Advisory Committee Report on Used-Tire Management

Review of Alternatives to TDF

October 31st, 2007

Executive Summary

The Minister established an Advisory Committee on July 13, 2007, to evaluate available management options for used tires in Nova Scotia. The Advisory Committee's work was to be separate and distinct from the request for proposal (RFP) process carried out by the Resource Recovery Fund Board (RRFB). It was broader in scope and premised on providing decision makers with a comprehensive review of management options. The terms of reference outlined the roles and responsibilities of the Advisory Committee on Used-Tire Management as created under authority of Section 9 of the Environment Act. The four individuals named by the Minister to serve as members of the committee: Dr. Louis LaPierre chair, Mrs. Judy McMullen, Dr. Mark Gibson, and Dr. Wilbert Langley.

The committee members agreed that tire derived fuel (TDF) is a waste tire management option which has been used to offset fuel choice in many industries since 1979. However, since 1992 various other management options have been developed as alternatives to TDF which do provide viable options. These options when considered within the universally accepted recycling model of the three "R's" can represent a high degree of economic and environmental sustainability as well as a high degree of social acceptability.

Given the terms and conditions of its mandate, the committee did not conduct a critical review of the Dalhousie study. They did review the report with Dr. Pegg and accepted the conclusions as the premise for their assessment.

Should TDF remain the preferred option of waste tire disposal for the Government of Nova Scotia, the committee members agree that the recommendations included in the Dalhousie study must be implemented prior to the granting of an operating permit to burn used tires at the Lafarge plant in Brookfield. The committee would also suggest that a baseline monitoring program be implemented to collect data for soil, air, surface water and ground water prior to permitting of TDF at the Brookfield plant.

Given the level of concern which have been expressed by the citizens living close to the plant, the committee would suggest that the current citizen advisory group should include citizens who reside close to the plant and that consideration be given by the Nova Scotia Department of Environment and Labour (NSDoEL) to ensure that the mandate of the committee allows them to

function as an independent body to review the results of the monitoring program. The committee should have the ability to report and have NSDoEL react to any discrepancies.

The committee members concluded that there are additional options to the TDF option. Tire Recycling Atlantic Canada Corporation (TRACC) has demonstrated that with approximately 800,000 tires they are running a profitable labor intensive operation while employing 35 to 45 individuals in an area of chronic high unemployment. They have aggressively developed niche markets for their products and currently they are using all of the tires which are discarded in New Brunswick. Given the expanding markets for some of their products, particularly the commercial and industrial rubber mats, they will need to find an additional supply of tires to meet these emerging demands. TRACC and Royal Mat officials indicated that they currently supply only 0.5% of the demand for industrial and commercial mats. Given the current high price of oil, it is conceivable that the use of crumb rubber for these products will remain strong over the coming years.

Royal Mat in Quebec has developed a more aggressive industrial model and they are currently producing a variety of products for the North American markets. The production of truck mudguards along with commercial and industrial mats currently using the greater majority of their used tire rubber. They are looking for additional tires and they have indicated that they are willing to take all of the used tires from Nova Scotia for their processing plant.

In assessing the current demand for many of the products which are produced by TRACC and Royal Mat, it is conceivable that a well managed, innovative and aggressive company could transform the used tires produced in Nova Scotia into usable secondary products. However, given the recent trends in using used tire shred for civil engineering applications, the committee believes that the Province should explore the possibility of focusing its efforts in developing a niche product for this sector. There is an increasing demand for lightweight fill to fill a growing need of civil engineering products. Currently most of these products are imported from outside the Province at high costs. It is possible that the Province, if it chose to follow this option, could become the focal supply point for Atlantic Canada in providing lightweight engineering fill. This option would certainly support the goals and objective of the ***Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"***.

One of the benefits of such an option is that it uses a limited amount of energy as the process involves only the crushing of the tires in variable shred sizes. It is also conceivable that this type of operation could be integrated within one of the larger aggregate companies in the Province and could serve as a value added product to their present productions. As a side benefit, tire shreds could also be provided for the landscaping industries.

The committee members agree that the following could serve as alternatives to TDF for the management of waste tires in Nova Scotia. The members have divided the alternatives in two groupings, one which provides an out of Province solution and the other which identifies option for solutions which could be developed within the Province.

Out of Province Alternatives:

- Tire Recycling Atlantic Canada Corporation (TRACC), Minto, New Brunswick.
- Royal Mat, Quebec.

In Province Alternatives:

Reuse Option:

- Tire Retreading Industry in Nova Scotia.

Recycle Options:

Lower energy input:

- Use of rubber from used tires for lightweight engineering fill.
- Use of Tire Chips for On-Site Domestic Wastewater Systems.
- Use of recycled waste tires for the manufacture of landscaping mulch.

Higher energy input:

- Use of recycled waste tires for the manufacture of roofing shingle and shakes.
- Use of recycled waste tires for the manufacture of animal mats.
- Use of recycled waste tires for the manufacture of playground and other sports related tracks.
- Use of recycled waste tires for the manufacture of construction & transportation associated products.
- Use of rubber from used tires for the production of asphalt rubber.

Technology which need additional assessment for energy requirements along with stack emissions:

- MedNova Tech International Ltd.

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1.0 Advisory Committee on Used-Tire Management

1.1 Preamble

Nova Scotia's Solid Waste Resource Management Strategy is premised on environmental protection, wise and efficient use of resources, and the development of economic opportunities. Used-tire management is part of the Province's waste management strategy.

The Resource Recovery Fund Board (RRFB) has managed Nova Scotia's used-tire program (900,000 tires annually), through three contractors since 1996. The management program has included tire collection, processing, and shipping of a percentage of tires to Quebec for tire derived fuel (TDF) applications.

In July 2006, RRFB put out a request for proposal (RFP) to new prospective contractors to manage used tires in Nova Scotia. Short listed bids were evaluated on the basis of technical quality, environmental, social, and economic impacts; and in January 2007, RRFB authorized its CEO to initiate discussions with the successful bidder, Lafarge North America.

RRFB's decision stated that the contract would be subject to Lafarge obtaining necessary environmental approvals from the Nova Scotia Department of Environment and Labour (NSDoEL).

An approval from NSDoEL is required, but no application from Lafarge North America has yet been received.

