

Is Alberta Running Out of Nature's Capital?

Physical and Monetary Accounts for Alberta's Timber, Oil and Natural Gas Reserves

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In all countries, rich or poor, economic development must take full account in its measurements of growth of the improvement or deterioration in the stocks of natural resources.

(United Nations, 1987).

¹ The opinions and observations expressed in this paper are those of the author and do not represent the positions taken by Alberta Treasury.

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Introduction

A country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife to extinction, but measured income would not be affected as these assets disappeared.. (Robert Repetto, World, Resources Institute, 1989)

There are three points of inquiry in this paper:

1. Is Alberta running out of natural resource capital - oil, gas, coal and forests?
2. If natural resources were considered as a capital asset, then has the depletion Alberta's natural assets overstated or understated the province's GDP figures- a measure of economic performance?
3. Has Alberta captured sufficient economic rents from the depletion of natural capital and has sufficient resource revenues been invested in other sustainable forms of wealth to provide sustained income streams in the future?

These three issues will be examined in light of evidence provided from the development of preliminary natural resource accounts for Alberta's oil, gas, coal, and forest resources. This paper builds upon the existing work on the oil and gas accounts by Smith (1992), Born (1992), and unpublished accounts by Alberta Treasury. The forestry account for timber capital is based on previous accounts by Anielski (1996, 1994, 1992). Non-commercial resource capital accounts for water, air, wildlife, and wilderness/ecosystems have not been developed, to date. Although, a preliminary analysis of the role of forests and peatlands in absorbing carbon dioxide emissions in the province was completed by Anielski (1992).

We shall also use a fictitious story to illustrate the notion of natural capital accounting, using the Adam family - the original owners of Alberta's natural capital. The story of the Adams will be woven throughout the paper to illustrate, in plain language, how the notion of natural resource accounting would relate in a contemporary situation. The story will be supported by empirical evidence and will be illustrated in italicised text.

As with all such analyses, sufficient caveats are required to assure the reader that these findings are preliminary and are intended to raise the level of discussion about the trends in the stock of Alberta's natural resource capital and its depreciation.

The importance of Alberta's natural resource assets to the provincial account goes without saying. In 1995 the energy industry (includes mining and petroleum manufacturing) accounted for

\$15.48 billion or 22.46% of the provinces GDP.² The last time energy production accounted for this proportion of provincial GDP was in 1975 when it was 22.8%. Non-renewable energy net revenues contributed \$3.08 billion or 20.6% to provincial revenues in 1995-96 (revenues are net of the royalty tax credit of \$292 million in 1995-96).³ While non-renewable energy revenues as a percentage of total revenues are lower than their high of 54.3 % in 1979, they remain significant. The value of production from non-renewable energy resource consumption in 1995 amounted to \$18.78 billion.⁴

The forest industry (includes forestry (logging), wood and pulp and allied manufacturing contributed \$1.16 billion or 1.67 % of the provincial GDP in 1995; a marginal improvement from 1972 when it stood at 1.0 % of provincial GDP.¹ In 1995-96 timber royalties and fees amounted to a mere \$63 million or only 0.4% of provincial revenues.

The Story of the Adam Family and Their Natural Capital Endowment

This is the story of the Adam family (Adam, Eve and their two kids) who live on a farm near the city of Redtown. The Adam's come from a farming and ranching tradition; both Adam's and Eve's parents and grandparents were farmers or ranchers. The Adam's have lived off the land for decades sustaining their income from agricultural production.

One day in 1962, a letter arrived in the mail announcing the death of Adam Adam's long-lost uncle who lived near Hintertown, a forested area known for its vast forests, oil, gas, and coal resources. The letter announced that Mr. Adam was the beneficiary of his uncle's entire estate, including a huge area of land endowed with natural capital - forests, oil, oilsands, gas and coal. The Adam's were amazed at their windfall "gift". They contacted the family financial advisor to discuss what they could do with their new-found wealth.

Their advisor suggested several options. One option was to do nothing; simply leave the oil and gas in the ground and leave the forests untouched.

A second option involved developing the natural capital stocks by mining the geological resources (oil, gas, and coal) and harvesting the ecological resource (timber). The annual revenues from the extraction of these resources would increase their annual disposable income stream and thereby increase their financial wealth. With the second option, the Adams could either mine the natural capital themselves or hire a subcontractor with expertise in mining of energy resources and harvesting of timber. If the Adams opted for the latter, they would collect rent from the extraction firms, in the form of royalties and taxes, for the right to access the Adam's natural capital wealth.

² Alberta Treasury (1995) *Alberta Economic Accounts - 1994*, Table 10 - Gross Domestic Product at factor cost by industry. Energy industry includes 1) mines, quarries and sand pits, 2) crude petroleum and natural gas, 3) service related to mineral extraction, 4) and refined petroleum and coal products (manufacturing).

³ Alberta Public Accounts (1996). Public Accounts 1995-96 Volume 2. Does not net out royalty tax credits which amounted to \$292 million or other subsidies to the energy industry.

⁴ Statistics Canada #26-213.

The Adams would also choose to expend all rent revenues in the current accounting period on a more lavish lifestyle, including a new home, farm equipment, and stuff for their kids. The Adams would have to decide at what rate they would extract the geological/non-renewable energy resources and at what rate they would harvest the ecological/renewable timber resource.

The Adams also had a third option, similar to the second; that is, a portion of the rent revenues from the non-renewable natural capital paid to them by the subcontractors would be saved in a trust fund or rainy day fund for future income generation. This would build a pool of financial wealth or endowment that would provide for future income for themselves, their children or future generations. The trust would provide for sustainable wealth if or when the non-renewable energy resources ran out. The savings rate would depend on how much of the non-renewable resource was left at any given level of production, that is, the economic life of energy resources. While there is no ideal savings rate, the Adams figured that it could range from 10% to 50% of their annual rent cheques.

Having discussed these options with their financial advisor they decided to go with option 2, at least at the outset.

First they hired professional geologists and foresters to complete an inventory of natural capital stock of oil, gas, coal, and timber. Volume of natural capital and area of reserves were assessed. The economically available reserve was assessed based on what could be exploited at the current market prices and production costs. The assessment of timber capital required an assessment of a level of harvest which would sustain the merchantable volume of timber in perpetuity. Oil, gas and coal assessment involved estimating a reserve life based on current remaining economic reserve relative to the current production or depletion rates.

Having no particular interest in leaving their farm near Redtown, the Adams chose to lease the rights of access to their natural capital endowment to several oil and gas and forest companies. These firms would have the right to develop and extract the resource for profit. In return, the companies would remit the Adams a rent (royalties and taxes) per unit of resource extracted. In order to establish a reasonable rent or royalty rate, the Adams sat down with their accountant to assess a net price based on current market prices for resource products (oil, gas, timber), production costs, capital costs, and an allowance for a profit margin or returns to invested physical capital (plant, equipment, machinery). The Adams felt that with the net price calculated, they could, in theory, charge up to 100 percent of this available rent and still leave the companies viable. However, in negotiations with the firms they decided to leave some room for rent capture by firms as an incentive for the firms to be innovative, and invest in new technologies and extraction techniques. The Adams understand that the firms would also be paying taxes to the federal government on their net taxable income. In addition to the royalties and resource taxes the Adams levied on the firms, the Adams also collected a resource-owners corporate income tax; a right given to them by the federal government under the national constitution. Therefore, the Adams would collect part of the resource rents through royalties, other resource-based taxes, and corporate income taxes; the firms and the

federal government would retain the remainder. However, the oil and gas firms were tough negotiators and argued that they should be provided tax credits, royalty holidays (when prices were depressed) and other benefits to encourage the industry (particularly smaller producers) to extract oil and gas and encourage exploration. The Adams agreed.

In the case of timber capital, the Adams entered into resource lease arrangement whereby companies would have the access rights to timber in exchange for timber royalties or stumpage fees and other forestry charges. Forest rents were estimated based on the net price of timber (price less cost of production and an allowance for returns to invested capital). An allowable harvest level was set for each of the firms; a level of harvest that would sustain the timber capital stock in perpetuity. The firms would assume the costs of managing the trees and the forest, including reforestation costs and other forest land management costs (but not fire fighting which would be provided by the Adams). The firms had no responsibility over managing non-timber resources, such as wildlife, water or peatlands. The Adams would perform period spot audits to ensure that harvesting and reforestation work were in compliance with their sustainable yield objectives.

Time went on and the Adams continued to spend the annual rents earned from the extraction of their natural capital endowment. However, in 1972 they began to think twice about this approach to living only in the present. They wondered about the future of their children and their welfare; what would be left to them after the oil and gas was gone? They went to their accountant to discuss how they might begin to save a portion of these revenues for the day when the depleting oil and gas reserves were gone. In 1974 world oil prices jumped dramatically. Flush with extra cash the Adams saw this as the right time to launch their new rainy day heritage savings fund. Their accountant provided a rough estimate of how much they might save from non-renewable energy rents. They toyed with rates from 10% to 100% of royalty revenues and agreed upon a 30 percent savings rate. They were satisfied that their "rainy day" fund would compound handsomely at this rate of saving so that future Adam generations would be assured a sustainable financial wealth base.

So time went on. The Adams were enjoying enormous revenue flows the next several years. Some funds were being invested in their heritage trust fund and some being used to fund their annual personal consumption. With all this cash they decided to begin spending it on a new house, a new barn, new farm equipment, a new car, a motorhome, and a motorboat. They travelled more, entertained more, and ate out more. Furthermore, they felt their kids should benefit as well, so they built them new homes and bought them new cars.

This continued until the mid to late 1980s when oil prices began to weaken and their revenue streams began to decline dramatically. In 1986-87 their non-renewable natural capital revenues declined by 62%. The Adams were stunned. The bad news continued the next ten years to 1994 when the revenues from oil and gas were only half of what they had been in 1985. The Adams were in a pickle. All the other assets they had bought needed annual maintenance (their house, their kids' houses, their farm equipment). They were in no position to liquidate these assets so quickly nor were they willing to cut back on their comfortable lifestyle. They consulted with their financial

advisor and they chose to run deficits until oil prices recovered. They would discontinue putting a portion of energy revenues in their heritage fund, they would dip into their heritage fund, and would borrow money to maintain their standard of living. But oil prices did not recover until 1995 but by then their personal debt load had ballooned. Clearly they had both a revenue and spending management problem. Moreover, their rainy day fund (their financial wealth base) had shrunk having constantly drawn from it. There was not nearly enough equity in the fund to provide a sustainable income to offset their annual energy revenue losses. What to do?

Mr. Adam always had a nagging feeling about how he was treating these natural capital assets. He knew enough about accounting practices that other physical capital, like his barn, equipment, and other physical assets of the farm, were depreciated every year, with depreciation as an expense against his income. He wondered why he would not treat his natural capital wealth in the same way. Maybe not quite the same way, but at least treat the asset the same way as accountants might treat inventory. He discussed the idea with his accountant who informed him that there were no such accounting conventions available to him. That is, natural capital (and human/intellectual capital) were not considered as a form of depreciable capital and were never placed in a balance sheet or its depreciation on an income statement. Reluctantly, Mr. Adam dropped the issue.

Frustrated by their predicament, the Adams sought the advice of an economist - not any old economist but a resource economist. The resource economist explained to them that had they properly accounted for the stock and value of their natural wealth endowment from the beginning, they may have had the foresight to prevent the revenue constraint which ultimately hampered their standard of living. Had they known the stock and net depletion rate of natural capital, they might have seen the problem coming. Had they saved a portion of their revenues into their heritage fund in 1962 they would now have a equity base to provide a healthy and sustainable income stream. Mr. Adam was frustrated recalling that he had failed to convince his accountant about the notion of accounting for the depreciation of this natural capital wealth. He asked the resource economist to construct a balance sheet and income statement for his natural capital wealth, going back to 1962. Here is the results of that analysis

Introduction

This paper assesses the sustainable development of Alberta's natural capital through the use of physical and monetary accounts for Alberta's oil, natural gas, gas by-products, coal and timber. The account covers the period 1962 to 1995.

The first purpose of the account is to derive a balance sheet or inventory of the physical stock of natural capital remaining in Alberta - oil, gas, coal timber, carbon, water, air quality, etc. This includes an accounting of the annual depletion rates and annual additions to the natural capital stock. From this balance sheet, an assessment of the sustainable natural capital consumption and the life of the remaining reserves can be made.

