project were:

- Historic (1950s) displacement of First Nation groups from the reservoir area
- Historic (1950s) difficulty of relocation and poor compensation by the Government of Canada
- Loss of traditional lands due to flooding for the reservoir
- Damaged grave sites from erosion on the Murray/Cheslatta River system
- Loss of traditional lands in Kitimat and Kemano
- Historic (1950s) expropriation of Haisla reserve land by the Government of Canada for the construction of the power transmission line
- Exclusion from the economic benefits of the hydroelectric project

Key environmental issues related to the project were:

- Erosion of Murray/Cheslatta River system from changed water flows
- Mass defoliation and tree loss in the receiving environment of the Smelter's plume
- On going vegetation damage from roof top fluoride releases
- Frequent operating permit non-compliances
- Poor house keeping and material containment
- PAH contamination in marine sediments
- Soil and groundwater contamination from spent potlining disposal

These issues culminated in the 1980s and 1990s with a series of legal injunctions, appeals, and governmental intervention that attacked the plants' operating permit, the reservoir's water license, and the Kemano Completion Project[9]. This resulted in significant economic consequences and costs to the company's reputation.

A legal injunction in 1980 by the Department of Fisheries and Oceans on Alcan's water license resulted in the 1987 Settlement Agreement between Alcan and DFO. This agreement removed 45 percent of the live storage available in the reservoir to produce electricity. Additionally there were requirements to regulate summer water temperatures to cool flows in the

[9] The Kemano completion project (KCP) was supposed to be the second phase of the 1950s Kemano power generation project, designed to increase power production.

Nechako and Fraser Rivers. A commitment was also required by the company to spill water to protect the salmon fishery at the expense of power and aluminum production.[lxxxviii]

An appeal to the British Columbia Environmental Appeals Board of Alcan's operating permit PE 1494 in 1992 was initiated by Kitamaat Village Council (Haisla First Nation). The Council's concern was that the permit did not sufficiently protect the environment or promote the rehabilitation of Kitimat's environment. The appeal resulted in an order for the company to conduct a detailed environmental review of it's discharges with the terms of reference to be jointly developed by the Regional Manager for the BC Minister of Environment, Kitamaat Village Council and Alcan.[lxxxix]

Significant public and stakeholder opposition to the Kemano Completion project between 1990 and 1993 resulted in the Provincial Government cancelling the project, at an approximate cost of $540 million ($CDN) to the company. Additionally, the 1997 settlement that resulted from the project's cancellation resulted in a 37 percent loss in water diversion rights.[xc]

In the 50 years since the Alcan project was completed, social and environmental values as well as attitudes towards the water resource and Kitimat Works have changed. The business model used by APM-BC since construction remained largely unchanged over and did not recognize the increasing power of stakeholders on environment and social fronts. The lessons to be learned from these interventions lie largely with the need to acknowledge the importance of stakeholder dialogue (consultation and accommodation), redressing historical issues and environmental leadership. This is an important issue for Alcan, as the company has assets in many jurisdictions and can not afford a "black-eye" with regards to social and environmental issues.

5.2 APM-BC Strategic Sustainability Initiatives and Strategy

Following the social and environmental interventions of the 1980s and 1990s the business model was adapted to recognise the changing positions of stakeholders and development. In the 1950s, water was the tool of economic development with stakeholders outside the development. Now, stakeholders and the environment are at the forefront of development and business operations. Adjustments to the business strategy were made on a number of fronts that largely focused on stakeholder relation improvement and developing a beyond compliance business culture. A beyond compliance culture is one that exhibits a willingness to be proactive in risk management, to prevent environmental incidents, to institute continuous improvement in pollution reduction, and to improve the efficiency of resource consumption.

Key initiatives implemented to adjust the business strategy, performance and stakeholder relations are presented in Table 11.

Table 11. Key Stakeholder Strategic Initiatives

Initiative	Date	Sustainability Stage[1]	Description	Result
Kitimat Works and Kemano				
Pollution Prevention Program (P2)	1996	Survival and Image / Strategic Preparation	Pollution prevention program identified 43 prevention opportunities and information gaps. A strategic 5-year plan was developed to act on implementing the prevention opportunities and closing the information gaps.	Through the course of the program, permit non-compliances have been reduced by 76% (Figure 20) and specific pollutant loads have been reduced by 73%. Key successes lie with GHG reductions, SPL management, and effluent quality improvements. Additionally, the Public Advisory Committee that was established under the P2 program facilitated a beyond compliance culture shift.
Public Advisory Committee (PAC)	1996	Survival and Image / Strategic Preparation	Established a public advisory committee to support the pollution prevention program. The committee provides input on pollution concerns prevention opportunities from the public and stakeholder perspective.	Historic adversarial stakeholder relationships have been turned into positive supportive relationships with transparent dialogue.
Environmental Improvement Program	1999	Survival and Image / Strategic Preparation	Established a 5-year program to address specific non-compliances and capital intensive opportunities to improve the environment.	Supported the Pollution Prevention plan, Public Advisory committee, and contributed to the 76% reduction in permit non-compliances.
Monthly Ministry Meetings	1999	Survival and Image / Strategic Preparation	Established a monthly forum for 3-way dialogue between the company, Provincial Ministry of Environment, and Haisla First Nation.	Relationships of two key stakeholders (on the environmental front) have changed from adversarial to positive and supportive.
Marine Monitoring program		Survival and Image / Strategic Preparation	Multi-year study funded by the Company and managed by the Haisla First Nation to investigate the effects of polycyclic aromatic hydrocarbon (PAH) contamination of the Marine environment and food chain.	Continuing study indicating effects of PAH pollution from the Smelter are not as severe as perceived by the Haisla community.

Table 11. Key Stakeholder Strategic Initiatives (continued)

Alcan-Haisla Protocol		Survival and Image / Strategic Preparation	Established a protocol for communicating on environmental issues with the Haisla First Nation. Funding was included to build environmental management capacity with the Haisla.	Open and transparent communications on key environmental issues facilitated understanding in the Haisla community of the Company, limitations of the technology used, and level of importance of environmental issues.
Alcan-Haisla Umbrella Working Group		Survival and Image / Strategic Preparation; growth and business development	Established a forum for senior management and Haisla community leaders to meet, discuss key issues of each organization, develop means for improving opportunities and including the Haisla community in economic opportunities.	Facilitated the development of trust and respect between senior management and Haisla community leaders. Critical economic and social development opportunities have been identified and acted on to improve the Haisla community.
DFO Relationship Building		Survival and Image	Developed a positive and supportive relationship with local representatives of the Federal Department of Fisheries and Oceans.	Reduced regulatory burden on local projects and opportunities to explore and experiment with techniques to reduce the environmental footprint in sensitive habitats.
Joint Environmental Committee		Survival and Image / Strategic Preparation	Implemented a joint committee consisting of union and management representatives to discuss environmental issues of concern to the business and union.	Established a forum for open discussion on environmental issues of concern to the union and direction that the Company is taking in terms of the environment.
ISO 14001 certified Risk Management System	2001	Survival and Image / Strategic Preparation	Implemented a risk management system that met the ISO 14001 and received certification.	Improved document control, developed work procedures, identified and assessed significant environmental aspects, identified legal and other requirements, and implementation of environmental management programs to control risk. The risk management system provides for internal and external auditing to ensure compliance with the system.
Watershed				
Nechako Watershed Council	1998	Survival and Image / Strategic Preparation	A multi-stakeholder group consisting of business, First Nations, communities, provincial government, and APM-BC. The goal of the group is to resolve long standing flow management issues of the Nechako River.	The group has established a flow model to develop more natural flow regimes for the Nechako River. Additionally, the group is developing a work plan for the cold water release facility.

Table 11. Key Stakeholder Strategic Initiatives (continued)

Reservoir logging		Growth and Business Development	Developing economic opportunity for the Cheslatta First Nation by providing technology and equipment to harvest underwater trees	Establishment of Cheslatta Forest Products Company and job opportunities for local and First Nations people.
Water License Settlement Agreement	1987	Survival and Image / Strategic Preparation	Legal challenge to the Department of Fisheries and Oceans for a final agreement on water rights.	Final settlement of water rights on the Nechako reservoir, flow releases, and protection of fish at the expense of aluminum production.
Forest Stewardship and First Nations Capacity building	2004	Growth and Business Development	Partnered with three First Nation groups (Cheslatta Carrier, Nee Tahi Bunn, and Skinn Tyee) to harvest beetle killed wood. Developed a harvesting and silvicultural program that may provide up to $2.7 million in revenues over a four year period.	Helped build positive relationships with the First Nation groups in the agreement.

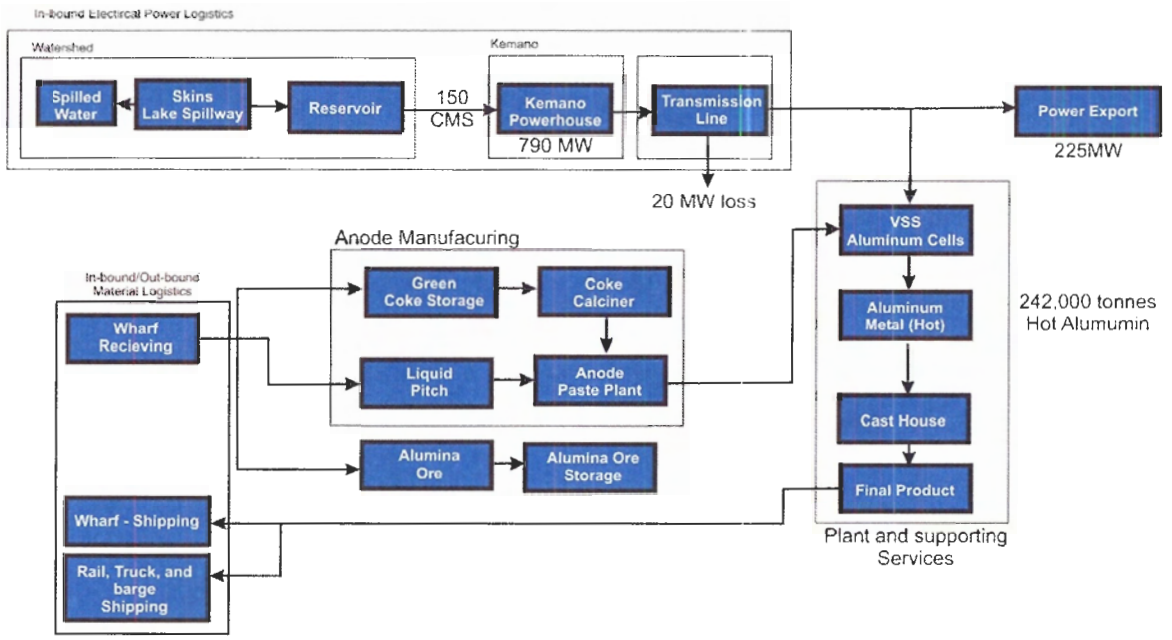
[1] Sustainability stage is the level on the sustainability business model presented in Figure 10 – Survival and image, Cost reduction and Strategic Preparation, Increased growth.

Source: Table by author.

5.3 APM-BC Value Chain

APM-BC has eight key components in its value chain, watershed, Kemano powerhouse, power transmission line, wharf, anode manufacturing, aluminum reduction, casting, and power exports (Figure 15). A brief geophysical description of each main component is provided in section 1.2 of this report. The value chain starts in the reservoir where water is impounded for the purpose of electricity generation in Kemano. Water is released from the reservoir at the Skins Lake Spillway for fisheries flow management and reservoir level management. An average 150 M^3/s is released to Kemano for power production. It is not until the powerhouse that the energy in the water is converted to a marketable commodity (an average 790 MW). Electricity is transmitted along an 80 km power transmission line, where 20MW is lost in the transmission process. At the smelter, an average 225 MW is exported to BC Hydro and the remaining average of 545MW is consumed in the plant for aluminum reduction, casting, support services and lighting. Raw materials of green coke, liquid pitch and alumina are brought into the plant site through the wharf shipping and receiving. Coke is calcined and combined with the liquid pitch to form paste briquettes that are consumed at a rate of 522 kg/tonne of aluminum. The Smelter produces 242,000 tonnes of aluminum that is cast into customer specified alloys. The finished alloys for the most part are shipped from the plant's wharf to markets in Korea and Japan.

Figure 15. APM-BC's Value Chain



Source: Created by author.

5.4 APM-BC Stakeholder Analysis

Identification and understanding of stakeholders is important in order to predict potential social and environmental interventions, and to develop strategies that avoid value destroying conflicts. A simple stakeholder analysis for APM-BC's value chain was completed to identify the groups and individuals affected by the company's operations. Additionally, the analysis provides an understanding of the stakeholders' position and level of influence. Results of the analysis are presented in Appendix A. The results of this analysis will be used in the value chain and business risk analysis

A total of 39 stakeholders have been identified that have an interest in the company. Stakeholders were identified from existing forum (such as APM-BC's Public Advisory Committee, and the Nechako Watershed Council[10]) by reviewing groups and identifying individuals who reside in the area and might potentially have a stake in the operation's environmental footprint. A simple analysis of stakeholders was completed by looking at their representation and their culture or mission. Their level of concern with each of four key components of APM-BC's value chain was then assessed as low, medium, and or high. Low concern is defined as a general interest in company performance that may affect the overall reputation and trust level of the company in the eyes of the stakeholder. A high level is defined as having direct importance for the group. The concern ratings assigned to the groups are based on the group's location and the company's past experience with the group. The level of stakeholder's influence, is a descriptive measure of influence that the group may have over the issue.

Seven key areas of sustainability were selected to assess stakeholders' concerns with specific issues. The key areas are biodiversity, emissions, effluents, resources, wastes, site contamination and economic performance. Additionally, a statement assessing the present quality of the relationship between the company and stakeholder was provided to determine where additional efforts are required to improve the relationship.

[10] The Nechako Watershed Council (NWC) is a group stakeholders in the Nechako Watershed, including APM-BC) who provide input on environmental concerns with the watershed and flow management.

The stakeholder analysis results are contained in Appendix A. The analysis identifies eight key stakeholder groups of importance to the company:

First Nation Groups:
- Cheslatta First Nation
- Kitamaat Village Council
- Skin Tyee

Regulatory Agencies:
- Environment Canada
- Fisheries and Oceans Canada
- Ministry of Water, Lands and Air Protection
- Province of British Columbia

Employees:
- Union

5.4.1 First Nations Groups as Stakeholders

Since the 1950s Aboriginal groups in British Columbia have garnered increasing influence and power over their traditional lands through court decisions, voicing concerns, NGO support and support from regulatory agencies. Although there are unresolved legal questions, the law is clear on the need to consult aboriginal groups before changing the use of traditional lands. For the company there is risk in ignoring First Nation groups who claim that their rights are affected by its operations and projects. For example, vocal opposition by the Cheslatta people was a prime contributor for the cancellation of the Kemano Completion project. APM-BC has at least five aboriginal stakeholder groups who may be affected by the company's operations at key steps in the value chain (Watershed and Kemano Power and Supporting Services, Power Transmission, and Reduction and Supporting Services). It is important for the company to understand the First Nations groups' positions with respect to the value chain and their level of support. In the Watershed key concerns of the First Nations groups lie with biodiversity related issues of aquatic and terrestrial ecosystem disruptions, white sturgeon and the resource issues of river flow management. Participation and development of economic opportunities, especially in an eco-friendly manner, are very important for the local First Nations communities.

5.4.2 Regulatory Stakeholders

Regulatory agencies are one of the most influential stakeholders groups, as they have high interests and high power in almost all parts of APM-BC's value chain. Regulatory agencies concerns can create very strong barriers to goals and require very costly studies and mitigative measures to regain trust. Engaging in a transparent process with the agencies is critical to gaining trust and confidence, and to deferring concerns (not to mention the associated expenses).

Environment Canada is primarily concerned with Kitimat Works. The specific concerns are: atmospheric emissions of (PAHs and GHGs), contaminated sites in Kitimat, and the Watershed and endangered species (white sturgeon). Fisheries and Oceans Canada, on the other hand, has a high stake in flow management in both the watershed and Kemano power production. The Ministry of Water, Lands and Air Protection is primarily concerned with permit compliance in Kitimat and Kemano Power production. The Province is mostly concerned with watershed flow management and power generation. Each of the regulatory agencies has unique and important concerns that must be addressed and dealt with in an efficient and timely manner.

5.4.3 Employee Stakeholders

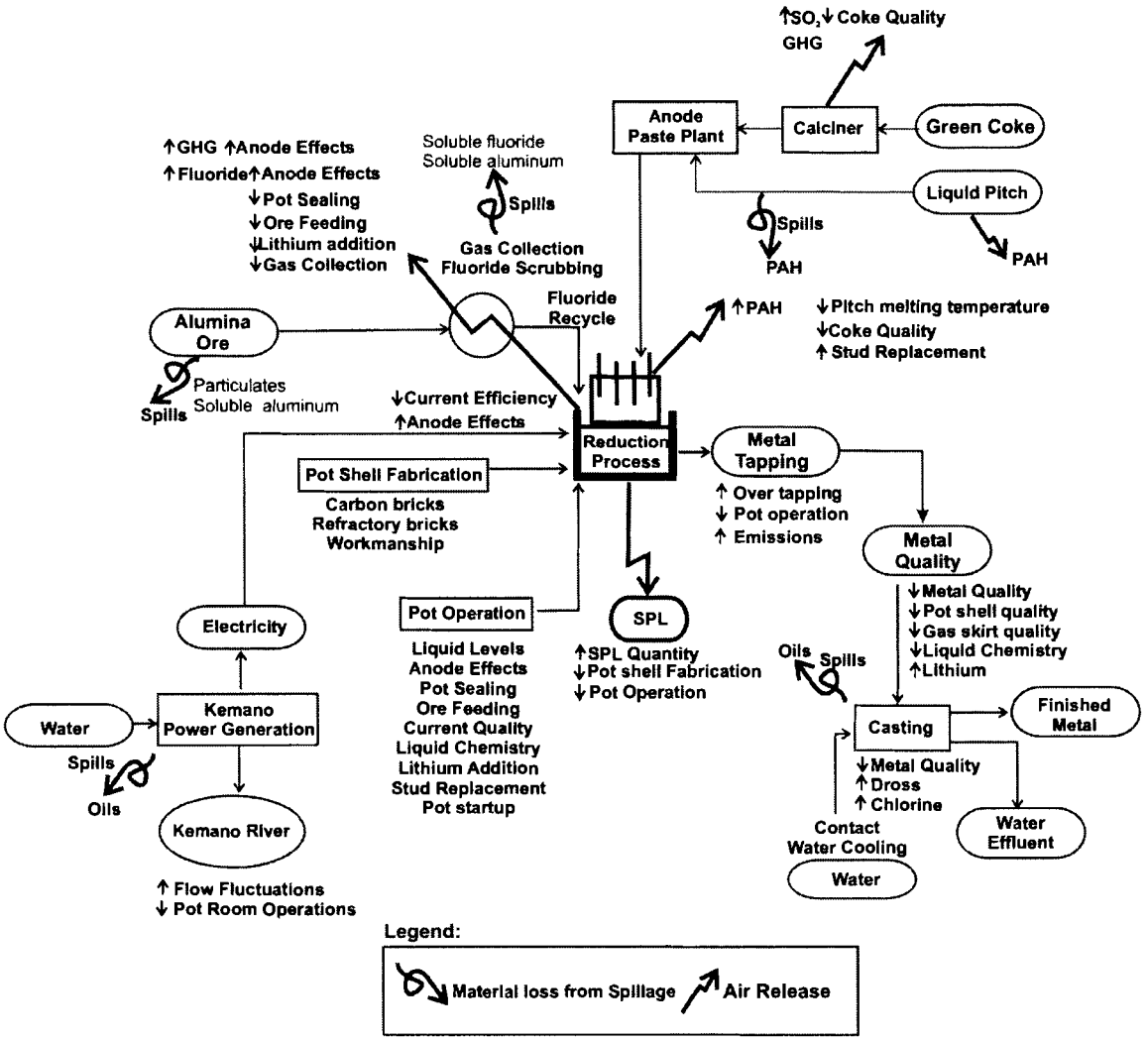
Employees are critical stakeholders in APM-BC as the environmental performance of the company depends on their contributions. Represented by the Canadian Autoworkers Union, they are interested in all components of APM-BC's value chain. The Union has high levels of concern regarding Kitimat and Kemano and has high levels of influence and power over environmental concerns. The employees can threaten work stoppages or report concerns to regulatory agencies. Conversely, lack of concern about environmental protection and regulations by employees can lead to permit non-compliances and regulatory investigations.

5.5 Analysis of APM-BC's Value Chain from a Sustainability Perspective

The value chain is more complex from an environmental view than from other perspectives. This is highlighted Figure 16 which depicts how key variables in the process influence each other and the outward footprint of APM-BC. An analysis of the value chain from this perspective is necessary in order to understand how susceptible the business is to environmentally driven interventions. The following sections analyze each of the specific components of the value chain.

Environmentally driven pressures on the segments of APM-BC's value chain will be reviewed using a modified PESTLE (Political, Economic, Social, Technological, Legal, and Environmental) framework. This analysis strictly looks at environmental issues that have PESTLE aspects. The analysis does not include economic or social issues that are unrelated to the environment. Political pressures arise from governmental interventions that influence the business. This also includes NGO influence. Economic pressures are issues deriving from environmentally related constraints, barriers and interventions arising from economically driven business decisions and vice versa. The social element of the PESTLE has been expanded to 'Social and Stakeholders' for the purpose of this analysis. Affected stakeholders and their influence on the identified issues are determined by the APM-BC Stakeholder Analysis Table in Appendix A. Technological concerns and pressures arise from both the technological limitations on environmental performance, and from pressures brought on by new technology. Legal pressures include elements of Federal, Provincial, and common laws as well as the regulations that affect the business. In addition to the present legal framework, future regulatory trends are reviewed. Environmental aspects include pressures that the ambient environment places on the business. Traditional elements of the environmental aspects of the business include emissions, effluents, wastes and spills (among others). It should be noted that environmental aspects also include some elements of the political, economic, social, technological, and legal factors when there are overlapping elements.

Figure 16. APM-BC's Value Chain from a Sustainability Perspective



Source: Created by author.

5.5.1 Watershed

The Nechako reservoir collects and stores water and its potential energy is then converted to electricity at the Kemano powerhouse. The 14,000km^2 watershed provides a commodity that becomes marketable when its energy is converted to electricity by running the water through the generators in Kemano. An average flow of 150 m3/s is diverted from the reservoir into the Kemano watershed through the aqueduct at West Tahtsa. Water is also released from the reservoir at the Skins Lake Spillway where water is spilled to provide flows for cooling maintaining fish habitat and the needs of a number of downstream stakeholders. Water concerns are socially driven as the watershed is a sensitive issue to a number of stakeholders. Some are affected by downstream flows and environmental concerns while others are affected by the history of the development of the reservoir. Table 12 presents a summary of the issues and concerns affecting the Watershed. These pressures are derived from a PESTLE analysis that is presented after the table.

Table 12. Summary of Pressures the Watershed

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Environment
Reservoir level management affecting biodiversity and impacting downstream stakeholders.	M	**H**	**H**	L	M	M
Flow management (Nechako River) and cooling water releases	M	**H**	**H**	L	H	**H**
Forest Management – Harvesting and Bug wood removal	L	**M**	M	L	M	**H**
Flooded trees in reservoir	L	**M**	M	L	L	L
reservoir draw down impacting shoreline and stakeholders	L	**L**	**M**	L	L	L
Stakeholders in Watershed not receiving benefits from living with environmental impacts from reservoir development	L	H	**H**	L	L	H
Land Management, Access, and Ownership	L	H	**H**	L	L	**M**
Erosion in the Murray-Cheslatta River system	L	H	**H**	L	M	M
Cheslatta fan	L	H	**H**	L	M	M
Nechako Canyon, dewateted section	L	H	H	**H**	M	H
Cold Water Release Facility	M	H	H	**H**	M	H
Species at Risk Act – Sensitive Fauna (White Sturgeon)	L	H	H	L	**H**	H
Federal Fisheries Act – Sensitive Fauna (Fisheries)	L	H	H	L	**H**	H
Environmental Assessments/Reviews under the Canadian Environmental Assessment Act.	M	H	H	L	**H**	H
First Nation Consultation	H	M	H	L	**M**	M
Sensitive Fauna (Osprey)	L	L	M	L	M	**M**
Sensitive Fauna (Woodland Caribou)	L	M	H	L	L	**H**
Sensitive Fauna (Beavers)	L	M	M	L	L	**M**
Soil Contamination and legacy issues	L	H	M	L	H	**M**
Spills	L	M	L	L	H	**M**
Resource Extraction (Mining)	L	M	M	L	H	**M**
Climate Change impacts	L	M	L	L	L	**M**

Note: Bold letters indicate the section of the PESTLE analysis where the issue is discussed.

5.5.1.1 Political

The reservoir is the most politicized aspect of APM-BC's value chain, and has very high political pressures and risks attached to it. The political aspects of the Watershed are complex and beyond the scope of this project and as a result, they are not discussed.

5.5.1.2 Economic

The water has little added value to the company while it is in the reservoir, never the less, there are key economic pressures on it that affect the environment. These pressures include water storage and flow management, forest management/harvesting, wood salvage from the reservoir and recreational opportunities.

Rents from power exports affect the day to day reservoir levels and flows from the Skins Lake Spillway. The water levels affect biodiversity issues in the reservoir and downstream. Additionally, forced spills of water from the reservoir can impact downstream biodiversity and cause flooding. Flow management has in the past has caused the ice jam formations and property losses as a direct result of the ensuing floods. Water storage and flow management are very high economic pressures.

There are high pressures from stakeholders to harvest the forests on Alcan lands. This pressure has increased with the pine beetle infestation. Issues stemming from forest harvesting issues include damage to lands and biodiversity impacts. When considering the beetle killed wood there are incentives to increase the rate and scope of harvesting on the company's properties in order to salvage some value and reduce forest fire risks.

The submerged trees in the reservoir present another economic pressure. There are market opportunities for the special qualities of the wood, which the submerged trees posses. The

trees can be economical to harvest with nominal stumpage fees but require specialized equipment for effective operations. Risks posed by the underwater logging include spill risks and damage to osprey nesting habitat. The risks to habitat loss are small given the volume of flooded trees and the low harvest rates.

Other third parties have recreational or small tourism business opportunities on the reservoir. These put pressure on maintaining and protecting the environmental quality of the reservoir. The third parties are negatively affected by the draw down of the water level needed in the normal course of reservoir operations. APM-BC maintains a good neighbour policy when managing reservoir operation by upgrading docks and water supplies that are damaged or impacted by fluctuating water levels.

5.5.1.3 Social and stakeholders

There are high social and stakeholder pressures on the reservoir. Resolving stakeholder issues is one of the most complex challenges to APM-BC as there are numerous stakeholders and stakeholder issues in relation to reservoir (which are discussed and analyzed in section 5.4). Stakeholder challenges have, in the past, confounded strategically important projects for the company. Key stakeholders pressures relate to being impacted by the reservoir while not receiving the benefits that it provides. These impacts range from flood risks, fisheries, wildlife and erosion among others. Historic legacy issues from the1950s development of the reservoir are still an important concern. The historic issues relate to resettlement, loss of land due to both flooding and title transfer to APM-BC, and damage to the land. These issues will place pressures on the watershed because of the need for access to land resources (timber) management or ownership of lost lands. This is especially true for the First Nations' lands, villages, and graveyards that are on property now owned by the company. These issues will confound future

strategies as stakeholders link their level of support for APM-BC to resolution of the aforementioned concerns.

Key stakeholder groups in these issues are the Cheslatta First Nation and collectively the groups involved in the Nechako Watershed Council[11]. The Cheslatta First Nation places high importance on all aspects of flow management, biodiversity, land management and resource issues. Of great importance to the Cheslatta are erosion of the Murray-Cheslatta River system, the Cheslatta fan (alluvial deposition caused by water releases from the Skins Lake Spillway) and access to land and resources within company owned property. The Nechako Watershed Council places high importance on biodiversity impacts from water releases and flow management affecting the Nechako River.

5.5.1.4 Technological

There are high pressures on the reservoir that is linked to the old technology of dams and historical development of the reservoir. The Kenney dam diverted flow away from the Nechako River, drying it over an approximate 14km reach. There is pressure from stakeholders and regulators to restore flow to the dewatered section of the river. A related pressure derives from the cooling water releases to the Nechako River. Presently, these flows are released at the Skins Lake Spillway. However, there is pressure (from stakeholders and regulators) to develop a cold water release facility at the Kenney dam to release these flows in a more efficient and beneficial way. This could invoke a $50 million commitment from the company to fund in part the cold water release facility.