NSDoEL contracted with Dalhousie University to assess the implications of Lafarge's proposal and to prepare a resource report for use in evaluating any applications to use TDF in Nova Scotia. The Dalhousie report was submitted to the department indicating that TDF vis-à-vis the Lafarge proposal is a viable option.

In light of a recently announced goal to further reduce waste disposal in the Province, NSDoEL is considering renewal of the Solid Waste Resource Management Strategy; it was therefore decided to step back and conduct a broader analysis of all the innovative options (along with TDF) available for used-tire management before deciding on the appropriate option for Nova Scotia.

1.2 Mandate of Advisory Committee

The Minister established an Advisory Committee to evaluate available management options for used tires in Nova Scotia. The Advisory Committee's work was to be separate and distinct from the RFP process carried out by RRFB. It was to be broader in scope and premised on providing decision makers with as comprehensive a review of management options as is possible. The terms of reference outlines the roles and responsibilities of the Advisory Committee on Used-Tire Management as created under authority of Section 9 of the Environment Act.

1.2.1 Advisory Committee Purpose

The purpose of the Advisory Committee on Used-Tire Management was to identify and evaluate options for used-tire management for the Province of Nova Scotia.

- The Advisory Committee evaluated management options including, but not limited to:
    - TDF applications
    - Recycling applications
    - Engineering applications

- The Advisory Committee used the following parameters in evaluating each management option for application suitability in Nova Scotia:
    - Environmental implications, including greenhouse gas emissions
    - Human health implications
    - Economic sustainability, including implementation feasibility and cost to consumers

- The Advisory Committee reported to the Minister, its findings and recommendations on management option(s) to undertake in Nova Scotia.

1.2.2 Operating Principles

The Advisory Committee:

- liaised with NSDoEL in accessing information resources, research, technical, and other support needed to execute its task;

- maintained open communications with the Department and kept the Department updated on key task milestones;
- liaised with innovators and stakeholders where deemed necessary;
- worked toward consensus whenever possible;
- adhered to the specific time-frames where possible;
- abided by these Terms of Reference.

1.2.3 Committee Members

The following four individuals were named by the Minister to serve as members of the committee: Dr. Louis LaPierre chair, Mrs. Judy McMullen, Dr. Mark Gibson, and Dr. Wilbert Langley. The members have a wide range of experience in the fields of environmental management, human health, engineering, and community management.

1.2.4 Process and Procedures

In order to address the mandate which had been given to the Committee by Minister Parent, the committee members limited their review to the following:

- Conducted interviews with selected individuals involved in the previous study along with individuals and corporations which had previously expressed an interest in the waste tire management program.
- Conducted sites visits at Miller Tire in Dartmouth, Lafarge North America in Brookfield, and TRACC in Minto, New Brunswick.
- Met with representatives of the Citizens Against Burning of Tires (CABOT).
- Reviewed the Dalhousie peer review study of the proposed Lafarge North America TDF and met with Dr. Mike Pegg.
- Met with Mr. Ring, CEO, RRFB to review the process and procedures in assessing the RFP, as well as obtaining information on the previous tire processing initiatives in Nova Scotia.
- Contacted the individuals who had previously written to the Minister on the Used-Tire Management options.
- Conference call with Mr. Michel Houle, CEO, Royal Mat, Quebec.
- Literature review of the waste tire management options.

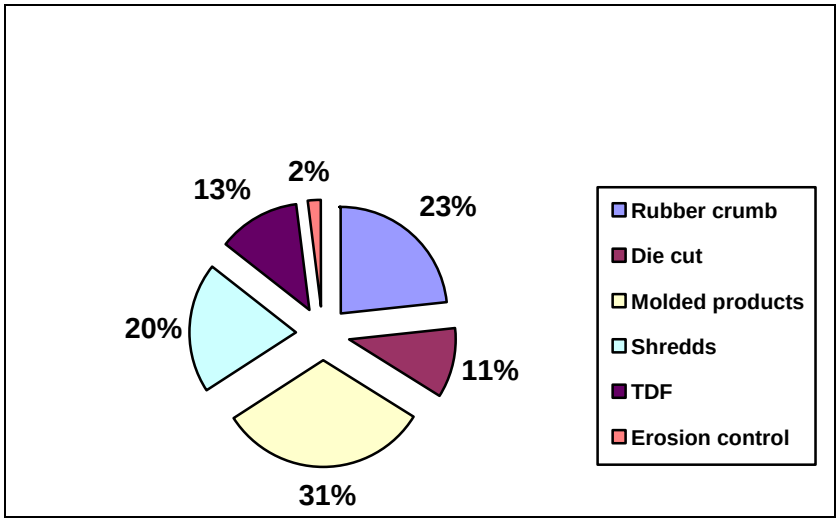
1.2.5 Reporting to Minister

The Committee formally met on July 13; and after assessing the scope of the review, they agreed to report to the Minister by October 1, 2007. The committee was not mandated to conduct public forums or undertake broad based consultation. However, the committee agreed to seek information from individuals as they deemed necessary to fulfill their mandate.

2.0 Brief Overview of Waste Tire Management Options

TDF was the first market for scrap tires. From the 1979 until 1992, TDF was the primary market for used tires. Beginning in 1992, there was a trend to use whole scrap tires as feedstock for ground rubber which was processed in a number of products. In 2003, 127 million tires were used as TDF in the US, this represented only 44 percent of the scrap tires going to market; as new applications are emerging for the use of rubber crumb, the use of TDF is diminishing. Used-tire crumb is currently also being used in a number of civil engineering applications[1].

Summary of manufactured products from used tires in Canada[2]



Used tires in Canada are categorized as municipal solid waste; their disposal falls under provincial and municipal jurisdiction, and as such there is no evidence of any consistent practices among the Provinces. While used tires are composed of relatively inert material and

[1] U.S. Environmental Protection Agency, Management of Scrap Tires, 2006.

[2] Canadian Council of Ministers of the Environment, Working Group on Used Tires, Processing Technologies and Manufactured Products From Used Tires, January 1991.

are considered to pose no direct harm to the environment, the disposal of tire in regular Municipal or Provincial landfills have been banned, primarily because of their bulking properties.