The second purpose is to determine the monetary value of natural capital assets and the value of annual depletion. The economic rent value of any annual natural capital depletion is deducted from Gross Domestic Product in the national income accounts to account for the depletion of physical natural capital stocks and reductions in the services of ecological services.⁵ The adjustment is necessary in order so that decision makers recognise that economic growth does not come without the expense of depleting the renewable and non-renewable natural capital which ultimately gave rise to economic production. In this paper only commercial natural capital assets (oil, gas, coal, timber) are considered in the resource account. Other ecological services and ecological capital such water quality, water quantity, air quality, wildlife, agricultural land, and ecosystem health are not considered in this paper, but are imperative in such a multi-dimensional accounting exercise. These non-market assets suffer from the inherent bias in our economic system which only "values" tradable goods and services which derive a price in the market place. To the extent that ecological services are not priced, they are also not valued in terms of what they provide to support our economic systems. We simply ignore their value to the health of our economies and consequently give them little attention in an accounting of physical and qualitative changes in the services our ecology provides. Daly (1996) argues that opportunity cost or replacement cost could serve as proxies for value of so-called non-market natural capital though even such proxies would face tremendous resistance from neo-conservative economists who are biased towards markets and market values.

The third purpose of the paper is to assess the economic rents generated by the consumption of natural capital and assess the government's efficiency as a rent collector through royalties and other taxes (including provincial corporate income tax).⁶ It is then possible to do a back-of-the-envelope

5 Currently national income accounts and GDP figures only account for growth of economic sectors. There are no adjustments made for the depreciation of either human-made, natural, human, or social capital. Ecological economists argue that GDP as a measure of economic progress is misleading since it ignores the depletion of the fundamental natural capital base which gives rise to much of the worlds economic production and enterprise. These economists argue that sustainable income can only be defined by including the value of the depletion or depreciation of natural capital.

6 We argue that economic rent while most efficiently captured through an efficient and equitable resource rent tax (based on net revenues earned by the producer of natural capital, in this case the firms which are provided rights of

assessment of residual rents that were retained by the developers of natural capital (rents which may be dissipated equity markets (stock share prices) or labour markets (salaries)). Also of importance in this assessment is the issue of royalty tax credits, royalty holidays, incentives, government funded research and programs that benefit the resource extractor (e.g. oilsands research, fire fighting, reforestation), and subsidies to business, including loan guarantees and transportation infrastructure (pipelines, roads, bridges, etc.) paid for by the Crown. How to treat such indirect and often hidden benefits to the resource capital producer presents difficulties both from a tax policy and philosophical perspective.

Finally, the natural capital accounts permits us to assess how much of the rents from a finite non-renewable natural capital stock should be saved and invested in alternative forms of wealth (renewable resource, financial, business, or social capital) that would for a sustainable income stream when the non-renewable capital runs out. We can assess, like Smith (1992), how much of the oil and gas royalty revenues were invested in Alberta's Heritage and Savings Trust Fund, what that Fund currently provides in terms of sustainable income from financial capital, and how much should have been saved under various saving scenarios, including Solow's (1986) rule of thumb⁷. The form of investment of resource rents matters less than ensuring that the alternative capital investment in which resource royalties are directed will provide for "renewable" or sustained income streams (therefore, the investment could be in renewable energy (wind, hydrogen, hydro), human health or wellbeing (health spending) or intellectual capital (education)). The key is that total wealth of the province is not reduced nor is the income earned from that wealth reduced with or without the non-renewable natural capital. With knowledge about the remaining reserve life of these finite resources, we can then evaluate what the future savings rate should be from the royalties earned from the production of remaining natural capital in order to achieve sustained income to province in perpetuity.⁸ Various savings rates can be used based on the experience of other jurisdictions; rate of royalties saved could range from Norway's 100%, Libya's 70%, Alaska's 50% (new oil)/25% (old oil), Alberta's original AHSTF rate (30%) or a minimal 10% "tithe" rate. Alberta initially chose a figure of 30 per cent (more recently zero) at the inception of the Alberta Heritage and Savings Trust Fund. Norway has recently attempted 100 per cent royalty investment and Alaska's Permanent Fund has attempted a 50% savings rate. Performing such sensitivity analysis on alternative rules of thumb allows us to assess what kind of sustained income Alberta might have today had it adopted such savings rate as early as 1962.

Accounting for Natural Resource Capital

access to extract or harvest timber, oil, gas, and coal), is ultimately also captured through other tax instruments, especially corporate income taxes, both federal and provincial.

⁷ Robert Solow (1986:149) suggests that "allowable consumption be interest on an initial patrimony of resource endowment." Smith (1992) uses a 5% of the opening annual stock value of non-renewable resource capital as the amount that might have been saved annually into the AHSTF.

⁸ As of March 31, 1996 the Alberta Heritage Savings and Trust Fund had financial assets of \$12.0 billion and provided investment income revenues to the General Revenue Fund of roughly \$1.18 million in 1995-96 (Alberta Public Accounts).

It has been ten years since the Report of the World Commission on Environment and Development (United Nations, 1987) was released recommending that nations begin to keep track of their natural capital assets. The United Nation's handbook "Integrated Environmental and Economic Accounting" (1993) provides all nations with a guide to developing resource capital accounts. Repetto's (1989) ground-breaking resource accounts for Indonesia is now eight years old. Yet despite these efforts the international community has yet to take up the challenge by accounting for natural capital and integrating natural capital depreciation into their system of national income accounts. Norway, Indonesia, Canada, the U.S., Netherlands, France, Japan, China, and Costa Rica have begun developing pilot satellite accounts but thus far no country has taken the next step of incorporating environmental expenditures and natural resource depreciation in their national accounts. Thus, Gross Domestic Product figures continue to overstate economic growth. Herman Daly (1996) has recently challenged the economics of sustainable development by calling on policy makers to explicitly recognise the importance of natural capital by actually making adjustments to national income accounts (Gross Domestic Product) by subtracting defensive environmental expenditures and the depreciation of natural capital.

Treating natural capital the same as human-made capital is possible within the realm of standard accounting procedure by treating natural capital as an inventory (albeit a gift or service from nature) and determining the depreciation (in physical and monetary terms) of that capital stock. Both quantity of natural capital and the quality of ecological services (e.g. water quality or air quality) can be accounted for. Such accounting is no different than when a firm takes an annual stock inventory and assesses its market value. By not accounting for nature's capital in a like manner we render natural capital as free goods and services, which they are not by virtue of the fact that these assets are finite in terms of the Second Law of Thermodynamics of energy.

Entropy, the Laws of Thermodynamics

Daly (1996) attributes much to Nicholas Georgescu-Roegen, *The Entropy Law and the Economic Process*, who provided us with significant insights into the relationship between the physics of energy (entropy) and economics; a relationship which economists in general ignore by assuming that the economy is limitless in its production capacity. Georgescu-Roegen presents the picture of an "entropy" hourglass which represents an isolated system in which no sand enters and no sand exists since there is a finite stock of solar energy (low entropy) from the sun. This solar stock provide a regular solar flow of energy of which much is lost or wasted as heat and some is captured by terrestrial natural capital (e.g. forests, land, plants, oil and gas). Intuitively we know that we there is a fixed supply of land, a fixed carrying or productivity capacity of that land, and steady state of total energy (total incoming solar energy is steady). The amount of sand in the hourglass is thus constant which conforms to the first law of thermodynamics, that energy can neither be created nor destroyed.

According to the second law of thermodynamics what can happen is the conversion of low-entropy or available/useful matter/energy from the sun to high-entropy energy or unavailable/waste

matter/energy. The sand continually flows from the top of the hourglass into the bottom chamber from low-entropy (useful and available) to high-entropy (waste) as energy is used up. Some of this low-entropy energy from the sun is stored or captured temporarily in terrestrial stock or natural capital (also low-entropy). This terrestrial stock endowment (low-entropy) can then be used up or consumed at a rate of our choosing. By using the low-entropy natural capital stock endowments by convert these stocks to high-entropy stocks or waste. As Daly (1996) notes “ we cannot “mine” the sun to use tomorrow’s sunlight today, but we can mine terrestrial deposits and, in a sense, use up tomorrow’s petroleum today.”

What is important about understanding entropy is that the stock of low-entropy solar energy is abundant but is limited in terms of our ability to use its energy. Alternatively, terrestrial stocks are limited in terms of their total stock but the amount which can be provide abundant flows but which themselves are temporary. Temporary in the sense that eventually we will have used up all of the stored low-entropy contained in the terrestrial stock (e.g. oil and gas). The issue for us is where we are at in the supply of low-entropy terrestrial natural capital stocks relative to our current consumption patterns. Daly and others have argued that we are in a full-world, that we have reached the limits of the terrestrial stock of natural capital. The “entropy (or “used-up-ness) increases in an isolated system” (Daly 1996). This is precisely what occurs when we take natural capital stocks (e.g. oil) and convert into high-entropy energy (e.g. combustion for automobiles). Our macroeconomic theories fundamentally ignores the tenets of physics believing instead that human-made capital is a perfect substitute for natural capital. The laws of thermodynamics, if accurate, precludes such an assumption. Ignoring that the reality of thresholds to both terrestrial stocks of non-renewable resource capital and thresholds to the capacity of ecological services is ultimately ruinous.

As Daly (1996) experienced during his term at the World Bank, accepting the constraints of the entropy law on the economy would create a crisis of confidence in world markets since it would mean that economic growth has a threshold. Daly’s experience with the World Bank’s chief economist rejecting a picture of a box called the “economy” bounded by a circle called the “ecosystem” meant admitting that there are economies of scale beyond which the consumption of natural capital cannot expand. Admitting to such a picture, or a picture of the entropy hourglass would mean admitting that there are indeed “limit to growth.” Despite such a convincing picture from the discipline of physics, economic decision makers continue to run silent like the Titanic ignoring the sonar and signals which warn of an emerging iceberg called the ecological service threshold hanging tenaciously to our faith that this ship will neither sink nor hit an iceberg.

The Ignorance of Macroeconomics

Ironically, macroeconomic theory ignores the fundamentals of the microeconomic conventions of maximum and optimal scale for the individual firm. Macroeconomic theory in our text books conveniently behaves as if the ecosystem does not exist all the while consuming products and services from the ecosystem which fuels economic growth. The macroeconomy ignores the

macro-environment ignoring that nature's capital has a maximum and an optimal or sustainable scale. If there is such a maximum or optimal state then the substitution effect of human-made and natural capital is refuted. Daly's analogy to a cooking recipe is appropriate - what good is the recipe if you have run out of ingredients to cook with?; you can't eat the recipe. Alternatively, what good is consuming beyond the optimal scale or sustainable income from nature's capital for immediate benefits or short-term financial wealth when this means foreclosing on ecological services for future generations? What good is a fishing boat if there are no fish, or a sawmill if there is no mature timber to harvest? Despite evidence that the ecology does in fact exhibit constraints in accordance with the laws of physics, we continue down a ruinous path too afraid, paralysed, or unable to acknowledge the truth since such a revelation would put in question all we have pursued since the Industrial Revolution. This would mean that the pursuit of increased wealth and prosperity by current generations will impose a high price on future generations.

As Daly (1996) notes, it is time to recognise that we live in a full world at the outer supply constraints of our ecology. It is time to recognise that the second law of thermodynamics does apply to both the economy and ecology. It means that there are constraints to the mining of low-entropy energy supplies like oil and gas and sustainable thresholds of consuming so-called renewable natural capital such as timber, air, and water. The world is currently in a state where there are more people chasing the last marginal unit of natural capital. As we approach that threshold, we must first recognise the constraint and then find ways of ensuring that limited ecological services and products are distributed in a fair and equitable manner to current and future world populations. The alternative is to wake up and find ourselves with high entropy paper recipes on our plates and no food to eat, no water to drink, no fuel to burn, and no trees to cut.

Sustainable Income

Daly (1996) notes that "although the environment has been abstracted from by standard economics, the concept of sustainability has been recognised and incorporated into the very definition of income as 'the maximum amount that a community can consume over some time period and still be as well off at the end of the period as at the beginning (Hicks 1946). Hicks (1946: 187) also noted that "if a person's receipts are derived from the exploitation of a wasting asset, liable to give out at future date, we shall say that his receipts are in excess of his income." Hicks was describing income in simple terms, however, it applies equally to human-made capital as for natural capital in that wealth (of whatever stripe) cannot be sustained unless there is prudent management to ensure that its physical and income earning capacity is sustained. This is true at the individual, firm, provincial/state, and national level. Natural resource accounts can provide a full accounting of whether or not we are living beyond nature's income, beyond the optimal scale of nature's ecological services to derive products (timber and oil) and services (clean air and water).