[11] The Nechako Watershed Council (NWC) is a multi-stakeholder group consisting of APM-BC and 24 other stakeholders affected by the Nechako reservoir.

5.5.1.5 Legal

Legal risks in the watershed are high. The risks arise from Federal Species at Risk Act (SARA), Federal Fisheries Act, First Nations consultation and the environmental review and assessment process for projects.

SARA provides protection for designated species at risk and requires action plans to be developed and implemented to protect and restore the populations of endangered or threatened species. The white sturgeon in the Nechako River system will be listed under SARA as endangered. Once this is done, an action plan will have to be drafted by regulatory agencies and stakeholders for the protection of the sturgeon. This will affect APM-BC who will have to provide funding for studies, likely have to contribute to a sturgeon hatchery, and possibly have to adjust water releases for the protection of the sturgeon. This has the potential to be a multimillion-dollar issue for the company.

The Federal Fisheries Act is a high pressure in the watershed due to the sensitivity of the salmon and trout fisheries. The Department of Fisheries and Oceans (DFO), which administers the Fisheries Act, has a high level of power over the watershed on issues affecting water quality and impacts on fish habitat. For instance, the 1987 settlement agreement was a direct outcome of DFO intervention that led to water releases from the Skins Lake Spillway. Also, the DFO can administer the Federal Environmental Review and Assessment process under the Canadian Environmental Assessment Act (CEA). This power adds a strong regulatory voice to potential fisheries concerns posed by a project. A recent example is the Tahtsa Narrows dredging project. This was undergoing a CEA environmentally assessment, and DFO concerns were strongly voiced and acted on during the process. In key strategic projects (such as the Tahtsa Narrows dredging project) this is an important issue to recognize. It can also be a driver to resolve issues well in advance of entering an environmental assessment.

The Federal environmental assessment through CEA exerts a strong pressure in the Watershed because of its ability to expand the scope of the assessment beyond the identified project boundaries. This has the potential of linking stakeholder concerns from the most easterly end of the watershed to the Kemano powerhouse and the lower Kemano Valley.

Consultation with First Nations has become important within the scope of projects affecting their traditional territories. The BC Supreme Court handed down a ruling that requires consultation regarding developments on lands claimed by First Nation groups. This increases the weight that First Nation groups have as stakeholders in the watershed.

5.5.1.6 Environmental

Environmental pressures in the watershed are high and are numerous but have a common biodiversity theme. The key issues are: sensitive fauna, mountain pine beetle forest damage, land management, soil contamination, spills, resource extraction and long term effects from climate change.

Sensitive fauna are key issues in the Watershed (beside the previously discussed issues with white sturgeon and fisheries) include the osprey, woodland caribou and beaver. Ospreys are a protected species and the reservoir has North America's largest nesting community. This is mainly due to the abundance of flooded dead standing trees that the ospreys use for nesting. While the ospreys present low risks, the issue needs to be managed in conjunction with the underwater tree harvesting that APM-BC sponsors. Woodland caribou are a moderate issue in the reservoir, but will become a high risk issue should a strategic project be implemented that affects the draw down of the water levels. The caribou use islands in the reservoir as calving grounds. The islands are free of predators (wolves) but if the water elevations are lowered the islands could become connected to the mainland allowing predators to gain access. Beavers residing in the reservoir and downstream of Skins Lake Spill Way can be affected by changing water levels. This

is of special concern during the winter when the beavers could be drowned in their lodges. Beavers are linked to stakeholder social issues, as there is a long-standing history of trapping in the watershed area since the pioneer days and there are still active trap lines.

The Mountain Pine Beetle and the forested lands around the reservoir are of high environmental concern. The pine beetle is presently destroying the lodgepole pine trees around the reservoir area. On some properties, there appears to be 100 percent mortality of the trees. The effects of the beetles are anticipated to alter the forest hydrology of the area and possibly affect water level control in the reservoir. The loss of trees will reduce the amount of runoff water attenuated through infiltration, evapotranspiration, and ponding. This will essentially make the damaged properties wetter. Due to the significant areas involved in the pine beetle epidemic, this could have long term effects on reservoir level management. The affected lands will have less attenuating capacity for rainfall runoff and the reservoir levels may then respond more quickly from a rainfall or snow melt event.

Forest fire will be an upcoming issue for the reservoir. This is because of the number of dead trees being created by the pine beetle. As the forest dries out, there will be a potential risk for large and frequent forest fires around the reservoir.

APM-BC is one of the largest landowners in Northern British Columbia when properties along the reservoir and downstream of the Skins Lake Spillway are considered. Aside from the stakeholder access discussed above, key issues associated with the impacts of third party agricultural use of the lands (cattle grazing), and forest harvesting. The impacts pose a challenge to diligent land management without raising stakeholder complaints about its use or access restrictions. The environmental aspect of property management is a moderate issue in the watershed.

Soil contamination from both the 1950s project construction and current issues created by third party land usage are moderate to high concerns for the Watershed. These issues could pose high liabilities and limit the potential of future strategic projects. A full understanding of the site management issues is needed to validate the strategic vision for the reservoir and its present operation.

Spills are a moderate issue for the watershed largely due the high consequences should a spill occur. Presently, spill risks are well managed on the reservoir and are mostly caused by third party (including recreational users) use of the reservoir.

Resource extraction (mining) within the watershed is a moderate concern that needs attention. Risks posed by mining could impair water quality in the reservoir, which would be a strategic concern for APM-BC. For example, there is a large copper mine along the Tahtsa Narrows reach with a significant tailings dam. Should a breach occur in the dam there would be a risk of metals being transferred to the Kemano River. The level of risk that this poses needs to be evaluated.

Long term concerns for the reservoir lie in potential climate change. Although the reservoir is a large body of water, it operates on a short two-year cycle. If climate changes cause the predicted warming and drying of the interior of British Columbia then there is a risk of water shortages in the years to come. A shortage of water in 2001 caused the shutdown of two potlines at Kitimat works for one year and approximately 10 percent of the production capacity have remained idle since the shutdown. Risks of water shortages need to be factored into long term business planning.

5.5.2 Kemano Powerhouse and Supporting Services

The Kemano powerhouse and supporting services consist of an electrical generating station (800 MW/h), camp, roads, utilities, and barge and docking facilities (at Kemano Beach). The Kemano power station is supported with a small permanent camp, a 16 km road to Kemano Beach (mouth of the Kemano River at the Gardner Canal), a dock and crew boats. Key issues with Kemano lie with biodiversity. Typical water consumption for the powerhouse in electrical production is 4.73 km^3/yr. Table 13 presents a summary of the issues and concerns affecting the Kemano powerhouse and supporting services. These pressures are derived from a PESTLE analysis and are discussed below.

Table 13. Summary of Pressures on Kemano Powerhouse and Supporting Services

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Environment
Flow Management (Kemano River)	L	**H**	H	L	M	H
Sensitive Fauna (Eulachon)	L	**H**	H	L	M	H
Asset Protection (Erosion)	L	**H**	M	L	M	**H**
Resource Management	L	**H**	H	L	L	M
Land Management and Access	L	M	**H**	L	L	M
Spills (Oils)	L	L	M	**M**	H	M
Federal Fisheries Act – Sensitive Fauna (Fisheries)	L	H	H	M	**H**	H
Sensitive Fauna (Grizzly bears)	L	L	M	L	**M**	M
Waste Management	L	M	M	L	M	**H**
Soil Contamination and Legacy issues	L	M	L	L	H	**H**

Note: Bold letters indicate the section of the PESTLE analysis that the issue is discussed.

5.5.2.1 Political

Power production is a high political issue for Kemano, however, in terms of environmentally driven issues political pressures are relatively low for Kemano. Political issues tend to focus on power usage and socio-environmental affects on the reservoir watershed. For these reasons, political aspects of Kemano are not discussed further.

5.5.2.2 Economic

Economic pressures are high with regards to flow impacts on the Kemano River and biodiversity. Taking advantage of market conditions creates demands on power production that can affect the Kemano River flows and sensitive downstream fisheries. Water from the powerhouse adds an average 150 cubic meters per second of water to the river, essentially

doubling the flow downstream. High flows in the River affect bank erosion, while variable flows can affect fisheries. At the tidal influence zone of the River, is a eulachon fishery that is a culturally important fishery to the Haisla First Nation. Eulachon are sensitive to high water velocities and declining water levels that can dewater their eggs. Resource management is an issue derived from EH&S First directives on the subject, and economic needs to generate as much energy as possible from the water used. This is also important from a stakeholder's perspective because the company needs to demonstrate the best use of the water resource.

5.5.2.3 Social and Stakeholder

Social and stakeholder pressures are high in Kemano due to the Haisla First Nation and their concerns over the eulachon Fishery. These concerns also link to the flow management of the Kemano River. Of moderate concern is the protection of other sensitive fauna including salmon and grizzly bears. Access to the Kemano Valley and its resources are upcoming stakeholder issues that will increase pressure on Kemano.

5.5.2.4 Technological

Technological pressures are high because of the risks of spills from the generating equipment to the tailrace (water flows to the Kemano River). Equipment designed in the late 1940s to early 1950s is susceptible to oil leaks from the bearings and cooling systems. Oil losses from the equipment are difficult to measure, track, predict, and control. Oil observed can be legally reportable to the Provincial Emergency Program (Ministry of Environment) and the Federal Department of Fisheries and Oceans as both can conduct investigations and issue regulatory fines. Kemano has an asset optimization program to improve reliability and energy generation at the powerhouse.

5.5.2.5 Legal

High legal pressures in Kemano due to environmental regulations protecting fish habitat and wildlife. Fish habitat surrounds almost all assets in Kemano and there must be careful management of the day to day work to manage risks of encroaching, disturbing and damaging habitat. Additionally, the Kemano Valley has a high diversity of flora and fauna, some of which is sensitive and protected, for example, the Grizzly bear.

5.5.2.6 Environmental

Environmental pressures are high and derive from erosion (asset protection), waste management and resource management concerns. Erosion is a strong concern in Kemano with annual problems of flooding and erosion of roads. Repairs to and prevention of the erosion represent large expenditures. They also impact local fisheries, vegetation and wildlife. Waste management techniques are an issue in Kemano from the operation of a landfill and an incinerator, to the handling of the different wastes produced from operations. The EH&S First Directive for waste management requires measurements, monitoring and the development of plans for reducing and recycling. Additionally, management and operation of the incinerator has been a source of non-compliance. Mismanaged wastes can lead to soil and groundwater contamination. Such contamination could present large liabilities stemming from the remoteness and environmental sensitivities of the Kemano area. Additional contamination concerns develop from legacy liabilities (1950s construction and operation) and third party use of the company owned lands in Kemano.

5.5.3 Power Transmission Line

The power transmission line conveys the electrical energy from Kemano to Kitimat. Key sustainability issues lie with biodiversity, resources, economic opportunities and historical land loss. Primary issues with land loss are associated with the power line that was constructed through Kitamaat Village and its occupation of a large portion of the reserve's developable space. This issue was resolved in 2003 with the relocation of the power line to an area outside the village, at a $6 million investment. Outstanding environmental issues affecting biodiversity and resources continue to be constant challenges to operations each year. Table 14 presents a summary of the issues and concerns affecting the Power Transmission Line. These pressures are derived from a PESTLE analysis and are presented in more detail after the table.

Table 14. Summary of Pressures Affecting the Power Transmission Line

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Environment
Independent Power Producer Access to Transmission Line	**M**	L	M	L	L	L
Environmentally driven O&M Costs	L	**M**	M	L	H	M
Land Management and Access	L	**M**	**H**	L	M	M
Sensitive Fauna (Grizzly bears)	L	L	**M**	L	M	M
Federal Fisheries Act – Sensitive Fauna (Fisheries)	L	H	M	M	**H**	H
Kildala-Dala Estuary Park	L	M	**H**	L	M	L
Forest Harvesting	L	M	H	L	M	**H**
Soil Contamination and Legacy issues	L	M	L	L	M	**H**
Spills	L	M	M	L	M	**H**

Note: Bold letters indicate the section of the PESTLE analysis that the issue is discussed.

5.5.3.1 Political

Political pressure on the power transmission line is low, however, there may be future demands to allow independent power producers to tap into the powerline. They would do so in

order to convey power generated from around the area to market in Kitimat. This has the potential to embroil the company in issues of environmental impacts if new power generation sites are developed. These issues are interesting and need to be monitored in the future but at the present they are not likely to pose a risk and therefore are not discussed further.

5.5.3.2 Economic

Economic pressures are moderate and are environmentally driven due to costs incurred though the operation and management of the powerline and access road. These cost include repairs to areas of erosion, vegetation management procedures to protect fish habitat, and environmental monitoring for construction and maintenance projects. Further economic pressures lie in third party access to the valleys via Alcan infrastructure. This pressure has been high because of logging companies requiring easements to cross APM-BC property, which exposes the properties to environmental damage and increases the overall environmental footprint of the company in these sensitive areas.

5.5.3.3 Social and stakeholder

Stakeholder pressure is moderate. The Haisla First Nation is the main stakeholder along the powerline. There are pressures from other third parties for access to the resources in the Kildala and Kemano valleys. Access is of high importance to these groups which include forestry contractors, Ministry of Forests, guiders, and the Haisla First Nation. A park was established in 2004, at the mouth of the Kildala River for grizzly bear protection. This park will likely increase social and stakeholder pressures in the future with the increase of public access to the area.

5.5.3.4 Technological

Technological pressures are low and are not discussed further.

5.5.3.5 Legal

Legal pressures are moderate. The key pressure is from the Federal Fisheries Act as the powerline is build around sensitive habitat (Kemano and Kildala River Valley's and Kitimat River Estuary).

5.5.3.6 Environmental

Environmentally driven pressures are high along the powerline. Key issues are with erosion/asset protection, biodiversity – fisheries and sensitive species, forest harvesting, contaminated sites and spills. Erosion problems similar to those in Kemano are prevalent along the powerline. The scope of erosion problems, however, is much more significant in terms of the number of issues, sizes, levels of impact, and their affects on the business. If erosion issues are not actively managed then there is the potential for the loss of roads and possibly, the powerline towers. Loss of roads may create significant costs to rebuild them to modern fisheries standards. Additionally, erosion issues strand powerline assets making repairs cost prohibitive or impossible.

Biodiversity issues are high concerns along the powerline. Approximately 73 percent of the powerline is within riparian and estuarine zones that include high value fish habitat (Chinook, pink, chum, and coho salmon, as well as steelhead trout). The valleys also have a high density of grizzly bears and other sensitive fauna. Alpine reaches of the powerline are within mountain goat ranges. Helicopter travel serving powerline maintenance and operations can cause biodiversity impacts through noise disruptions.

Forest harvesting by the Province and third parties can cause environmental impacts on APM-BC property affecting the powerline and embroil the company in regulatory and stakeholder conflicts with the forest industry. Forest harvesting can affect the local hydrogeology

and promote long term beaver activity, both of which increase the risk of localized flooding and promote conflicts between fisheries concerns and powerline maintenance.

The powerline has 50 years of history, and there are potentially legacy issues that may impair soil quality. Consequences of soil contamination along the powerline could be high due to the sensitivities of the area.

Spill risks are moderate and need to be managed. Consequences of spills are high in the operating areas of the powerline due to the close proximity to and abundance of fish habitat.

5.5.4 Anode Manufacturing

Andode manufacturing includes coke calcination, anode paste production and green coke storage. Carbon is approximately 10 percent of the hot metal cost for western smelters.[xci] Carbon is supplied to the plant via two sources, Strathcona (Alcan owned coke calcining facility in Alberta), and Alaskan Petroleum refiners. Green coke is received at the Kitimat Works' wharf, where it is transported by truck to open storage piles and then selectively blended and calcined to remove volatiles. The calcined coke is then broken down into different aggregate size fractions and recombined with liquid pitch (binder for carbon particles) to form the paste briquettes. Approximately 520 kg of carbon is consumed per tonne of aluminum. The anode paste plant is contained within the Kitimat Works Smelter site. Key constituents of coke are carbon, ash, sulphur, metals (nickel, vanadium) and PAHs. The pitch binder is predominantly a tar containing PAHs. Table 15 presents a summary of the issues and concerns affecting the carbon plant. These pressures are derived from a PESTLE analysis and are expanded upon after the table.

Table 15. Summary of Pressures Affecting the Carbon Plant

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Environment
Declining green coke quality	L	**M**	M	L	M	M
Increasing green coke sulphur content	M	**H**	**M**	**M**	M	H
Regional economic development and diversification	M	**H**	**H**	M	M	H
Material losses from green coke stockpiles	L	H	**M**	L	**M**	M
Calciner modifications / Heat recovery	L	H	M	**M**	M	M
Spills	L	L	M	L	M	**M**

Note: Bold letters indicate the section of the PESTLE analysis that the issue is discussed.

5.5.4.1 Political

Political risks to coke calcination and anode paste production are low. Although there is high concern with PAH emissions that are created by the consumption of anodes there are low concerns stemming from the production of the anode paste.

5.5.4.2 Economic

Economic pressures of anode manufacturing are moderate but may increase in the future with economic growth and diversification. Obtaining a low cost green coke supply that meets production quality requirements is a current economic priority. However, there can be a lack of understanding between the purchasers and suppliers about required quality of the material. Poor quality coke with high sulphur levels has resulted in lower current efficiencies, anode effects, increased carbon outs, increased stud wear and corrosion and higher sulphur emissions from both the coke calciner and pot lines. The global shortage of anode grade coke and its increasing sulphur content is making environmental performance more challenging for Kitimat Works.

Kitimat Works sulphur dioxide permit limit is 27 tonnes/day. This limit was raised in 1999 with the Pollution Prevention (P2) program and permit. On average, Kitimat Works is operating approximately six tonnes/day below the permit limit on a yearly average, while on a monthly basis the operating range is between 2 to 6 tonnes below the limit.[xcii] This operating margin is important to protect as a hedge to the risks posed by increasing sulphur content in green coke and to avoid costly upgrades to maintain compliance.

Future economic pressures on the coke calcination process will increase with regional economic growth and development. If further industrial development occurs in the Kitimat Valley that has the potential of sulphur and particulate emissions it could trigger a regulatory review of emissions from the calciner. This could result in the requirement to invest in a sulphur and particulate scrubbing system on the calciner. This cost would be over a million dollars.

5.5.4.3 Social and Stakeholder

There are three key stakeholder groups in the carbon plant. They are the Haisla First Nation, the Public Advisory Committee and the Union. The Haisla have the strongest external voice, (through communications to regulators) that can affect the business. All groups have expressed concerns over the quality of the coke supply and its impacts on overall site emissions. They would have high levels of concern about overall emission loadings to the Kitimat Valley brought about by any future economic diversification. Additionally, concerns have been raised about the green coke stockpiles. The stockpiles are outdoors and are subject to material losses by wind erosion and rainfall. Losses of the green coke can contribute to PAH contamination in the environment. These concerns are estimated to be of moderate importance.

5.5.4.4 Technological

Technological pressures are moderate for anode manufacturing. The coke calciner is the largest source of sulphur dioxide emissions for APM-BC, and there are no emissions controls for the calciner due to the high temperature and velocity of the exhaust gases. Should there be modifications to the coke calciner that result in lower exhaust temperatures (such as heat recovery/cogeneration) there may be a requirement (as mentioned above) to upgrade the system with sulphur dioxide controls.

5.5.4.5 Legal

Legal and regulatory pressures are moderate for the same issues discussed within economic and technological sections. At the present time, regulators have not raised pressing concerns over the emissions. However, as mentioned above, this could change with pressures to diversify the regions industrial base. Recently, Environment Canada has begun looking at outdoor material stockpiles and may require measurements and reporting of dust losses from stockpiles. This could result in a requirement for investing in a dust suppression system, wind controls or possibly covered storage.

5.5.4.6 Environment

Additional environmental pressures besides those raised above are with coke losses to the stormwater system, and liquid pitch spills that result in PAH releases. The green coke storage area drains into two gravel slot filters to remove the coke particulates from the runoff. However, fine coke particles can pass through the filters, and continue into the effluent treatment system. PAHs in the coke are a concern when the material reaches the effluent system and has the potential for being discharged into the environment. At the present time, the lagoon is efficient in removing particulates but during high rainfall events, the treatment efficiency is dramatically

reduced, changing from a settling mode to a diluting mode. Liquid pitch spills occur from transferring the pitch from the Pitch vessels at the wharf and at the liquid pitch storage tanks. The pitch when it is spilled, freezes solid and is very difficult to cleanup. However, the material if left in the environment will release PAHs to if it is exposed to precipitation.

5.5.5 Reduction Services and Support

The aluminum reduction process is approximately 65percent of the hot metal cost (excluding power costs). Based on an LME price of $1500 the process adds approximately $400/tonne of hot aluminum (before casting)[xciii]. The process consumes 2 tonnes of alumina, 520 kg of carbon, utilizes 19.6 MW to produce 1 tonne of aluminum and releases 6.5 tonnes GHGs, aluminum, 1.9 kg fluoride, and 0.8 kg PAHs per tonne aluminum. Key issues with the reduction process lie with atmospheric emissions (GHGs, fluorides, and PAHs). Table 16 presents a summary of the issues and concerns affecting the carbon plant. These pressures are derived from a PESTLE analysis that is expanded on after the table.

Table 16. Summary of Pressures Affecting Kitimat Works Aluminum Reduction Facilities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Environment
Environmental releases – PAH Emissions	**M**	H	M	H	H	**H**
Environmental releases – GHG Emissions	**M**	H	M	H	L	**M**
Environmental releases – Fluoride Emissions	L	**H**	H	M	M	**H**
Environmental releases – PFC Emissions	L	**H**	M	M	L	**M**
Environmental releases – Carbon Monoxide Emissions	M	**M**	L	L	L	**M**
Asset optimization	L	**H**	M	M	L	M
Energy Conservation	L	**H**	M	H	L	M
Natural gas conservation	L	**M**	M	L	L	L
Management commitment to beyond compliance	L	**H**	H	L	L	M
Employee awareness, attitudes, and behaviour	L	H	**M**	L	M	H
PAC and P2 Program	L	H	**H**	L	H	H
Land Management and Access	L	H	**H**	L	M	H
Lack of qualified environmental professionals	L	L	**L**	L	L	M
VSS technology	L	H	H	**H**	H	H
Soil contamination and legacy issues	L	H	H	M	**H**	**H**
First Nation Consultation	M	L	H	L	**M**	L
Federal Fisheries Act – Sensitive Fauna (Fisheries)	L	M	M	M	**H**	**H**
Environmental releases – Particulate Emissions	M	M	M	M	M	**H**
Environmental releases – Effluent Quality	L	L	L	L	M	**M**
Waste Management	L	M	M	L	M	**M**
SPL Management	L	H	H	L	M	**M**
Spills	L	H	M	L	H	**H**
Sensitive fauna (Others)	L	L	L	L	M	**H**
Resource management	L	M	M	L	L	**M**
Water conservation	L	L	M	L	L	**L**

Note: Bold letters indicate the section of the PESTLE analysis that the issue is discussed.

5.5.5.1 Political

There are political environmental pressures at Kitimat Works from both federal and provincial governments related to PAH and GHG emissions. NGOs and international pressure are pressing the Federal government for action on reducing GHG emissions. Additionally, NGOs such as the Environmental Defence and the Canadian Environmental Law Association have released reports press releases on their stand against carcinogenic emissions and are pressing to have carcinogenic emissions stopped by 2008.[xciv] This will add pressure to Kitimat Works to deal with PAH emissions, which have known carcinogens such as Benzopyrene. Alcan Inc. has already committed to close VSS smelters in Quebec by 2014 and action has already been taken to close the Söderberg lines at Arvida. No commitment has been made to retire Kitimat Works VSS technology. Due to the government and NGO pressures, PAH emission is the highest environmentally driven political risk to Kitimat works.

Pollutionwatch has issued a press release identifying Alcan Inc. as being Canada's second largest polluter. A second press release identified APM-BC as British Columbia's largest polluter in terms of total NPRI reported emissions. 81.4 percent of the emissions being GHG related (carbon monoxide), this will add to the political pressure for improving GHG reductions; possibly at the risk of ignoring APM-BC's existing 30 percent reduction (600,000 tonne reduction of annual GHG production).[xcv] It is important to note that Kitimat Works' total GHG emissions are approximately 1.6 million tonnes CO2e. Government imposed carbon taxes could decrease the cost competitiveness of Kitimat Works. Therefore, the GHG issue must be carefully tracked and continued efforts need to be made on GHG reductions.

5.5.5.2 Economic

Economically driven environmental factors can be related to pushing the production envelope to optimize economic value. A key economically driven pressure is with the asset optimization program, specifically the hot metal production and the current amperage increases. Increasing the electrical current in the pot cells may lead to higher operating temperatures and increased fluoride emissions. Presently, the plants fluoride emissions are maintained near the 1.9 kg/t Al fluoride emission level and there are already ongoing compliance concerns. While the plant is largely compliant with the annual average, on a monthly basis there are repeated non-compliances. For instance, in 2004, there were four non-compliances of the monthly average.[xcvi] Higher fluoride emissions from current increases will present compliance challenges that may limit the realization of the full potential of the asset optimization strategy.

Eco-efficient opportunities lie in improving hot metal production through reducing anode effects, conserving resources and conserving energy. A useful proxy for anode effects is PFC emissions, which are directly dependant on anode effects (both duration and frequency. Benchmarking data on PFC emissions shows that VSS technology is average. Kitimat Works is operating in the upper 80th percentile for PFC emissions in the global VSS community[xcvii]. This shows that there are opportunities for Kitimat Works to reduce PFC emissions through anode effect reductions. Benefits of anode effect reductions include energy conservation, reduced consumption of pine poles, reduced fluoride emissions, reduced PFC (GHG) emissions and increased hot metal production. Resource conservation is another opportunity. Spills of process material increase the overall cost of hot metal through material losses, cleanup costs, and recycling costs. Value may be captured through recycling opportunities, such as spilled alumina ore.

Energy conservation is an important opportunity for Kitimat Works and is also a pressure on the business from APMG. The plant's energy sources are electrical, natural gas and other fossil fuels. The largest opportunities lie in electrical energy and natural gas. Kitimat Works may have significant opportunities for conservation since the plant was designed and built in the 1950s with a low cost stranded energy supply. There was little pressure to build the plant for energy efficiency at that time, a legacy that remains to this day. Kitimat Work's average energy demand for aluminum reduction is 19.6 MWh/t Al. As can be seen in Figure 17, Kitimat Works consumes almost 60 percent more energy on a per tonne basis than the best in class producer, and is about 21 percent more energy intensive than the western world average for Söderberg plants. Assuming an energy cost of $25/MWh, the cost spread between the Western World Söderberg average and Kitimat Works average energy demand is $87.5/tonne hot metal. This translates into about $21 million per year at a 242,000 tonne production capacity. Reducing the cost spread through energy conservation will not only improve the competitive position of the plant but also the reduced the environmental footprint through GHG emissions savings.

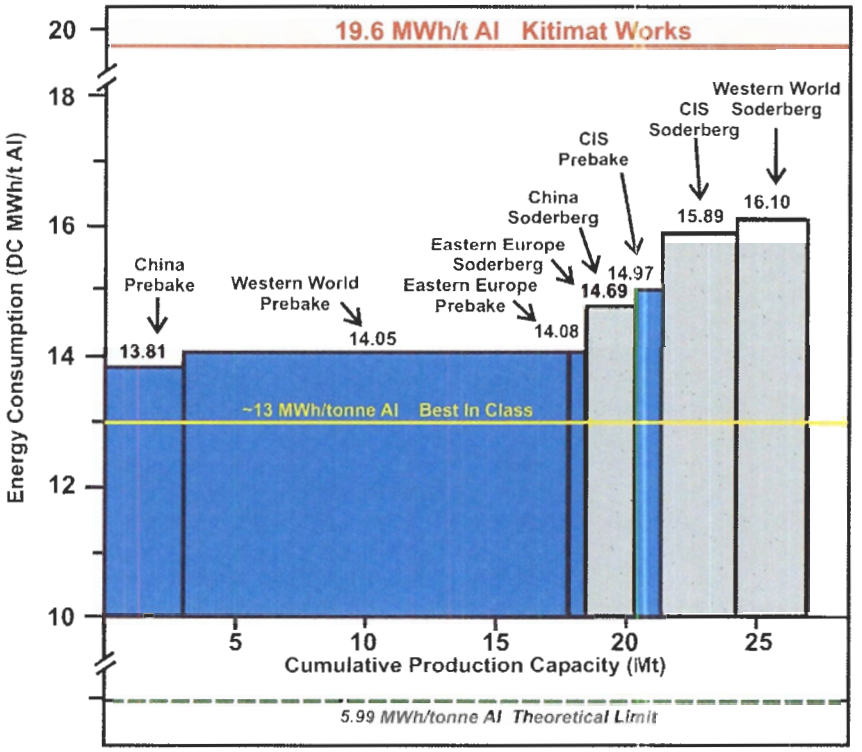
Natural gas is another opportunity for both environmental and cost savings. A pollution prevention (P2)[12] conservation target for natural gas was set at a 20 percent improvement in efficiency.[xcviii] This objective was established in 1999 and is an outstanding P2 commitment that needs to be met. Efficiency is a challenging parameter to measure in natural gas consumption but measurements and identification of opportunities for conservation and efficiency improvements will reduce overall energy costs and GHG emissions.