Table 1: Material composition of average 9.5 kilogram automobile tire (Goodyear P195/75R14)[3]

Principal material composition	Kilograms of product in average tire
30 different kinds of synthetic rubber	2.2
Eight types of natural rubber	1.8
Eight types of carbon black	2.2
Steel cords for belts	0.5
Polyester and nylon	0.5
Steel bead wire	0.5
Different kinds of chemicals, waxes, oils, pigments, etc.	1.4
Composition percentage carbon	85%
Ferric metal	10-15%
Sulphur	0.9 to 1.25%

There are approximately 20 million tires (or 28 million PTE) discarded each year in Canada. Tire recycling in Canada is a diverse industry ranging from low-technology "cottage" enterprises to large companies with international patents on new recycling processes which market their technology and products world-wide.

Bridgestone/Firestone, for example, has a division that produces and installs rubber running tracks, both indoor and outdoors from recycled rubber from used tires[4]. At the low-technology end of the industry, are small companies that knit whole used tires into such things as blasting mats and playground equipment. However, with the current push towards a greater use for more sustainable waste management practices, a variety of new products made from recycled tires are emerging as viable commercial options; the production of rubber shingle is an example of high end product aimed at replacing slate roofing tiles[5]. As ASTM standards are further refined, the market for rubber derived products from waste tire should continue to expand.

[3] Texas Natural Resource Conservation Commission, 2002

[4] Rubber Recycling 2006, Changing Concepts, Ottawa, 2006.

[5] Canadian Council of Ministers of the Environment, Working Group on Used Tires, Processing Technologies and Manufactured Products From Used Tires, January 1991.

2.1 Recycling of Waste Tires, Overview of the Options

2.1.1 Re-use of Tires by the Retreading Industry

Used but undamaged tires can be returned to commercial facilities for retreading. In Nova Scotia, roughly 125,000 truck tires are retreaded each year. The market for retreaded car tires is relatively small; a company in Pictou County, N.S., and TRACC in N.B., are currently processing a small number of automobile, tires for the off-shore retread market. New tires at the low end of the price range are relatively cheaper than retreads.

2.1.2 Shredding of Used Tires

Tire shredding is a mature technology which is gaining market acceptability. Tires are first shredded, cut into manageable pieces then shredded into various sizes to meet market demands. Relatively large sizes can be used for roadbed materials[6].

The use of tire chips or shreds as road base material appears to be a promising application with the potential of consuming large numbers of used tires. In Minnesota, tire chips were used at a thickness of 0.6 to 2.5 metres as the bottom base material, and then overlaid with gravel and the normal two layers of asphalt. The open nature of the chips was found to allow good water drainage through the base, and the extent of frost heaving was reduced. In a controlled test in Maine, a layer of chips 15 to 30 centimetres deep reduced frost penetration from 130 to 90 centimetres, and subsequent frost heaves from 9 to 3.5 centimetres.

Tire chips are also being used in landfill engineering applications. At some new landfill sites, chips are placed on top of the bottom plastic liner in the deepest part of the pit, where they act as a porous filter, separating the leachate from the garbage above. The collected leachate is pumped out and given waste water treatment. Chips may also be used as a daily landfill cover to suppress odours and dust and to discourage vermin. In addition, tire chips have been found to be superior to wood chips as a means of improving aeration in composted sewage sludge[7].

[6] Canadian Council of Ministers of the Environment, Working Group on Used Tires, Processing Technologies and Manufactured Products From Used Tires, January 1991.

[7] Canadian Council of Ministers of the Environment, Harmonized Economic Instruments for Used Tires, 3 August 1994.

2.1.3 Tire Crumb

Crumb rubber may be produced by an ambient process (mechanical sizing) or by cryogenic process (freezing). In the mechanical process, tires are reduced to chips or shreds and then put through granulators which separate and remove loose steel and fibre and further reduce rubber particle size. Finally, the small rubber chunks are ground to produce rubber crumb of 30 to 40 mesh size. In the cryogenic process, tire chips are frozen in liquid nitrogen as they pass through a cryogenic tunnel then broken down by impact. They then pass through a series of screen meshes where they are shattered into their three component parts: rubber, steel and fabric. Although the cryogenic process is the more expensive of the two, it produces smoother and smaller crumbs.

Rubber crumb is sold as feedstock for chemical devulcanization or reclamation (pyrolysis) processes, added to asphalt for highway paving and pavement sealers, or used for the production of a large number of recycled rubber-containing products (Table 2).

Table 2: Possible applications for recycled rubber from used tires

Sport Surfaces	Automotive Industry	Construction	Geotechnical/ Asphalt Applications	Adhesives and Sealants	Shock Absorption and Safety Products	Rubber and Plastic Products
• Kindergarten Playgrounds and Recreation Areas • School Sports Areas • Athletic Tracks • Tennis and Basketball Courts • Golf Tee-Off Areas • Swimming Pool Surrounds and Garden Paths • Lawn Bowling Greens • Non-Slip Boat Dock Surfaces	• Bumpers • Car Body Underseal and Rustproofing Materials • Splash Guards and Fenders • Floor Mats for Cars and Trucks • Floor Liners for Trucks and Vans • Dunnage Materials for Shipping	• Hospital, Industrial, and Bathroom Flooring • Floor Tile • Carpet Underlay • Waterproofing Compounds for Roofs and Walls • Foundation Waterproofing • Dam, Silo, and Roof Liners	• Rubberized Asphalt for Roads and Driveways • Sub-base for Horse Racing Tracks • Subsoil Drainage • Drainage Pipes • Soil Conditioner • Filtering Agent for Mercury and Metallic Surfaces • Porous Irrigation Pipes • Road Building and Repair	• Adhesives and Sealing Compounds • Textured and Non-Slip Paints • Compounding Ingredient (Filler) for Rubber Mouldings and Extrusions • Compounds for Conveyor Belting Repair • Expansion Joint Compounds • Roof Coating and Waterproofing	• Shock Absorbing Pads for Rails and Machinery • Sound Barriers for Highways • Crash Barriers • Abrasion Lining in Mining Equipment	• Pipe Insulation and Lining • Baseboards and Kickplates • Flower Pots • Garbage Cans • Shoe Soles and Heels • Wire and Cable Insulation • Industrial and Agricultural Tires • Barn Mats and Flooring • Conveyor Rollers and Idlers • Filler in Many Plastic Mouldings and Extrusions[8]

[8] Canadian Council of Ministers of the Environment (1994).