Revision of National Income Accounts

The revision of national income accounts through adoption of natural capital accounting

conventions is imperative if we are to measure the success or failure of so-called sustainable development policies. If we are in fact approaching the maximum scale of nature's ecological services and consuming natural capital at unsustainable rates then our current income accounts provide no indication of such a state of affairs. National income accounts, adopted by the United Nations shortly after World War II, ignore the value and role of natural capital. The use of natural capital from timber harvesting or oil and gas production is an addition to GDP. No account is made of the depletion or depreciation of a natural capital stock or of any losses in ecological services (e.g. clean air or clean water). Income accounts also treat environmental expenditures as positive additions to GDP rather than a defensive expense to correct human's impact on the ecology. For example, income accounts ignore the "costs" to ecological services from ecological disasters like the Exxon Valdez oil spill. The clean up of the spill resulted in a huge boost to U.S. GDP from the clean up costs and legal bills, yet the original value of natural capital and the costs to the Alaska salmon fishery, wildlife, clean water, and pollution never showed up in the U.S. income accounts or GDP. A necessary step in recognising the limitations of our current economic activities is to attempt to account for the stock and loss of those terrestrial stocks of low-entropy energy and understand their relationship to our world economy. Natural capital accounting is proposed as one means to rectify our myopia. Moreover, such accounting for non-renewable natural capital and the use of royalties and other resource revenues can help economies assess whether they are pursuing a sustainable income path.

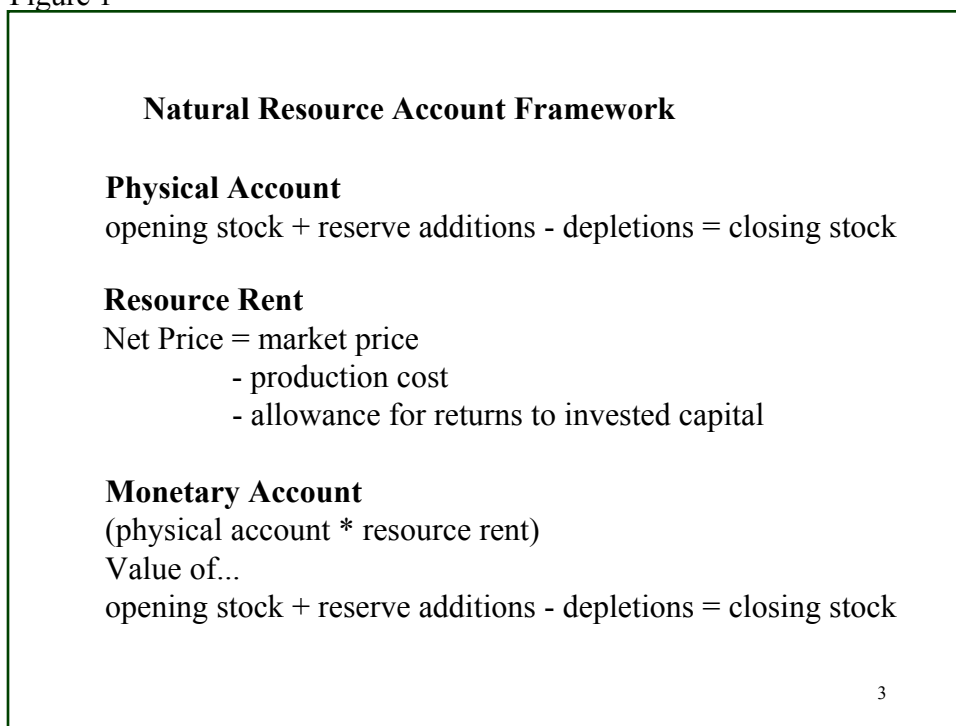
Because economic growth is possible because of access to supplies of natural capital, accounting for the stock and value of this natural capital is important in order to pursue a sustainable economic path. We must recognise that natural capital can be exploited beyond the carrying capacity of the ecosystem to supply ecological services and supplies of raw natural capital. Capacities are being revealed all around the globe whether fisheries in British Columbia, Newfoundland or Costa Rica, tropical rainforests, groundwater supplies, or crop failures.

Improved measures of national income that accounts for natural resource depletion and environmental degradation are tantamount to ensuring that our current generation consume this capital at sustainable rates which provide for sustained income for future generations. Physical and monetary balance sheets of resource capital stock must be made part of the national balance sheets for the economy in order to account for so-called sustainable development. Only through such transparent accounting for such capital can we hope to pursue policies that are truly sustainable.

Physical Natural Capital Accounts

Natural resource accounts provide an annual reconciliation of the remaining stock of natural resources of a nation or state. The accounts are broken into physical and monetary components (see Figure 1). The physical account shows the opening and closing stock of remaining natural resource capital.

Figure 1



Since the original intent of resource accounts is to incorporate them into national income accounts, the physical account only considers the resources which are currently economically available to the market, at current production costs and product prices. (Note: environmental asset accounts can also be established for non-market environmental values such as for air, water, wildlife which would account for physical and qualitative changes in the remaining stock; reconciliation with commercial natural capital stocks is still not possible). The closing stock balance is developed by adding new additions, discoveries (oil), and technologically-induced additions, and growth (timber) to the opening stock balance and subtracting production or consumption of natural capital in each accounting period. A net change in the capital stock is thus calculated and used to adjust the opening stock balance.

The physical account can provide robust information on how the current depletion rates are affecting supplies and whether or not depletion rates are in line with annual addition rates, that is physically sustaining the original stock. Assessments of the remaining life of the reserve can be assessed, as in the case of non-renewable energy resources. Crude oil, natural gas, gas by-products, and non-conventional crude oil (crude bitumen and synthetic crude) remaining reserves, production, and additions figures are from the Canadian Association of Petroleum Producers (CAPP) statistical handbook (various series) while coal production figures are from the Alberta Energy and Utilities Board (AUEB, formally the Energy Resources Conservation Board). Timber resource statistics for volumes and area of forest land area, annual harvest and natural disturbance losses are from forest inventory data from Alberta Environmental Protection (Alberta Land and Forest Service); growth figures are estimated based on the assumptions of growth used in a recent study by the Land and Forest Service (1995).

In the case of renewable resources, such as forests, an assessment of sustainability of the original stock can be made to determine whether this has been eroded or not.

Monetary Natural Capital Accounts

The monetary account is constructed on the basis of determining the economic rent generated by the consumption of the natural capital in each year (see Figure 1). **Economic rent** is defined as the net price or the difference between the market price of a commodity less costs of production (including exploration, development, harvesting, operating, marketing, transportation costs, and other capital costs) including an allowance for adequate returns to physical and financial capital⁹ (excluding taxes, duties and royalties) (Repetto et al, 1989).¹⁰ In essence this is a modified form of Hotelling rent.¹¹ Rent for oil and gas resources is calculated as per Born (1992: 31) where the author calculates a net price rent using the return to man-made capital methodology outlined by Branson (1972) and Copithorne (1979) “using the replacement cost value of the net capital stock in structures, machinery and equipment, depreciation on that capital stock and the average yield on long-term corporate bonds reported in *the Bank of Canada Review*.” The average yield on industrial/corporate bonds represents the normal return to capital. As Born (1992: 31) notes the net price or net rent should be net of all costs including an allowance for the real user cost of capital, including the depreciation charge and interest costs. This capital allowance in essence provides the industries consuming provincial natural capital stocks with a return on invested man-made and financial capital that leaves them no worse off than if they had invested in the next best capital investment opportunity. Rent figures for timber capital use the net price Hotelling rent approach

9 Rent should also net out subsidies to industry, including any direct payments or direct benefits to industry including royalty tax credits, royalty holidays, loan guarantees, government program expenditures (e.g. oilsands research, forest fire fighting, forest management, reforestation) and infrastructure paid for by the province (e.g. bridges, roads). These will be considered later in the paper.

10 The United Nations *Statistical Handbook on Integrated Environmental and Economic Accounting* (1990: 144) states that the discounted value of future net returns should be future market price minus all exploitation cost including a normal rent of capital. Born (1992) notes that “these authors do not make these terms (particularly future market prices) operational.”

11 Hotelling, Harold (1931). *The Economics of Exhaustible Resources*; *Journal of Political Economy*, vol. 39, pp. 137-175.

but determine an allowance on man-made capital as roughly 10 percent of the total physical capital investment of various producers within forest industry.

The monetary account is constructed by multiplying the opening physical stock balance at the end of the preceding accounting period times the per unit rent of the preceding period¹² The net change (the difference between additions less depletion of reserves) in the physical stock during the period is multiplied by the current per unit of resource rent. It is the value of the net change in physical stock which would be used to adjust GDP figures in the income accounts. A reduction (negative net change) in the stock is valued at the average rent for that period and would result in a negative adjustment to GDP. An increase in the stock (positive net change) would result provide more stock available for future consumption and would result in an addition to GDP (Smith, 1992: 391). A “revaluation” value is also calculated - the value of the opening stock times the rent change that occurred from the current period since the previous period. It is the capital gain or loss that has occurred because of the change in rent values. The value of the closing stock is calculated adding to the value of the opening stock the value of the net change in resource stocks plus the revaluation figure.

The non-renewable resource account for oil and gas uses rent figures for 1962-1988 are based on Smith’s (1992) preliminary oil and gas account for Alberta and in consideration of rents calculated by Born (1992) for Alberta. Smith’s figures were chosen since they were felt to best approximate an appropriate return to capital.¹³ Both Born (1992) and Alberta Treasury (1992) rent calculations provide an alternative. Rent figures for the period 1990-1995 are based on production and capital cost data from Canadian Association of Petroleum Producers statistics and including a return to capital component based on ratio of returns to capital to production costs used by Smith (1992), Born (1992) and Alberta Treasury (1992). In the case of rent figures for coal, these figures are based on data from the Alberta Energy and Utilities Board (AUEB) on sale price and estimates of production costs from industry experts.

12 See Born (1992: 41-42) for an exhaustive assessment of the alternative approaches to valuing the total natural capital stock. Born opts for the net present value of assessing closing stock balances, using the long term corporate bond rate as the discount rate and the economic reserve life as the discount period for oil and gas natural capital stocks. While this is ultimately the correct approach to valuing natural resources, we opt (in the interest of time) for a more simplistic approach which values annual stocks at current rent values. Also, our approach to the treatment of capital costs differs from Born’s approach since we, like Smith (1992) treat capital costs as current expenditures against revenues in determining net economic rent. Born experiments with different amortization or depreciation rates for capital.

13 The choice of the appropriate discount rate to use in assessing a normal return to capital is of great debate. Figures range from 7% (Alberta Treasury), 7% plus inflation (Smith, 1992) to 15 % (the “hurdle rate” suggested by the National Energy Board) of invested man-made and financial capital. Smith (1992: 407) assumes the cost of equity assumed to be 7 per cent plus inflation rate in each year, with the equity investment in oil and gas wells taken from *Corporation Financial Statistics* (Statistics Canada). This is similar to Born’s (1992) approach. Born assumes the return to equity to be equal to the long term corporate bond rate - a rate similar to Smith’s 7% plus annual inflation rate. “Landefeld and Hines (1985) use a constant discount real 10 percent discount rate (to calculate present values of resources) because it represents the rate of return on private investment before taxes and after inflation. The National Energy Board employs a 15 percent real rate before taxes, royalties and land costs to approximate the “hurdle rate” used by investors (Bowers and Kutney, 1990). Long-term bond rates are used by Eglinton and Uffelmann (1983) and McLachlan (1991) in determining the present value of replacement costs of oil and gas reserves in Alberta” (Born, 1992: 42).

Alberta's non-renewable Natural Capital Account: Oil, Gas, and Coal

Theory and Methodology

“Although we cannot invest in non-renewable, we can manage their liquidation in such a way as to increase direct passive investment in renewable energy and other renewable forms of capital and indirect active investment in measures to increase throughput productivity that make waiting (throughput reduction) easier.” Daly (1996)

The focus of non-renewable resource accounts for oil, gas, gas-byproducts and coal resources is to assess both their reserve life and the sustainability of income. Sustainable income is determined by the degree of reinvestment of non-renewable resource revenues into other forms of sustainable capital (including renewable energy, petroleum savings funds) that would yield a sustained wealth and income after the non-renewable resources are gone. The accounts would be comprised of an account of the stock, additions, and depletion rates of non-renewable energy resources. Statistical records from the Canadian Association of Petroleum Producers (CAPP) and the Alberta Energy Utilities Board (AEUB) are sources of data to derive these accounts.

An "economic reserve life" - the years of remaining reserves left at current production - is derived from the physical accounts and is the ratio of the closing stock balance of economic reserves to current production volume. This provides an indication of how much non-renewable capital remains in terms of years. The reserve life does not consider new additions to the existing reserve from new discoveries or technological improvements that allow for enhanced recovery. However, sensitivity analysis is performed on the reserve life figures by using historic net changes (production less additions) as a proxy for how long the reserve life might be extended because of new discoveries and technological changes.