Additional economically driven pressures arise from internal budgetary constraints that increase competition within APM-BC for financial resources and limit the willingness to invest in beyond compliance programs until they become subject to compliance or regulatory driven

[12] Refer to Table 11 for a description of the pollution prevention (P2) program.

pressure. This pressure is one of the key challenges to the broadened definition of value, especially since most environmental issues are difficult to value.

Figure 17. Energy Consumption Benchmarking



Source: Drawn by author, data from Evans, 2003 and Chaote and Green, 2003.

5.5.5.3 Social and stakeholders

As mentioned previously, in section 5.1, Kitimat Works has had past encounters with social interventions. While significant progress has been made on stakeholder relations by transforming past adversaries into positive partners for the environment, there continues to be social and stakeholder pressure on environmental performance in the plant. Key stakeholders,

Employees/Union, Public Advisory Committee (PAC)[13], regulatory agencies and Haisla First Nation to continue exert pressure on environmental issues. An analysis of stakeholders and stakeholder issues/positions are presented in section 5.4. Based on the Analysis, a key challenge to sustaining environmental performance lies with employees. Attitudes and behaviour are an identified challenge at Alcan to environmental performance and maintaining the balance of sustainability's three dimensions.[xcix] Understanding, buy-in, and ownership of issues is key to achieving sustained environmental performance. As can be seen in Figure 20 since 2003 an average of 25 percent of non-compliances (reported as miscellaneous) is related to employee actions. For example, non-compliances from dissolved aluminum and rooftop fluoride emissions can be linked to components of employee adherence to work procedures and management decisions. This is not to say that the employees do not share concerns about the environment. The Union has been committed to active participation in the PAC and a Joint Environmental Committee.

The PAC, regulatory agencies and Haisla are concerned with all aspects of environmental performance – emissions, effluents, waste generation/management, permit compliance and any other environmental risk posed by the company. Pressures exerted by these stakeholders are brought on by real, perceived or potential risks and impacts. Non-compliances, perceived poor performance and lack of progress on stakeholder driven issues could induce regulatory, or political risk that can lead to economic barriers. Issues brought by these groups are expected to be proactively managed and progress on them is expected to be demonstrable. This explains why the P2 Program is an important component of APM-BC's sustainability strategy. The P2 program provides a forum for multi-stakeholder discussions on environmentally driven issues. The P2 program also serves as a key driver for culture change at APM-BC as it is a catalyst for a shift to

[13] Public advisory committee (PAC) was established by APM-BC under Kitimat Works Pollution Prevention Program to provide input on Alcan related environmental concerns affecting the community and track the Kitimat Works' Pollution Prevention Program.

a beyond compliance culture as opposed to a command and control culture. It is exceedingly important for the Haisla and PAC to see continued dedication by management to a beyond compliance vision.

Other issues and pressures that can be linked to social/stakeholder pressure include access to land and waterfront. These create environmental pressures from due-diligence land management, environmental performance from leaseholders, environmental damage by trespassers and managing contaminated site legacies from past land use. Internal EH&S audits have identified property management as a risk that needs to be addressed.

One social limitation in the Kitimat area is access to and retention to qualified environmental professionals and technicians. Resources that are unavailable in the northwest must be mobilized to Kitimat at a cost and often with a time delay.

5.5.5.4 Technological

The 50 year old VSS technology used in the plant poses a barrier to improving environmental performance through technological process improvements. The VSS technology has limited ability to control PAH emissions from the anode. It is also subject to emissions of fluoride, GHG, and particulates, all of which are caused by process instabilities and operation. Some companies that are dominantly Söderberg operations, such as RUSAL, believe that there is much room for technological improvement in VSS operations.[c] Kitimat Works has the potential to improve emissions through technological improvements. The environmental analysis section below on the plant operations it shows that Kitimat Works does not operate the best in class VSS operation. Rather the facility operates in the 80th percentile for PFC[ci] emissions and 60th percentile for fluoride[cii]. Technological improvements have been made with pitch to reduce PAH emissions from the anodes, gas collection with skirts, green coke and paste formulation to improve anode quality. Areas outside of the reduction process that affect environmental performance have

largely been addressed through the Environmental Improvement program including suspended solids in water effluent, effluent toxicity failures and dissolved fluoride non-compliances have been addressed (Figure 20). In fact, through technological improvements non-compliances have been reduced by 73 percent between 1996 and 2004.

5.5.5.5 Legal

Environmentally driven legal and regulatory risks are presently well managed at Kitimat Works and are tracked through a detailed legal registry with the ISO 14001 risk management system. The highest future risk is PAH emissions on which there is no regulatory limit. Environment Canada is examining toxic emissions such as PAH very closely and looking at imposing restrictions across Canada. As PAHs are technologically very difficult to control in the VSS process, their regulation could jeapordize the operation. There is, however, current action to develop a voluntary reduction agreement with Environment Canada and the Provincial Ministry of Environment on PAH emission levels and on their reduction. The P2 Program will play a key role in this effort.

New provincial legislation called the Environmental Management Act is redefining some aspects of Provincial environmental law that will impact plant operations. It is important to track the waste management regulations that may alter hazardous waste handling. The regulations may require financial bonds for material stored on site. Contaminated sites regulations under the Environmental Management Act will be encountered with increasing frequency as the interest in developing Alcan owned property rises as do EH&S First requirements for managing property risks including leaseholders.

5.5.5.6 Environment

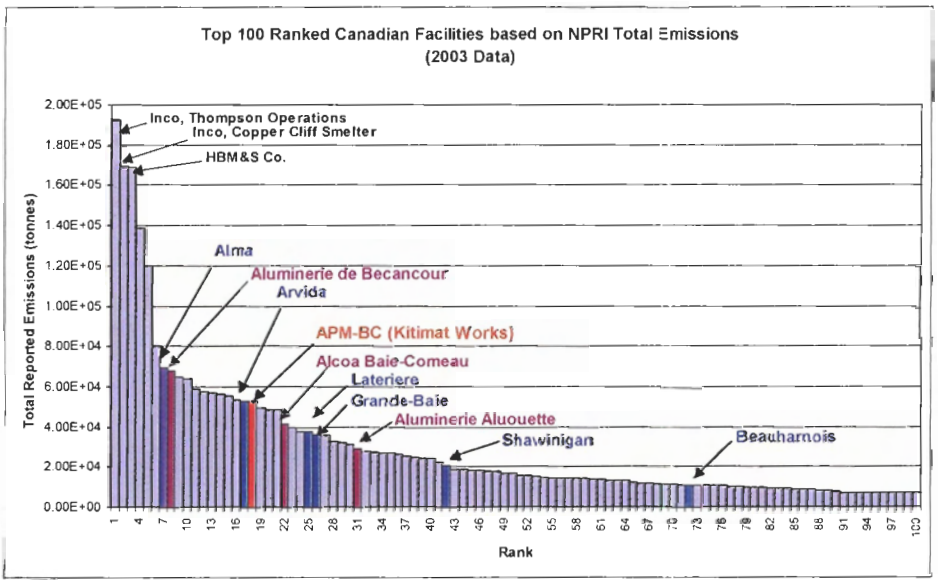
Environmental risks and pressures on Kitimat Works are very high. This is one of the largest topics and could be discussed at length. However, only a brief discussion of key environmental issues with sustainability links is provided. Key issues are:

- Emissions, government, NGO and stakeholder response to the emission levels
- Fluoride emissions and their control
- Overall environmental performance and permit compliance
- Old technology limiting environmental performance
- Contaminated sites and land management
- Waste and SPL management
- Resource and water conservation

Total emissions from Kitimat Works are significant and can present a negative image of the APM-BC and Alcan. Pollutionwatch benchmarks Kitimat Works as the 18th largest polluter in Canada and the largest polluter in British Columbia (Figure 18) out of a total of 6066 firms. The rankings need to be put into perspective. As 81.4 percent of the NPRI reported emissions (used by Pollutionwatch) from Kitimat works total emissions are carbon monoxide, which is a gas that converts to carbon dioxide within a couple of days in the atmosphere. Carbon monoxide emissions represents only 2.6 percent of Kitimat Works' total emissions, while toxic emissions represent only 0.6 percent. Carbon dioxide, although a contributor to climate change are not a chronic concern as toxic emissions are, but represents 96.8 percent of Kitimat Works total emissions. Benchmarking on toxic emissions (Figure 19) places Kitimat Works falls as 95th out of 2861 firms, in the middle of the APMG family. It is important to note that Eurocan Pulp and Paper company (a physically located neighbour to Kitimat Works), ranks number 165th. Despite the adjustments to the rankings based on the significance of the impact (toxic verses total

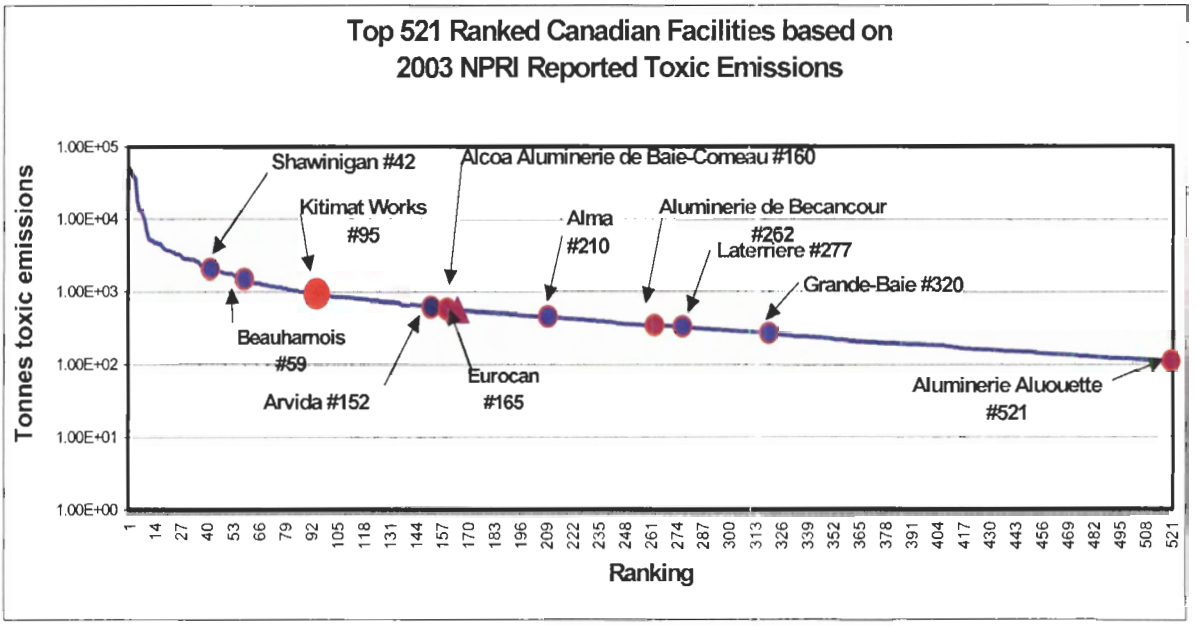
emissions) the negative image of the volume will add pressure to Kitimat Works for emissions reduction and source prevention. This is especially true considering the 2005 Susuki Foundation report that criticized the Canadian Government for carbon monoxide emissions management, a gas that Kitimat Works emits on an order of magnitude greater than the national average.

Figure 18. Canadian Total Emissions Benchmarking – Top 100 Ranked Facilities



Source: Created by author, data from Pollutionwatch, 2005.

Figure 19. Canadian Toxic Emissions Benchmarking – Top 521 Ranked Facilities



Source: Created by author, data from Pollutionwatch, 2005.

Table 17. APM-BC Emissions Benchmarking of Ten Commonly Reported Atmospheric Emissions

Emissions Comparison	Oxides of Nitrogen NO_2 equivalent	Carbon Monoxide	Sulphur Dioxide	PM-Total Particulate Matter	PM10 Particulate Matter	PM2.5 Particulate Matter	Volatile Organic Compounds
APM-BC Emissions (Tonnes)							
	243	42,986	7,046	1,638	581	295	158
APM-BC's Percent Contribution to Total Emissions							
National	0.03%	4.1%	0.36%	0.85%	0.53%	0.46%	0.06%
Sector	25.9%	23.75%	13.49%	14.26%	17.02%	16.64%	18.94%
Regional	0.65%	37.8%	13.63%	6.03%	4.22%	3.53%	0.47%
Average Emissions (Tonnes)							
National	243 **B**	401 **D**	2,118 **C**	157 **D**	33 **D**	17 **D**	143 **C**
Sector	154 **C**	28,428 **C**	4,352 **C**	957 **C**	310 **C**	161 **C**	76 **C**
Regional	204 **C**	665 **D**	784 **D**	155 **D**	50 **D**	34 **D**	106 **C**
Maximum Emissions (Tonnes)							
National	35,342 **A**	62,097 **A**	190,655 **A**	7,355 **A**	4,871 **A**	2,103 **A**	31,666 **A**
Sector	1,010 **A**	58,927 **A**	8,097 **A**	3,599 **A**	1,563 **A**	791 **A**	158 **B**
Regional	2,933 **A**	42,986 **E**	10,987 **A**	1,870 **B**	1,278 **A**	943 **A**	1,196 **A**
APM-BC Percentile Ranking							
National	84.5%	99.8%	98.2%	98.4%	98.7%	98.5%	81.2%
Sector	80.0%	72.7%	75.0%	83.3%	81.8%	81.8%	90.9%
Regional	75.4%	99.4%	97.0%	98.3%	97.5%	95.9%	79.1%

Notes:

A = Emission is lower than average, **B** = Emission falls within range, **C** = Emission is within one order of magnitude greater than, **D** = Emission is greater than 1 order of magnitude, **E** = Emission is the maximum reported.

Source: Table by author, data from 2003 NPRI data supplied by ENDECO, 2005.

Fluoride emissions are a high pressure for Kitimat Works from a regulatory compliance perspective but low to moderate from observed levels of impacts to flora and fauna. Fluoride emissions are a chronic non-compliance issue for the business. Kitimat Works typically experiences at least one monthly non-compliance per year, and has had historical problems

meeting the 1.9kg/tonne Al annual permit limit. Kitimat Works operates in the 60th percentile in VSS technology for total fluoride emissions.[ciii] Gaseous and particulate fluoride emissions represent a loss of process resources. Damage from fluoride emissions is presently low largely due to emissions reductions. Local vegetation damage typically shows up as leaf burn around the plant. Vegetation health in Kitimat has improved since the 1970s from extensive damage/defoliation to very limited damage in 2005. Limited amount of fluorosis has been measured in small mammals but not at levels that cause impairment or affects the animal.[civ]

Particulate emissions and the particulate fallout are a concern for Kitimat Works. As shown on the benchmarking survey of Canadian industries (Table 17) Kitimat works ranks in the 95-98th percentile for total and PM2.5 particulate matter. On a sector basis (including other industries and aluminum smelters), Kitimat Works ranks in the 82-83rd percentile for particulate matter. On a national and regional basis, Kitimat Works' particulate emissions are an order of magnitude greater that the averages for the two ranking categories. Particulates are a concern because of their composition (aluminum, flouride and PAHs), size and deposition in the environment.

Effluents risks posed by effluent quality are low due to reduced loadings of aluminum. From 1995 to 2004 aluminum loadings have decreased by 70 percent. However, dissolved fluoride non-compliances are a frequent occurrence (Figure 20) with one or two permit exceedances annually. These exceedences are typically marginally above the permit limit of 10mg/l dissolved fluoride and have not failed toxicity testing.

Contaminated sites are a high concern. Historic legacies from past operating practices and third parties have created high environmental liabilities that may limit strategic business decisions and options for Kitimat Works. Legacy issues may also increase the complexity or confound economic development initiatives. Present land management issues are linked to

contaminated sites with third parties (leasees and land users) potentially causing environmental damage and leaving APM-BC with remediation costs.

Waste and SPL management is a low to moderate pressure. SPL is shipped offsite to Oregon for treatment and disposal at a special waste landfill. APM-BC is also engaged in trials for recycling SPL into cement and has completed trial burns of the SPL carbon fraction as a fuel alternative in two cement kilns. Waste management now presents mostly economic opportunities for improvement. There are opportunities for improving the handling, segregation, and recycling within the plant. These issues largely lie in obtaining buy-in and co-operation from employees and contractors.

Spills are a high concern due to the sensitivity of the surrounding environment, potential for causing soil and groundwater contamination and financial loss of replacing the material spilled. Kitimat Works is surrounded by fish bearing habitat and spills directly or indirectly to fish habitat have the potential for causing significant ecological damage and steep regulatory penalties. Spills to the soil, depending on the material, can cause contamination of the soil and groundwater with high cleanup costs. For instance, an oil spill to soil can create hazardous wastes from high concentrations of oil that cost money for the disposal/treatment of the oil soaked soil as hazardous waste. Process materials losses are a high cost for Kitimat Works. For example, the 1999 P2 program provided an opportunity to recover approximately $2.2 million in spilled ore from the pot room basements. Since the first basement cleaning an estimated 2000 – 3000 tonnes of ore and bath are recovered each year, but there is an added cost of sorting, cleaning and recycling the ore. Losses of the ore are the largest contribution to dissolved aluminum and fluoride loadings to the effluent lagoon.

Sensitive flora and fauna is a high pressure on Kitimat Works. APM-BC's plant site and properties are within the path of sensitive migratory birds and raptors. The company also holds a

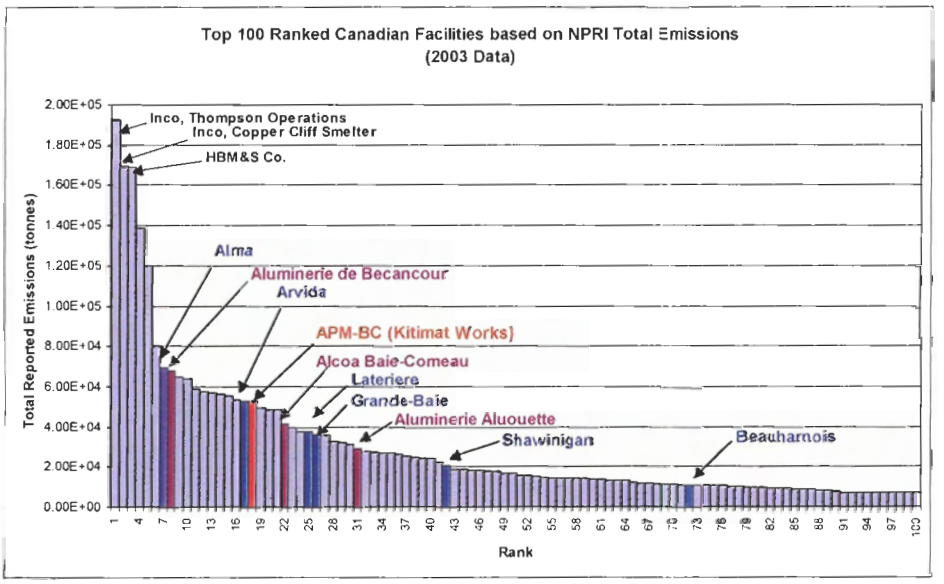
significant part of the Kitimat River estuary, which is highly sensitive fish, bird and grizzly bear habitat. The plant site has a salmon spawning creek running through the middle of the site. Additionally, it is bounded on the north side by a second salmon spawning creek. Both creeks have been impacted by channelization and dyking works done in the 1950s for flood protection when the plant was built. There will be future pressure for habitat restoration on these creeks.

Resource management is a high priority for Kitimat Works, largely driven by the EH&S First Directive for resource management. Resource conservation opportunities lie in the areas of energy, pine pole and process materials consumption. There are key linkages with resource management and spill prevention. Benefits to the conserving resources lie not only in economic, but also in reduced waste generation, reduced GHG emissions and demonstration of best energy use.

Water conservation is a low pressure at Kitimat Works in terms of the environment. This is largely due to the high annual precipitation that the Kitimat area receives. However, there is pressure from Alcan Inc. to conserve water and efforts need to made in measuring, monitoring and identifying opportunities for conservation. Savings in water will yield some financial return from reduced energy and water treatment costs.

emissions) the negative image of the volume will add pressure to Kitimat Works for emissions reduction and source prevention. This is especially true considering the 2005 Susuki Foundation report that criticized the Canadian Government for carbon monoxide emissions management, a gas that Kitimat Works emits on an order of magnitude greater than the national average.

Figure 18. Canadian Total Emissions Benchmarking – Top 100 Ranked Facilities



Source: Created by author, data from Pollutionwatch, 2005.

Table 18. Summary of Pressures Affecting the Casting Facilities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Environment
Metal purity and lithium addition in Lines 1 and 2	L	**H**	H	L	M	H
Dross production and management	L	**M**	M	L	L	M
Energy conservation	L	**H**	M	L	L	**M**
Chlorine gas usage	L	H	**M**	H	L	**M**
Water consumption	L	L	L	L	L	**M**
Spills (oils)	L	L	M	L	M	**M**

Note: Bold letters indicate the section of the PESTLE analysis that the issue is discussed.

5.5.6.1 Political

Political pressures are low and there are no outstanding issues with casting.

5.5.6.2 Economic

Economic pressures from casting are moderate. Key issues lie in metal purity that creates pressure to reduce or eliminate the use of lithium in Lines 1 and 2. Metal purity is addressed through fluxing with chlorine, which creates dross, a hazardous waste, emits chlorine gas that affects local air quality and consumes energy for maintaining the furnaces during fluxing. Lithium additions to the bath in Lines 1 and 2 reduce the gaseous fluoride emitted from the pots and improve the overall operating permit compliance for the plant. Dross, while a hazardous waste, is recycled for aluminum recovery. The recycling creates a net loss from the energy costs, handling, and transportation costs. Energy is a key cost item for casting, and is also a source of GHG emissions at Kitimat Works. There is corporate pressure to have the energy inputs to the furnaces monitored and measured with the intent of identifying opportunities to optimize furnace operations and reduce energy costs.

5.5.6.3 Social

Social and stakeholder concerns are moderate for casting. The main concerns are with chorine gas use and metal emissions from the casting furnace stacks. Chlorine gas will be discussed with technological pressures and concerns over metal emissions were addressed during the first P2 program with metal measurements and communications of the results to key stakeholders.

5.5.6.4 Technological

Technological pressures at casting are high for the removal of gaseous chlorine from the fluxing process. APMG is exerting pressure to replace chlorine gas with chlorine salts in the casting process. This would result in reduced chlorine gas emissions and eliminate the EHS risks of storing chlorine gas on site.

5.5.6.5 Legal

Legal risks are low for casting. Casting maintains operations largely within permit compliance (refer to Figure 20) with one (in 2002) exception between 1999-2004 where the daily 300kg limit of chlorine consumption was exceeded. On a daily basis, casting is operating at 99.95 percent compliance.

5.5.6.6 Environmental

Environmental pressures on Casting are moderate and arise in the three key areas of chlorine gas, water consumption and spills. Chlorine use was discussed above and as mentioned their emissions from the casting furnace stacks affect air quality. Chlorine gas on release to the atmosphere reacts with moisture to form hydrochloric acid resulting in acidified rainfall in the locality of the plume. Water consumption is a concern from the volume of water that casting consumes on a daily basis. An estimate 35,000 m^3/day (approximately 12 million cubic meters each year) is consumed in the casting process through the one time contact cooling processes. Canola oil and an emulsifying agent are added to the water causing continual oil releases to the effluent treatment system. Despite the high water consumption, the flow of Casting water to the lagoon provides an important source of water for lagoon operation. Spills and excess build-up of Canola oil are frequent in the lagoons. These spills present a concern to migratory wildlife that stopover in the lagoons.

5.5.7 Wharf Shipping and Receiving

All alumina, liquid pitch, and most of the green coke are received at, and most of the metal is exported overseas from the wharf. The inbound-outbound logistics of the wharf are a cost centre and not a value added process. The Wharf has limited environmental issues. Key wharf issues are the releases (spillage) of materials being unloaded at the wharf. Table 19 presents a summary of the issues and concerns affecting the casting facilities. These pressures are derived from a PESTLE analysis that is expanded on after the table.

Table 19. Summary of Pressures Affecting Wharf Shipping and Receiving

Issues	Political	Economic	Social/ Stakeholder	Technological	Legal	Environment
Spills (from Ships)	L	M	M	L	M	**M**
Spills (from APM-BC)	L	M	M	L	M	**M**
Sediment contamination	L	H	M	L	M	**M**

Note: Bold letters indicate the section of the PESTLE analysis that the issue is discussed.

5.5.7.1 Political

Political pressures are low and there are no outstanding issues at the wharf.

5.5.7.2 Economic

Economic pressures are high as the wharf is a key strategic asset for the plant. Presently there are no environmental pressures that limit shipping and material loading/unloading capacity at the wharf. Upgrades at the wharf made under the environmental improvement program have removed most environmental concerns that could, in turn, cause economic concerns for the company.

5.5.7.3 Social

Social and stakeholder pressures at the wharf are low due to the environmental improvements that significantly reduced or eliminated process material losses.

5.5.7.4 Technological

Technological improvements have been made at the wharf that includes a pneumatic alumina unloader, diversion of stormwater so it drains away from the marine environment, improved house keeping and modifications to the coke unloading process. Technological derived pressures are low.

5.5.7.5 Legal

Legal pressures are moderate due to the potential for spillage at the wharf berth. There is the potential for spills from the ships docked at the wharf and spillage of coke during the unloading of coke barges. The ships are owned independently from Alcan and operate under Canadian marine laws and international MARPOL. Never the less, spills at the wharf can embroil APM-BC in investigations and subsequent cleanups under the Federal Fisheries Act. Of concern is the potential for sediment contamination from historic spills of materials at the wharf. This may present a future legal risk and the need for complex maintenance dredging work.

5.5.7.6 Environmental

Environmental pressures at the wharf are moderate, arising as mentioned above from spill risks. This risk needs to be managed through employee environmental awareness and investments in spill containment and prevention.

5.5.8 Power Export

Power exports supplement the aluminum revenue base of APM-BC. Exports fluctuate from zero to approximately 14 percent of revenues depending on reservoir water levels. Rents are received from two sources: first power exports from a Long Term Agreement (LTA) that was

developed from the 1997 KCP settlement agreement to supply 140MW; and second, sales of surplus power above the LTA (about 65MW). There are no key environmental issues associated with this part of the value chain. There are pure social interventions expressed by the District of Kitimat on the subject, which are beyond the scope of this project.

6 APM-BC SUSTAINABILITY STRATEGY DEVELOPMENT

Eighty key environmental issues have been identified that can exert pressure on APM-BC across its value chain. To effectively manage these numerous issues and simultaneously obtain the maximum benefit from investing resources, an implementation strategy is required. The objective of the strategy is to protect shareholder value by efficiently addressing the environmental challenges while optimizing stakeholder benefits.

The set of strategies will be developed using the identified environmental issues affecting APM-BC and mapping them according to the risk they pose to the business and environment. The risks for each issue are based on the results of the PESTLE analysis. The business risk is a subjective weighting of the political, economic and legal factors, while the environmental risk is based on the level of importance assigned to the issue during the analysis. Although a detailed discussion of the evaluation of each issue in terms of risk is not provided the risks are evaluated in tabular format and are presented in Appendix B (Table 21 to Table 27). As most issues are dependent on the outcomes of other issues or have natural linkages that are synergistic between issues, linkages between the issues are made and shown on the map. The level of stakeholder opportunity (potential for involvement and benefit creation) is represented on the map by using size of the issue represented on the map. The assessment of stakeholder potential is provided in the tables of appendix B.