2.1.4 Devulcanization

In the process of devulcanization, used rubber is returned to its raw state as a soft, tacky, plastic material, which can then be used in the production of a variety of moulded or die cut rubber materials, such as mats, tubs, and pails. A great deal of research has gone into rubber devulcanization; however, the final renewed material has slightly different chemical properties from virgin rubber. The renewed material is rigid, whereas virgin rubber is composed of long, flexible strands. The devulcanization material does not meet the stringent requirements of modern tire manufacture, nor can it be used in the manufacture of flexible products such as hoses. The cost of processing old tires, particularly modern radial tires with steel belts, into devulcanized rubber exceeds the cost of virgin rubber production.

2.1.5 Reclamation (Pyrolysis)

Pyrolysis is a thermal process that can degrade used tires to their chemical constituents. The traditional process involves burning tires under conditions of oxygen limitation so that the tire material is not completely converted to gases and ash. In 1994, a Canadian company, Exxadon/EWMC, patented a new tire pyrolysis process (the Emery Microwave Process) that breaks tires down to their component parts more efficiently. The typical automobile tire contains approximately 4 litres of oil, about 230 grams of fibre, a kilogram or more of carbon black and about a kilogram each of steel and methane. At several traditional small-scale pyrolysis plants in operation in Japan and the United States, the methane is burned to produce steam heat and electricity and the carbon black and oil are sold to industrial users. Recycled carbon black is acceptable for use in industrial hoses, mats, roofing materials and mouldings[9]. The tire industry uses a great deal of carbon black to give strength to their product but unfortunately recycled carbon black contains too many contaminants for use in new tires.

2.1.6 Energy Recovery

The production of energy from waste, although not a form of recycling in the strict sense of the word, can be an economically sound end-use for used tires. Public perception of incineration, however, makes it difficult to promote as a waste management option. Complete combustion to inorganic gases and ash can be achieved through high-temperature combustion, as is practiced in cement kilns and coal-fired thermal-electric generating stations. There is a limited amount of

[9] Hicks, J.P. (2006). A Whole New Dimension to Retreads.

peer reviewed research and general expert agreement which demonstrates that tires can be safely incinerated at high temperatures and the released energy used for industrial applications; consequently, concerned citizens and environmental groups tend to oppose all tire incineration on the grounds that it might pose a health hazard. In most countries, cement kilns are allowed to use scrap tires as fuel. Canadian cement kilns in Quebec, Alberta and British Columbia may off-set a portion of their fossil fuel needs with used tires[10].

2.1.7 Ranking of Waste Tire Management Alternatives

The State of Ohio which has limited the use of used tires as TDF has developed an environmental sustainable ranking system for the disposal of used tires. Economists and engineers following a life cycle analysis of the most sustainable options for the disposal of used tire have derived the following hierarchal classification which is ranked according to environmental and economic impacts.

Table 3: Hierarchal ranking scale for waste tire disposal and recycling options[11]

1. *Use PRODUCTS for its originally intended use as long as possible. Retreads, etc.*	***2.*** *Use material to make new products. Grind scrap tires into crumb rubber, separate steel and fibre. Sell rubber as raw material or proceed in new products.*	***3.*** *Use whole used tire for energy recovery.*	***4.*** *Use mechanically processed tires for energy recovery.*	***5.*** *Alter the chemical structure of used tires and recover the basis ingredients. This process involves pyrolysis, supercritical extraction, etc.*	***6.*** *Monofilling for possible recovery at a later time. Deposit the tires or chips in a tire only secured landfill.*	***7.*** *Disposal without and current or future use: land filling option.*

[10] Canadian Council of Ministers of the Environment (1994).

[11] Scrap tire management alternatives ranking index, Scrap Tire Resources Ohio Department of Natural Resources.

3.0 Tire Derived Fuel Option (TDF)

The manufacture of Portland cement involves the calcination and sintering of raw materials at a temperature in the order of 1450 °C. Raw materials consist of limestone, silica, clay and iron ore or a combination of materials to provide the above basic ingredients. After sintering (to form clinker), the mass is cooled and stored until ground and mixed with a small quantity of gypsum (to control set or rate of hardening) in the final product (sketch attached).

Cement plants produce high levels of greenhouse gases, inherent in the manufacturing process, principally due to the reduction of limestone to lime and carbon dioxide. The production of one tonne of cement produces slightly less than one tonne of carbon dioxide. Cement plants typically burn coal, natural gas and/or additions of waste oils and tires.

The use of Tire Derived Fuel (TDF) has become fairly commonplace in the cement industry. Per kilogram, tires have a higher calorific value than coal or oil and are of low ash content (in the order of 6 percent). ASTM Designation: D6700-1 (Reapproved 2006) Standard Practice for Use of Scrap Tire-Derived Fuel provides guidance for the material recovery of scrap tires for their derived fuel as “the end product of a process that converts whole scrap tires into a specific chipped form”. This specified product then would be capable of being used as fuel. A whole tire is defined as “a scrap tire that has been removed from a rim, but has not been processed”. Thus, the ASTM D6700-1 does not cover the burning of whole tires.

ASTM Designation: D6700-1 under Significance and use states “New combustion units dedicated to the use of TDF (or whole tires) as the sole fuel source are rare”. It is known that some specially designed boilers and cement kilns have had their feed systems designed to accept whole tires. TDF has been used successfully in properly designed combustors with good combustion control and appropriate add-ons such as electrostatic precipitators or bag-houses. Air emission characteristics of proper TDF combustion are typical of most solid fuels such as wood or coal. Up to 20 percent TDF usually satisfies environmental compliance limits.

3.1 Meeting with Mr. Ring to review the TDF option.

During the initial meeting of the committee, it was agreed that the members would not spend time reviewing the TDF option as this option had already been peer reviewed by the Dalhousie Engineering team headed by Dr. Mike Pegg. The committee decided to meet with Dr. Pegg in

order to understand the rationale which supported the conclusions of the Dalhousie report. The members also agreed to meet with Mr. Ring, CEO for the RRFB, in order to gather information on the process which was followed in order to arrive at the conclusion that supported TDF as their preferred option.

The Committee met with Mr. Ring to gather specific information on the goal and objectives of the RRFB. The committee members also explored with Mr. Ring the reasons which lead to the failure of the previous tire recycling initiatives in Nova Scotia. The committee also reviewed with Mr. Ring the selection and assessment of the RFP process which concluded that TDF was the preferred option for the management of waste tire in Nova Scotia.