The monetary account is derived by taking the information from the physical account and multiplying through by the economic rent figures for oil, gas, and coal. Economic rent is calculated by taking the price of energy products less reported costs of production (from CAPP and AEUB) less an allowance for returns to invested capital. The economic rent value of the depletion of non-renewable resource capital or depreciation value would be used as a negative (or positive) adjustment to GDP figures. Only to the extent that natural capital stocks are being The monetary or economic account for oil and gas would track the change in the value of oil and gas capital and would provide the financial information necessary to make an adjustment to GDP in the event of depreciation of the asset. While ultimately non-renewable resources are finite in physical terms (unless new discoveries always replace annual extraction) the income generated from the production of the oil and gas can theoretically be sustained if those rents are invested in other forms of sustainable capital, for example, renewable energy. Smith (1992) examined Alberta's oil and gas account and made adjustments to conventional income accounts for the province. He also assessed whether Alberta's historical expenditure of oil and gas resource revenues (royalties) met Robert

Solow's (1986) suggestion that "allowable consumption (be) interest on an initial patrimony of resource endowment." In other words, was there a sufficient reinvestment of the economic rent from oil and gas into Alberta's Heritage Fund to derive a sustainable income stream over time, to replace future income stream losses when the resource is eventually depleted?

Accounting for the sustainability of a non-renewable resource such as oil and gas resources requires the establishment of physical stock and flow accounts plus a value or monetary account. Because oil and gas constitutes a finite resource, physical sustainability can only be ensured when new additions (through discoveries and technological innovations, which make more oil economically accessible,) are equal to depletion rates.

Another consideration of sustainability should consider the sustainability of income derived from the consumption of the resource. Sustainable income is based on the notion that a person or society should be no worse off from an income perspective, today than when a non-renewable capital asset runs out. This of course requires reinvestment of diminishing rents or royalties into an alternative form of wealth (e.g. financial or other social and human capital) that would provide a sustainable income stream in the future. In a sense our interest is maintaining a stock of wealth from which returns from that wealth base can be derived to leave society no worse off today (with oil and gas) and tomorrow (without oil and gas). Expensing current consumption out of rents generated from a non-renewable resource is not a financial sustainable path. However, saving some of these rents (for example, the Alberta Heritage Trust Fund) to be reinvested in alternative and usually renewable income generating activities is the correct course for a sustainable income stream. The question of whether or not Alberta reinvested enough of its oil and gas royalties into a savings account (Heritage Fund) for future income streams is not addressed in this paper, however, Smith (1992) did address the subject. His conclusion was "the provincial (Alberta) government may, at times, have overspent resource revenues during the past quarter century; at other times its policies appear to have been quite conservative.

The primary focus of this paper is on the physical reserve of the oil and gas remaining in Alberta. This focus is important from assessing future energy royalty streams to the provincial treasury. The notion of an "economic reserve life" is used which provides an indicator as to how much oil and gas remains once you have accounted for net changes in the physical stock (annual discoveries and less annual depletion or production). An economic reserve life can be calculated as the ratio of remaining reserves to current production. The reserve life tells us how long the finite resource will last at current consumption.

The second focal point of the account involves estimating the current economic value of the oil and gas capital stock. This involves determining the economic rent of the capital stock based on an estimate of the value of marketable production in the oil and gas industry in Alberta. To determine economic rents, the average prices and production costs (including capital costs) are used for various oil and gas products. Another aspect of the monetary account is to consider the income stream from royalties and taxes derived from the use of the public asset. Roger Smith (1992), in his

article "*Income Growth, Government Spending, and Wasting Assets - Alberta's Oil and Gas*", examined the issue of whether the Alberta Government expenditures of oil and gas royalty revenues were effectively reinvested to ensure a sustainable stock of wealth for Alberta.

An important note is that natural capital accounts for oil and gas consider only the economically accessible reserve of the resource. The non-economic portion of the reserve can also be accounted for in physical terms, however, these reserves are currently economically inaccessible thus should not appear in the monetary account. Accounting for the stock and flow of oil and gas resources requires an accounting of the additions (new discoveries, technological improvements to increase economic reserves) and depletion (production) from the economic reserve or stock of resources. With this physical information, it is possible to estimate the economic reserve life of oil and gas resources remaining in Alberta

The Alberta Oil, Gas, and Coal Resource Account - Results

Alberta's oil and gas account was developed for conventional crude oil, synthetic and bitumen crude oil from oilsands, natural gas, and gas by-products. Most industry statistics come from the Canadian Association of Petroleum Producers (1996) annual *Statistical Handbook* and in some cases from the AEUB (Alberta Energy and Utilities Board).¹⁴ Data on coal production, reserve, cost and price data is from the Alberta Energy and Utilities Board) data set. Preliminary accounts were developed by the Alberta Bureau of Statistics spanning the years 1970 to 1992. The current Statistics Unit in Alberta Treasury has recently updated the oil and gas account to 1993.

Physical and monetary accounts are developed for conventional crude oil, synthetic crude oil from oilsands, natural gas, coal (sub-bituminous and bituminous), liquid gas byproducts from natural gas (ethane, butane, pentanes, propane), and sulphur have been developed. Production is valued at current rent values as is the closing remaining reserve balance of all resources. An alternative approach is to determine the net present value of the closing balance using the reserve life as the discount period and the long term corporate bond rate as a discount rate (see Born, 1992).

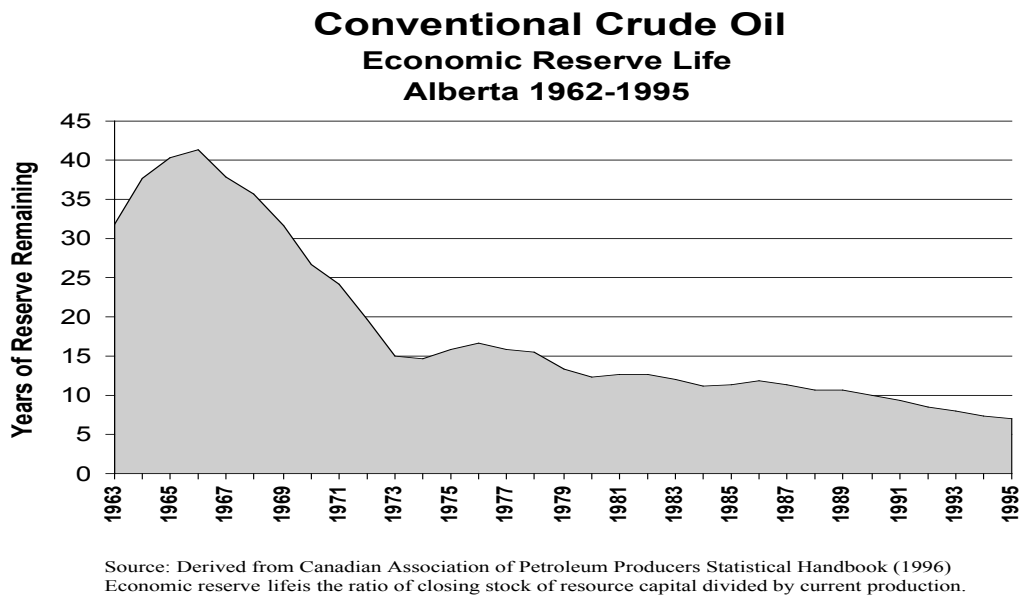
Conventional Crude Oil

The economic reserve life of conventional crude oil remaining has been in steady decline since the peak in 1966 and as of 1995 stands at 7.0 years of remaining production (see figure 2). Though this does not imply that in 7 years Alberta will have exhausted its conventional crude reserves given that new discoveries could extend the reserve life. Yet, the reserve life is declining at an annual rate of 5% per annum (see also tables in appendix). Production was 356.8 barrels of oil in 1995. Production has increased at an average rate of 2.7% per year since 1962. Over the past 30 years the production of conventional crude oil has also declined. Production peaked in 1973 at 83 million

¹⁴ CAPP statistics are chosen over alternative statistics from AEUB because the consistency of CAPP's time series data for oil, gas and gas byproduct data. Also, it is CAPP data which is used for presentation of materials to U.S. equity markets.

cubic meters or 522 million barrels. In 1995, production was 56.7 million cubic meters or 357 million barrels, up slightly from the previous year.

Figure 2



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The determination of economic rent is complicated by the fact that there are differences of opinions amongst economists as to the correct treatment of capital expenditures and appropriate

allowances for returns to invested capital in the determination of rents. This paper cannot explore these issues in details but defers to the wisdom of Born (1992) in her exhaustive discussion on the subject in the case of constructing oil and gas resource accounts for Canada. Whether capital is allowed to be written off fully (100 percent) against revenues or is depreciated in accordance with conventional accounting seems to be a contentious debate within economics. This discrepancy seems more of a difference of opinion between economics and accounting. For example, Smith's (1992) work on Alberta's energy resource accounts treats capital as an annual operating expense by allowing 100% expensing against income in determining rents plus a built in allowance for returns to capital. Born (1992) different approaches to capital using both the Smith approach and looking at accounting conventions for depreciating capital. There is no doubt that treating capital as an annual operating expense undervalues the resource to the province and thus distorts the assessment of whether the Crown is receiving a fair return (in terms of royalties and other fees) from the petroleum industry. Pragmatically it would only make sense to treat capital in a manner consistent with existing accounting conventions, which are used in determination of corporate income taxes. Some economists would however still stand on theoretical grounds supporting full expensing of capital. I believe common sense should guide the correct accounting stance. It can be said that regardless of the accounting stance taken in rent estimations, they should be consistent across resources and sectors.

We use the work of Smith (1992) and extend his rent estimates to 1995. Note that Smith treats capital expenditures as annual operating expenses, writing them off 100% against revenues. We estimate the economic rent value of a barrel of conventional crude oil at \$2.18 per barrel of production in 1995. Multiplying this figure against the remaining physical stock of reserves yields a current resource value of \$56.2 billion in 1995. I often argue that the more important information in the resource accounts is not the monetary estimates of rent and total value, but the physical accounts, which provide information on the trends in reserve life. The continued declines in reserves are cause for concern given that conventional crude production contributed roughly \$1 billion in net royalties to the Alberta government in 1995-96. Moreover, savings of oil and gas revenues in the Alberta Heritage Savings and Trust Fund have long ceased since the collapse of oil prices in 1986. The question raised is whether Alberta's revenue stream can be permanently compromised as conventional crude is exhausted and where sustainable income can be achieved given that earnings from the savings funds in fact being eroded through inflation and lack of investment of oil revenues?

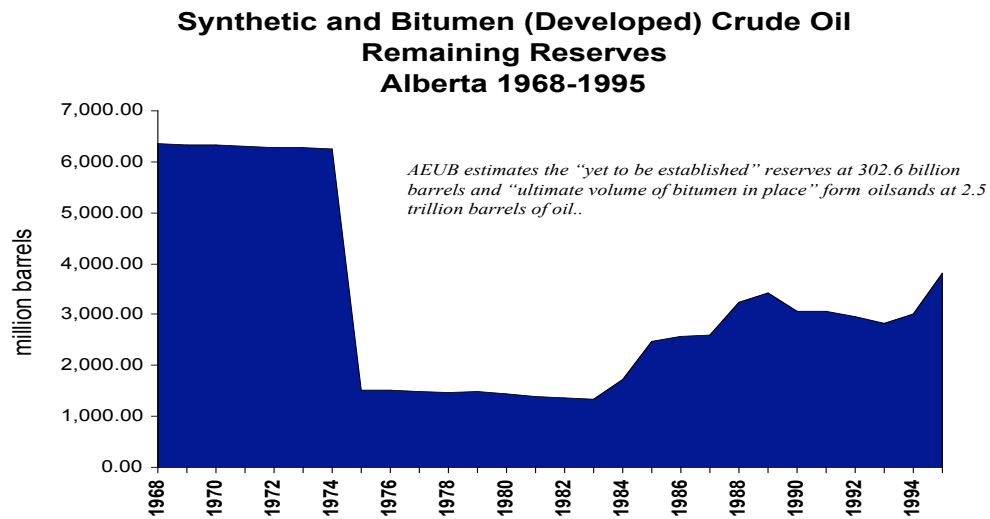
Synthetic and Bitumen Crude Oil from Oilsands

While conventional crude oil reserves have declined steadily over the past 30 or more years, synthetic and bitumen crude oil have played an increasing important role. Production from of crude oil from synthetic and bitumen reserves now accounts for 33 percent of total crude oil production in 1995. Production in 1995 was 156 million barrels compared with 356.8 for conventional crude. This will continue to increase as conventional crude reserves are drawn down. The total developed recoverable reserves of both synthetic and bitumen crude oil amounts to 605 million cubic meters or 3.8 billion barrels of crude oil. The Alberta Energy and Utilities Board estimates that a further "yet

to be established reserves”(reserves available through technological advances) total as much as 302.6 billion barrels or 48 billion cubic meters. The “ultimate volume of bitumen in place” (currently uneconomic to produce, however potentially available) is estimated by the AEUB at over 4000 billion cubic meters or 2.5 trillion barrels of crude oil.