The issues will be grouped into strategic sets of issues. Each issue will be analyzed by identifying its strengths, weaknesses, opportunities and threats. This is the SWOT analysis technique. Results of the SWOT analysis are presented in appendix C (Table 28 to Table 34).

Using the strategic groups of issues, a set of recommended management strategies will be generated using the SWOT results.

6.1 Strategic issue Mapping by Value Chain Component

Interesting results are provided by mapping the key environmental issues according to their risk (environment and business) and assessing their dependencies. For each component of APM-BC's value chain a map of the environmental issues has been generated (Figure 21 to Figure 27). Linkages between the issues are identified by assessing the dependency or influence of each issue on the others. Natural groupings of issues are highlighted where the issues can be assessed together to form holistic management strategies. The linkages also identify issues that could cause hold-ups in business. Potential issues that can be considered as hold-ups or barriers are those that have more than three dependencies or influences (links) on other issues. For these issues, their level of risk to holding up strategy must be evaluated. A total of 25 groups of issues have been identified. There are 22 by value chain component and three common groups that are can be addressed for the business as a whole.

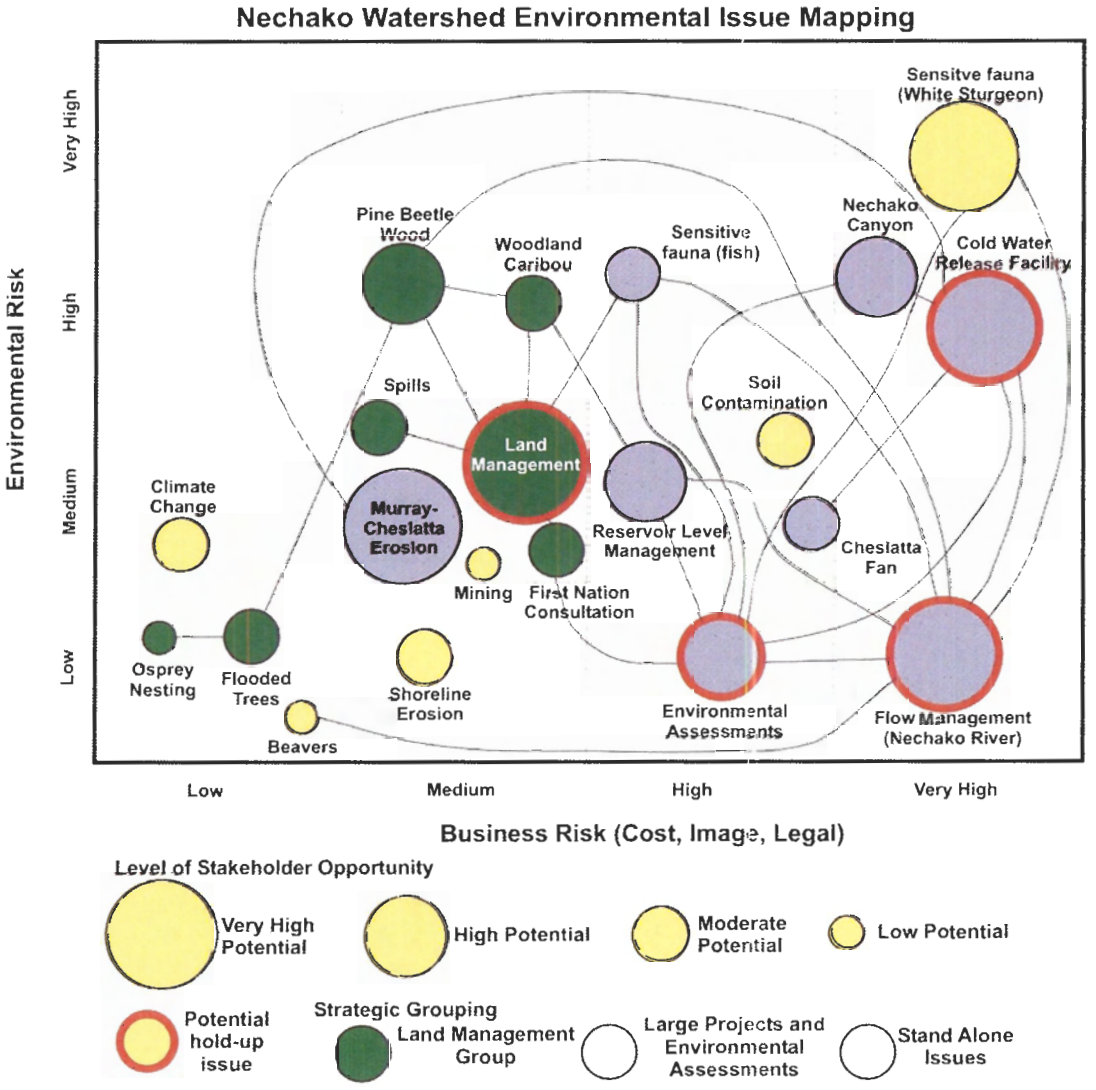
6.2 Nechako Reservoir Strategy Development

Four strategic groups out of 21 issues have been mapped out for the Nechako reservoir.

These groups, as shown in Figure 21 are:

- White sturgeon management
- Land and resources management
- Large projects and environmental assessments
- Stand alone issue (soil contamination, shoreline erosion, and mining)

Figure 21. Nechako Watershed Environmental Issue Mapping



Source: Drawn by author.

6.2.1 White Sturgeon management

As can be seen on Figure 21, white sturgeon is the largest and most pressing environmental issue and business risk for the reservoir and APM-BC. Although this issue is not shown as a hold-up to other issues in the Watershed the SARA mandated recovery plan for white sturgeon directly ties in with flow management for the Nechako River. This could impact many other issues, initiatives and above all the amount of water available for power production. Currently, there are multi-stakeholder initiatives to research white sturgeon ecology in the Nechako River and discussions on potential plans for a sturgeon hatchery to assist with the sturgeon's population recovery. APM-BC has a presence in the sturgeon initiatives and needs to maintain a leadership role in developing an understanding of the habitat limiting factors that affect the sturgeon's life cycle. Alcan funded research has identified a sturgeon spawning ground in the Nechako River, and further participation in the sturgeon research is required. This would involve participation and funding support for white sturgeon research by stakeholders such as the Carrier-Stikani Tribal Council with the Nechako White Sturgeon Recovery Initiative (NWSRI). Funding for this work should be made a priority, and the consideration of moving salmonid studies funding for white sturgeon. This may be justifiable as the release of the Nechako Fisheries Conservation Technical Data Review states that the conservation goal of the 1987 Settlement Agreement has been achieved and the population targets are within the range identified in the Agreement.[cv]

The most likely scenario for the sturgeon recovery plan is the development of a hatchery to assist the recovery of the sturgeon population. Consideration should be given to funding the research and development of the hatchery so that strategic input could be provided. The full potential of a hatchery needs to be assessed in terms of providing benefits to stakeholders.

The white sturgeon issue has very high stakeholder potential in terms of opportunities and value creation. The ecological research provides employment opportunities to First Nations' fisheries technicians and the prospect of a hatchery will provide some long term employment opportunities. Both fisheries research and a hatchery are consistent with First Nations interest in protecting resources within their traditional territories.

6.2.1.1 Recommendations

1. High-level management support and commitment to sustain funding and support for white sturgeon ecological research. Recognition is needed that this is of high strategic importance to the company.

2. Maintenance of high level of involvement with the stakeholder groups who are conducting sturgeon research.

3. Consider funding research and development of a hatchery for White Sturgeon.

4. Identify feasible dimensions for creating stakeholder value with a hatchery.

6.2.2 Land and Resources Management

Land and resource management encompasses seven issues: land management, pine beetle wood, woodland caribou, spills, First Nation Consultation, flooded trees and nesting osprey. This grouping is formed from linkages with land management issues. The land management issue has been identified as a potential hold-up issue for the Watershed. For instance, land management issues have provided a slow and untimely response to pine beetle wood issues and have had implications for First Nations consultations. Among the identified issue groups, this particular

grouping has the largest sustainability potential in the Watershed for stakeholder benefit and wealth while serving the needs to the company.

A key land issue is the under utilization of company lands around the watershed, with most lands serving only to provide a legal protection buffer around the flooding and erosion effects of the reservoir. Additionally, the value of resources and land use opportunities remain largely an unexplored frontier. APM-BC is one of the largest landholders in Northern British Columbia but the management of the numerous landholdings is limited. The strategies deriving from the SWOT analysis for land management (Table 28) involve engaging First Nations groups for land management services to act as stewards for the properties. This would fit with their interest in addressing the social land issues created by their resettlement away from their traditional lands. This would also fill an identified gap in APM-BC's land management. A key element for success in such a plan would be education and training of the First Nation groups. This need is further discussed as a common issue for APM-BC as there are similar land management issues across the company's physical footprint. A link that will provide synergy to land management is the issues of spills. Educating and creating environmental awareness in stakeholders, land users, and employees will reduce the overall environmental footprint of the company and improve the local environmental quality. This fits the Alcan EH&S policy of environmental leadership and engaging stakeholders for improving performance.

Pine beetle wood is a natural link to land management due to the extensive infestations of mountain pine beetle on company property. A strong land and resource management is needed to address the beetle epidemic and to effectively recover the damaged lands. Unfortunately, the real risk of the beetle has not been fully appreciated until recently and more action is required before significant opportunities are lost. Consideration should be given to quicker and extensive harvesting of pine trees on company's properties as the forests are heavily infested and most pine trees will fall to the beetle within a few years. Providing increased stakeholder access to the wood

on Alcan property will provide economic benefits to the communities around the reservoir. Alcan has partnered with three First Nations groups (Cheslatta Carrier, Tahi Buhn, and Skin Tyee) to harvest beetle killed wood over a four year period. This is expected to provide $2.7 million in revenues to the First Nations groups over the four years. The work should be reviewed to see if there is a potential to accelerate the harvesting, as both the rate and the area of beetle infestation are rapidly expanding each year. Additionally, it is in the company's best interest to manage the pine beetle wood on an expedited basis, as the dying trees will greatly increase the risk of forest fires around the property.

First Nations consultation may be greatly facilitated by the forum generated by developing a land and resource management plan and working in tandem with them on pine beetle wood harvesting. These issues may strengthen trust and relations between the company and the First Nation Stakeholders.

Woodland caribou will be affected by the changing forest conditions and there needs to be the separation of the effects of forest changes from reservoir operations. Strategically investing in caribou research and monitoring will provide the factual basis to demonstrate the level of impact (or lack of) on the caribou population. This has the potential to be viewed by stakeholders as proactive management by the company. Further, caribou may be an important issue for future strategic environmental assessments where reservoir draw down levels are questioned.

Flooded trees in the reservoir are another key resource that the company has been assisting the Cheslatta in developing. The trees have a lot of potential value. However, more attention should be paid to harvesting the uplands pine trees before the forest value is lost. Within 10-15 years, the pine forests are expected to be devastated by the pine beetle, which will hurt local economies. It will be advantageous to encourage harvesting the uplands forest and supporting the harvesting of flooded trees when the uplands forestry declines in productivity.

6.2.2.1 Recommendations

5. Engage a stakeholder to form a land management company and provide training for land and resource management according to the strategy recommended under the 'common issues for APM-BC.' The company structure could include a joint board of directors consisting of both Alcan and First Nations representation.

6. Engage the stakeholder to develop an accelerated forest management plan to harvest pine trees at the earliest opportunity. The plan should target harvesting uninfected and recently infected trees first to optimize the value from the harvesting operations. Dead standing trees should be harvested following significant gains on the live trees.

7. Participate in both market research and product development for the pinewood and beetle killed wood. For the dead standing wood, a portable pellet plant may be one opportunity to create value.

8. Examine the feasibility of using the beetle killed wood for the pine poles used to kill anode effects. Using the beetle killed wood salvaged from company property would provide a unique sustainability opportunity to employ a key stakeholder and use a resource from company property while addressing a serious biodiversity problem. This opportunity needs to be managed in conjunction with APM-BC Procurement, who may be more interested to minimize the cost of the pine pole supply than in sustainability goals.

9. Develop and implement a forest regeneration plan for the infested properties. The goal of the plan will be identify how to optimize the regeneration of the forest and tree species by planting/re-seeding the cleared and damaged forests. This option may provide long term employment opportunities for a stakeholder group through tree planting and managing the forest stands. A multi-stage forest development plan will provide sustained economic

opportunities by developing and harvesting a hardwood tree overstory (following 20-30 years of growth). This has a link to the feasibility of a portable wood pellet plant that could consume hardwoods for the pellets.

10. Commence a planting program around key sites such as the Kenney dam, Skins Lake Spillway and the Skins Lake Camp ground where the pine trees will be at risk of beetle infestation.

11. Hold off on harvesting flooded trees and focus on beetle killed pine trees. The flooded trees will provide a needed economic opportunity once the value in the pine forest is lost.

12. Assess the feasibility of developing a woodland Caribou management plan for the reservoir area using local stakeholders. The objectives of the plan would be to provide population and health estimates, and to track migration and calving areas.

13. Implement a program that would coincide with the underwater logging operations to survey nesting sites and track population densities of osprey to monitor the effect of harvesting.

6.2.3 Large Projects and Environmental Assessments

Large projects and environmental assessments are comprised of eight issues. These are:

- Flow Management (Nechako River)
- Cold Water Release Facility
- Nechako Canyon
- Cheslatta Fan
- reservoir Level Management
- Murray Cheslatta Erosion
- Sensitive Fauna (fisheries)
- Environmental Assessments

These items reflect significantly large projects. A detailed discussion on each topic is beyond the scope of this report. However, it is important to realize, based on an analysis of the SWOT table in appendix C, that the cold water release facility, flow management, and environmental assessments are hold up issues for the Watershed. The Cheslatta Fan, Nechako Canyon, and Murray-Cheslatta erosion issues can only be resolved with the cold water release facility. Environmental assessments, meanwhile, can touch on just about every issue in the watershed and hold up strategically important projects.

The cold water release facility was rated as a very high business risk due to the significant capital investment required ($50 million) plus the links the issue has to environmental assessments and flow management. A cold water release facility may alter the flow releases from the reservoir, which could possibly affect the degree of control that the company has on a day to day releases of the reservoir. The facility carries high environmental risk due to the linkages to the Cheslatta fan, Nechako Canyon, Murray-Cheslatta River system erosion and cooling water releases, all of which have very high environmental and stakeholder benefits. The cold water release facility has very high stakeholder potential for involvement in the design and construction process as well as the potential for long term economic benefits. These issues will become priorities in the near future as the Province has renewed its funding support for the project.

The Nechako Canyon is a business risk due to the public image that the dewatered canyon presents of the company and the potential costs for restoration of the canyon once the flows are returned. Similarly, the Cheslatta Fan presents a high risk due to the image and restoration costs. These issues present moderate to high potential for stakeholder opportunities for participation in the design process and for employment opportunities in restoration work, and they address key stakeholder concerns.

Flow management is a very high business risk since it involves a number of stakeholders in determining the seasonal flows from the reservoir. This removes some flexibility in flow management from the company's control. It is an established issue with the Nechako Watershed Council and no recommendations on flow management are made at this time. The issue needs to be kept in mind as it affects reservoir management and it will be affected by the development of the cold water release facility.

The Murray-Cheslatta erosion issue is one of the most interesting in terms of stakeholder opportunities. Once the cold water facility is built the high flow events that cause the erosion in the river system will be diverted to the Nechako. This will allow restoration projects on the river system to stabilize the banks and erosive sediments as well as to repair fish access to a number of tributaries on the river system. This work could be led by stakeholders through a multi-year project that would create employment that is consistent with the interests and capacity of the stakeholders. Additionally, the work could potentially be scheduled when the local forestry industry is in decline due to the mountain pine beetle.

Environmental assessments for large projects present high business risks due to the number of stakeholders involved, the lack of control on the assessments' overall scope and stakeholder and regulatory attention that can be brought to bear on sensitive business issues. Before entering the assessment phase of a project, detailed consideration of all the potential issues is required to determine if the project can feasibly be brought through the environmental assessment. One risk of the assessment process is that stakeholders can link both social and environmental issues from Vanderhoof to Kemano to it. Before advancing into an assessment an action plan should be developed to address the potential issues identified in the review process and stakeholders should engaged to resolve issues on which their support will be required.

A link to environmental assessment is the fisheries issue. Downstream of the reservoir this issue has been extensively studied, with the exception of white sturgeon. Within the reservoir, the body of knowledge is not as great as it is in the Nechako River. This gap may be an issue if an assessment is required. Presently, there are no resources dedicated to fish studies within the reservoir and the effort required to undertake a study is not known. To resolve the spending uncertainty, it would be beneficial to benchmark environmental spending on power generation reservoirs and determine the appropriate spending ranges.

6.2.3.1 Recommendations

14. Assess the environmental aspects and social issues that could be linked (from Kemano to Vanderhoof) to a project before initiating the environmental assessment process. Identify the level or risk that each issue poses to the proposed project and company and reassess the feasibility of the project in light of the potential environmentally and socially driven costs. Develop an action plan to address the issues well in advance of the assessment process. Use potentially affected stakeholders in the action plan to generate key benefits.

15. Develop a comprehensive strategy for the cold water release facility that includes the Nechako Canyon, Cheslatta Fan and Nechako River flow management issues. Identify key methods to maximize stakeholder involvement in the design and implementation of the remediation of the Nechako Canyon and the Cheslatta Fan.

16. Assess the Murray-Cheslatta River system for restoration potential and develop a preliminary remediation plan for the erosion and tributary access damage. Develop the plan as part of the cold water release facility work, and schedule implementation to coincide with the anticipated slowdown of the local forest industry (due to the mountain pine beetle infestation).

17. Benchmark spending for environmental monitoring or ecological studies on hydroelectricity reservoirs to determine two items: first, what level of funding should be committed to ecological research and to the monitoring of the reservoir; second, if the company's present spending and resource dedication is comparable to with other power producers'.

6.2.4 Stand Alone Issues (Soil Contamination, Shoreline Erosion, and Mining)

Stand alone issues of soil contamination, shoreline erosion and mining present low to moderate environmental risks. None of these issues has links that would be considered as hold up issues.

Soil contamination concerns may arise from contamination legacies created from the 1950s reservoir construction and contamination caused by third parties. APM-BC has a site assessment program that examines property risk for contamination concerns but key issues that would hold up projects have not been identified. Stakeholder opportunities could exist for any sites that require long term monitoring. Capacity building with stakeholders would be required to monitor a site.

Shoreline erosion along the reservoir carries a low environmental risk but is of importance to landowners along the reservoir. This issue mainly affects the company in terms of image and annual costs are moderate. Stakeholder benefits are moderate, and are generated from Alcan's policy of addressing the erosion issues and local employment opportunities for contractors.

Mining in the watershed currently occurs at one site, Huckleberry Mines. This is a large open pit copper mine with a significant tailings dam. While the site is regulated by BC Mines and the Ministry of Environment, there is interest and concern from Alcan over potential risks that the tailings dam could have on the reservoir. This issue carries moderate business risk because of the

consequences a breach in the tailings dam would have on the company, as the mine is located near Tahtsa Lake where the aqueduct intake is situated.

6.2.4.1 Recommendations

18. Continue to support the assessment of all properties for historic use and potential soil and groundwater issues. Follow through on risk assessment and management requirements as per the EH&S First Directive on Soil and Groundwater Protection.

19. Identify potential for capacity building with stakeholders on environmental monitoring of sites that require management under the EH&S First Directive on Soil and Groundwater Protection.

20. Conduct annual visits to the Huckleberry Mine and meet with the mine's environmental manager to review significant environmental aspects of the mine's operation and potential risks to the reservoir. Results of the meeting will be of interest to stakeholders in both Kemano and the Nechako Watershed.

21. Continue with the present shoreline erosion protection program.

6.2.5 Climate Change:

Climate change is a long-term issue that needs to be addressed in future scenario analysis on long-term power supply and smelting capacity. The climate of British Columbia's interior may become drier over the next 50 years, which would decrease the amount of precipitation available to maintain the reservoir. The scenarios need to balance downstream flow requirements with the smelter power demands. A hotter drier climate will require increased cooling flows from the reservoir to meet the requirements of the 1987 agreement with DFO. This issue could affect the financial return of investing in a smelter rebuild. In the long run, this issue may be a driver for

developing the cold water release facility as it would reduce the flow volumes required for downstream temperature management.

6.2.5.1 Recommendation

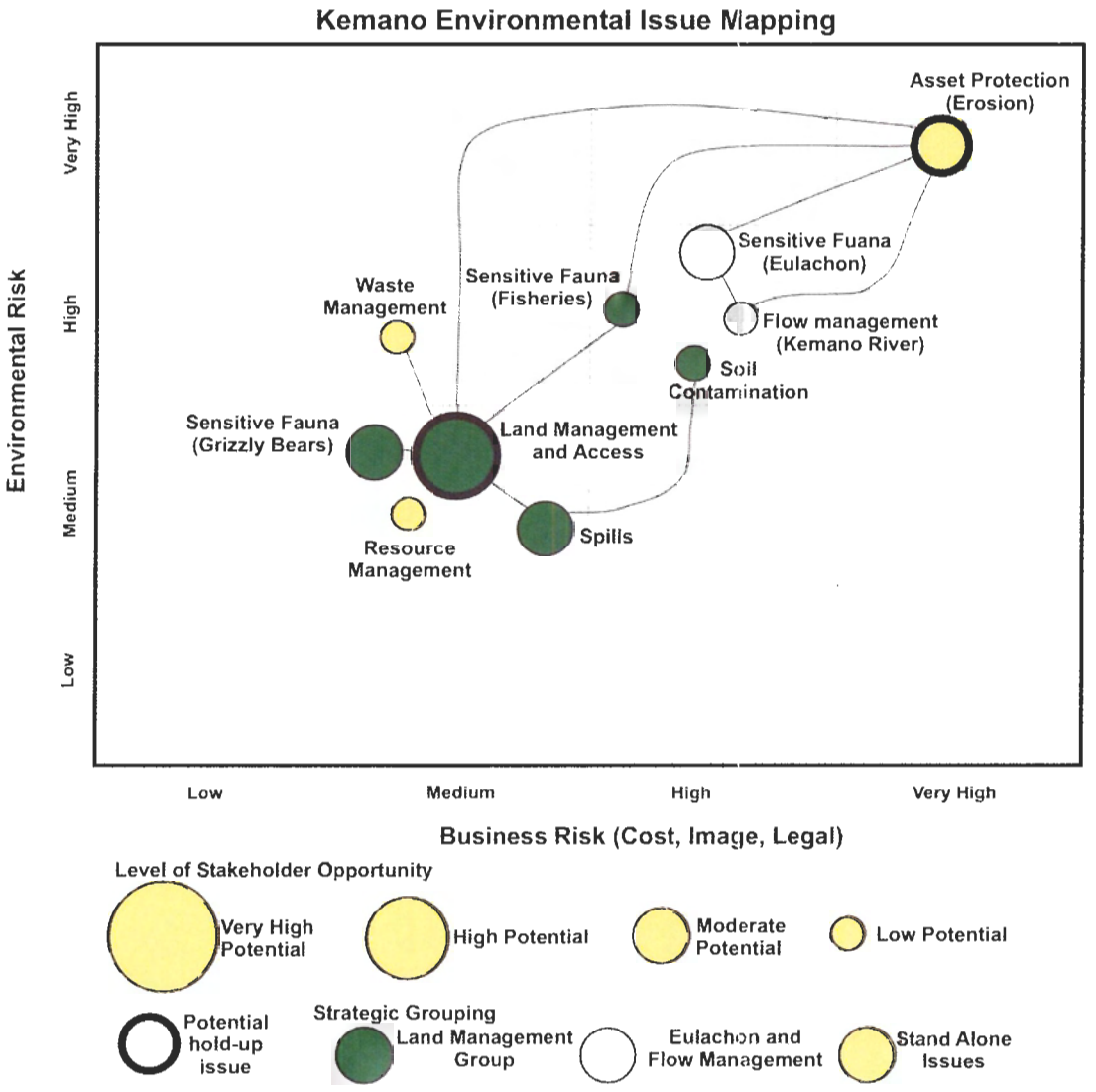
22. Scenario analysis on the stability of the long-term power supply factoring in climate change predictions and effects on downstream water demands.

6.3 Kemano Strategy Development

Four strategic groups out of 10 issues have been mapped out for the Kemano. These groups, as shown in Figure 22, are:

- Asset protection
- Land and resources management
- Eulachon and flow management
- Stand alone issues (waste management, resource management)

Figure 22. Kemano Environmental Issue Mapping



Source: Drawn by author.

6.3.1 Land Management

Land management and access has the highest stakeholder potential in Kemano but is also a key hold-up issue for the business. Land management is grouped together with sensitive fauna (fisheries), soil contamination, spills and grizzly bears. Soil contamination will be discussed as a common APM-BC strategic issue.

Most of the land issues are considered moderate risks for both the environment and business. Key issues with land management lie with third party access and use of the Kemano properties. Primarily the users have been forestry companies, which have used the area since the late 1960s. Limited management and supervision of the users have led to soil quality concerns and development that has impacted company property. The issue has high stakeholder potential for access due to potential economic opportunities that the Kemano properties provide. Kemano provides coastal access for wood from around the reservoir and an access road that leads from Kemano to Tahtsa Lake. Additionally, Kemano has high recreational qualities for fishing and ecotourism, which could be of potential interest to stakeholders. Land management is a common issue throughout the operating areas, and strategic recommendations are provided as a common strategy for the company as a whole.

Past issues with third parties relate to spill management and prevention. Consideration should be given to providing spill awareness and response training or at the very least documented expectations to third party land users. Spills while, they are a medium risk, can cause high business risks from soil contamination. Spills from the powerhouse are also a concern that requires improved management. Stakeholders involved in spill management are largely employees and there is a need for their support and understanding in managing the spill risk. The

technology in Kemano provides some barriers to monitoring oil leakages from the powerhouse, however, the employees need to vigilant in checking oil levels and other indicators of potential leak formation. An awareness training package for spill response will be discussed as a company wide strategy.

Kemano appears to have a healthy population of grizzly bears and little is known about the sensitivity of the bears to company operations. Grizzly bears are under pressure in North America and there has been discussion at the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[14] about listing the bears under SARA threatened species. To understand the potential risks that the listing would put the company under, a population assessment should be conducted to determine the density of the bears in Kemano and their level of coexistence with operations. This issue is likely a very positive biodiversity issue for the company, especially if the powerline is included in the study as the vegetation management for the powerline creates forage habitat for the bears. Presently, there are no rules or company policies for viewing the bears (or other sensitive wildlife). Developing guidelines for viewing wildlife would be an opportunity to improve biodiversity protection as well as the safety of company employees.

Sensitive fisheries are included with the land management group as fish habitat is ubiquitous around Kemano and the operating areas. Best practices have been developed for operating around fish habitat. However, improved employee awareness and sensitivity to habitat concerns is required. An environmental awareness package delivered to Kemano employees should be completed to refresh the awareness of issues that need to be addressed when working around water.

[14] Committee on the status of endangered wildlife in Canada (COSEWIC) is a committee of scientific experts that assess extinction risks to wildlife under the federal Species at Risk act (SARA).

6.3.1.1 Recommendations

23. Provide training for EH&S co-ordinators in Kemano on property management, inspections and APM-BC's expectations for best management practices on company owned properties. Use the co-ordinators to monitor and provide support to third party users of Alcan lands.

24. Ensure third party users have acceptable spill response training, follow acceptable practices and have appropriate countermeasure materials on site.

25. Assess grizzly bear populations in Kemano (and the powerline) and degree of coexistence between the bears and company operations to understand if operations affect the bears. Identify sensitive habitats and best management practices for working in and around those areas.

26. Establish wildlife viewing rules from the roadside and helicopters to protect Grizzly bears and other sensitive species (such as mountain goats). These rules will be applicable to both Kemano and the powerline.

27. Provide environmental awareness training to employees and contractors on fish habitat, rules, regulations and best management practices in order to protect habitat when undertaking construction and maintenance work.

6.3.2 Asset Protection

Asset protection is a critical issue in Kemano with very high business and environmental risks. This issue has the potential of causing interruption across all operating areas if sections of the beach road were to be lost and the power house operations could not be sustained as a result. Erosion is a high environmental risk due to the risks that repairs can have on fisheries and wildlife. Of importance are the sensitive eulachon fishery at the intertidal section of the Kemano

River, which can be affected by changes in flow patterns and water velocities caused by installing protective bank armouring. Present risk planning for erosion protection is very static and limited to cursory assessment of obvious concerns.