Mr. Ring indicated that the RRFB is a self funded agency which reports on an annual basis to the Minister of Labour and Environment; however, he did stress that the RRFB operates at arms length from the Minister. They are responsible for managing the beverage, paint and used-tire program for the Province of Nova Scotia. Fifty percent of the revenues generated from the recycling program are returned to the municipalities to assist with their recycling and waste management programs. Incentives have been established to entice the municipalities to introduce innovative waste diversion systems.

To operate the used-tire program, the Province collects a recycling fee of $3.00 for automobile tires and $9.00 for truck tires. This fee is turned over to the RRFB to offset the costs associated with the management of the waste tire program. Previously three individual companies held contract with the RRFB to manage the waste tire program. The most recent company was Atlantic Recycled Rubber (ARR). ARR received $2.50 per tire for processing; however, this fee did not allow for a successful operation and ARR requested an additional $1.50 per tire from the RRFB to continue the program. The RRFB reviewed the request for additional funding; however, following the review, they decided against increasing the fees and opted to proceed with a public tendering process in December 2006.

The RRFB decided to hire an external consulting company to assist with the preparation and administration of the RFP. Prior to finalizing the tenders, the RRFB did contact several prospective companies in order to entice them to reply to the RFP. The RRFB had anticipated that they would receive 11 responses to their RFP; however, they received only five. A team of three individuals assessed the RFP and concluded that Lafarge North Amereica had presented

the most comprehensive RFP with the lowest bid proposal. The Lafarge proposal was for five years with a fixed rate for three years. The Lafarge proposal would utilize 60% of the tires at their Brookfield cement plant as TDF and forward the remaining 40% to their plant in Saint-Constant, Quebec.

Following the successful review of the RFP, the RRFB commissioned an independent scientific review of the TDF option by Conestoga-Rovers and Associates to assess the potential air quality impacts of TDF. This report was subsequently reviewed by Global TOX. The studies assessed the potential from air contamination from TDF against the stringent Ontario standards and concluded that the discharges to the ambient air would have a limited impact on the area.

Until a firm application is approved for the TDF at Lafarge, the RRFB is currently sending 40% of the used tires to Royal Mat in Quebec for recycling within their plant and the remaining 60% are forwarded to the Lafarge plant at Saint-Constant for combustion as a fuel alternative. The current cost is higher than the one negotiated with Lafarge; however, it provides an interim solution.

3.2 Meeting with Dr. Pegg, chair of the TDF Peer Review Study by Dalhousie University

The committee members met with Dr. Mike Pegg, the primary author of the Dalhousie report. The members reviewed various aspects of the report with Dr. Pegg. Given the variables which have been reported in the study on various operational components of TDF, Dr Pegg stressed the need for the implementation of a risk management framework prior to the approval for the Lafarge plant in Brookfield. This risk management framework should provide definite guidelines for the acceptability of risk associated with TDF given that a number of assumptions have been identified by the review team prior to arriving at the conclusion that the TDF was an acceptable supplementary fuel for Lafarge. The following provides an overview of such an assumption:

> *"Since the mechanism and rate of dioxin/furan formation is still unknown, and although it is at this point impossible to predict what effects the use of whole tires to replace 20% of the energy content of coal would have on the overall emission of dioxin and furans, it is felt that the overall effects would not be significant. Should kiln upsets be found to results*

in larger dioxin and furan emissions values, several control measures are suggested, their efficacy is unknown"[12]

Dr. Pegg indicated that in order to address the issues of furans and dioxin, it will be necessary to implement a comprehensive testing and monitoring program. Such a program should focus on solid baseline testing to determine stack emissions and off-site ground level pollutant concentrations together with detailed air dispersion modeling. Following collection and analysis of the data, a monitoring and testing program should be designed and implemented within a risk management framework.

3.3 Meeting with Lafarge North America, Brookfield, Nova Scotia

The committee members met with Mr. Kirkpatrick, Plant Manager, Mr. C. Richard, Environment & Alternate Fuels Manager, and Mr. Kim Unger, Operation Manager, on the 7th of August to review the content of the RFP and visit the facility.

The committee members were provided the following information:

- Lafarge will collect and process all of the used tires generated in Nova Scotia in a consistent and environmentally effective manner.

- The estimated 7500 metric tonnes will be managed in the following manner:
    - 5300 metric tonnes will be consumed in Brookfield.
    - 2200 metric tonnes will be consumed in Saint-Constant, Quebec.
    - Systech will transport the tires to Saint-Constant until Brookfield is operational.
    - Plant modification in Brookfield will take an estimated 10 months after approval has been received from NSDoEL.

- Lafarge will collect the approximately 900,000 tires generated within Nova Scotia on a regular basis through a Province wide collection program which will service the approximately 800 registered generators. The collected tires will be stored in covered trailers which ensure that the tires are kept secured until they are processed. Six

[12] An Assessment of the Use of Tires as an Alternative Fuel, Faculty of Engineering, Dalhousie University, April 2007.

permanent jobs will be created for the collection program and three additional jobs will be created for the onsite handling and processing.

- Lafarge is looking for safe, effective alternative fuels to offset the increasing price of imported coal.

- The tire management will be processed by Systech Environmental Corporation who has been in the business of alternate fuels for 37 years. They operate 10 alternate fuel plants, six of which are used tire operations.

- Systech provide used tires to cement kilns and other users, they employ 150.

- Tire derived fuel is a well-established process which is recognized worldwide which provides an efficient and complete combustion of the material at 1000 C. Over 60 cement plants use tires worldwide.

- The process recycles all of the raw material components and leaves no residues.

- Lafarge will modify the cement kilns to burn the tires at a cost of $4 million. No additional modifications are contemplated to the stack to control air emissions after tires have been integrated in the feed stack.

- They currently have no plans to modify the current monitoring parameters which are required by NSDoEL unless changes are brought to their operating license.

- They currently have an independent citizen's advisory board which meets on a regular basis and reports on a number of issues to the plant.

- They do not predict any increase of heavy metals in the CKD following the burning of used tires. They do not intend to modify the current disposal practices related to CKD following the use of tires as a fuel source.

- They do not perceive that furans and dioxins will be a problem.

- They have a limited number of minor upsets a year and they do not perceive this to be a contributing factor for the release of combustion by-products to the atmosphere. They are satisfied that they can meet all of the CCME guidelines as it pertains to the release of contaminants to the environment.