Figure 3 shows the economic reserve life of only the developed portion of the synthetic and bitumen crude oil reserves primarily from oilsands. The chart indicates that the economic reserve life has remained steady at roughly 24 years over the past decade indicating a sustained supply of crude oil resources and just-in-time inventory of the mining operation. This reserve life figure, however, ignores the reality that there are thousands of years of actual established reserves. If one considers the economic reserve life using the *yet to be established reserves* we impute an economic life of 1,900 years at 1995 production levels. Thus Alberta is not likely to run out of oilsands any time soon nor will revenues generated from oilsands find the same depletion rate as conventional crude oil so long as the government is fiscally prudent in capturing an adequate return through royalties from this most valuable asset.

Figure 3



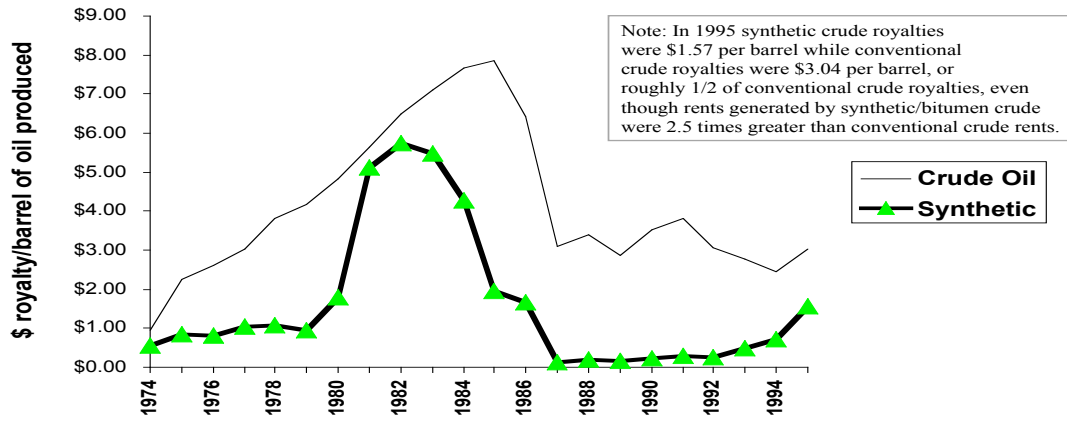
Source: Canadian Association of Petroleum Producers Statistical Handbook (1996).

The same preceding discussion of resource rent estimates applies to oilsands production. Using the Smith(1992) approach to rent estimation non-conventional crude oil produced rents of \$3.66 per barrel in 1995. Again, all cost data was taken from CAPP's Statistical Handbook, which provides operating and capital cost expenditure data. The economic value of the developed bitumen and synthetic reserve stock was estimated \$24.7 billion in 1995, using the rent estimate and reserve figures. Despite the promise of greater production and potential rents from non-conventional oil, resource royalties from the resource were only \$245.3 million in 1995-96 or 22.6 per cent of conventional crude royalties. The low rent capture through royalties is cause for concern as conventional reserves are estimated to be exhausted in 7 years and with royalty on synthetic crude so low. The primary question posed to government is whether nonconventional oil revenues from oilsands will offset a declining revenue stream from reduced conventional crude oil production? How should oilsands royalties be structured to ensure maximum rent capture by government while allowing for an adequate return to invested capital of capital-intensive mining operations? How should capital costs and allowances for returns to capital be treated in the determination of royalties and rents? Future and sustainable revenues from this non-renewable resource will depend on how the government constructs royalty regimes.

Figure 4 shows the trends in royalties per barrel of production for conventional and non-conventional oil production. The collapse of royalties for oilsands is particularly noteworthy following the collapse of oil prices in 1986. By 1995 oilsands royalties appear to be recovering vis-à-vis conventional oil royalties but will this continue?

Figure 4

Royalties per Barrel of Production Conventional Crude vs. Synthetic Crude Oil

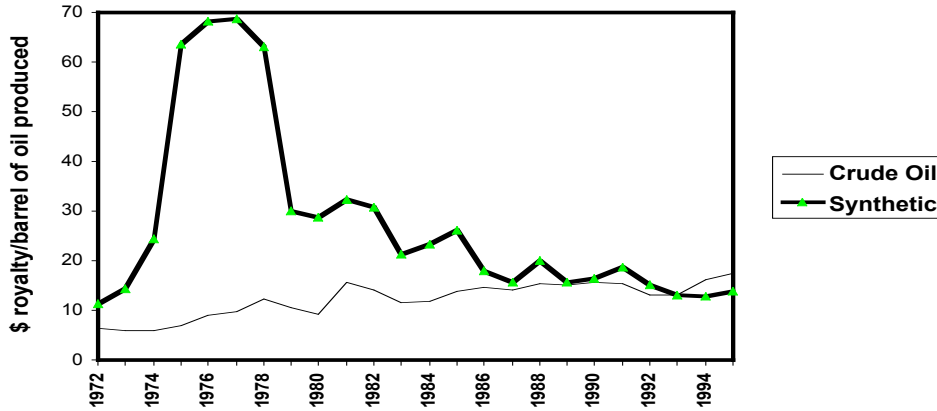


Source: Alberta Public Accounts and non-renewable energy natural capital accounts

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Comparing production costs between conventional crude oil production and oilsands yields figure 5. At least according to CAPP statistics oilsands production has become increasingly competitive. Figure 5

**Production & Capital Costs per Barrel of Production
Conventional Crude vs. Synthetic Crude Oil
(Constant 1986\$)**



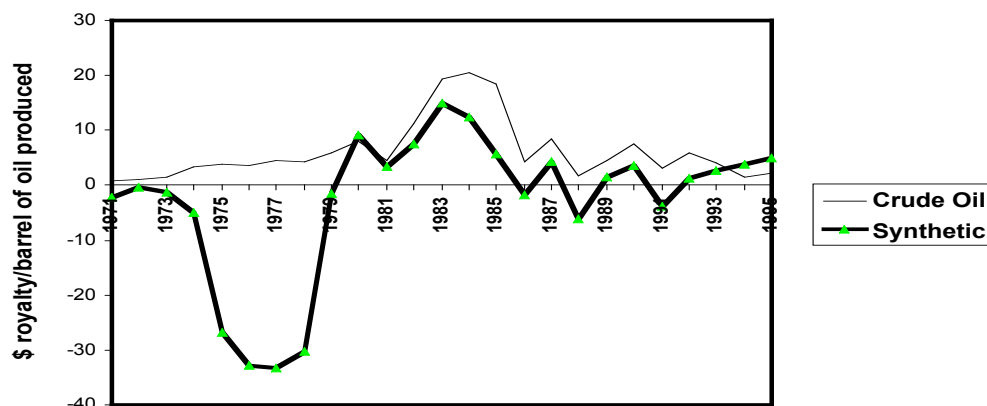
Source: Non-renewable Energy Accounts
Note: Costs of production include all production costs plus an allowance for returns to invested capital.

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Comparing economic rents (using the Smith approach) between oilsands and conventional crude oil yields figure 6. It would appear that economic rents are now more favourable than conventional crude oil, the first time in Alberta's history.

Figure 6

Resource Rents per Barrel of Production Conventional Crude vs. Synthetic Crude Oil



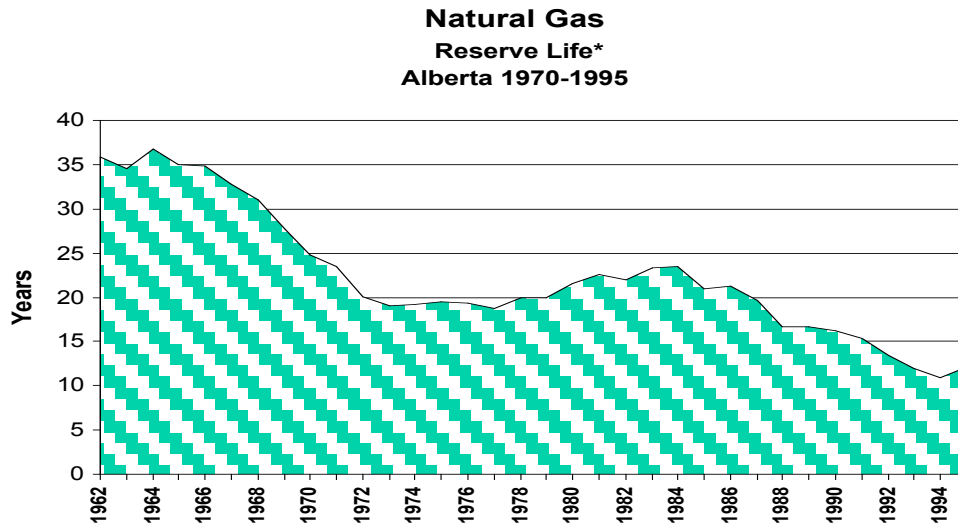
Source: Non-renewable energy capital accounts

Note: In 1995 synthetic crude royalties were \$1.57 per barrel while conventional crude royalties were \$3.04 per barrel, or roughly 1/2 of conventional crude royalties, even though rents generated by synthetic/bitumen crude were 2.5 times greater than conventional crude rents.

Natural Gas

The reserve life for natural gas reserves has also exhibited a steady decline from a peak in 1964 of over 35 years remaining production to only 12 years by 1995 (see figure 7). Production in 1995 was 129.6 million cubic meters. Should we be alarmed at this steady decline given that Alberta is now developing pipeline capacity to double the flow of natural gas across Alberta's borders? Should we be concerned as Albertans that one of the most strategically important resources for heating and reducing carbon emissions in North America exhibits a steadily declining reserve life? Some may argue that there are many gas fields yet to be developed in this province yet the reserve life shows continually decline. Where will new gas fields be found to replace the older and larger pools and at what marginal cost? Will the eastern slopes of the province become an active exploration area with enormous land use impacts? What about the feedstock for petrochemical producers reliant on natural gas? Rents generated from natural gas production were \$6.19 per cubic meter down significantly from previous years. The closing reserve stock is estimated at \$9.7 billion in 1995.

Figure 7

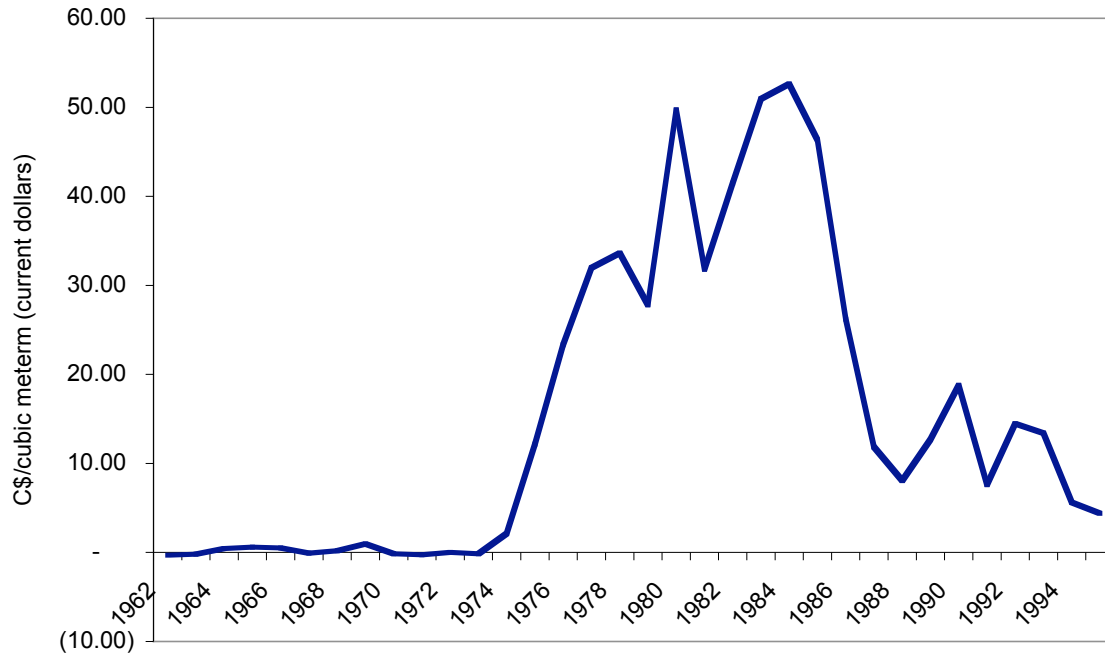


Source: Canadian Association of Petroleum Producers Statistical Handbook (1996).
* Reserve Life is calculated as the ratio of closing stock volume to annual production volume.

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The decline in reserves of natural gas is also problematic for resource revenues to the Crown since they account for more than \$500 million in 1995-96. Including revenues from gas byproduct production government revenues are amounted to \$1.18 billion in 1995-96. Figure 8 shows the trends in estimated resource rents per cubic meter of natural gas production for the course of history. In 1995 natural gas yielded an estimated economic rent of \$4.40 per cubic meter, a far cry from the peak of \$52.63/cubic meter in 1984 (see tables in appendix).