To address the issue, the best management of the erosion risk would be to develop an erosion protection plan that would assess risk and the ability to respond, and which would present proactive measures to minimize risk and the extent of repairs. It is also important to minimize the environmental footprint of the work by using the repairs as a method to improve and create fish habitat beyond the capacity of the original site conditions. Proactive management should provide cost savings by downsizing projects and through planned mobilization of equipment and contractors.

It is in the company's best interest to manage the relationships with the Department of Fisheries and Oceans (DFO). This relationship can become strained with repeated requests for emergency work approvals. The added benefit of proactive erosion management is the maintenance of a supporting partnership with DFO.

6.3.2.1 Recommendations

28. Develop an erosion protection plan for Kemano that will assess the erosion risk level of assets and the company's ability to respond to loss of critical infrastructure. Erosion sites should be prioritized over a five-year rolling plan.

29. Develop a template of best designs and construction practices for erosion protection that incorporates fish habitat protection.

30. Develop a monitoring plan for erosion and identifying areas of risk. Assess feasibility of using Haisla for the monitoring.

6.3.3 Eulachon and Flow Management

Both eulachon and flow management are high business risks due to the high sensitivities of the stakeholders involved and the degree of regulatory risk under the Federal Fisheries Act. To protect the eulachon fishery it is important to maintain a steady flow from the powerhouse and to avoid scheduling maintenance shutdowns of the generators during the eulachon run. APM-BC has strong in-house expertise and has collected one of the largest sets of data on eulachon by monitoring the run. The monitoring should continue due to the highly variable nature of the eulachon returns and the ease of linking powerhouse management to the failure of the fishery. Although the eulachon is primarily a stakeholder concern there is only moderate potential for stakeholder involvement due to the limited time involved in the issue. The Haisla are engaged in partnering on the annual eulachon assessment.

6.3.3.1 Recommendations

31. Maintain commitment to the existing annual eulachon monitoring program. Assess opportunities for greater Haisla involvement in the monitoring activities and knowledge transfer from senior fisheries biologists involved in the work.

32. Protect the eulachon fishery by maintaining consistent water flows from the powerhouse during the eulachon run and until their eggs hatch. Maintain commitment to the flow ramping protocols and the eulachon flow management developed internally by APM-BC.

6.3.4 Stand Alone Issues (Waste and Resource Management)

Waste management can be a high environmental risk for Kemano. Presently in Kemano, there is low level landfill monitoring and management and there are opportunities to implement

sustainable business practices for waste recycling, minimization, handling and disposal. Waste is a unique environmental issue in that it touches every employee in Kemano and can serve as a physical reminder of environmental awareness and improvement. A program needs to be implemented in Kemano that identifies good practices, provides recognition to employee stakeholders with good practices and sets measurable goals for reducing amounts of waste generated and increased amounts recycled. Landfill management needs to be improved in Kemano to minimize the long-term risk of site environmental liabilities. A landfill operating, monitoring and closure plan would address this risk.

Resource management is another sustainable business practice that needs to be brought to Kemano. While this is issue ranks as a moderate environmental and business risk the EH&S First Directive requires an implementation of an APM-BC resource management program. Kemano has not been audited under the program for resource conservation opportunities. However, it should be audited, as there may be savings when the cost of transporting materials to Kemano is considered.

6.3.4.1 Recommendation

33. Develop a waste management program for Kemano. Elements of the program should include: 1) a landfill operating and closure plan for the Kemano landfill; 2) employee awareness and training on waste management and incinerator operation; 3) and examination of opportunities for waste reduction or elimination.

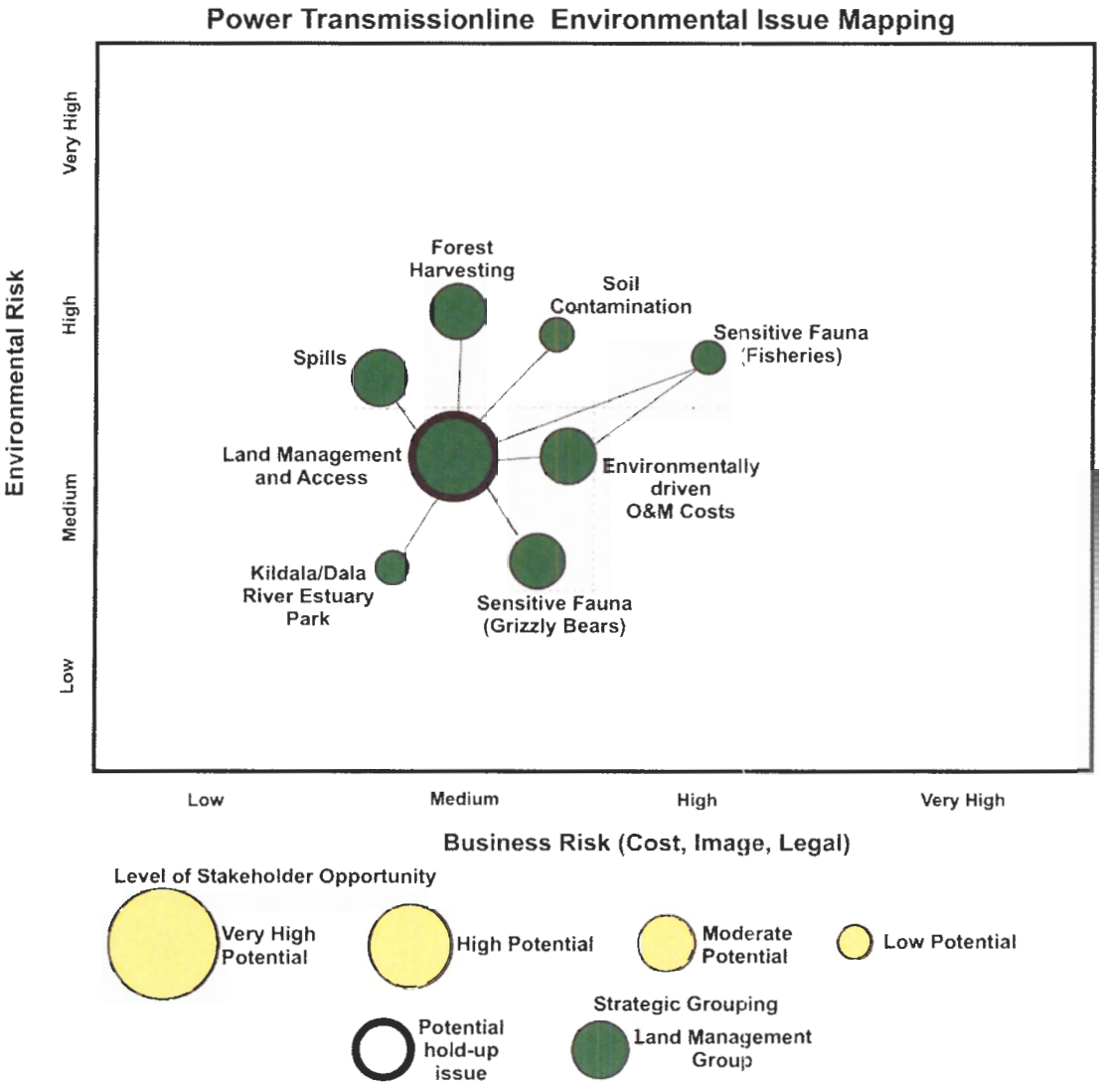
34. Complete a resource management audit of Kemano to identify opportunities for conserving energy and materials.

6.4 Power Transmissionline Strategy Development

Two strategic groups out of nine issues have been mapped out for the power transmissionline. These groups, as shown in Figure 23, are:

- Asset protection
- Land and resource management

Figure 23. Power Transmissionline Environmental Issue Mapping



Source: Drawn by author.

6.4.1 Asset Protection

Asset protection is the highest business and environmental risks for the powerline. Very similar conditions and issues exist for the powerline as were described for Kemano. The exception is that the powerline is very sensitive to having towers isolated by the Kemano and Kildala Rivers. Once a tower is isolated, or becomes stranded in the middle of a river, maintenance and emergency repairs are extremely complex and costly. Additionally, emergency repairs on isolated towers cannot occur quickly. The erosion management plan recommended for Kemano issues should be expanded for the powerline.

6.4.2 Land Management

Land management consists of a group of seven issues: land management and access; forest harvesting, Kildala/Dala Estuary park, grizzly bears, fisheries, spills, environmentally driven operation and maintenance (O&M) costs, and soil contamination. Soil contamination and spills will be discussed and included as an overall APM-BC strategic issue.

Land management and access is hold-up issue for the powerline but is only a moderate environmental and business risk. The issues with the long and narrow ribbon of land that stretches from Kemano to Kitimat are that the properties are highly environmentally and geologically sensitive to pressures of industrial access, and they have a low level of supervision and management. Industrial access pressures are primarily from forestry companies utlitizing the powerline roads for access to timber outside the company's property. Timber harvesting can present risks to the company through increased O&M costs for road maintenance to deal with increased beaver activity and flooding from altered site hydrological conditions. These concerns need to be addressed through discussions with the Ministry of Forests and stakeholders.

Land management has the highest stakeholder potential for the powerline and stakeholder benefits through potential opportunities to capitalize on the natural beauty of the area, wild life resources and road assets. Presently, the properties are under untilized and there may be opportunities to increase their usage by providing access to trusted stakeholders. These opportunities will be discussed as a common APM-BC business strategy for land management.

The Kildala and Dala River Estuary Park presents a moderate risk to the powerline from the physical presence of the new park that bounds the powerline property. This increases the consequences if there is an environmental issue stemming from operations and maintenance of the roads that extends into the Park boundaries. Additionally, the Park will focus public attention on the area. Conversely, the park may also create opportunities for synergistic stakeholder benefits if opportunities for stakeholder access to company property are considered.

Grizzly bears present a moderate risk to the business. The strategic recommendations for grizzly bears in Kemano should be extended to include the powerline.

Sensitive fisheries issues present a high business and environmental risk to the powerline. These issues are affected by asset protection and by the operation and maintenance of the powerline roads. There is strong in-house expertise on fisheries and on managing the regulatory risks that they pose. A key issue that fisheries concerns drive is the increasing O&M costs for the roads due to changing expectations from DFO. Strategically, these issues should be managed by developing standardized best management practices that DFO agrees on for maintenance and operation work. This would allow for a common and stable set of expectations for work that will survive staff turnover at DFO. Stakeholder opportunities exist for fisheries issues by utilizing stakeholders for work in sensitive areas. For instance, some potential examples for stakeholder opportunities are manual brushing, culvert cleaning and beaver control.

6.4.2.1 Recommendations

35. Extend the grizzly bear management plan from Kemano to include the powerline areas. Measure (correlate) the effects of powerline vegetation management in providing forage habitat for the bears.

36. Standardize operating rules around sensitive environments with written best practices that are agreed on with regulatory agencies. These practices will communicate expectations and lead to more stable operating costs.

37. Review forest harvesting plans with the Provincial Ministry of Forests and assess impacts of harvesting to company property and interests. Discuss and identify mitigation measures that the forestry contractors must follow. This is an opportunity to involve the Haisla as a partner in the environment.

38. Develop environmental awareness and training packages for working in and about fish habitat.

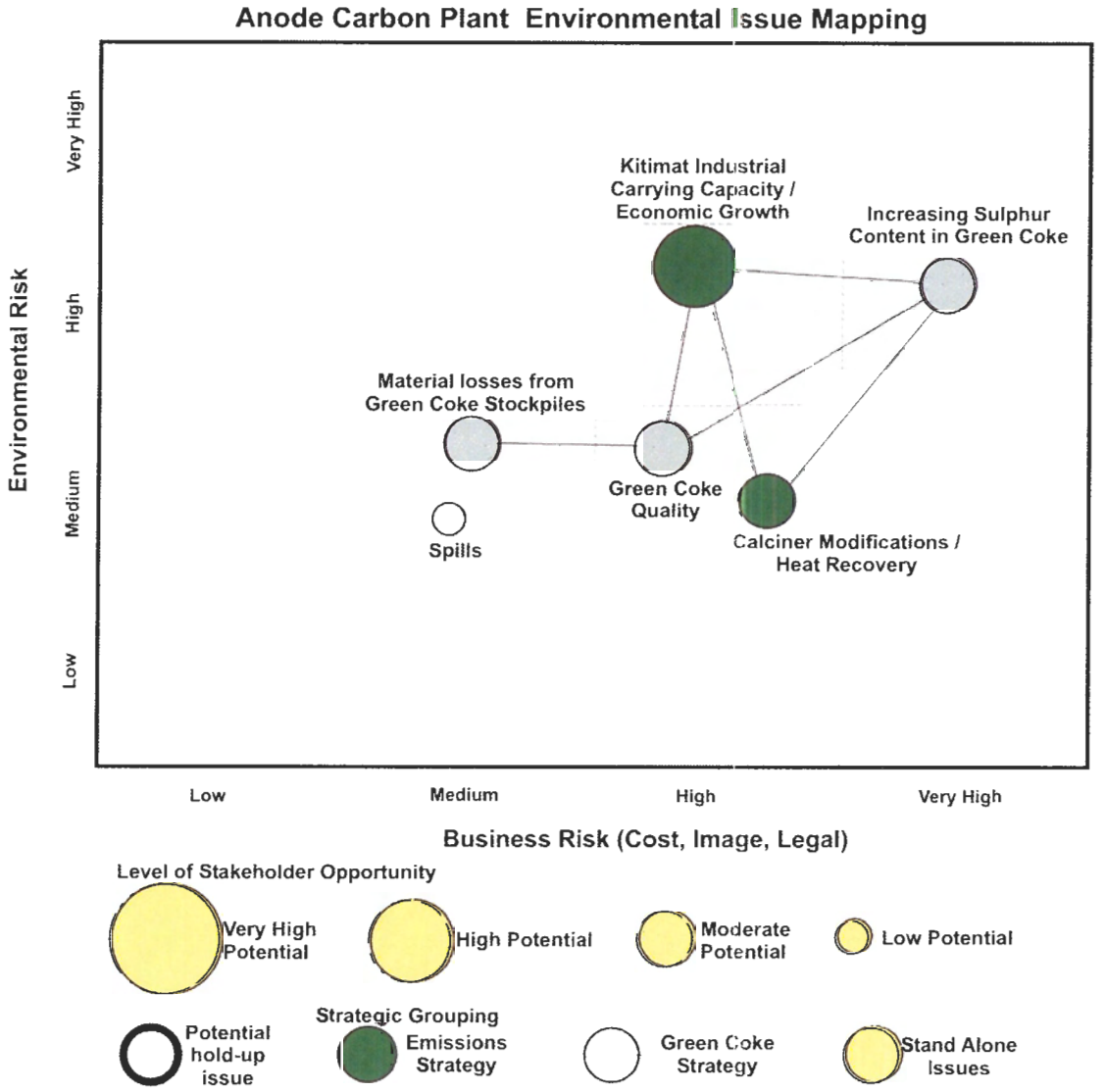
39. Review the potential to engage a Haisla vegetation management crew for beaver control and culvert cleaning to minimize conflicts between fisheries concerns and road maintenance.

6.5 Anode Carbon Plant Strategy Development

Two strategic groups out of six issues have been mapped out for the for the carbon plant. These groups, as shown in Figure 24, are:

- Emissions strategy
- Green Coke management

Figure 24. Anode Carbon Plant Environmental Issue Mapping



Source: Drawn by author.

6.5.1 Emissions Strategy

Emissions are the highest business risk to the Anode carbon plant (and APM-BC). The rising content in sulphur in the green coke will increase the risk of permit related sulphur dioxide non-compliances. Permit non-compliances can result in the Provincial Ministry of Environment ordering the company to install sulphur dioxide control technologies on the calciner smokestack.

An assessment should be done to determine the quantity of sulphur in coke that will bring the plant out of permit compliance at current consumption rates. This estimate will help assess the risk level that the sulphur content poses and help determine when sulphur controls may be required.

Sulphur dioxide may also be a limiting factor in economic growth and diversification in the Kitimat area. The Kitimat Valley's airshed may have a limited capacity for adsorbing the mix of atmospheric pollutants from APM-BC, Eurocan Pulp and Paper and other prospective industries before causing adverse environmental impacts. For the purpose of this paper, this limit is referred as the industrial carrying capacity. The Province has conducted airshed monitoring and management programs around the Province, but has not assessed the Kitimat Valley's capacity for pollutants. New industries proposing development in the Kitimat area could pressure the Province to assess the airshed which could lead to a clawback on the APM-BC sulphur dioxide permit limit in addition to requiring installation of sulphur dioxide controls. Additionally, limitations imposed by the Province on new sulphur dioxide sources to protect the environment may make development in the Kitimat Valley less feasible.

A proactive determination of the industrial carrying capacity of the Kitimat Valley would assess level risk that APM-BC faces on sulphur dioxide control requirements. It could also be used as tool to market the area for development if there is room for additional sulphur dioxide sources. The results may also present justification to invest in sulphur control technologies in

order to promote economic growth and diversification. This strategy is discussed as an APM-BC common issue, as the emissions from aluminum reduction affect the carrying capacity as well.

The emissions strategy also needs to consider the long-term vision for the fate of VSS technology at Kitimat Works. If VSS technology is replaced with pre-bake technology then the sulphur dioxide emissions strategy may require adjustment. The effect of technological change on sulphur emissions would have to be assessed to determine the effect that a rebuild may have on the overall emissions of the plant.

6.5.1.1 Recommendation

40. Determine the margin available for sulphur dioxide compliance and the potential future requirements for sulphur dioxide scrubbing. First, develop an estimate for both sulphur content and process quantity that will cause a permit non-compliance for sulphur dioxide. Second, determine, at the present rate of increase in sulphur content and calculate, when or if Kitimat Works will be out of compliance for sulphur dioxide emissions.

41. Develop a concept for sulphur dioxide scrubbing to determine technological and conceptual costs. Identify if there would be savings and synergies in developing a sulphur scrubber in conjunction with a heat recovery/cogeneration project.

42. Determine if the long-term vision for the plant will involve on-site calcination of green coke. (If the VSS technology is replaced with pre-bake technology on-site calcination may not be required.) The effect of a technology change on sulphur emissions needs to be estimated to assess the impact that a potential rebuild may have on the industrial carrying capacity of the valley.

6.5.2 Green Coke Management

Presently, issues with green coke quality have been managed by developing a purchasing strategy and integrated team work between the carbon group and reduction management. The strategy has resulted in the procurement of larger stockpiles of coke from a number of suppliers and blending of the coke to obtain the best quality mix. This has increased the size of coke stockpiles kept on site and the working areas on the piles. As a result, there is a potential for increased windblown particulate losses (fugitive dust) of coke. This has the potential to generate regulated requirements to cover, contain, or install dust suppressants to reduce particulates. A sustainable strategy is required to better manage the coke piles and to make recommendations for a sustainable business practice that would involve the environmental group in the coke management team and the strategic decisions on the management of the coke supplies. This would facilitate advance PAC consultations on the issues stemming from declining coke supplies. Additionally, management of regulatory driven issues would be better risk management.

The procurement strategy should also be reviewed to ensure that the optimal structural quality and sulphur content requirements for coke are met.

Additionally, advance work on measuring particulate emissions from the coke piles should be initiated to determine the true EH&S impact of the coke losses. This will be important for negotiating with regulatory agencies and the PAC on fugitive dust control requirements.

6.5.2.1 Recommendation

43. Develop an integrated team with carbon plant management, procurement and environmental services. The team will determine the quantity of coke that needs to be to stockpiled on site, the pile shapes, and requirements for dust suppression.

44. Develop a procurement strategy to maintain coke quality and sulphur content. Identify the likelihood of maintaining consistency in coke quality and its sulphur content. Identify the effects that variations in the new supplies will have on emissions performance.

45. Involve the PAC in the issues of declining coke quality and its effects on emissions performance. Reduce the future burden of developing action plans for the emissions by informing the PAC and Ministry of Environment so they are aware of and understand the material quality issues.

46. Develop a method to measure particulate releases from the Coke piles and assess the significance of the release in terms of losses, particulate sizes and EH&S impacts.

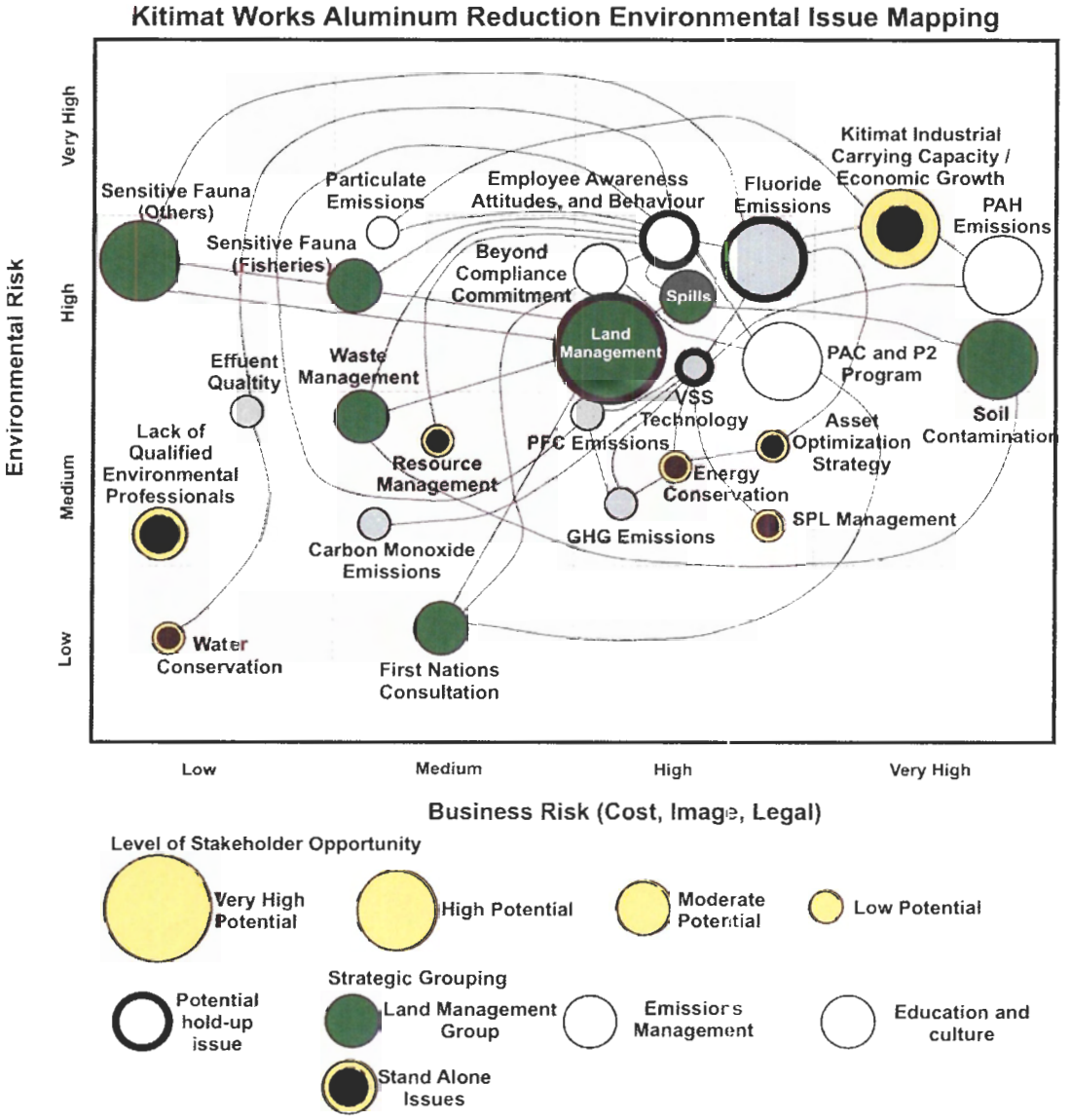
6.6 Kitimat Works Aluminum Reduction Process Strategy Development

Four strategic groups out of 24 issues have been mapped out for the Kitimat Works.

These groups, as shown in Figure 25, are:

- Land and resource management
- Emissions strategy
- Strategic programs (AOS, energy conservation, resource management)
- Education and culture

Figure 25. Kitimat Works Aluminum Reduction Process Environmental Issue Mapping



Source: Drawn by author.

6.6.1 Land Management

The land management grouping consists of seven linked issues: land management, First Nations consultation, fisheries, sensitive fauna waste management, spills and contaminated soils. Spills and contaminated soils will be addressed with common APM-BC strategies since they are a common theme across the value chain.

The land management issue includes all of APM-BC's properties in the Kitimat area, which covers a wide range of land and use types, from the plant site, to leased industrial, leased commercial, green belt, and undeveloped properties. Similar issues for management and supervision of the lands exist for the Kitimat properties as in the watershed, in Kemano, and in the powerline. Properties in Kitimat, interestingly, are a legacy from the 1950s development of Kitimat Works and the town site, when the development of the town was part of the company's development plan for British Columbia. Now, the plant is left with a limited capacity for managing the numerous remaining lots, and the properties are no longer a core aspect of APM-BC's business. Ironically, the properties represent the largest stakeholder potential for development opportunities. The company now needs to look at how to use and mange the properties to the benefit of the community. Recommendations for creating stakeholder value are presented as a common APM-BC strategy. The recommendations will also account for First Nations consultation and relationship improvement opportunities as the management options are closely aligned with First Nations interests.

Sensitive fisheries concerns surround the properties in Kitimat. These issues can present regulatory risk from operators not knowing the rules for working in these areas. They can also limit development of properties. It is important that all who have the potential to impact a fisheries area know and understand the fisheries' issues and best practices. An environmental awareness training course for fisheries' concerns and work practices should be developed and

presented to groups who work in the sensitive areas. The fisheries sensitive areas around the plant site are largely known and documented. Beyond the boundaries of the plant, the fisheries concerns are largely undocumented and present an unknown risk and constraint to property development. All of the properties should be reviewed and assessed for fisheries issues so that their development potential can be determined. This recommendation presents some potential for stakeholder involvement as trained stakeholders can participate in the on-site reviews of the properties.

Sensitive fauna present another potential limiting factor to the development of the properties, as many of the properties are located in potentially highly sensitive environments home to grizzly bears, and to eagles and other migratory birds. A review of potential wildlife concerns on key properties should be undertaken where there is development potential or where key projects are planned. Additionally, sensitive fauna may be susceptible to impacts from the plant's emissions and may have the potential of transporting contaminants into the food chain. This is also a concern from potentially contaminated sites around the plant (such as the Scow Grid and Yacht Club). A review of wildlife that may potentially encounter the contaminants should be undertaken to determine if sites pose a risk to wildlife and if the impacts would present risks to the management of the sites.

Waste management presents opportunities for improving sustainable business practices in the plant. There are opportunities to reduce the amount of waste generated, improve the quantities recycled, and improve the segregation and disposal practices of the waste. This issue also presents a moderate level of opportunity for stakeholder involvement. Stakeholder potential largely lies with partnering with Kitimat Understanding the Environment (K.U.T.E, a local environmental organization that promotes recycling) on improving recycling options. By leveraging recycling volumes with the community and the plant, certain recycling streams may become economical (such as electronic wastes and plastics). Presently, paper and batteries are successfully recycled in

partnership with K.U.T.E. Other recycling waste streams should be explored to expand the recycling programs. Plastic lunch bags, for instance, would be an interesting item to explore as a recycling potential. Lunch bags are a costly nuisance in the plant's landfill but are increasingly becoming a valuable recyclable due to the rising cost of oil.

The plant's waste management program should be examined to identify if there are potential cost savings opportunities of reducing the amount of waste generated and improving the segregation of wastes for landfill disposal. The EH&S First Directive for waste management requires that an action plan be established for quantifying the amount of waste generated and for reducing it. This directive supports the establishment of sustainable business practices that should lead to cost savings through reduced waste volumes and landfill operating costs. Additionally, options for using the District of Kitimat's landfill for disposing of organic wastes should be examined. Eliminating organics from the company's landfill will reduce operating costs and eliminate risks to biodiversity from wildlife (bears, eagles, and birds) scavenging the lunchroom wastes.

6.6.1.1 Recommendations

47. Review waste management issues and program with the PAC to determine if there are any synergies with the community for recycling and waste management.

48. Develop and implement an environmental awareness training package for waste management to employees and contractors.

49. Provide employees with environmental awareness training for spill response and prevention. The objective is to have employees familiar with identifying spill risks and knowing the consequences of spills. Above all, the employee must know how to manage a spill.