3.4 Meeting with the Citizens Against the Burning of Tires (CABOT)

The committee members met on August 7 with Allan Sorflaten, Lydia Sorflaten, Don Murray, Emily Keirstead, Trudy Johnston, Fred Blois, all members of CABOT. The members presented their concerns on tire burning to the members. Their concern focused on the following issues:

- The use of whole tires versus shredded tires, they are concerned that the use of whole tires could result in a higher discharge level of pollutants to the ambient air.

- Kiln Upsets and Increased Emissions
    - Increased stack emissions of fine particle sizes of fly ash.
    - Increase level of heavy metals into the atmosphere; particularly, zinc, cadmium, chromium, mercury and manganese.

- Elevated presence of heavy metals within solid ash waste (CKD).

- Contamination of the water table with heavy metals from the landfill.

- Production and release of dioxin and furans to the environment.

- Release of chlorine to the environment.

- Modernize the Brookfield plant prior to allowing the burning of tire, modernization should include a 5 stage cyclone pre-heater, an appropriate modified pre-calciner, a reliable ESP, state of the art bag house to supplement the current pollution control system, sophisticated facility to shred tires and an accompanying pneumatic injection system for the introduction of shredded tires to the kiln.

- Monitoring and reporting of the contaminants to the environment

    - Self-reporting is not seen as an acceptable process.
    - The inclusion of testing by an independent third party.

- An independent monitoring protocol which would ensure that adequate baseline data is obtained prior to the start of the TDF program along with a detailed stack monitoring program.

- The establishment of an inclusive citizen review committee.

The CABOT members presented the committee with a series of supporting documents which served to highlight the research documents they had reviewed in the preparation of their submission. The members also expressed their frustrations in getting information from both the Lafarge Company and the Provincial Environment representatives. They also expressed their total disapproval of the burning of tires as an option for the disposal of waste tires. They strongly believe that there are more sustainable options which should be considered by the Province.

3.5 Members Comments on the TDF

The committee members agreed that TDF is a waste tire management option which has been used to offset fuel choice in many industries since 1979. However, since 1992 various other management options have been developed as alternatives to TDF which do provide viable alternative uses. These lternatives when considered within the universally accepted recycling model of the three “R’s” can represent a high degree of economic and environmental sustainability as well as a high degree of social acceptability.

Given the terms and conditions of its mandate, the committee did not conduct a review of the Dalhousie study. They accepted the results and conclusions as presented by Dr. Pegg and his colleagues. They did review the report with Dr. Pegg and accepted the conclusions as the premise for their assessment.

Should TDF remain the preferred option of waste tire disposal for the Government of Nova Scotia, the committee members agree that the recommendations included in the Dalhousie study must be implemented prior to the granting of an operating permit to burn used tires at the Lafarge plant in Brookfield. The members would want the modeling exercise to contain an

assessment of the entire year in order to account for the various weather inversions and their impact on air dispersal within the area. The committee would also suggest that a baseline monitoring program be implemented to collect data for soil, air, surface water and ground water prior to permitting of TDF at the Brookfield plant.

Given the level of concern which have been expressed by the citizens living close to the plant, the committee would suggest that the current citizen advisory group should include citizens who reside close to the plant and that consideration be given by the NSDoEL to ensure that the mandate of the committee allows them to function as an independent body to review the results of the monitoring program. The committee should have the ability to report any discrepancies to the NSDoEL.

4.0 Assessment of the Alternative Options to the TDF Proposal

4.1 Introduction

In order to assess the alternative options to the TDF proposal, the committee decided to focus on the basic principles of sustainable development as it relates to the reduction of waste product by focusing on the internationally accepted principle of the three "R's", which focus on Reduce, Reuse and Recycle as the major component of a sustainable waste management program. This concept is further enhanced with the passing of **Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"** which was given Royal Assent on April 13, 2007. This act defines the strategic direction the Government of Nova Scotia wishes to adopt as it moves toward developing a sustainable prosperity framework. The act states that the Province wishes to build on the foundation it has achieved as a world leader in recycling programs and in managing its waste to protect and enhance the environment[13].

In review of the options provided within the three "R's" concept of waste management, the committee members agreed that the first of the three "R's" reduce was one which they could not apply to their current analysis model as the number of used tires which enter the waste stream are defined by the current societal imperatives within Nova Scotia. However, the other two

[13] Environmental Goals and Sustainable Prosperity Act, Chapter 7 of the Acts of 2007.

options **reuse** and **recycle** were areas upon which the committee focused for their assessment of alternative options to TDF.

4.2 Analytical Procedure

Following a review of the potential options which had been provided to the members from the briefings from the technical experts and the literature surveys of existing usages, the members undertook a scoping of all the options which possibly could provide a realistic sustainable solution to the waste tire streams in Nova Scotia. Following an initial review of the possible options, the committee members decided to focus on the alternatives which focused on proven technologies that were currently available, which could be integrated and implemented in Nova Scotia within a reasonable timeframe.

Prior to proceeding with the screening of the alternative which initially demonstrated a potential for the sustainable management of the waste tire stream in Nova Scotia, the members developed an assessment framework which focused on the integration of the sustainable waste management principles as defined within the concept of the three “R’s”. The details of the model are included in the *“Screening Template for the Assessment of Alternative to TDF”*.

The following alternatives were assessed against the assessment framework and provided a sustainable ranking based on the results of the analysis. A detailed description of each option is provided in Annex “B”.

Following the review of the results obtained in the assessment framework, each option was allocated a sustainability index based on their ranking against the “R” recycling concept. The index ranking allocated was:

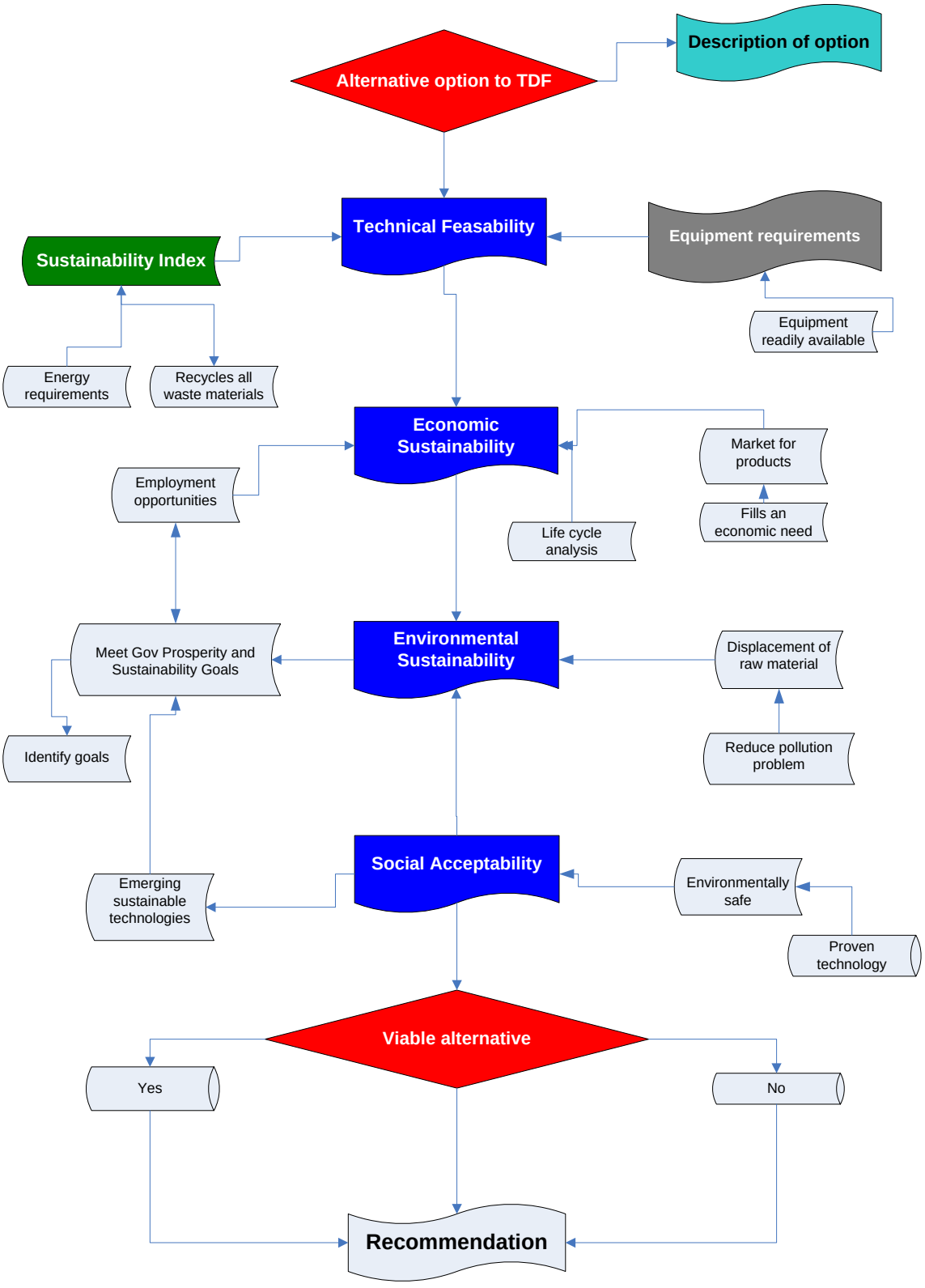
(1) If they met all of the criteria within the assessment grid, and they were currently operational options with a proven track record of developing economical sustainable recycled products for an available market.

(2) If they met most of the criteria within the assessment grid but they were not currently operational in Nova Scotia due to lack of processing facilities. However, they offered a good potential for viable option within the Province.

(3) If they met most of the criteria within the assessment grid but they were not currently operational in Nova Scotia due to lack of processing facilities and they required a high degree of energy for the processing of a usable rubber product.

(4) Project met most of the criteria; however, there were outstanding knowledge gaps associated with environmental issues such as energy consumption and stack emissions at the time of our assessment..

Screening Templates for the Assessment of Alternatives Options to TDF



5.0 Description and assessment of the alternatives which were retained and reviewed by the Committee

5.1 The Reuse Option: Tire Retreading

Given that retreading of used tires is the only viable option currently available under the reuse option, it was the only one assessed. The retreading of tires does not remove the used tires from the waste stream; it essentially prolongs its useful life and delays its integration within the waste stream. To assess the capacity of the tire retreading industry to reduce the used tire stream, the committee met with Brian Miller, President of Miller Tire, along with Corey Miller, the current CEO. The Miller Tire Plant is located in Burnside Industrial Park, Dartmouth, Nova Scotia. The committee members agree that waste tires could be used for a series of smaller initiatives, the numbers of tires used are relatively small in number.

5.2 Overview of the Tire Retreading Industry in Nova Scotia

Approximately 125,000 tires are retreaded each year within the Maritimes and currently only commercial vehicle tires and off-road industrial tires are retreaded. Given the costs associated with the retreading of a tire, it is not economically feasible to retread passenger vehicles tires. There is one plant in New Glasgow which retreads approximately 100,000 passenger tires annually. These tires are exported off shore for use in the domestic automobile industry. Given the current economic growth rate within the Maritime, it is unlikely that the need to increase the current capacity of 125,000 will be required.

Miller Tire operates its retreading operation under license with Michelin Canada. In 1998, Michelin decided to support a network of tire retreading facilities within Nova Scotia under a strict retreading protocol which is rigidly enforced by Michelin. As a result of Michelin quality control standards, many of the smaller tire retreading operations have closed or amalgamated with larger operations. Currently Miller Tire produces 40,000 retreads a years; if additional tires were processed, Miller Tire would need to have additional equipment. Under proper tire management, it is possible to retread a tire up to 3 or 4 times.

Corey Miller did indicate that the large off-road industrial tires do pose a problem too as they are too large to process within the Province and most used large commercial tires are forwarded to Thunder Bay, Ontario. Small off-road vehicles tires and large commercial tires do cause some

concern to the retreading industry, as they presently have to be shredded prior to being discarded with the waste stream at the regional landfill. Mr. Miller would like to see the inclusions of all used tires within a Provincial waste tire management program.

5.3 Summary

The current capacity of 125,000 truck tires per year seems to be the upper limit which can be economically processed within the Province; and given that the retreading of passenger tires is not economically feasible, other than the limited number of passenger tires which are processed in Pictou for the off-shore market, there is no potential to reduce the current waste stream by adding additional retreading capacity until new markets are developed within Nova Scotia.