Natural Gas Rent Estimates



Liquid Gases from Natural Gas

Resource accounts for Alberta's liquid gas byproducts, including ethane, butane, pentanes, propane, and sulphur, were also derived. Data can be found in the appendices. Reserve lives range from 12.2 years for sulphur, 12.9 years for pentane, 14.4 years for propane, 17.9 years for butane, and 41.3 years for ethane in 1995. Resource rents also vary widely (see appendix for resource accounts for gas byproducts). Gas byproducts contribute roughly have of the \$1.18 billion in natural gas and gas byproduct revenues to the Crown. These resources are important to the Alberta economy.

Coal

The reserves of sub-bituminous (plains), metallurgical bituminous (mountains), and thermal bituminous (foothills) are enormous. Sub-bituminous coal, used for electricity production in Alberta, has a reserve life in excess of 1,200 years. Thermal bituminous is either exported or used in Alberta and has a reserve life of 607 years while metallurgical bituminous coal, exported for use in the metals industry, has a life of 134 years. Estimating the economic value of coal is complicated since the ERCB does not provide sale price data for coal. A price was determined using Statistics Canada data. Costs of production are even more difficult to determine and thus "guesstimates" were used using a certain formula. Using these formula, sub-bituminous stocks of coal would be valued at

\$49 billion and bituminous coal at \$16 billion in 1995.

There is little chance that Alberta will deplete its reserves of coal at current rates of production. Coal royalties also contribute relatively little to provincial revenues - only \$20 million in 1995-96.

So is Alberta Running Out of Nature's Non-renewable Capital

The answer to this question is in some cases yes and some no. Certainly when considering the reserve life of conventional crude oil, natural gas and several gas byproducts there are only a few years of remaining reserves left. This assumes of course the same level of production in future years and no new additions to the economic reserves. A recent article "What's Left: Western Canadian Reserves" in the March edition of *Oil Week* (March 1997; 19-23) supports our conclusions and estimates of dangerous low reserve lives. *Oil Week* found that there are 6.9 years of conventional crude oil and 12.6 years of natural gas, using the same definition of reserve life. The article also notes that only 16 percent of Alberta's original conventional oil reserves remain.

Some might discount such dire warnings as dangerous and misleading and that economics will dictate the entry of once marginal reserves into the economic reserve stock thus sustaining the reserve life of this non-renewable asset. But despite these assurances it is clear that, at least based on industry (i.e. CAPP) statistics, that the direction of the slopes in most conventional petroleum resources continues to be downward sloping. The key question is whether this will continue or whether the province will move to some kind of just-in-time inventory system whereby the reserve life is held steady at some nondeclining rate, say seven years. As noted, the key concern related to exhaustion of conventional petroleum resources is fiscal since the majority of oil and gas revenues for government come from traditional or conventional sources. With a steady decline in reserves and reserve life, what will the impact on government royalty revenues be and can nonconventional oil revenues (i.e. oilsands revenues) generate sufficient and sustainable income to offset declining conventional petroleum revenues?

Certainly in the case of nonconventional oilsands and inset oil reserves, the picture is very healthy. With reserves larger than Saudi Arabia's sweet crude oil reserves, Alberta's oilsands will last for hundreds if not thousands of years at current rates of extraction. This is also true in the case of sub-bituminous coal, which has supplies that seem to extend to infinity.

The following Figure 9 summarises the estimated economic reserve life and economic value of oil and gas natural capital as of 1995.

Figure 9

Non-Renewable Resource	Economic Reserve Life in 1996 (years)	Economic Value in 1995 (\$ billions)
Conventional Crude Oil	7.0	\$56.2
Synthetic and Bitumen Crude Oil *	21.5+	24.7
Natural Gas	12.1	9.7
Sub-Bituminous Coal	1,275	49.2
Thermal Bituminous Coal	607	16.5 (included in thermal figure)
Metallurgical Bituminous Coal	134	
Ethane	41	7.7
Butane	18	2.8
Pentanes	13	9.6
Propane	14	5.6
Sulphur	12	1.6
Totals		\$183.6 billion

- Note: The estimated “yet to be established reserves” of bitumen and synthetic crude oil are estimated by the AUEB at 48,080 million cubic meters or 302.6 billion barrels. This would last 1,900 years at current production volumes. The “ultimate volume of bitumen in place” is estimated by AEUB at 400,000 million cubic meters or 2.5 trillion barrels, an amount greater than the current total World “estimated ultimately recoverable” reserve of 2.0 trillion.

Has the Return on Natural Capital Production Been Sufficient?

The question of sufficiency of return on investment in natural capital to the Crown is an inquiry into resource rents generated and the collection of those rents through royalties and other taxes by government. Since the natural capital assets of the province belong to all Albertans, governments are obligated, as stewards and agents of the people, to ensure maximum returns to the resource entrusted to industry to develop. The answer to this question is complicated since it depends on how rents are calculated.

As already noted, the earlier resource rent calculations of Smith (1992) and Born (1992) in the case of Alberta’s petroleum resources, demonstrates the variety of approaches to determining

rents. The key difference between the two studies appears to be the treatment of capital costs and allowance for returns to capital. This also reflects differences of opinion between economics and accounting professions and even within the economics community. Common sense would suggest that capital be treated in a consistent manner across all industries without bias to any given resource sector. Prudence would also suggest that capital cost allowances in determination of rents (from which royalties should be derived) be consistent with accounting conventions for the depreciation of capital in determination of taxable income. There is considerable differences of opinions within economics as to the proper treatment of capital. Some would argue that in the application of a Resource Rent Tax for royalty instrument that capital be treated as an annual operating expense, that is written off at 100% in the year expensed. Others would argue that this presents a distinct bias to capital intensive projects and may distort behaviour of firms. More importantly such treatment of capital, particularly in the case of capital intensive projects like oilsands, could mean that governments would receive virtually no return in terms of royalties from natural capital production. This would be like a small businessman allowed to right off the full cost of his or her computer and new furniture every year against income thus potentially never paying income tax; or a farmer allowed to right of the full cost of farm equipment thus encouraging annual capital expenditures to ensure minimum or zero taxable income.

It must be noted that royalties are different than other taxes. Royalties are effectively a payment to the owner of the resource, the Crown on behalf of Albertans, for the right to exploit and develop natural capital assets. The Crown must act as a fiscally prudent agent in negotiating with developers the best price (royalty) for the right of resource access and development. It could also choose to develop the resource itself and thus become an equal player in resource development. This would provide the government an insight into the true cost profile of resource development upon which it could more informatively determine royalty payments. This is the case of Statoil in Norway, the state owned oil company which plays a major role in Norway's resource development. This goes with our Adam's family story. In the case of Alberta, the government does not play such a direct role as producer of the natural capital thus it must trust the industry to provide honest accounting of its costs and expected returns on capital investment. The real question is can the government be assured of maximum returns if it must rely on industry statistics for the determination of resource rents upon which royalties are levied?

This paper, because of its brevity, cannot possibly complete a full return on rent assessment but differs to the discussions of Smith (1992) and Born (1992) on the subject. However, note that neither Born nor Smith discuss or assess the thorny issue of whether governments collect a sufficient share of energy resource rents. Using their rent estimates we could compare royalties per unit of production with estimated resource rents generated from oil and gas production to ascertain a the performance of government in rent collection. As noted, the conclusion to this inquiry depends entirely on the accounting stance taken in the treatment of operating and capital costs. Smith's generous treatment of capital means that rents are smaller thus government's performance will look more favourable while Born's rent estimates where capital is depreciated will yield less favourable results.

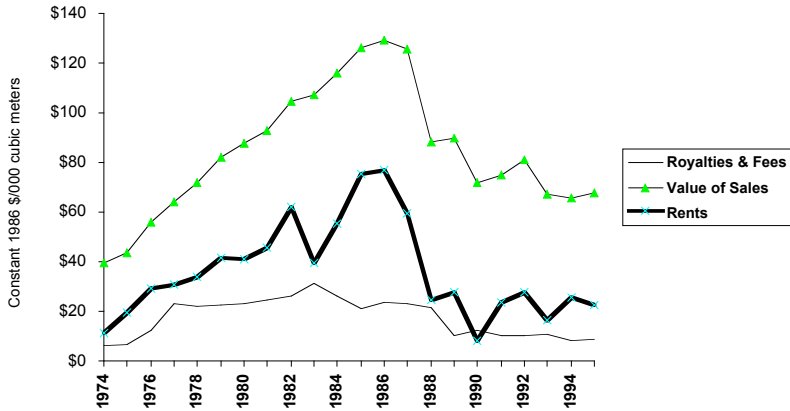
Taking the easiest approach we use the Smith (1992) approach to rent estimation including the generous treatment of capital costs in extending Smith's original estimates forwards to 1995. As per the tables in the appendix, there are discrepancies between our estimates and Smith's original due to apparent discrepancies in the operating and capital cost data sets. We use the CAPP Statistical Handbook as the source for our data but use the Smith methodology. The Born estimates are also shown in comparison (see appendix) and are notably lower in absolute value than our figures.

We estimated that over the study period 1962 to 1995, the government of Alberta captured an average 55.0% of available economic rents from the entire petroleum industry through royalties and taxes. This rate of capture varied considerably over the years. Again, notice that these are likely very liberal given the treatment of capital costs in determining rents. It is important to note that the rents retained by industry are in excess of normal rates of return to invested capital and include a generous provision for capital costs. We estimate that over this period 1962-1995 the estimated rents retained (i.e. not captured by government) by industry were roughly \$54 billion dollars. In other words, the Alberta government failed to capture \$54 billion in potential revenues that represented resource rents in excess of normal operating costs and returns to invested capital. This is an extraordinary figure. If this accumulated revenue had been invested in the Alberta Heritage Fund it would now be generating roughly \$4.32 billion in annual revenues at a long-term bond rate of 8.0%. As we will note earlier, such a revenue stream would have more than offset the need to cut government expenditures when Premier Klein took power in 1992 faced with a fiscal deficit.

We then estimated the resource rent capture for conventional crude oil, oilsands and natural gas over the study period. Rent capture for conventional crude oil through royalties (not including royalty tax credits) averaged 85% of available rent. In the case of oilsands this was a mere 15% of available rents and for natural gas 52% of available rents (see appendix for tables).

The following Figure 10 best illustrates the trend in resource rents, royalties and fees and value of petroleum sales for all non-renewable energy, expressed in constant 1986 dollars. This shows clearly that in virtually every year since 1962, excess rents have been retained by industry.

Non-Renewable Energy Revenues, Rents, and Value of Sales per Thousand Cubic Meters of Total Resource Production* (in Constant 1986 \$)



Source: Canadian Association of Petroleum Producers.

* Includes conventional crude oil, synthetic/bitumen crude oil, natural gas, gas by-products volumes of production in thousands of cubic meters. Non-renewable revenues are net of tax credits. Delfated using Alberta GDP Implicit Price Index₁

Some economists might argue that it is normal for industry to retain excess rents over and above normal coverage of operating and capital costs (including a return on invested capital) since this encourages reinvestment and new development. The key question is how much excess rent should be retained by industry and how much should the government attempt to capture before industry begins to consider alternative investment choices? This becomes the realm of political economy and negotiation prowess of the industry vis-à-vis government over a fair sharing of resource rents.

The evidence revealed here suggest the government could adopt more rigour to estimating annual returns on invested natural capital through such rent estimates. More importantly the values at risk are so significant that they warrant such scrutiny. It is ironic that the government does not adopt a process by which it annually audits the cost profile of corporations, which develop Alberta's non-renewable resources, which it could conduct through the arms-length service of reputable chartered accounting firms. Certainly our \$54 billion back-of-the-envelope calculation, using industry data and generous cost allowances, suggests that a small investment in such a resource rent audit process is warranted.

What is Our Rate of Savings Sustainable?

Dealing with the subject of sustainable income derived from non-renewable resource use extraction must assess the degree of savings of royalties and other fees derived from resource use development. This requires an assessment of the financial capital reinvested in alternative forms of sustainable capital, be they renewable forms of energy or human and social capital that will generated a sustained income stream once the oil and gas is depleted.