6.6.2 Emissions Strategy

Emissions pose the greatest risk to APM-BC with increasing government and public scrutiny. However, they also present high stakeholder potential. The emissions strategy should be examined on two fronts: first, an emissions reduction strategy; and second, the significance and limitations posed by the emissions should be understood. The VSS technology used in the plant is limited in its ability to control and reduce emissions without reducing production. Significant success has been realized with GHG and fluoride emissions reduction. PAHs reduction methodologies are being researched. The plant has a fluoride action plan that has resulting in a substantial reduction in the number of permit non-compliances for fluoride emissions. GHG's have been reduced by reducing the number and duration of anode effects.

6.6.2.1 Reductions Strategy

Further reduction strategies are required to manage the emissions risks. Potential opportunities lie with the human aspects of the operations and with improving work practices that minimize emissions. Consideration should be given to enforcing and monitoring work practices to ensure pots are sealed with adequate ore cover, to prevent ore losses to the basements (through sweeping ore into the floor vents), and to reduce the time between breaking the pot crusts and feeding the pots. Additional opportunities lie with improving the decision process for shutting down sick pots, versus nursing them back to health. Quicker decisions for shutting down sick pots that have no hope of recovery will reduce the amount of fluoride lost to the atmosphere. These recommendations have a strong link to employee awareness, attitudes, behaviour and awareness of how individual actions and decisions can have impacts on the external environmental and the plant's overall performance.

6.6.2.2 Significance and Limitations of Emissions

Plant emissions can place limits on strategic development goals. Conversely, third party development can present a risk to Kitimat works through regulated reductions to manage the industrial carrying capacity of the region. It is, therefore, important to understand the environmental significance of the emissions. As this issue affects both the anode carbon plant and cast houses as well as the reduction process a strategy will be recommended as a common APM-BC issue. Of critical importance to the reduction process will be the realization of an agreement on PAH emissions from Environment Canada. PAH emissions are the largest threat to Kitimat Works, as regulated reductions could require reduced production, drive metal costs beyond economical practicality or require the termination of VSS technology at Kitimat.

6.6.2.3 Recommendations

50. Maintain and support the fluoride action plan and provide updates with progress to the PAC.

51. Examine opportunities to improve the management decisions for shutting down sick pots. Identify if there are opportunities to reduce the exposure time of sick pots so that the overall fluoride emissions are decreased and the level of compliance is improved.

52. Develop environmental awareness at the floor level of the impacts that the individual worker can have on the environment through the individual work practices. This will require training, coaching sessions, and follow-up monitoring (a potential opportunity for EHS co-ordinators).

53. Follow through with Environment Canada and AMPG to obtain a voluntary agreement on PAH emissions with Environment Canada.

6.6.3 Stand Alone Issues (AOS, Resource Management, Energy Conservation, SPL Management)

Asset optimization needs to be supported so that environmental issues will not present barriers to realizing improved productivity. The key project is the Kitimat high amperage low energy project (KHALE). However, there must be assurance that the asset optimization strategy will not bring Kitimat Works out of permit compliance for fluoride emissions. A key strategy to minimize this risk would be to improve existing operations to their best environmental performance and increase to the margin in tolerable fluoride emissions in order to absorb the potential increase output of fluoride from higher current run pots.

Resource management and energy conservation are EH&S First driven requirements that Kitimat Works must address. These issues fit with a beyond compliance vision, as they are non-permit issues and work towards reducing the overall footprint of the business. For Kitimat works key resource management gains can be made with alumina ore management and with the reduction of fluoride losses. These goals have a large employee attitude and awareness component, which are discussed in section 6.6.4. Water conservation is a key issue for Alcan Inc. and there are opportunities to support the corporate initiative. However, it needs to be discussed in context of the overall APM-BC structure. Similarly, energy conservation will be combined into a common APM-BC strategy.

SPL management is an issue tracked by the PAC and a P2 opportunity that the company is actively engaged in. The existing stockpiles of SPL on the site have been stabilized and disposed of in a landfill. There are on going trials to recycle SPL in cement kilns. Additionally, the plant is on schedule to extend the life of the cathodes. There are no recommendations to alter the present SPL strategy.

6.6.3.1 Recommendation

54. Support the asset optimization strategy with input from environmental services on compliance and emissions management. The objective is to reduce environmental barriers to realizing the productivity gains.

55. Implement a resource management program that will focus on optimizing the use of raw materials. The program should be designed to prevent alumina ore from entering the basements, to recover spilled ore from the basements, and to recycle reclaimed materials.

6.6.4 Education, Culture, and Awareness

This last group is the most challenging of the four strategic groupings to address. Education, culture and environmental awareness are human resource issues that present barriers to both improving and sustaining environmental performance. This group is comprised of three issues: employee attitudes and behaviour, beyond compliance commitment and the PAC and P2 program. These will be addressed by proposing strategies aimed at management, employees and APM-BC's stakeholders (PAC) as developed from the SWOT analysis for Kitimat Works (Table 32).

6.6.4.1 Management

A common vision for the environmental position of the plant should be developed. This vision will help guide the various organizations within the plant to common performance goals. At a minimum the vision needs to include achieving zero non-compliances with the operating permit, 100 percent compliance with EH&S First Directives and, lastly, sustained stakeholder support. This vision will be a challenge to develop and sustain due to increasing competition between organizations for dwindling resources. Implementing sustainable business practices

should not have to require commitment of large financial resources that would compete with production requirements. Rather, these practices can be low cost items that target going beyond compliance while demonstrating the vision for the plant. Three examples are:

- House keeping – improving the frequency of basement and courtyard cleaning,
- Enforcing work practices that minimize the ore loses to the basements and courtyards,
- Improving the decision process for sick pots to reduce the time for leaving pots open and releasing gaseous fluoride.

An environmental awareness training package targeting the management group should be developed. The package should review the specific environmental impacts from the operations and the relationship that management decisions have on the environment.

6.6.4.2 Employee Awareness

Employee attitudes, behaviour and awareness can have significant effects on the degree of compliance that Kitimat Works can achieve. Comprehensive environmental training and awareness packages should be prepared and delivered to the hourly employees and supervisors to educate them on the environmental impacts that their individual actions can have. The training packages should be tailored to the specific locations and work areas, address compliance issues of the areas and cover EH&S Directives and programs. Additionally, the awareness packages should educate people to identify problems and opportunities that they see and to report them to management.

Support of the employees should be given through on the floor coaching, follow-up visits and monitoring. The increased presence on the floor would serve as a sign of management commitment to environmental performance and an indication of its importance to the company. On the floor presence may be an opportunity for EH&S co-ordinators.

Employee recognition needs to be included in the development of environmental awareness. Positive achievements, identification of environmental improvement opportunities and

profound performance should be recognized in order to promote environmental awareness. The recognition should consist of an award and publication of the achievement.

6.6.4.3 PAC and Beyond Compliance

APM-BC's beyond compliance commitment needs to be adjusted and aligned with the Corporate EH&S Directives. The six environmentally related directives (Table 10) are designed to push the business units into a beyond compliance position in six areas. APM-BC's focus on issues that are beyond compliance should be adjusted so that the efforts are focused on complying with the directives and on implementing best management programs and practices brought forth by the EH&S First Program.

The re-alignment of the beyond compliance commitment will affect the PAC through initiatives and commitments previously made to the PAC. A detailed presentation should be made to the PAC on the EH&S Directives and programs that covers APM-BC's strategy on implementing them to bring the business unit within corporate compliance. Emphasis should be made on explaining how compliance with the directives will also meet PAC expectations for continuing on a road to beyond compliance.

Sustaining the company's commitment to the PAC and Pollution Prevention Program by developing a solid link to reduction management is mportant. A management champion should be named to support the PAC and to bring them a business perspective. Besides helping sustain the PAC, this will help to find the balance between business and stakeholder driven environmental concerns.

The PAC also has a link to the attitudes and culture within the plant, because attitudes and culture affect environmental performance, which is the external view that the community obtains of the plant. The PAC represents the community's concerns and impressions of the

company. It is therefore important to convey to the PAC an understanding of the limitations of the VSS technology and the actions that APM-BC is implementing to mitigate and reduce potential non-compliances. Demonstrating a mutual understanding of concerns for the environment (by the company) and limitations of the technology (by the PAC) ideally will convey to employees a cooperative position of supporting the business while reducing the overall foot print of the operation. It will be one method of communicating to employees on the need to be proactive in following the established work procedures. The PAC, should be challenge to prepare an annual report card on the performance of Kitimat Works. The report card could be developed through inspection tours of the operating areas and key performance indicators. This would serve to convey the community's assessment of the business to employees (who make up the community) and highlight where the business could improve on performance.

The strategic importance of the PAC also needs to be recognized and utilized for issues where there is a known risk of non-compliances such as the quality concerns of the coke supply and its effects on the performance of the reduction process. Strategic discussions with the PAC about the potential issues and the efforts Kitimat Works makes to manage the changes will reduce their outrage over non-compliances when they occur. An understanding of APM-BC's management of the issues will reduce the future burden it will face in dealing with both the regulators and with PAC to explain the non-compliances and the action plans that the company has instituted. Additionally, it demonstrates a pro-active business culture to manage risks.

6.6.4.4 Recommendation

56. Develop and deliver environmental awareness training packages to employees and management that link their actions to demonstrable environmental impacts. The objective is to make people aware of the consequences of their actions and of the individual support required to improve the overall environmental performance of the company.

57. Develop a method for receiving feed back from employees on environmental concerns and provide a mechanism to assess the concerns and to implement appropriate actions by management. Inaction on employees concerns may reduce the willingness of employees to take extra care in their work, if they perceive that their concerns about environmental performance are not considered to be important.

58. Develop a recognition program for employees and contractors who demonstrate outstanding performances in the environment. Such a program may increase the overall awareness of people about the environment and show them that their efforts are important.

59. Have the PAC complete annual score cards or report cards on APM-BC environmental performance and provide recommendations on improvements. The results should be presented to Management and included in the annual environmental performance report.

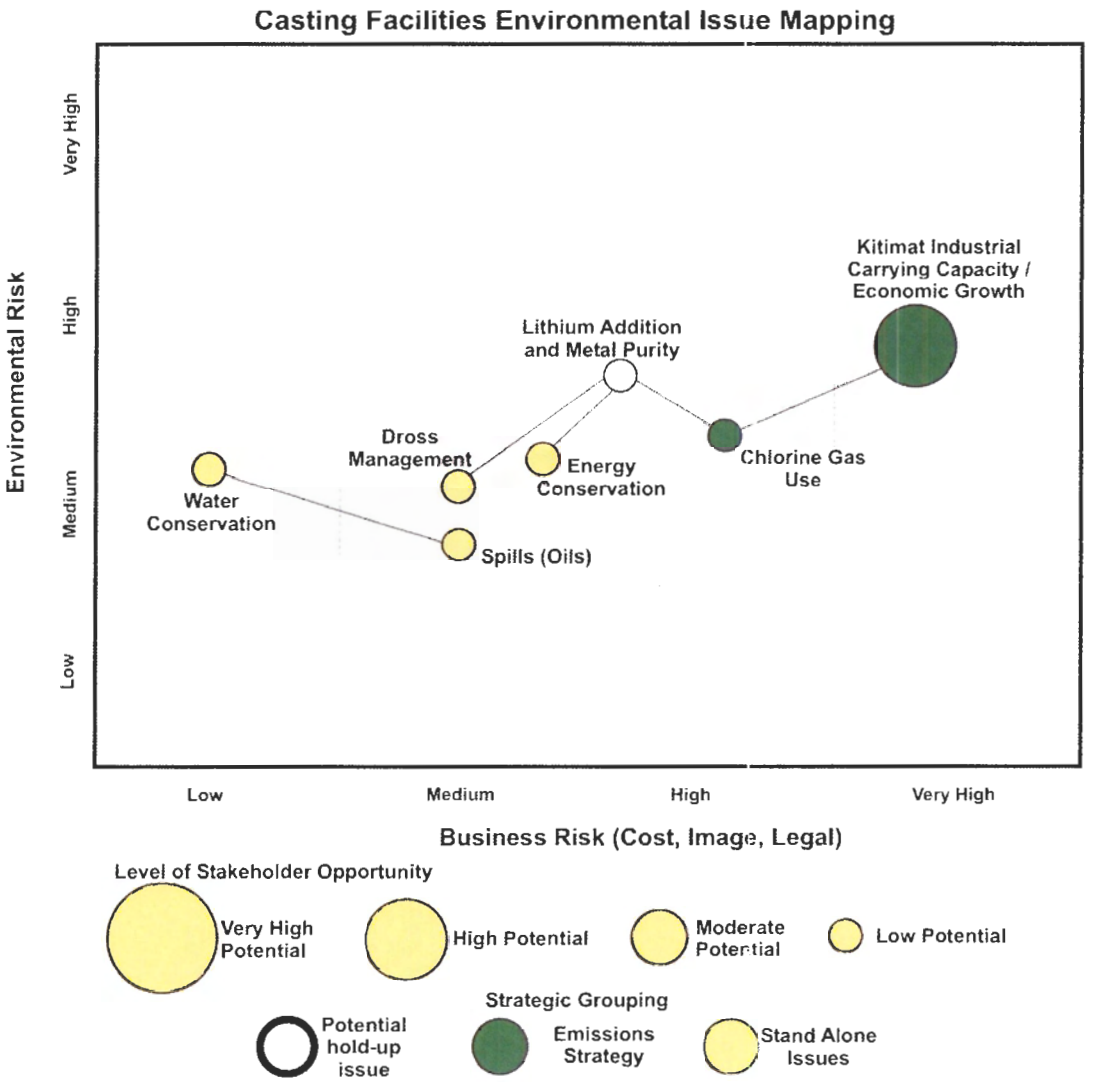
60. Have strategic discussions with the PAC on key issues of emissions and expected performance trends with the objective of creating an understanding of upcoming issues. Such consultations will prepare the PAC and Ministry of Environment for potential non-compliances through discussions so that the future burden of reporting and developing action plans will be lessened.

6.7 Casting Facilities Strategy Development

Two strategic groups out of seven issues have been mapped out for the Kemano. These groups, as shown in Figure 26, are:

- Emissions strategy
- Stand alone issues (energy conservation, dross management, water management)

Figure 26. Casting Facilities Environmental Issue Mapping



Source: Drawn by author.

6.7.1 Emissions Strategy

Emissions are the highest business risk issue for casting and have the largest stakeholder potential. The emissions affect the industrial carrying capacity of the airshed and need to be incorporated into the overall emissions strategy for APM-BC. The key issue for casting will be to remove chlorine gas from the metal fluxing process and to replace it with salts. This will reduce the overall chlorine loading in the airshed and the localized toxic effects of chlorine and acid rain.

6.7.1.1 Recommendation

61. Continue with the commitment to replace gaseous chlorine with chlorine salts. Elimination of chlorine gas will reduce acid rain generated from the casting furnace stacks.

6.7.2 Stand Alone Issues

The five stand alone issues of energy conservation, dross management, lithium additions, spills and water management have low stakeholder opportunities but represent sustainable business practice opportunities.

Energy conservation, while a moderate business risk, is a key sustainability issue for the company relating to both GHG emissions reductions and cost efficiencies. The key energy component for casting is natural gas and the conservation of natural gas is an outstanding P2 program commitment. Despite efforts in casting to reduce consumption, the conservation goals have been difficult to realize. Natural gas should be included in APM-BC's common strategy for energy management and an audit should be done on gas consumption to identify potential savings.

Dross management issues are primarily related to the handling and recovery of aluminum. Dross is a hazardous recyclable material that can be dangerous to handle.

Additionally, value is lost through having to ship the dross to a recycling plant for aluminum recovery. A continuous improvement project should be initiated to review dross management and identify methods to improve the handling of and reduction in dross production. Aluminum recovery on site should be explored as an option to reduce the life cycle costs of the recycled aluminum.

Lithium addition to the aluminum reduction cells in Lines 1 and 2 is important for maintaining fluoride emissions within compliance levels. Although lithium presents an added cost to Casting and increases dross production, its addition should not be reduced. No other recommendation on lithium addition is provided.

Spills from casting are primarily related to Canola oil releases that end up in the lagoon treatment ponds. Spill management strategy will be discussed as a common strategic issue for APM-BC.

Water management is a key sustainability issue for Alcan Inc. Casting is APM-BC's largest user of process water that is pumped from the Kitimat River. The benefits of conserving or recycling water at Casting need to be evaluated carefully to determine the effects on the lagoon system and effluent quality. Recommendations for a water management strategy are discussed as common issues for APM-BC because this issue affects a common plant asset.

6.7.2.1 Recommendation

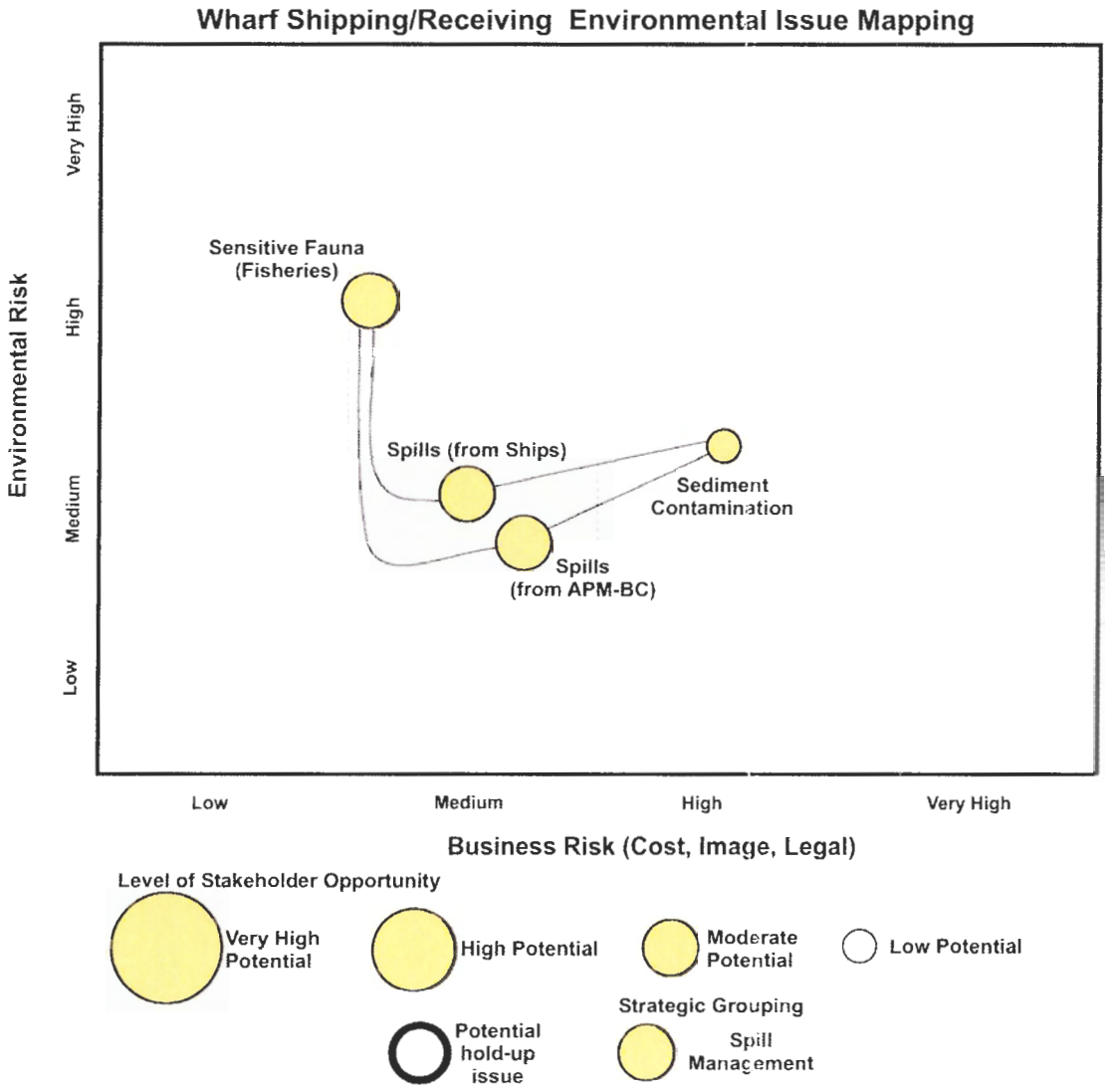
62. Develop an energy conservation program for casting in conjunction with the plant's energy co-ordinator. Consider a continuous improvement project for natural gas conservation.

63. Develop a continuous improvement project for optimizing dross handling and recycling. Develop an estimate of the potential savings and risk reductions.

6.8 Wharf Shipping/Receiving Strategy Development

Only a single strategic group for spill management was made out the five issues mapped for the wharf on Figure 27.

Figure 27. Wharf Shipping/Receiving Environmental Issue Mapping



Source: Drawn by author.

The highest business risk for the Wharf is with the potential for contaminated sediments resulting from process material spillage. Consequentially, it is important to have effective controls and prevention in place to prevent and contain spills. Education and environmental awareness training in addition to ensuring adequate containment will help in reducing the risk of spills or their escape into the environment. A larger concern is with the ships that dock at the wharf to unload process materials and load aluminum ingots. APM-BC does not have control over the ships and must rely on the management controls of the shipping companies. Partial mitigation of the risks posed by ships would be to review spill control requirements with the ships' captains and ensure there is an understanding of Canadian regulatory requirements for protecting the marine environment.

6.8.1.1 Recommendation

64. Develop a spill prevention program that will provide training and awareness on environmental protection (fisheries), spill response and containment methods suitable for use at the wharf.

65. Review welcoming procedures at the wharf for docking vessels. Identify suitability of the procedures for communicating spill prevention. Develop new procedures if required.

6.9 APM-BC Common Strategies

There are seven common themes across the value chain that need to be addressed as common strategies to promote sustainable business practices. These common themes are:

- land and resource management
- emissions strategy
- employee awareness
- spill prevention
- energy conservation
- water conservation
- soil contamination

6.9.1.1 Land and Resource Management

APM-BC owns 309 different lots covering 48,860 acres between the Kenney dam site and Kitimat. The company has a limited capacity to manage these large expanses of property holdings. Common issues for land management are:

- Lack of ability to supervise leases and 3rd party users
- Lack of understanding of biodiversity issues that may affect planned land use
- Land has the highest stakeholder potential for value creating opportunities
- Land and assets are largely under-utilitized

To improve the capacity for managing the properties and for building stakeholder opportunities consideration should be given to developing stakeholder capacity to assist in the day to day management of the properties. This would leverage the interests of First Nations in lands and resources (Table 20), create economic benefits for the stakeholders, and potentially create a forum for improved communications with key First Nation groups. This recommendation could be developed through partnering with a post secondary educational institution to deliver courses, to train stakeholders on property and resource management, and to utilize Alcan's industry leading EH&S practices for environmental management.

To improve property planning and to capitalize on the natural resources of the land an inventory of the properties should be undertaken. Current environmental regulations should be

considered to identify limiting factors that would affect the development of the properties. An inventory project could be used to build First Nation capacity through the partnering of First Nations' environmental technicians with qualified professionals.

The majority of APM-BC's properties is under-utilized and has resources that can create potential economic opportunities for stakeholders. For instance, company owned waterfront lots in Kitimat have recreational and commercial potential port development, while properties in Kildala and Kemano have marinas, docking facilities and, roads that could be used to develop eco-tourism opportunities. An internal APM-BC workshop should be held with key internal stakeholders to identify potential opportunities, concerns over access and potential risks that the company would be willing to take on in order to promote economic opportunities with stakeholders on company property.

6.9.1.2 Emissions strategy

The combined emissions from Kitimat Works (calciner, aluminum reduction, and casting facilities) could limit future economic development and diversification if the emissions loading are found to be near the industrial carrying capacity of the Kitimat Valley's airshed. Conversely, promotion of industrial development could initiate a regulatory review of Kitimat Works emissions and require the reduction of emissions loadings. In particular, sulphur dioxide could be a target for reductions. To better understand the airshed capacity a review of the emissions and environmental impacts should be conducted. This will entail building on the existing plume dispersion models; environmental field sampling; monitoring for pollutant depositions and impacts to vegetation, soil and water quality. This would require a multiyear program for the field data collection. The data collection aspect of the program could be used to create stakeholder opportunities either by utlilizing First Nations technicians in conjunction with qualified environmental professions, or by developing applied environmental courses in partnership with a

post secondary institution. An emissions monitoring program would support unique learning opportunities in a variety of subjects such as: environmental science, ecology, water quality, soil science, atmospheric chemistry, GIS mapping, and biological monitoring. Consideration could be given to integrating the annual vegetation monitoring survey into an applied education program, which could support at least three different courses.

In addition to assessing the significance of APM-BC's emissions, the significance of the plant's emissions and management efforts should be communicated externally. This is important as NGO press releases ranking APM-BC as British Columbia's top polluter needs to be put into context and discussed in terms of the emissions real significance.

6.9.1.3 Employee awareness

Employee awareness on environmental issues and the impacts that their individual actions have on the overall performance of APM-BC needs to be communicated. Specific training packages on the EH&S First programs for beyond compliance as well as packages on the effects that effluents, emissions and wastes have on the environment should be presented to all employees and supervisors. The objective of such training would be to improve individual performance in relation to environmental protection.

6.9.1.4 Spill prevention

Spill prevention has a link to employee awareness training. In addition to awareness training, refresher courses need to be delivered on spill prevention, containment and cleanup methods. This training should be extended to all leaseholders, contractors and potentially interested stakeholders.

6.9.1.5 Energy conservation

Energy conservation is an Alcan Inc. priority and an EH&S First Directive compliance requirement. Conservation provides both cost efficiencies and environmental benefits. Additionally, it is important to be able to demonstrate the best use of the energy provided by the water resources licensed to the company. Casting, aluminum reduction and the supporting services have high potential for conservation opportunities to reduce the overall operational costs. An energy co-ordinator should be designated for Kitimat Works who will be mandated to assess energy consumption and to develop a prioritized plan to implement energy conservation projects.

6.9.1.6 Water conservation

Similar to energy, water conservation is a priority for Alcan Inc., and is part of the resource management directive. However, water conservation is not a high priority for Kitimat Works due to the environmental setting of the facility and other higher priority environmental issues such as emissions and biodiversity management. Water conservation opportunities should be looked at in time, following achievements in conserving other priority resources and improved house keeping. Water conservation must develop a holistic picture of the water and effluent treatment systems to ensure that it will not cause impairments of the effluent treatment system.

6.9.1.7 Soil contamination

Soil contamination can limit business strategy and decisions though high remediation costs and time requirements. To facilitate the development of company properties each one should be assessed for historic risk and those risks should be incorporated into the property development potentials. Key sites should be assessed and a plan for development that assists with

remediation should be made. For instance, the Scow Grid and Yacht Club (two high priority and profile sites) should be assessed for the feasibility of developing waterfront access in conjunction with remediating the contaminated sediments. Potentially, the remedial costs through developing the sites would be substantially less than if the sites were restored to its clean natural habitat. APM-BC undertakes an annual monitoring program for groundwater contamination from the SPL Landfill. Consideration should be given at the possibility of creating value from the monitoring work by either building stakeholder capacity to assist with the monitoring, or by volunteering the program for a partnership in an applied environmental education program. The monitoring program would provide sufficient data and experience to support a course on soil and groundwater hydrology.

6.9.1.8 Recommendations

66. Develop educational programs that would build capacity in the Kitimat area to allow stakeholders and others to participate in environmentally related opportunities. This may be accomplished by partnering with a post secondary educational organization to develop applied educational opportunities that would also address environmental issues that are relevant to the needs of APM-BC or other local industries. Potentially, there are significant sustainability gains that can be made by developing an applied environmental learning centre. APM-BC is well leveraged to support and take advantage of partnering on post secondary educational programs. Recommended opportunities that need to be assessed for feasibility are:

    Land Management: Develop a program that would build capacity with First Nation groups and other interested stakeholders and students for land and resource management / stewardship using (among others) ISO 14001 risk management systems, Alcan's EH&S

Directives, learnings and best management practices. This program would provide capacity for First Nation groups to participate in the management of APM-BC's properties.

An applied environmental field school or an industrial ecology program could be supported by using some of the routine environmental monitoring work such as: vegetation monitoring; soil and groundwater monitoring; and soil and sediment investigations. Additionally, monitoring of the industrial carrying capacity of the Kitimat valley could be included in the program. These issues would support at least 10 different courses. For instance, the routine vegetation monitoring program for tracking impacts from emissions could be turned into three courses (industrial ecology, biological systems monitoring, and GIS mapping) that would deliver a GIS based map of emissions, a short report on the extents of fluoride accumulation in vegetation and a short report describing the biophysical conditions of the sampling plots. This would provide a unique opportunity that may be attractive to students outside the region.

67. Proactively develop a program to assess the industrial carrying capacity of the Kitimat Valley. This program is strategically important for Kitimat Works in order to defend the plant's emissions, especially the sulphur dioxide permit limit. The program would identify the sustainable emissions loading range for the valley and define the margin left for developing and diversifying the industrial base of Kitimat. The risk of not undertaking this initiative is that the Province will undertake it (there have been indications that the Province wants to measure emissions loadings in the valley) and the company will be in a defensive position when the results are tabulated. Scenarios need to be run to assess the potential gains of implementing sulphur scrubbers on the calciner, rebuild options and loadings from potential industries. Results from the scenario analysis could be uses to market the region as an attractive location for industrial development if it can be shown that the region has capacity for further industries.

68. Provide a publicly communicated document that reports on APM-BC's emissions and compares Kitimat Works' emissions with other industries across Canada. Include strategies and management methods that are being employed to reduce emissions in light of the limitations of VSS technology.

69. Develop a program to assess environmental sensitivities and resource development potential of all properties owned by APM-BC. An understanding of the properties in light of current environmental guidelines and regulations for property development will identify the development potential of the properties and will avoid potential hold ups in bringing development to the region.

70. Initiate an internal workshop to identify and evaluate potential additional uses and opportunities for under-utilized properties and assets. Identify the potential risks and level of risk that would be acceptable to the company. There are a number of potential opportunities that stakeholders such as the Haisla could take advantage of while providing some supporting services to the company. These opportunities range from fish guiding, ecotours using the powerline road, cultural tours along the grease trails and grizzly bear watching.

71. Complete the assessment of properties for risks of soil contamination concerns that may affect potential development or strategic business choices. Link the property review for contamination risks to the condition and opportunity assessment of the properties.

72. Develop an environmental awareness training program that will be delivered company wide. The intent of the program should be to give employees and management an understanding of the environmental issues facing the company (these can be tailored to the specific operating areas) and how their individual performances contribute to the business' overall environmental performance. Of importance will be to provide decision-makers with an

understanding of sustainability and the need to balance production issues with environmental and social concerns.

73. Assign an energy co-ordinator to lead an energy conservation program at Kitimat Works. Provide high-level management support for implementing the energy conservation program.

74. Develop sustainability reporting metrics for APM-BC that would communicate progress made on addressing the industry's key sustainability challenges.

75. Provide training to employees responsible for data collection used by management and Alcan Inc. to model the company's sustainability performance and how the metrics are used to competitively position the company.

7 IMPLEMENTING RECOMMENDED STRATEGIES

Seventy-five recommendations for implementing sustainable business practices have been developed across the seven components of APM-BC's value chain. These strategies fall into three categories:

1) External stakeholder development
2) Internal stakeholder development
3) Strategic positioning

Each category requires a different method of implementation, as described below. These sets of recommendations address key environmental issues and barriers facing the business. They are designed to create greater value by considering the social and economic aspects of addressing the environmental challenges. For each set of strategies a road map for implementing the recommendations needs to be developed. These road maps need to be developed as a follow-up to this paper, with the input of senior management and corporate affairs. The maps will essentially lay out the vision for the company according to the three categories, and will dictate how the strategic recommendations will be implemented.

To implement the sustainability strategies, a steering committee to oversee APM-BC's sustainability strategies is recommended. The steering committee, should be comprised of management representatives consisting of at least APM-BC's director, corporate affairs, APM-BC's economic development officer, financial comptroller and the EH&S superintendent.

7.1 External Stakeholder Development

External stakeholder strategies fall within the third tier of the sustainability model (Figure 10) and target stakeholder growth and development. These strategies can build stakeholder

capacity for assisting APM-BC in moving out of the second tier of the model - prevention and conservation. Additionally, some of the strategies touch on the highest level of the sustainability model, for value creation. For example, the land management recommendations can provide simple opportunities for developing stakeholder owned businesses using the under utilized lands and assets owned by the company. Another example is using low risk routine monitoring work to develop unique education programs, which can attract economic opportunities to the community. Such strategies have the potential for creating true stakeholder value.

The suggested approach for implementing the external stakeholder development recommendations is to present the strategies along with their issue base to the sustainability steering committee. The expectation would be for preliminary approval of the recommendations and further to determine if they will become a direction that would be beneficial for the company. Next, those strategies that meet with approval need to have a business case developed to identify benefits, risks, and exit options. Finally, the business cases will need to be presented to the committee for review and approval to communicate proposals externally to potentially interested stakeholders.

7.2 Internal Stakeholder Development

Internal stakeholder development strategies are strategic preparations aimed at prevention, risk management and culture change, in addition to assisting with the implementation of the EH&S First Directives and programs. It is important to develop cultural awareness within the business about environmental sensitivities and impacts that individuals may have on environmental performance. By changing attitudes and behaviours through awareness it may be possible to realize large gains in prevention, regulatory compliance, and stakeholder trust with minimal costs. These types of strategies will likely have the lowest resistance to implementation among the different management organizations within APM-BC. However, they will have the

highest resistance among employees, and will require ongoing sustaining support, follow-up, and assessment.

Internal stakeholder strategies should be implemented through APM-BC's EH&S team and the Joint Environment Committee (Union). These strategies should be implemented as priorities for the organization, considering the preventative benefits that they will create and the mandate for EH&S First implementation.

7.3 Strategic Positioning

Strategic positioning strategies are forward-looking strategies that are focused on the business and on positioning the company to be able to better achieve its vision. These strategies fall into the second tier of the sustainability model for strategic preparation and create the platform for growth opportunities. These strategies target the following:

- Operating margins through eco-efficient programs and opportunities in areas such as energy and resource conservation.
- Risk management for improved environmental protection and preventing stakeholder outrage. This includes preparing stakeholders for future changes in environmental performance, and for the level of performance that the plant can sustain.
- Reducing environmental barriers and uncertainties that could impede the company's business plans and vision for providing economic and participatory opportunities to its stakeholders.

These strategies will meet with the internal resistance from the various operating areas who are competing for financial resources to sustain the needs of their area and achieve their own objectives. Consequentially, there will need to be a well thought out and communicated overall

vision of APM-BC's future position, and of the roadmap that will allow the company to achieve this position. To implement the strategic positioning strategy recommendations, similar requirements for implementing the external stakeholder development strategies are required. This will involve presenting the environmental issues and their recommended approaches to the sustainability committee. Following the discussion, management input and agreement on the recommendations, the business cases for each of the approved recommendations will be required. After which, the business cases will need to be reviewed with the committee for approval to implement. There will need to be an agreement on the financial resources to address the issues, such as the emissions strategy, which will require funding for modelling and field studies.

8 CONCLUSION

From an environmental perspective, the business case for sustainability is simple – ignoring environmental issues destroys value through social outrages and economic impairment. The key to developing a sustainable business is: first to identify and understand the environmentally driven issues that pressure the business, and second, to develop economically efficient strategies to confront and address the issues while building stakeholder support. This paper presented the first step in developing a sustainability based business. Further work is required to implement the strategies, by building management support for the recommendations. Of importance to keep in mind is that the recommendations are presented from an environmental perspective. Sustainability is comprised of this plus two other pillars, namely, economic and social perspectives. This paper looked at the economic and social concerns strictly from the environmental pressures affecting APM-BC, and identified value supporting strategies that bring the economic and social viewpoints into the solution of the environmental issue. In some sense, they are a new way of looking at old problems.

Through the course of analyzing the environmental pressures affecting the business, potentially new and unrecognized concerns have been raised. One concern lies with the capacity of the airshed of the Kitimat Valley to absorb pollutants without further ecological damage. This is important to recognize, as it could affect the industrial capacity of the area, and could possibly affect APM-BC through requirements to further reduce emissions in order to allow for industrial growth. A second concern lies with the capacity of APM-BC to manage the environmental issues of all of its properties. Both concerns present potential opportunities to create stakeholder

capacity and develop new economic opportunities for the communities within APM-BC's influence.

The most pressing sustainability concern identified in the analysis is the mountain pine beetle wood management. Until recently, the significance of the problem was under recognized and now significantly more effort is required to protect the value of APM-BC's properties in the Watershed. The management of the wood should take priority over other competing land and resource issues.

Of interest would be to repeat the issue analysis from the economic and social perspectives. Perhaps this would provide the opportunity to develop a comprehensive sustainability strategy for the business. This would likely be invaluable to the business, as ignoring either economic or social issues can erode the value of the business.

APPENDICES

Appendix A – APM-BC Environmental Stakeholder Analysis Table

Table 20. APM-BC Stakeholder Analysis

			Level of assessed Concern[1]					Level of assessed Concern[1]							
			Level of Influene[2]					Specific areas of concern							
Organization	**Representation**	**Culture Statement**	**Kitimat**	**Transmission Line**	**Power Generation**	**reservoir**	**Engagement Method[3]**	**Biodiversity[4]**	**Emissions[6]**	**Effluents[6]**	**Resources[7]**	**Wastes[8]**	**Site Contamination[9]**	**Economic Performance[10]**	**Relationship[11]**
BC Trappers Association	Focus group	Protection of members rights and interests for trapping and culture.	L	L	L	H	6	H	L	L	H	L	L	L	
			L	L	L	M		All	GHG	GI	N-FM	GI	GI	R	
BC Parks	Provincial Government	Protection of BC Parklands and influences on parks	L	M	L	M	1	H	L	L	M	L	L	L	
			L	L	L	L		All	GHG	GI	N-FM	GI	GI	All	
Carrier-Sekani Tribal Council	First Nations groups within the Nechako Basin	Land and resource, Heritage culture. Key interest in Fisheries.	L	L	L	H	1,6	H	L	L	H	L	M	L	M
			L	L	L	H		All	GHG	GI	N-FM	GI	WT	L	
Cheslatta First Nation	First Nations	Land and resource, historical displacement, Heritage culture	L	L	L	**H**	1,6	**H**	L	L	**H**	L	M	M	**G**
			L	L	L	**H**		**All**	GHG	GI	**N-FM**	GI	WT	L	
City of Terrace	Municipal Government	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	M	L	H	G
			L	L	L	M		WS,AE	All	GI	N-FM	S, H	GI	All	

Source: Table and analysis by author.

APM-BC Stakeholder Analysis Table (continued)

City of Prince George	Municipal Government	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	M	L	H	
			L	L	L	M		WS,AE	GHG	GI	N-FM	S, H	GI	All	
Community Futures Development Corporation of Stuart Nechako	Economic development	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	All	
District of Fort St. James	Municipal Government	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	L,R	
District of Kitimat	Municipal Government	Promote local and regional economic development.	H	L	L	L	1,2,6	L	M	M	H	M	M	L	P
			M	L	L	M		AE,TE	All	C,BC	E	All	SG, SPL	L	
District of Vanderhoof	Municipal Government	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	M	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	S, H	GI	L,R	
Environment Canada	Federal Government	Federally mandated environmental protection	**H**	L	L	M	1,2,3	**H**	**H**	M	M	**H**	**H**	L	**M**
			H	H	H	H		**WS**	**GHG, PAH**	PAH	E	**S, H**	**WT,SG, SPL**	All	
Fisheries and Oceans Canada	Federal Government	Protection of fish and fish habitat.	M	**H**	**H**	**H**	1,2,3	**H**	M	**H**	**H**	L	M	L	**G**
			H	**H**	**H**	**H**		**WS,AE**	All	**C,BC**	**N-FM,K-FM, W**	GI	WT,SG, SPL	All	
Fort Fraser Chamber of Commerce	Chamber of Commerce	Promote local business opportunities	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	L,R	
Kemano Fishing Guide (Potential)	Small Business		L	L	H	L		H	L	L	M	L	M	L	U
			L	L	L	L		AE	All	GI	K-FM	GI	GI	L	
Kildala Fishing Guide (Potential)	Small Business		L	H	L	L		H	L	L	L	L	M	L	U
			L	L	L	L		AE	All	GI	GI	GI	GI	L	

APM-BC Stakeholder Analysis Table (continued)

Kitamaat Village Council	Haisla First Nation	Land and resource, Heritage culture, land claim	**H**	**H**	**H**	M	1,2,3, 4	**H**	**H**	**H**	**H**	**H**	**H**	**H**	G
			H	**H**	**H**	L		**All**	**All**	**C,BC**	**K-FM**	**All**	**SG,WT, O**	**L,A**	
Kitimat Chamber of Commerce	Chamber of Commerce	Promote local business opportunities	L	L	L	H	6	M	M	L	H	M	L	H	
			L	L	L	M		WS,AE	All	GI	N-FM	S, H	GI	All	
Kitimat/Stikene Regional District	Municipal Government	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	M	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	S, H	GI	L,R	
K.U.T.E.	Community Group	Local environmental protection and recycling	H	L	M	L	2	H	H	H	H	H	M	M	G
			M	L	M	L		All	All	C,BC	All	All	SG, SPL	All	
Lions Club	Community Group		M	L	L	L	2	M	H	M	M	M	M	M	M
			M	L	L	L		All	All	C,BC	All	All	SG, SPL	All	
Lheidli T'enneh	First Nations	Land and resource, Heritage culture, land claim	L	L	L	H	6	H	L	L	H	L	L	L	M
			L	L	L	H		All	GHG	GI	N-FM	GI	WT	L	
Ministry of Water, Lands, and Air Protection	BC Government		**H**	L	M	L	1,2,3, 4	**H**	**H**	**H**	M	**H**	**H**	M	G
			H	H	H	H		**All**	**All**	**C,BC**	All	**All**	**All**	All	
Ni Thai Buhn	First Nations	Land and resource, Heritage culture, land claim	L	L	L	H	1,6	H	L	L	H	L	L	L	M
			L	L	L	H		All	GHG	GI	N-FM	GI	WT	L	
Nechako River Alliance	Focus group		L	L	L	H	6	H	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	L	
Nechako Valley Regional Cattlemen's Association	Focus group		L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		All	GHG	GI	N-FM	GI	GI	L	
Northwest Communities Coalition	Community Group		L	L	L	H	6	M	M	L	H	L	L	L	
			L	L	L	M		All	GHG	GI	N-FM	GI	GI	L	

APM-BC Stakeholder Analysis Table (continued)

Northwest Watershed collation	Community Group		L	L	L	L	2	L	L	M	M	M	M	L	G
			M	L	L	L		All	All	C,BC	All	All	SG, SPL	All	
Province of British Columbia	BC Government		L	L	L	**H**	6	**H**	**H**	**H**	**H**	**H**	**H**	M	**G**
			H	H	H	**H**		**All**	**All**	**C,BC**	**N-FM**	**All**	**All**	All	
Regional District of Bulkley Nechako – Area 'D'	Municipal Government	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	L,R	
Regional District of Bulkley Nechako – Area 'E'	Municipal Government	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	L,R	
Regional District of Bulkley Nechako – Area 'F'	Municipal Government	Promote local and regional economic development.	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	L,R	
Skin Tyee	First Nations	Land and resource, Heritage culture, land claim	L	L	L	H	1,6	H	L	L	H	L	M	L	
			L	L	L	H		All	GHG	GI	N-FM	GI	WT	L	
Southside Economic Development Association	Economic development	Promote local business opportunities	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	All	
Terrace and District Chamber of Commerce	Chamber of Commerce	Promote local business opportunities	L	L	L	H	6	M	L	L	H	M	L	H	G
			L	L	L	M		WS,AE	All	GI	N-FM	S, H	GI	All	
Tweedsmuir Recreation Commission			L	L	L	H	6	H	L	L	H	L	L	L	
			L	L	L	M		All	GHG	GI	N-FM	GI	WT	L,R	
Union (CAW)	Employee Union	Promotion and protection of members; protection of community health and environment	H	H	H	M	1,2,5	M	H	H	H	H	H	M	M
			H	L	H	M		All	All	C,BC	N-FM	All	All	L	
University of Northern BC	Educational Institution		L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	All	GI	N-FM	GI	GI	All	

APM-BC Stakeholder Analysis Table (continued)

Vanderhoof and District Chamber of Commerce	Chamber of Commerce	Promote local business opportunities	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE	GHG	GI	N-FM	GI	GI	L,R	
Vanderhoof Fish & Game	Focus group	Conservation of fish and game; promotion of hunting and fishing rights and interests.	L	L	L	H	6	M	L	L	H	L	L	L	
			L	L	L	M		WS,AE, TE	GHG	GI	N-FM	GI	GI	L,R	

Notes:

1	Level of concern	L = Low concern; Some - Moderate interest and concern; High level of concern.
2	Level of influence	L = Low power of influence in area of concern; M = Moderate influence power; H = High power of being heard and influencing the subject outcome.
3	Engagement Method	1=Direct Communications; 2= Public Advisory Committee (PAC); 3 = Stakeholder Committees on specific issues; 4 = Ministry Meetings; 5 = Joint management and Union committees; 6 = Nechako Watershed Committee (NWC).

Specific areas of concern

4	Bio Diversity	SSF = Sensitive Flora and Fauna; WS = White Sturgeon; F = non-specific Fisheries; AE = Aquatic Ecosystems Disturbances; TE = Terrestrial Ecosystem Disturbances; GI = General interest.
5	Emissions	GHG = Green house gases; HF = Fluoride emissions; PAH = Polycyclic aromatic hydrocarbons; SO2 = sulphur dioxide; P = Particulate; All = All emissions; GI = General interest.
6	Effluents	C = Compliance; BC = Beyond compliance; GI = General interest.
7	Resources	N-FM = Nechako River Flow Management; K-FM = Kemano flow management; W = Water consumption; E = Energy; All = water and material consumption; GI = General interest.
8	Wastes	S = Safe transportation; H = Hazardous wastes; SPL = Spent potlining waste; 3R = Reduce/Reuse/Recycle; GI = General interest.
9	Site Contamination	G = General concern; SG = Scow Grid; DS = Douglas Channel Sediments; WT = West Tahtsa; All = All potential and reported contaminated sites; GI = General interest.
10	Economic Performance	L = Locally to the stakeholder; R = Regional; A = Alcan well being; All = Local, regional and company economic performance.
11	Relationship	P = Poor to adversarial; M = Moderate - Open to positive discussion; G = Good positive and cooperative relationship; U = Unknown

Source: Table and analysis by author.

Appendix B - Stakeholder Opportunities by Value Chain Component

Table 21. Nechako Watershed Issues and Stakeholder Opportunities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Business Risk	Environment	Level of stakeholder engagement	Level of Opportunity
Reservoir level management affecting biodiversity and impacting downstream stakeholders.	M	**H**	**H**	L	M	H	M	H	H
Flow management (Nechako River) and cooling water releases	M	**H**	**H**	L	H	H	**H**	H	**H**
Forest Management – Harvesting and Bug wood removal	L	**M**	M	L	M	M	**H**	M	**H**
Flooded trees in reservoir	L	**M**	M	L	L	L	L	H	H
reservoir draw down impacting shoreline and stakeholders	L	**L**	**M**	L	L	M	L	M	L
Land Management, Access, and Ownership	L	H	**H**	L	L	M	**M**	L	**VH**
Erosion in the Murray-Cheslatta River system	L	H	**H**	L	M	M	M	L	M
Cheslatta fan	L	H	**H**	L	M	H	M	M	M
Nechako Canyon, dewateted section	L	H	H	**H**	M	H	H	M	M
Cold Water Release Facility	M	H	H	**H**	M	**VH**	H	H	M
Species at Risk Act – Sensitive Fauna (White Sturgeon)	L	H	H	L	**H**	**VH**	H	H	VH
Federal Fisheries Act – Sensitive Fauna (Fisheries)	L	H	H	L	**H**	H	H	H	M
Environmental Assessments/Reviews under the Canadian Environmental Assessment Act.	M	H	H	L	**H**	**H**	H	L	VH
First Nation Consultation	H	M	H	L	**M**	M	M	H	M
Sensitive Fauna (Osprey)	L	L	M	L	M	L	**M**	M	**M**
Sensitive Fauna (Woodland Caribou)	L	M	H	L	L	M	**H**	L	**H**
Sensitive Fauna (Beavers)	L	M	M	L	L	L	**M**	M	**M**

Table 21. Nechako Watershed Issues and Stakeholder Opportunities (continued)

Soil Contamination and legacy issues	L	H	M	L	H	H	**M**	L	**L**
Spills	L	M	L	L	H	M	**M**	L	**M**
Resource Extraction (Mining)	L	M	M	L	H	M	**M**	L	**L**
Climate Change impacts	L	**M**	L	L	L	L	**M**	L	**L**

Table 22. Kemano Powerhouse and Supporting Services Issues and Stakeholder Opportunities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Business Risk	Environment	Level of stakeholder engagement	Level of Opportunity
Flow Management (Kemano River)	L	**H**	H	L	M	H	H	L	L
Sensitive Fauna (Eulachon)	L	**H**	H	L	**M**	H	H	H	M
Asset Protection (Erosion)	L	**H**	M	L	M	**VH**	**H**	**M**	**M**
Resource Management	L	**M**	H	L	L	M	**M**	L	L
Land Management and Access	L	M	**H**	L	L	M	**M**	L	H
Spills (Oils)	L	L	M	**M**	H	M	**M**	L	M
Federal Fisheries Act – Sensitive Fauna (Fisheries)	L	H	H	M	**H**	H	H	M	M
Sensitive Fauna (Grizzly bears)	L	L	M	L	**M**	M	M	L	M
Waste Management	L	M	M	L	M	**M**	**H**	**L**	**L**
Soil Contamination and Legacy issues	L	**M**	L	L	H	**H**	**H**	**L**	**L**

Table 23. Power Transmission Line Issues and Stakeholder Opportunities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Business Risk	Environment	Level of stakeholder engagement	Level of Opportunity
Independent Power Producer Access to Transmission Line	**M**	L	M	L	L	M	L	M	L
Environmentally driven O&M Costs	L	**M**	M	L	H	M	M	M	
Land Management and Access	L	**M**	**H**	L	M	M	M	L	H
Sensitive Fauna (Grizzly bears)	L	L	**M**	L	M	M	M	L	M
Federal Fisheries Act – Sensitive Fauna (Fisheries)	L	H	M	M	**H**	H	H	M	M
Kildala-Dala Estuary Park	L	M	**H**	L	M	M	L	L	L
Forest Harvesting	L	M	H	L	M	**M**	**H**	**L**	**H**
Soil Contamination and Legacy issues	L	M	L	L	M	**M**	**H**	**L**	**L**
Spills	L	M	M	L	M	**M**	**H**	**L**	**M**

Table 24. Carbon Plant Issues and Stakeholder Opportunities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Business Risk	Environment	Level of stakeholder engagement	Level of Opportunity
Declining green coke quality	L	**H**	M	L	M	H	M	L	M
Increasing green coke sulphur content	M	**H**	**M**	**M**	M	VH	H	L	M
Regional economic development and diversification/Industrial Carrying Capacity	M	**H**	**H**	M	M	H	H	L	H
Material losses from green coke stockpiles	L	H	**M**	L	**M**	M	M	L	M
Calciner modifications / Heat recovery	L	H	M	**M**	M	H	M	L	M
Spills	L	L	M	L	M	M	**M**	L	M

Table 25. Kitimat Works Aluminum Reduction Facilities Issues and Stakeholder Opportunities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Business Risk	Environment	Level of stakeholder engagement	Level of Opportunity
Environmental releases – PAH Emissions	**M**	H	M	H	H	VH	**H**	M	H
Environmental releases – GHG Emissions	**M**	H	M	H	L	H	**M**	M	L
Environmental releases – Fluoride Emissions	L	**H**	H	M	M	H	**H**	M	L
Environmental releases – PFC Emissions	L	**H**	M	M	L	H	**M**	M	L
Environmental releases – Carbon Monoxide Emissions	M	**M**	L	L	L	M	**M**	M	L
Asset optimization	L	**H**	M	M	L	H	M	L	L
Energy Conservation	L	**H**	M	H	L	H	M	L	L
Natural gas conservation	L	**M**	M	L	L	M	L	M	L
Management commitment to beyond compliance	L	**H**	H	L	L	H	M	L	M
Employee awareness, attitudes, and behaviour	L	H	**M**	L	M	H	H	L	M
PAC and P2 Program	L	H	**H**	L	H	H	H	H	H
Land Management and Access	L	H	**H**	L	M	H	H	L	VH
Lack of qualified environmental professionals	L	L	**L**	L	L	L	M	L	H
VSS technology	L	H	H	**H**	H	H	H	L	M
Soil contamination and legacy issues	L	H	H	M	**H**	VH	**H**	M	H

Table 25. Kitimat Works Aluminum Reduction Facilities Issues and Stakeholder Opportunities (Continued)

First Nation Consultation	M	L	H	L	**M**	M	L	H	M
Federal Fisheries Act – Sensitive Fauna (Fisheries)	L	M	M	M	**H**	M	**H**	M	M
Environmental releases – Particulate Emissions	M	M	M	M	M	M	**H**	M	L
Environmental releases – Effluent Quality	L	L	L	L	M	L	**M**	M	L
Waste Management	L	M	M	L	M	M	**M**	M	M
SPL Management	L	H	H	L	M	H	**M**	M	L
Spills	L	H	M	L	H	H	**H**	M	M
Sensitive fauna (Others)	L	L	L	L	M	L	**H**	L	H
Resource management	L	M	M	L	L	M	**M**	M	L
Water conservation	L	L	M	L	L	L	**L**	M	L

Table 26. Casting Facilities Issues and Stakeholder Opportunities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Business Risk	Environment	Level of stakeholder engagement	Level of Opportunity
Metal purity and lithium addition in Lines 1 and 2	L	**H**	H	L	M	H	H	L	L
Dross production and management	L	**M**	M	L	L	M	M	L	L
Energy conservation	L	**H**	M	L	L	**M**	**M**	**M**	**L**
Chlorine gas usage	L	H	**M**	H	L	**H**	**M**	**M**	**L**
Water consumption	L	L	L	L	L	**L**	**M**	**L**	**L**
Spills (oils)	L	L	M	L	M	**M**	**M**	**L**	**L**

Table 27. Wharf Shipping and Receiving Issues and Stakeholder Opportunities

Issue	Political	Economic	Social/ Stakeholder	Technological	Legal	Business Risk	Environment	Level of stakeholder engagement	Level of Opportunity
Spills (from Ships)	L	M	M	L	M	**M**	**M**	L	M
Spills (from APM-BC)	L	M	M	L	M	**M**	**M**	L	M
Sediment contamination	L	H	**M**	L	M	**H**	**M**	**L**	**L**

Appendix C – SWOT Analysis Tables on Environmental Issues Affecting APM-BC's Value Chain

Table 28. SWOT Analysis of Nechako Reservoir Environmental Issues

Issue	Strength	Weakness	Opportunities	Threats
Forest Management – Harvesting and Bug wood removal	1. Large tracts of affected land	2. Lack of understanding of land sensitivities 3. Large tracks of land	4. High volume of merchantable timber	5. Timber loosing value if not harvested 6. Changing soil and forest hydrology 7. Increase precipitation runoff 8. Damage to land from harvesting
Flooded trees in reservoir	9. Large area of flooded trees	10. Costly to remove 11. Navigational hazards	12. economic opportunity	13. Fisheries risk 14. Sensitive operating environment with high consequences

Table 28. SWOT Analysis of Nechako Reservoir Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunities	Threats
Land Management, Access, and Ownership	15. Large tracks of land	16. Low property management level 17. Environmental sensitivities are unknown 18. Limited knowledge on Resource values and potentials.	**19.**	20. Unsupervised use of properties 21. Unrecognized environmental sensitivities may complex or obstruct business strategies
Erosion in the Murray-Cheslatta River system	22. Legally permitted flows	23. Impacts from erosion 24. Cold water release facility needed before impacts can be addressed	25. Very high opportunities for rehabilitation led by stakeholders	26. Stakeholder intervention
Cheslatta fan	27. Ongoing impact is low	28. high remedial cost	29. Very high opportunities for rehabilitation led by stakeholders	30. Complex issues with Coldwater release facility 31. Increase cost of developing a cold water release facility
Nechako Canyon, dewateted section	32. Ongoing impact is low	33. Loss of productive habitat 34. Restoration is tied to the Cold water release facility	35. High opportunities for rehabilitation led by stakeholders 36. Address a stakeholder key issue	**37.** Stakeholder intervention

Table 28. SWOT Analysis of Nechako Reservoir Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunities	Threats
Species at Risk Act – Sensitive Fauna (White Sturgeon)	38. Proactive involvement by Alcan 39. Supporting Stakeholder initiatives	40. Very high regulatory risk 41. White Sturgeon population is endangered	42. Very high stakeholder opportunities 43. Opportunities for proactive studies 44. Opportunities to proactively engage in developing a sturgeon hatchery strategy	45. Very high regulatory risk 46. White Sturgeon population is endangered
Federal Fisheries Act – Sensitive Fauna (Fisheries)	47. In-house Fisheries expertise 48. Recognition of fish habitat 49. knowledge of working around and protecting fish habitat 50. Best management practices	51. Sensitive fisheries habitat in most operating areas 52. Relationship with DFO 53. Poor public image on fisheries issues 54. High investment in fishery science in Nechako River system, Limited resources for reservoir.	55. Stakeholder opportunities for habitat protection and identification.	56. Regulatory risk 57. Increased project costs to manage habitat issues and address regulatory requirements.
Environmental Assessments/Reviews under the Canadian Environmental Assessment Act.	58. Building positive stakeholder relations	59. Limited knowledge on reservoir environment 60. Unrecognized linking of social legacies to current environmental issues	61. High stakeholder opportunities for involvement in data collection 62. Improving First Nation Consultations and relations	63. Chaining environmental issues from downstream of reservoir to Kemano River. 64. Unrecogonized linkages

Table 28. SWOT Analysis of Nechako Reservoir Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunities	Threats
First Nation Consultation	65. Recognition of importance to sustain and improve relations. 66. Good relationships and partnerships with some First Nations	67. Distrust of company and its intentions. 68. Outstanding social legacies	69. High stakeholders opportunities that are inline with First Nations culture and community alignment.	70. Some groups may not want to talk to the company
Sensitive Fauna (Osprey)	71. Large and extensive areas of flooded trees providing quality habitat	72. Limited knowledge about Osprey	73. Opportunities for stakeholder involvement in Osprey management	74. Underwater logging removing Osprey habitat
Sensitive Fauna (Woodland Caribou)	75. Numerous islands provide high quality protected habitat for calving	76. Low reservoir operating levels may open calving areas to predators	77. Opportunities for stakeholder involvement in Caribou management	78. Stakeholder intervention 79. Environmental impact assessments may identify business risks associated with caribou protection.
Soil Contamination and legacy issues	80. In-house expertise 81. EH&S Directive on Soil an groundwater	82. Unknown risks and potential for soil contamination	83. Understanding risks of soil contamination 84. Improved property management	85. Contaminated soil could affect or hinder business strategy

Table 28. SWOT Analysis of Nechako Reservoir Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunities	Threats
Spills	86. In-house expertise 87. EH&S Directive on spill containment and counter measures. 88. Knowledge and training 89. Risk assessment and auditing process	90. Third party operations on company property 91. Lack of environmental awareness 92. Lack of training	93. Risk reduction 94. Improving responses to spills 95. Knowledge transfer	96. Environmental damage from spills 97. Regulatory infractions 98. Attitudes and behaviour
Resource Extraction (Mining)	99. Good relationship between Mine and company	100. Infrequent contact and communication	101. Best practice sharing	102. contaminated runoff or burst tailing dam impacting reservoir water quality
Climate Change impacts	103. In-house expertise 104. GHG reductions at Kitimat Works	105. Lack of understanding 106. Misperception of risk and time scale	107. Stakeholder consultation	108. Stakeholder action towards Kitimat Works over emissions.