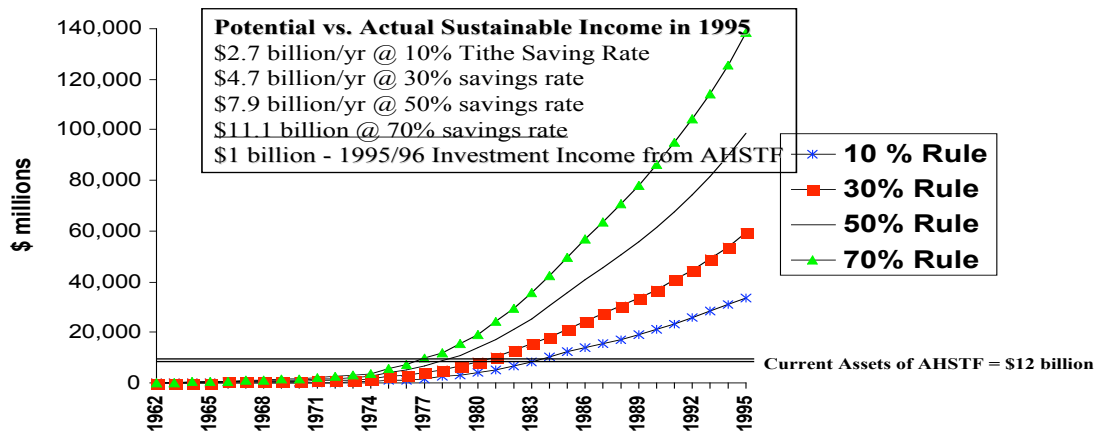
Smith (1992) deals with the issue of the savings rate in the Alberta Heritage Savings and Trust Fund. Smith concludes that up until the mid-1980s the government was investing robust amounts of energy royalties into the fund that would yield healthy financial returns in the future. However, with the collapse of oil prices in 1986 the savings discipline of the government collapsed. The Heritage Savings and Trust Fund stagnated at roughly \$12 billion dollars. Indeed Alberta began to borrow from abroad to finance current government program spending as well as using annual interest earnings from the Trust Fund for current expenditures. We refer the reader to Smith's analysis and discussion of the performance of the government with respect to its savings behaviour.

As previously noted other jurisdictions can be used as benchmarks royalty savings rates. For example, royalties saved in petroleum funds range from Norway's 100%, Libya's 70%, Alaska's 50% (new oil)/25% (old oil), and Alberta's original AHSTF rate (30%). Alberta initially chose a figure of 30 per cent (more recently zero) at the inception of the Alberta Heritage and Savings Trust Fund. Norway has recently attempted 100 per cent royalty investment and Alaska's Permanent Fund has attempted a 50% savings rate. Performing such sensitivity analysis on alternative rules of thumb allows us to assess what kind of sustained income Alberta might have today had it adopted such savings rate as early as 1962.

Using common sense approach to the issue we estimated what different rates of savings of Alberta's oil and gas royalty and related taxes/fees would have generated in annual interest income dating back to 1962. The results are intriguing. Figure 11 shows that had Alberta saved at a rate of 10% its royalties and fees from oil and gas production between 1962 and 1995 it would have build up financial capital stock that would be now generating \$2.7 billion per annum (based on a long-term bond rate of 8% per annum). At a 30% savings rate (Alberta's original objective), an annual income of \$4.7 billion per annum would now be flowing from the fund over the period 1962-1995. At the Alaskan rate for new oil (50% savings), \$7.9 billion per annum would be flowing from the Heritage Fund and at the Libyan savings rate (70%) an astounding \$11.1 billion per annum would be available for Albertans for discretionary spending. This is in stark comparison to the mere \$1 billion in 1995/96 that the Heritage Fund generated. These are not insignificant and would have meant that Alberta could have avoided the dramatic budgetary cutbacks it felt forced to incur in 1992 when Ralph Klein came to power. Combined with our earlier findings of \$54 billion in accumulated foregone rent to the energy industry, our Heritage Fund would have been considerably more robust and generating what might be accurately be defined as a sustainable income stream.

The second important question is whether any of these non-renewable resource revenues were being reinvested in alternative, renewable energy. The general answer to that question is that while government did have some programs dedicated to energy efficiency the investment in renewable energy research and development were small if not non-existent over the period of study. One might argue that because of the longevity of oilsands and coal Alberta has the luxury of avoiding such a sustainable income future. Conversely, one could argue that Alberta had and still has the luxury of investing in alternative energy forms given the financial wealth being generated

Potential Sustainable Financial Wealth Based on Royalty Savings Scenarios



Source: Figures are derived assuming 30%, 50%, and 70% savings of annual royalties, investing these in a heritage fund, compounding at 8% interest rate per annum.

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from fossil fuels. It is really a matter of political will and choice. Alberta could choose to be both a leader in non-renewable resources for the world plus a leader in renewable energy production thus becoming a world leader from a total energy perspective.

Renewable Natural Capital: Forests, Wildlife, Soils, Air, Water.

We have spent the majority of this discussion focused on non-renewable assets. Sustainable development is clearly more about the sustaining of renewable resources -- forests, agricultural land (soil), air, water, wildlife and biodiversity. The author has conducted preliminary inquiries into the sustainability of Alberta's forests and forest carbon sequestration accounting for the stock, flow and value of timber capital and the carbon stock and sequestration rate of forests and peatlands (see Anielski, 1996, 1992, 1992). The primary focus of a time capital account is to determine whether the income stream (growth of capital stock) is sustainable relative to the depletion rate (harvesting, land use changes, and natural causes, such as fire, insect, and disease). To sustain timber capital it is necessary to sustain the annual interest or allowable cut from the original timber capital base. So long as the consumption of timber does not exceed the annual growth of new timber volume, then in principle the capital stock is being sustained and we are only living off the interest of nature's capital. If however, we choose to deplete the natural capital stock at a rate greater than the natural growth or natural rate of interest, then we are knowingly depleting or cannibalising the capital base. There is a draw back to focusing too narrowly on timber as the sole source of forest capital. This may ignore the ultimate goal, which is to sustain the productive capacity of the entire forest, namely the forest soils, upon which a healthy timber stock depends. Also, other non-timber benefits, such as clean water, wildlife, clean air, carbon fixation, that must be accounted for in a holistic perspective on the forest. The construction of these accounts and for a more holistic ecosystem sustainability accounts are works in progress.

The forest account includes a timber volume and forest area physical account and a monetary account for the volume component. Additions to the stock of timber capital include the natural

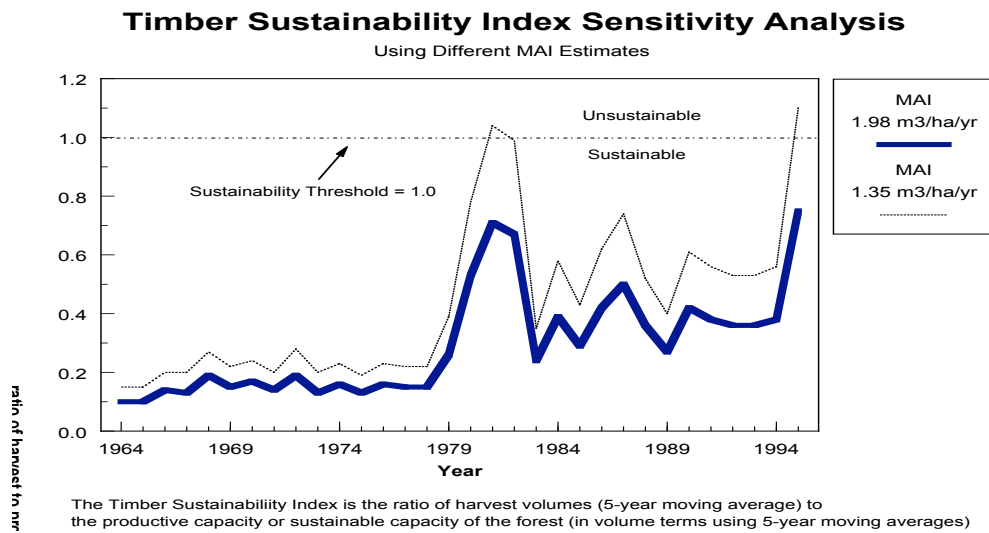
growth rate of the timber growing stock plus reforestation volumes. Depletions of the stock includes harvesting, fire, insect/disease, and losses to alternative land use. The net change is then calculated as the difference between additions and depletions. The monetary account is developed by determining the economic rent generated for all timber capital consumed in any one period. The rent figure should be a blended figure weighted by the relative consumption of timber capital by Alberta' lumber, pulp and paper, newsprint, and panel board industries. This is an extremely challenging task given the absence of sound financial data on production and capital costs for forest producers in Alberta. Previous estimates from Anielski (1991) for forest economic rents provides a basis for forest rent figures, however, these figures have not been updated to 1995. This would require an exhaustive study of production and capital costs since 1991 in Alberta' forest industry. Needless to say, we do not attempt forest rent calculations in this paper simply because we are satisfied that the physical stock is more than sustainable.

Without getting into too much detail, some observations are important. First, the sustainability of timber capital depends most importantly on the growth rate or interest on the timber capital stock. It is worth noting that since the first Alberta timber account was estimated, the estimates of timber growth rates for the province have changed considerably. Originally, provincial foresters were reluctant to provide an annual growth estimate at the provincial scale noting that such a figure did not exist and any estimate would be invalid. This was remarkable since it seemed to imply that we had no definitive idea of whether Alberta's forest capital was sustainable or not. While we did have accurate depletion data (harvesting, land use, seismic cutting, fire, insect and disease) we lacked accurate growth estimates. Traditionally we have relied on one single figure, the Annual Allowable Cut (AAC), as the basis for determining sustainability. The AAC is determined by forest timber supply modellers and makes many assumptions about growth and disturbance rates. To the extent that harvest rates do not exceed the AAC means that the province is not exceeding the sustainability threshold as defined by the AAC.

When the first timber account was constructed the estimated provincial growth figure (the Mean Annual Increment- MAI) used was 1.35 cubic meters/hectare/year. This was based on the best estimates of federal and provincial growth experts, even though no official provincial MAI existed. By 1996, when the third timber accounts were constructed, the province had completed a timber supply study and for the first time issued a new provincial average growth figure of 1.98 cubic meters/hectare/year or nearly 2.00 m³/ha/yr. This significant difference between growth rates used in the 1992 account versus the 1996 account made a considerable difference in the conclusions of sustainability (see figure 12). The earlier accounts revealed that Alberta in several years breached the sustainability threshold for timber capital due primarily to the impact of fires but compounded by increasing allocations of timber for harvesting. The earlier studies warned that the trends toward breaching the sustainability threshold (where depletions exceeded annual growth or interest on capital) was evident and continued allocation of timber for industrial harvesting combined with the ongoing risk of catastrophic fires could put Alberta's timber capital in sustainability jeopardy. However, the new provincial growth figure solved this problem overnight. The main question remains: can we be certain about the growth of the entire provincial timber capital stock given that

this is the most vital component of ensuring sustainability?

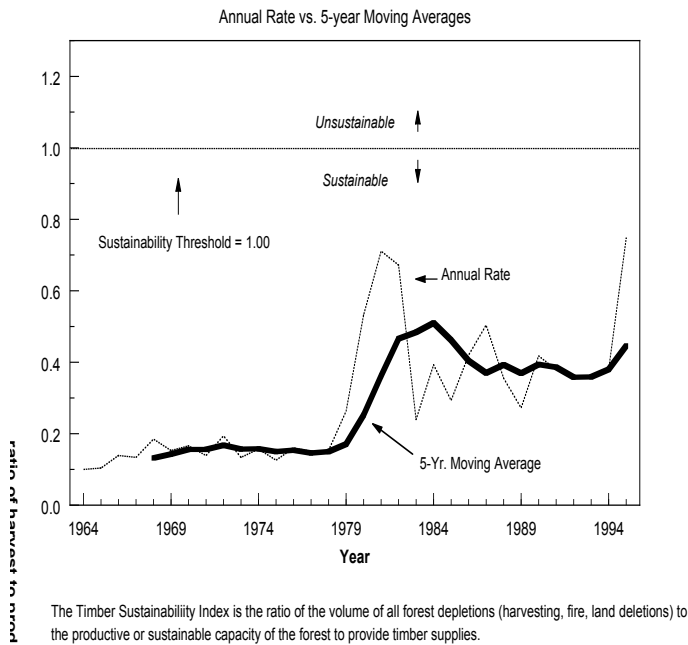
Figure 12



The 1996 timber account for Alberta reveals that Alberta’s forests appear to be on a sustainable path (see Figure 13). Figure 13 shows the “timber sustainability index” – the ratio of annual growth to annual total depletion rates (harvest, fire, and land use). Though this could quickly change depending on the impact of catastrophic fires or impacts of climate change that could dramatically change the timber capital stock available for sustainable harvesting. This can be seen clearly by the spikes in the sustainability index in the peak fire years of the early 1980s and again in 1995.