Table 29. SWOT Analysis of Kemano Powerhouse and Supporting Services Environmental Issues

Issue	Strength	Weakness	Opportunity	Threat
Flow Management (Kemano River)	1. In-house expertise 2. Recognition of sensitivities and importance of the Eulachon fishery	3. Limited understanding of flow regime 4. Limited flow and stage monitoring in lower section of River	5. High stakeholders opportunities/involvement that are inline with First Nations culture	6. Loss of flexibility in managing peak demand production.
Sensitive Fauna (Eulachon)	7. In-house expertise 8. Extensive scientific database on Eulachon fishery 9. Co-operative support/partnership with Haisla First Nation	10. Limited understanding of flow regime 11. Limited flow and stage monitoring in lower section of River 12. Limited understanding on causes in variability on fish returns.	13. High stakeholders opportunities/involvement that are inline with First Nations culture	14. Loss of flexibility in managing peak demand production.

Table 29. SWOT Analysis of Kemano Powerhouse and Supporting Services Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Asset Protection (Erosion)	15. In-house expertise 16. Excellent relationship with DFO and Provincial regulators 17. Positive relationship with the Haisla First Nation.	18. Lack of commitment for proactive prevention	19. Moderate potential for involving stakeholders in erosion works, and monitoring	20. Condition of assets have not been maintained 21. Poorly designed and constructed roads, bridges and protective works. 22. Sensitive fisheries around areas at risk 23. Significant costs to repair and protect all assets. 24. Isolation of towers by Rivers and streams
Resource Management	25. Highly efficient power conversion	26. Resource conservation opportunities and benefits have not been fully assessed.	27. Potential for savings from resource conservation opportunities. 28. Efficient powerhouse is a good demonstration of efficient water use.	29. Opportunities for resource conservation may not be priorities.

Table 29. SWOT Analysis of Kemano Powerhouse and Supporting Services Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Land Management and Access	30. Under-utilized assets 31. Road network 32. Marine docking facilities 33. Cultural heritage of Kemano Valley	34. Low property management level 35. Environmental sensitivities are unknown 36. Limited knowledge on Resource values and potentials	37. High potential for stakeholder benefits and economic opportunities	38. Unsupervised use of properties 39. Unrecognized environmental sensitivities may complex or obstruct business strategies 40. Reduced flexibility in managing land issues if stakeholder involvement increases
Spills (Oils)	41. In-house expertise 42. Availability of spill kits 43. EH&S First Directive on spill containment and counter measures 44. ISO 14 0001 Risk management system 45. spill reporting and data management	46. Oil levels in powerhouse are difficult to accurately measure to monitor for leakage/spills	47. Risk reduction 48. Improving responses to spills 49. Knowledge transfer	50. Old assets pose risk of leakage 51. High regulatory risk from spills in Kemano 52. Sensitive environments surrounding most operational areas. 53. Third party use of property who do not have same level of awareness and accept responsibility for containment, prevention, and cleanup. 54. Soil and groundwater contamination from spills.

Table 29. SWOT Analysis of Kemano Powerhouse and Supporting Services Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Federal Fisheries Act – Sensitive Fauna (Fisheries)	55. In-house expertise 56. Knowledge in identifying fish habitat 57. Awareness of habitat protection requirements 58. Positive Relationship with DFO 59. Best Management Practices for protecting fish habitat	60. Sensitive fisheries habitat in most operating areas 61. Poor public image on fisheries issues	62. Stakeholder opportunities for habitat protection and identification 63. Opportunities for environmental monitoring	64. Regulatory risk 65. Increased project costs to manage habitat issues and address regulatory requirements.
Sensitive Fauna (Grizzly bears)	66. Apparent high density of bears coexisting with Alcan Operations.	67. Limited knowledge of bear populations in Kemano	68. High value opportunity for stakeholders.	69. Safety issue for workers 70. Potential for SARA listing of grizzly bears
Waste Management	71. Management awareness of waste management issues 72. EH&S First Directive on Waste Management 73. In-house expertise 74. ISO 14001 risk management system	75. Employee awareness and training 76. Remoteness and cost of shipping out recyclables.	77. Risk reduction 78. Knowledge transfer	79. low level of landfill management and monitoring 80. No landfill operating plan

Table 29. SWOT Analysis of Kemano Powerhouse and Supporting Services Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Soil Contamination and Legacy issues	81. In-house expertise 82. EH&S First Directive on Soil and Groundwater protection 83. APM-BC Site Management Program	84. Undocumented sites and use history 85. Potential for undocumented spills 86. Lack of supervision of third party land users	87. understanding risks of soil contamination 88. Improved property management	89. Extensive development history since 1950s 90. Poor environmental practices from 1950s 91. Poor environmental practices from third parties 92. Legacy issues may impair business strategies and projects.

Table 30. SWOT Analysis of Power Transmission Line Environmental Issues

Issue	Strength	Weakness	Opportunity	Threat
Independent Power Producer Access to Transmission Line	1. Existing powerline from Kemano to Kitimat	2. Increased vegetation management requirements from potentially higher powerline loads	3. Economic development opportunities for stakeholders.	4. Increased third party use of property 5. Disruption to sensitive habitats. 6. Potential inclusion of existing powerline into to environmental assessments of proposed power generation/transmission proposals.
Environmentally driven O&M Costs	7. In-house expertise 8. Best Management practices 9. Good relationship with DFO and Stakeholders 10. Knowledge of environmental sensitivities 11. Employee awareness	12. Changing environmental rules and expectations 13. large areas and variability in environmental sensitivities	14. Improving and standardizing operating practices 15. Knowledge transfer	16. Employee awareness and attitudes 17. Third party use of properties

Table 30. SWOT Analysis of Power Transmission Line Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Land Management and Access	18. Under-utilized assets 19. Road network 20. Marine docking facilities 21. Cultural heritage of Kemano Valley	22. Low property management level 23. Environmental sensitivities are unknown 24. Limited knowledge on Resource values and potentials	25. High potential for stakeholder benefits and economic opportunities	26. Unsupervised use of properties 27. Unrecognized environmental sensitivities may complex or obstruct business strategies 28. Reduced flexibility in managing land issues if stakeholder involvement increases
Sensitive Fauna (Grizzly bears)	29. Apparent high density of bears coexisting with Alcan Operations. 30. High value forage habitat created by powerline right-of-way and vegetation management of right-of-way.	31. Limited knowledge of bear populations in powerline areas.	32. High value opportunity for stakeholders. 33. Opportunity for stakeholders to provide input to improve operating practices. 34. High opportunities for biodiversity protection and promotion	35. Safety issue for workers 36. Potential for SARA listing of grizzly bears

Table 30. SWOT Analysis of Power Transmission Line Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Federal Fisheries Act – Sensitive Fauna (Fisheries)	37. In-house expertise 38. Knowledge in identifying fish habitat 39. Awareness of habitat protection requirements 40. Positive Relationship with DFO 41. Best Management Practices for protecting fish habitat	42. Sensitive fisheries habitat in most operating areas 43. Poor public image on fisheries issues	44. Stakeholder opportunities for habitat protection and identification 45. Opportunities for environmental monitoring	46. Regulatory risk 47. Increased project costs to manage habitat issues and address regulatory requirements.
Kildala-Dala Estuary Park	48. Best management practices 49. Beachfront docking facilities.	50. Property line is immediately adjacent to park 51. Need to cross park to access Kildala Beach 52. Conditions of roads and culverts near park boundaries 53. Road maintenance near park.	54. High value opportunity for stakeholders	55. Increased public usage of area and potential scrutiny of Alcan operations 56. Stakeholder pressure on expanding park boundaries for Grizzly bear protection. 57. Expectations for public access Alcan property for park viewing. 58. Helicopter flight patterns may be affected for grizzly bear protection. 59. Potential loss of reference sampling sites.

Table 30. SWOT Analysis of Power Transmission Line Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Forest Harvesting	60. Existing road access and infrastructure	61. Lack of specific site use contracts due to change in Forest license.	62. High value opportunity for stakeholders	63. Changing soil and forest hydrology 64. Increase precipitation runoff 65. Damage to land from harvesting 66. Flooding of roads due to environmental changes 67. Increasing beaver habitat that will lead to flooding of properties and infrastructure 68. Increased O&M costs due to environmental changes caused by forest harvesting.
Soil Contamination and Legacy issues	69. In-house expertise 70. EH&S First Directive on Soil and Groundwater protection 71. APM-BC Site Management Program	72. Undocumented sites and use history 73. Potential for undocumented spills 74. Lack of supervision of third party land users	75. understanding risks of soil contamination 76. Improved property management	77. Development history since 1950s 78. Poor environmental practices from 1950s 79. Poor environmental practices from third parties 80. Legacy issues may impair business strategies and projects.

Table 30. SWOT Analysis of Power Transmission Line Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Spills	81. In-house expertise 82. Availability of spill kits 83. EH&S First Directive on spill containment and counter measures 84. ISO 14 0001 Risk management system 85. spill reporting and data management	86. Remoteness of sites	87. Risk reduction 88. Improving responses to spills 89. Knowledge transfer	90. High regulatory risk from spills in Kemano 91. Sensitive environments surrounding most operational areas. 92. Third party use of property who do not have same level of awareness and accept responsibility for containment, prevention, and cleanup. 93. Soil and groundwater contamination from spills.

Table 31. SWOT Analysis of Carbon Plant Environmental Issues

Issue	Strength	Weakness	Opportunity	Threat
Declining green coke quality	1. Monitoring and measuring of coke quality	2. Unstable base of producers 3. Procurement driven to seek low cost suppliers	4. PAC involvement in green coke supply issues	5. Continued declined of coke quality 6. Increased fluoride, PAH and GHG emissions 7. Sourcing of coke from overseas. 8. Tight market supply of anode grade coke
Increasing green coke sulphur content	9. Monitoring and measuring of coke quality	10. Unstable base of producers 11. Procurement driven to seek low cost suppliers	12. PAC involvement in green coke supply issues	13. Continued increase in sulphur content 14. Increased sulphur emissions and permit non-compliances 15. SO_2 carrying capacity of the Kitimat valley. 16. Potential development of other SO_2 emitters. 17. Requirements for SO2 controls on calciner emissions.

Table 31. SWOT Analysis of Carbon Plant Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Regional economic development and diversification/Industrial Carrying Capacity	18. On going permit compliance with sulphur emissions 19. Calciner emissions could be improved to provide space for other industrial development.	20. Small margin remaining in permit for increased SO2 emissions 21. Industrial carrying capacity of the Kitimat valley is unknown.	22. High potential for stakeholder and PAC involvement. 23. Potential opportunity to improve development potential in Kitimat area.	24. Calciner would be seen as an easy target for regulated SO2 reductions 25. Provincial Ministry of Environment has indicated desire to conduct airshed study in Kitimat Valley.
Material losses from green coke stockpiles	26. No regulatory limits at present	27. Increasing size of coke piles kept on site to mitigate supply problems. 28. Lack of dust suppression 29. Strong prevailing winds from south 30. No measurements for assessing amount of material lost to the environment.	31. Moderate potential for stakeholder and PAC involvement.	32. Reporting on materials losses from coke pile 33. Regulatory requirements for dust control and suppression 34. High cost for dust controls/suppression
Calciner modifications / Heat recovery	35. High temperatures of exhaust (1200°C) 36. Potential opportunity for cost recovery if SO_2 emission controls are requested.	37. I.R.R. Hurdle for investing in a heat recovery/cogenerat -ion facility.	38. High sustainability option for producing energy	39. Requirements for SO2 controls on calciner emissions.

Table 31. SWOT Analysis of Carbon Plant Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Spills	40. In-house expertise 41. Availability of spill kits 42. EH&S First Directive on spill containment and counter measures 43. ISO 14 0001 Risk management system 44. spill reporting and data management	45. Coke handling methods are subject to spillage. 46. Paste briquettes are frequently spilled from trucks on route to delivery points. 47. Liquid pitch spills are difficult to cleanup	48. Improved risk management	49. Slow responses to cleanup liquid pitch spills. 50. Employee attitudes and awareness

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues

Issue	Strength	Weakness	Opportunity	Threat
Environmental releases – PAH Emissions	1. Alcan technology and research support for developing high softening point pitch.	2. VSS technology is limited in PAH emissions control	3. Past success in PAH reductions can be demonstrated	4. Potential regulatory emission limits on PAHS 5. Competitors with similar technology reporting much lower PAH emissions than from Kitimat works. 6. Commitment for closure of Söderberg plants in Quebec.
Environmental releases – GHG Emissions	7. Corporate TARGET program 8. EH&S First Directive on GHG management 9. Audits of GHG data 10. Reductions made to GHG emissions 11. High level management support and commitment	12. Primary emission from aluminum smelting	13. Productivity improvement potential through GHG emissions reductions. 14. Positive image through GHG reductions. 15. Strong case studies for celebrating successes.	16. NGO reporting and press releases on emissions and polluters. 17. Government of Canada commitment to GHG reductions 18. Limited success by Government of Canada for GHG reductions

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Environmental releases – Fluoride Emissions	19. In-house expertise. 20. Good monitoring of fluoride emissions 21. past projects to measure sources of fluoride emissions 22. Vegetation monitoring has shown continuous improvement in vegetation health since the early 1970s	23. Frequent non-compliances in fluoride permit emissions levels. 24. Fluoride monitoring in pot rooms is not real time. 25. Employees attitudes and behaviour affect emissions levels	26. High opportunities for stakeholders to participate in emissions effect monitoring. 27. Knowledge transfer on biological monitoring programs	28. Regulatory fines from non-compliances 29. Vegetation impacts and damage from fluoride emissions. 30. Economic development reducing the industrial carrying capacity of the Kitimat Valley. This may Possibly result in increased pressure to reduce permit limits.
Environmental releases – PFC Emissions	31. Anode effects reduction program 32. Corporate TARGET program 33. High level management support and commitment	34. Emissions are in the 80th percentile for IAI surveyed VSS smelters. (above industry average)	35. Productivity improvement potential through GHG emissions reductions. 36. Positive image through GHG reductions.	37. NGO reporting and press releases on emissions and polluters. 38. Government of Canada commitment to GHG reductions 39. Limited success by Government of Canada for GHG reductions

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Environmental releases – Carbon Monoxide Emissions	40. Corporate TARGET program 41. EH&S First Directive on GHG management 42. Audits of GHG data 43. Reductions made to GHG emissions 44. High level management support and commitment	45. Primary emission from aluminum smelting	46. Productivity improvement potential through GHG emissions reductions. 47. Positive image through GHG reductions.	48. NGO reporting and press releases on emissions and polluters. 49. Government of Canada commitment to GHG reductions 50. Limited success by Government of Canada for GHG reductions
Asset optimization	51. Strong potential for improving productivity of Kitimat Works.	52. Low buffer in emissions compliance to adsorb increased fluoride emissions from higher electrical currents	53. Strong potential for improving productivity of Kitimat Works. 54. Low potential for stakeholder involvement	55. Regulatory fines from non-compliances 56. Vegetation impacts and damage from fluoride emissions.
Energy Conservation	57. EH&S First Directive on Resource Management 58. Corporate commitment for energy conservation 59. Potential for reducing operating costs	60. Management commitment for energy programs 61. I.R.R hurdle rate for projects	62. Low potential for stakeholder involvement. 63. High potential for energy savings.	64. Management commitment for energy reduction 65. Employee attitudes and behaviour.

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Management commitment to beyond compliance	66. Strong successes in beyond compliance and environmental improvements	67. sustained management commitment 68. sustained employee commitment	69. Stakeholder potential involvement in pushing beyond compliance	70. Financial constraints 71. Declining resources available to sustain operations.
Employee awareness, attitudes, and behaviour	72. Commitment of union to environmental issues. 73. In-house training. 74. In-house environmental experts for leadership.	75. Sustained employee commitment.	76. Stakeholder potential involvement in pushing beyond compliance.	77. Non-compliances 78. Barriers to environmental improvements 79. Regulatory infractions 80. Higher generation rates of emissions, wastes and spillage.
PAC and P2 Program	81. 10 year history of P2 work and PAC involvement 82. Strong commitment and support from PAC 83. Improved stakeholder relations. 84. Forum for dialogue on environmental issues	85. Sustained management support for P2 commitments and initiatives	86. Strong stakeholder potential for involvement	87. Unfulfilled commitments will cause loss of stakeholder confidence and support.

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Land Management and Access	88. Under-utilized assets 89. Large land holdings 90. Waterfront access 91. Water lots	92. Low property management level 93. Environmental sensitivities are unknown 94. Limited knowledge on Resource values and potentials	95. High potential for stakeholder benefits and economic opportunities	96. Unsupervised use of properties 97. Unrecognized environmental sensitivities may complex or obstruct business strategies 98. Reduced flexibility in managing land issues if stakeholder involvement increases
Lack of qualified environmental professionals	99. In-house expertise 100. Availability from southern BC	101. Response times are delayed to get the professionals to Kitimat 102. Local professionals are often booked, or have similar problems in maintaining qualified technical support.	103. Knowledge transfer 104. Strong opportunities to develop local talent.	105. Delays in obtaining appropriate resources for addressing compliance or emergency situations can lead to regulatory risk.
VSS technology	106. Research and Development into improving VSS technology has lead to reduced GHGs, increased productivity, and lower PAH Emissions	107. Kitimat Works is reaching the limits of technological improvements for emissions reduction with the existing VSS technology. 108. Employee attitudes and behaviour affect operation performance	109. Limited stakeholder opportunities.	110. Closure of VSS technology due to environmental emissions.

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Soil contamination and legacy issues	111. In-house expertise 112. EH&S First Directive on Soil and Groundwater protection 113. APM-BC Site Management Program	114. Undocumented sites and use history 115. Potential for undocumented spills 116. Lack of supervision of third party land users	117. understanding risks of soil contamination 118. Improved property management	119. Development history since 1950s 120. Poor environmental practices from 1950s 121. Poor environmental practices from third parties 122. Liability issues may impair business strategies and projects.
First Nation Consultation	123. In-house expertise 124. PAC forum 125. Monthly joint meetings with Ministry and Haisla	126. Ability to sustain commitments.	127. Moderate potential for growing the consultation process.	128. Ability to sustain commitments.
Federal Fisheries Act – Sensitive Fauna (Fisheries)	129. In-house expertise 130. Knowledge in identifying fish habitat 131. Awareness of habitat protection requirements 132. Positive Relationship with DFO 133. Best Management Practices for protecting fish habitat	134. Sensitive fisheries habitat in most operating areas 135. Poor public image on fisheries issues	136. Stakeholder opportunities for habitat protection and identification 137. Opportunities for environmental monitoring	138. Regulatory risk 139. Increased project costs to manage habitat issues and address regulatory requirements.

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Environmental releases – Particulate Emissions	140. In-house expertise 141. Particulate monitoring	142. Particulate emissions are the 98.4 percentile on a national level, and above average for the industry average. 143. Economic development may affect ambient particulate emissions monitoring, and complex measurements from the plant.	144. Stakeholder opportunity potential for participation in monitoring 145. Knowledge transfer	146. PM2.5 releases are significantly above average 147. Stakeholder concern over health effects of particulates.
Environmental releases – Effluent Quality	148. Effluent quality is largely permit compliant 149. Over 70% reduction in dissolved aluminum loading 150. High solids removal efficiency	151. Effluent lagoon has insufficient hydraulic capacity 152. Effluent quality is affected by level of house keeping and spillage of process materials. 153. Employee attitudes and awareness	154. Recovery of process materials through house keeping and basement cleaning 155. Knowledge transfer 156. Limited stakeholder opportunities	157. Permit limit reductions to reflect effluent quality 158. Non-compliances from reduced level of house keeping

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunity	Threat
Waste Management	159. In-house expertise 160. Waste management program 161. EH&S First Directive for Waste Management 162. Waste segregation 163. Paper recycling 164. Partnership and support of K.U.T.E 165. Metal recycling	166. Employee attitudes and awareness 167. Management support 168. High landfill operating costs	169. Reduced waste generation 170. Moderate stakeholder involvement	171. Biodiversity impacts (bears and eagles)
SPL Management	172. Reduced SPL generation through Improvements to cathode fabrication and potshell replacements 173. P2 opportunity for extending potshell life 174. Pre-treatment of SPL before landfilling 175. Testing for recycling SPL in cement kilns 176. SPL Memorandum of Understanding with the Province 177. Research into SPL leachate treatment	178. Exporting SPL to the United States 179. Existing SPL landfill has resulted in soil and groundwater contamination	180. Potential for Recycling of some SPL 181. Limited stakeholder potential 182. Reduction in SPL generation	183. Restrictions on exporting hazardous waste to the United States 184. Remediation of contaminated soil and groundwater at SPL Landfill.

Table 32. SWOT Analysis of Kitimat Works Aluminum Reduction Facilities Environmental Issues (Continued)

Spills	185. In-house expertise 186. EH&S Directive on spill containment and counter measures. 187. Knowledge and training 188. Risk assessment and auditing process 189. Spill reporting and data management	190. Third party operations on company property 191. Lack of environmental awareness 192. Lack of training	193. Risk reduction 194. Improving responses to spills 195. Knowledge transfer	196. Environmental damage from spills 197. Regulatory infractions 198. Attitudes and behaviour
Sensitive fauna (Others)	199. Landholdings in sensitive environments	200. Unknown sensitive fauna residing on company property.	201. high stakeholder opportunity 202. High biodiversity opportunities	203. Contaminant transfer to fauna
Resource management	204. Numerous potential resource savings opportunities in energy and raw materials.	93. Resource conservation opportunities and benefits have not been fully assessed.	94. Potential for savings from resource conservation opportunities.	95. Opportunities for resource conservation may not be priorities.
Water conservation	205. Plentiful clean water supply in Kitimat area. 206. low pressures on conservation requirements	207. High flow volume of water used. 208. Wastage of water	209. Low stakeholder potential 210. conservation opportunities 211. Support Alcan Inc. strategic initiative on Water	212. Conservation initiatives could affect effluent quality

Table 33. SWOT Analysis of Casting Facilities Environmental Issues

Issue	Strength	Weakness	Opportunities	Threats
Metal purity and lithium addition in Lines 1 and 2	1. high quality cast metal	2. Hot metal contaminants of lithium, iron, and others. 3. Increased chlorine emissions to flux metal 4. Increased dross production as metal quality goes down.	5. Limited stakeholder opportunities	6. Fluoride non-compliances if lithium is removed from lines 1 and 2.
Dross production and management	7. Aluminum recovery from Dross	8. recycling costs 9. hazardous waste product 10. difficult handling and storage	11. Limited stakeholder opportunities 12. Opportunities for increasing efficiency in handling	13.
Energy conservation	Metering system installed for consumption monitoring	14. Outstanding P2 Commitment	15. Limited stakeholder opportunities	16. high cost of energy/natural gas 17. loss of stakeholder confidence

Table 33. SWOT Analysis of Casting Facilities Environmental Issues (Continued)

Issue	Strength	Weakness	Opportunities	Threats
Chlorine gas usage	18. Chlorine use within permit compliance	19. contribution to acid rain 20. vegetation impacts	21. replace chlorine gas with salt 22. Support Alcan Inc. strategy for removing chlorine gas from process.	23. Chlorine toxicity 24. Handling dangers of chlorine
Water consumption	25. Consumed water supports effluent lagoon.	26. Inefficient use of water 27. Oil releases in effluent	28. Recycling opportunity 29. Support Alcan Inc. strategy for water	30. Decreased effluent production could lead to increased non-compliances in the lagoon effluent. 31. Biodiversity impact from oil releases.
Spills (oils)	32. In-house expertise 33. Most oils used are biodegradable	34. Impairment of effluent quality and biochemical oxygen demand. 35. Employee attitudes and awareness	36. Maintenance for Spill prevention 37. oil removal from effluent system 38. knowledge transfer	39. Biodiversity impact from oil releases. 40. Regulatory fines for discharging oils to the environment

Table 34. SWOT Analysis of Wharf Shipping and Receiving

Issues	Strength	Weakness	Opportunities	Threats
Spills (from Ships)	1. Communication of port rules and requirements to the ships	2. lack of control on activities on the ship 3. Spill response time is delayed, as emergency responder is not on site.	4. Limited stakeholder opportunities 5. environmental awareness training	6. Regulatory infractions from spills and releases from ships that are in port.
Spills (from APM-BC)	7. In-house expertise 8. EH&S Directive on spill containment and counter measures. 9. Knowledge and training 10. Risk assessment and auditing process 11. Spill reporting and data management	12. Lack of environmental awareness 13. Lack of training	14. Risk reduction 15. Improving responses to spills 16. Knowledge transfer	17. Environmental damage from spills 18. Regulatory infractions 19. Attitudes and behaviour
Federal Fisheries Act – Sensitive Fauna (Fisheries)	20. In-house expertise 21. Awareness of habitat protection requirements 22. Positive Relationship with DFO	23. Sensitive fisheries habitat around wharf 24. Poor public image on fisheries issues	25. Limited stakeholder opportunities 26. Environmental awareness and knowledge transfer	27. Regulatory risk from spills.

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