Figure 13

Timber Sustainability Index (1964-1995)



In a paper (Anielski, 1992) presented in Stockholm, Sweden at the International Society for Ecological Economics conference in August 1992, the author presented preliminary findings of carbon sequestration accounting for Alberta's forests and peatlands. Based on estimates of the sequestration rate of Alberta's growing timber capital stock and stock of forest peatlands, estimates of the potential annual carbon sequestration rate related to the annual net increment (growth) of timber and net increment of peat were made. The findings revealed that in 1990:

“Alberta's growing stock of timber for 1990 (by species), the carbon contained per cubic meter of green wood, and the total tonnes (millions) of carbon in Alberta's provincial forests. The total C equivalent sequestered by Alberta's provincially managed forests is estimated to be 7.28 million tonnes (Mt) of carbon. Including federal, provincial reserves and other forest land (most of it reserved in parks and Indian reservations) an additional 0.89 Mt of C is sequestered. Therefore, the total C sequestered by Alberta's forests is roughly 8.17 Mt. Using 1988 figures for Alberta's CO₂ emissions of 33.9 Mt. C equivalent suggests that Alberta's forests absorb or sequester roughly 24 percent of the total CO₂ emitted.”

This means that every cubic meter of growth increment of Alberta's total forest growing stock is fixing a total of 8.17 Mt of C in 1990. Alberta's peatlands, which contain vast quantities of stored carbon, sequestered an estimated net 1.13 Mt/yr. of carbon.¹⁵ Combined with the forest total an

¹⁵ There is some debate amongst carbon scientists as to whether peatlands are carbon sinks or sources. There is consensus, however, that peatlands do contain vast quantities of stored carbon and that any disturbance of peatlands would lead to the release of stored carbon exacerbating the atmospheric carbon build up problem.

estimated 9.3 Mt/yr. of sequestered by Alberta's forests and peatlands. This total equates to roughly 27.3% of total anthropogenic emissions from Alberta's industries, households, and farms.

It is important to point out that the forests and peatlands, which cover 60% of the provincial land base, only have the **capacity** to sequester less than 30% of total human-related emissions. This does not mean that the forests-peatlands are actually capable of sequestering anthropogenic any of our emissions. What if forests and peatlands are already in a kind of equilibrium, which precludes them from sequestering new, sources of carbon other than that which is naturally cycled within the forest-peatland ecosystem? This would mean that human-related C emissions are being exported to the atmosphere or other parts of the globe. No matter what the accounting stance, Alberta is a huge net exporter of carbon. We should thus be cautious to conclude that the forests are capable of sequestering any of the 33.9 Mt C we emitted in 1990. Moreover, we should be realistic in our assessment of the benefits of forest and land management practices (including planting of bare land) in hopes of increasing carbon sequestration for Alberta to deal with our carbon export problem. That is not to say that such practices should not be encouraged, only that they represent an insignificant dent in the carbon challenge.

Using the carbon values study of van Kooten, Arthur and Wilson (1992), we can estimate the value of sequestration services by forests and peatlands in their current state. Using their range of values (based on the marginal costs of reducing CO₂ emissions) for British Columbia, van Kooten (1992) uses a range of carbon values from \$20/tonne/yr to \$50/tonne/yr to \$300/tonne/yr of sequestered carbon. Using these values with the estimates of C sequestered by forests indicates that Alberta's forests contribute a valuable service to carbon absorption in 1990 ranging from \$163 million, to \$409 million to \$2,451 million, depending on the carbon value used. The economic value of carbon fixation services of peatlands ranges from between \$23 million to \$339 million per annum, using the same values as for forests. Therefore, the combined value of services of Alberta's boreal forests and peatlands in carbon fixation could range from between \$186 million to \$2,790 million per annum, depending on the value of these services used. These carbon values are significant in comparison with the economic contribution of Alberta's forest industry which in 1990 contributed \$807 million to Alberta's GDP.

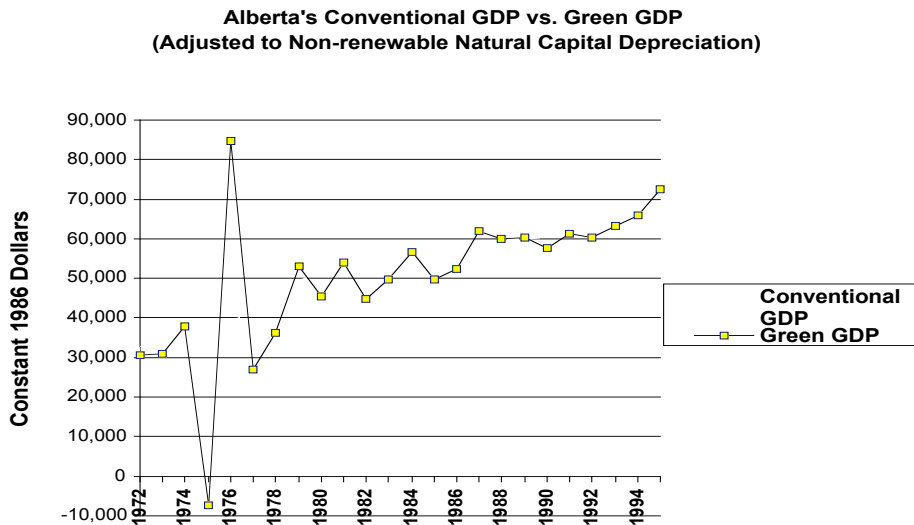
The forest account is by no means complete. As it stands it considers only timber. A forest eco-system is far more complex and future resource accounts should attempt to account for the complexity that constitutes a forest ecosystem with its flora and fauna. The sustainability of a forest cannot be assured simply by focusing on the sustainability of timber growing stock. A forest ecosystem account would consider both the stock, flow and values of non-timber capital but also the interrelationship of various components of the forest ecosystem that considered as a whole constitute the wellbeing and thus sustainability of the system.

Other accounts should also be considered for Alberta including agricultural soil accounts, that consider the productivity of soil (how has natural productivity changed), soil erosion, loss of prime arable land. Water accounts should be constructed that consider both the quality and flow rates of

groundwater and surface water, by watersheds. Air accounts that consider emissions and air quality by various airsheds in the province. Wildlife accounts that account for the state (population, habitat, habitat fragmentation, and overall health) of all species. Toxic waste accounts that monitor the stock and state of toxic waste streams and storage facilities. Other accounts that are possible relate to the construction of “ecological footprint” accounts that monitor the amount of land/nature’s resources required or appropriated to fulfil the needs and demands of each Albertan for food, clothing, fuel, and shelter. Such an ecological footprint account would be tied to the natural capital stock and flow accounts to ascertain the import-export trade of natural capital required to maintain Albertans standard of living. Such accounts would also reveal our current ecological deficit or surplus as a province and thus help us determine the nature and extent of future economic development of nature’s capital and also how to live sustainably off of nature’s capital with reduced import requirements. Taken together these accounts could form an integrated set of natural capital accounts that in essence mimic the ecosystems themselves and would provide us a robust guidance system for tracking sustainability, as we intuitively understand the concept.

Revisions to GDP from Non-Renewable Resource Depletion

The ultimate end to the resource accounting exercise is for the inclusion of natural capital accounts into the system of national accounts from which the gross domestic product (GDP) figures are derived (see Figure 14). The intent to derive an adjusted or “green GDP” figure when the



Source: Alberta Economic Accounts - 1995 and Non-renewable natural capital accounts..

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depletion of natural capital is properly account for as a depreciation expense. Revisions to Alberta’s income accounts for the net change in physical capital of non-renewable and renewable resources requires an adjustment equal to the economic value of the net change in the physical

supply. Based on the monetary accounts developed from non-renewable resources, Alberta's conventional GDP figure would have been adjusted upwards in some years (due to positive net change in resource stocks) or downwards (in years of negative net changes). Figure 14 shows this adjustment. For example, in 1995 GDP would have been adjusted upwards by 3.6% (understated) but in 1978 GDP would have been overstated by 18%.

While such results are interesting and the revised GDP figures important, the importance of the resource accounts for Alberta is revealed in the information on the sustainable nature of natural capital. Such resource accounts would provide important information to policy makers to ensure that Alberta was pursuing a path of resource development that was truly sustainable. Just as companies keep physical inventories of their stocks of resources and assets, so should provincial and federal governments account for the stock, flows, and values of their most important common assets: nature's capital. As yet, no such accounts exist for Alberta nor is any move to construct them. As is evidenced in this paper, such accounts would reveal important information on the sustainability of Alberta's 'renewable and non-renewable natural capital, which is the basis of Alberta's comparative advantage.

Conclusion

This paper examines the complex issue of the sustainability of Alberta's natural capital assets: forests, oil, gas, coal, carbon, and other natural capital. Based on the evidence revealed by the preliminary accounts constructed for non-renewable petroleum resources and renewable forest resources, Alberta would be wise to construct and utilise natural capital/resource accounts for the prudent and sustainable management of Alberta's natural resource assets.

Determination of sustainability with respect to non-renewable resources is complicated by the fact that we are dealing with resources that are ultimately finite in their supply. No matter how much more oil, gas and coal we discover, there is only so much that will ever be discovered, much of which will be uneconomical. Based on the resource accounts for oil, gas and coal the evidence suggest that Alberta is progressively depleting its most valuable (from a royalty revenue perspective) assets; conventional crude oil and natural gas. With reserve lives of less than 7 years for conventional crude oil and only 12 years of natural gas, the province should be thinking ahead to a time when these resources will be depleted and their associated revenue stream to provincial coffers. While the case can be made that the oilsands resource will provide hundreds of years of production and royalty revenues, this resource must also be managed prudently as we transition from traditional resources to nonconventional energy sources. The key question with respect to oilsands is not supply but ensuring adequate returns on investment to the Crown through royalties and other fees from this most valuable resource that rivals Saudi Arabia's conventional oil reserves.

However, in the case of non-renewable resources the key test of sustainability is that of testing for sustainable income. As we illustrated it is apparent that sustainable income has not been a priority for the province neither has reinvestment of oil revenues to renewable alternatives. While in the early stages roughly 30% of energy resource revenues were being saved in the Alberta

Heritage Savings and Trust Fund, with the collapse of oil prices in 1986 Alberta has failed to make any savings in the Alberta Heritage Savings and Trust Fund. Thus the Fund is stagnant at roughly \$12 billion generating a mere \$1 billion in interest and other revenues. This is a far cry from what might have been possible had the province consistently saved 30% of royalty revenues from 1962 to 1995. As noted the revenue stream that financial capital would produce today would have been sufficient to offset the budget cuts begun in 1992/1993. Moreover, had Alberta adopted the more ambitious savings rates of Norway (100%), Libya (70%), or Alaska (50%) significant financial returns would now be available for funding a sustainable income stream for reinvestment in sustainable capital.

Revisions of Alberta's GDP (gross domestic product) figures are possible using the monetary accounts from the natural resource accounts. Alberta's GDP figures adjusted for non-renewable energy capital suggest that in some years GDP was over estimated while in others it was underestimated depending on whether there was a net depletion or increase in the economic reserves of oil, gas, and coal. The adjusted GDP figures are less interesting and important than the physical and monetary accounts themselves.

The monetary accounts reveal interesting information about the economic rents generated from the production of natural capital assets. Depending on the manner in which economic rents are calculated, one can then use the rent figures to ascertain whether the province was collecting a sufficient return, in terms of royalties, fees and taxes, from the industry. This study shows that over the period 1962-1995 the province collected roughly 55% of available rents. It was theoretically entitled to 100% of rents given that rent estimates already build in allowances of operating costs, capital costs (a generous 100% capital write off provision) and returns to capital investment. We estimate that the accumulated amount of rents retained by industry over the period amounted to some \$54 billion. Such a financial capital stock might now be generating \$4.3 billion per annum based on a long-term bond rate of 8% p.a. return.

The answer to the question of whether Alberta's forests are sustainable is mixed. Previous timber accounts of the author in 1992 revealed that sustainability was not assured given that the sustainability threshold had been breached in a few cases and that the risk of catastrophic fires and continued allocation of harvest rights may lead to a permanent compromise of timber sustainability. However, recalculations of the timber account in 1996 using new and more generous provincial growth figures from the Alberta Forest Service changed in picture of sustainability entirely to one, which posed no immediate concern for timber sustainability. The dramatic change in the provincial growth figure is cause for concern given the importance of this figure for assessing timber sustainability.

Preliminary accounts for carbon sequestration by Alberta's forests and peatlands reveal that their sequestration capacity is equivalent to only 27% of total emissions from human-industrial sources. But this does not suggest that the forests and peatlands actually have the capacity to sequester any of the 33 Mt of C emitted in 1990 given that these systems are already likely in a

steady state of carbon cycling. The economic value of Alberta's forests and peatlands in sequestering carbon is significant, depending on how you value a tonne of carbon, rivalling the contribution of the forest industry to Alberta's GDP.

These preliminary natural resource accounts for Alberta suggest tremendous utility in the information they contain for guiding Alberta towards a sustainable future. The main challenge is having decision makers appreciate and embrace the importance of such accounts for managing the comparative advantage of Alberta's natural capital assets.

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Appendix

Tables and Data