6.0 Overview of Recycled Options which are currently available outside of the Province of Nova Scotia

6.1 Tire Recycling Atlantic Canada Corporation (TRACC), Minto, New Brunswick

The TRACC waste tire processing facility is located in the Minto Industrial Park, Minto, New Brunswick. It has been in operation for 11.5 years and it currently manages all of the truck and car tires which are produced in New Brunswick. It is owned and operated by Mr. John Leonard and managed by Mr. Stephen Richardson. They are licensed under the Province of New Brunswick's Environment Department as the only waste tire managing facility within the Province. They report operationally to the New Brunswick Tire Management Board. The board members representing business and Government Departments are named by the Government. TRACC has the responsibility to collect and process the entire waste tire stream in New Brunswick. However, larger industrial tires as well as a number of off-road tires are not currently processed within the main stream of the operation. Farm tractor tires as well as other off-road tires which are too big to fit into the crusher are processed separately to supply the rubber chips components which are used in the production of the landscaping product line. TRACC currently employs a staff of 44 which ensure the functioning of the plant on a 24hrs per day, 7 days per week on a year round basis. Most of the workers are from the Minto area.

TRACC currently process close to 880,000 tires a year. The tires are collected across New Brunswick and transported to the plant. Upon arrival at the plant, the tires are shredded and/or

crumbed prior to being used as feedstock for the processing. All part of the tires are used or recycled and as a consequence they do not produce any waste. The steel once it is separated from the tires is sold as scrap metal.

The processing equipment primarily consists of grinders and front end sorting lines, which are used in shredding the tires to usable sizes. In the shredding process, the steel bands are magnetically removed. Inside the building, specialized equipment and heat presses are used to produce the final products. Electricity is the primary source of energy consumed in the processing of the waste rubber into the final products.

6.2 Products Developed by TRACC from Recycled Rubber from Tires

6.2.1 Retread Tires

TRACC selects the better tires from the waste stream and they retread the tires using technology and products supplied by Michelin. The tires are exported to third world countries where they are sold for use in the domestic sector. No retreads are sold within the Canadian market.

6.2.2 Roofing Shingles

TRACC has started to produce rubber shingles which are produced from used tires, waste rubber from the maritime Michelin plants, as well as recycled plastic bags. The rubber shingles marketed as modern slate have a warranty of 50 years and they are completely recyclable. They offer an alternative to asphalt shingles which currently have a lifespan of 25 to 35 years and they need to be land filled or burnt following their removal. The rubber shingles are roughly double to triple the costs of asphalt shingles; however, they compare favourably with steel. Given that they are warranted for 50 to 60 years, they could compare cost effectively with asphalt shingles on a life cycle cost analysis.

TRACC is currently exploring the European market for the sale of the rubber shingles as they are aesthetically similar to slate and the cost is comparable. TRACC rubber shingles are currently available in Atlantic Canada through a distributor in Fredericton.

TRACC currently sells all the shingles it produces and the management sees the shingles as a viable product.

6.2.3 Mattresses for cow and horses

There is a great demand both in North America and Europe for these animal mattresses. They presently sell all the mattresses they can produce; and given the result obtained within the farming communities, they are expecting to continue a strong demand for the mattresses in the future. Currently they are only supplying 0.05% of the market demand.

6.2.4 Bases for reflector road construction markers

They are currently producing plastic bases for the reflector currently used as safety markers along the road. They currently sell all their production to the New Brunswick Department of Transportation.

6.2.5 Thread cover for the oil drilling industry

Drilling pipes have very precise threads which need to be protected during storage. TRACC has developed thread covers which protect the threads and they have a ready market for all the thread covers they currently produce. If the drilling activities increase, they will increase their production.

6.2.6 Industrial and domestic floor mats

TRACC is producing all purpose rubber mats which are used both in the domestic and industrial market. They cannot currently supply the demand and they see an ever expanding market for these mats. They find use as domestic doormats as well as mats in arenas and other industrial sectors.

6.2.7 Lightweight fills for road construction and other industrial applications

Recently TRACC provided 16 thousand tonnes of shreds to the New Brunswick Department of Transportation for use as lightweight fill for the new international bridge abutment in St. Stephen. Rubber shreds can also be used as a substitute for aggregate in road bed construction.

6.2.8 Mulch for the landscaping industry

Rubber crumbs and shavings are currently being used to replace bark nuggets as landscape mulch. It is also used as a shock absorbent material in playgrounds. Given that rubber does not blow away or disintegrate, there is a market developing in the horticultural landscaping. The rubber can also be color treated to match any architectural requirement.

Given the current strong demand for specific products such as the cattle mattresses and the floor mats, TRACC is experiencing a need for additional rubber and it would be prepared to absorb all of the tires produced in Nova Scotia within its current operations. TRACC has the capacity to increase its production with little modifications to the current plant. They anticipate being able to process the additional tires with the addition of a second production line. Most of the equipment for the production of a second line is currently in place.

TRACC would be willing to entertain discussions with the Province of Nova Scotia for the delivery of its tires to New Brunswick for processing into secondary products. The anticipated cost for accepting tires from Nova Scotia by TRACC would be $2.00 per PTE. TRACC would also prefer that Nova Scotia manage the collection and delivery to TRACC.

6.2.9 Comments

Given the variety of niche products which TRACC was able to develop and market from used tires, they provide a sustainable option which not only produces secondary product from used tire while providing a sustainable income to an area which has a relatively high unemployment level. TRACC, by retreading the suitable used tires it receives, also complies with the second option of the sustainable recycling code by producing usable tires for the off-shore market. TRACC have demonstrated that it is possible to operate a small scale profitable operation with under a million used tires per year.

6.3 Royal Mat, Quebec

Royal Mat, a Quebec waste tire recycling firm, confirmed to the committee that they had submitted a proposal to the RRFB for the collection and management of all the waste tires produced in Nova Scotia. They also indicated that they had been short listed for the RFP. Royal

Mat currently recycles 100% of the 3.3 million tires they collect. They currently process all passenger and truck tires as well as small industrial and farm tractor tires. Smaller off-road tires are shredded and the crumbs are used in many of their products. The only tires which they currently do not process are large industrial tires. Royal Mat have the potential to recycle 4.5 million tires.

Their processed rubber is transformed primarily into noise absorbing membranes, industrial mats, sport complex mats and pad, along with various protective padding for the transportation industry. They also supply material for playground, sport fields and the landscaping industry. They have markets for all of their products: 65% is exported to the US, 30% is sold in Canada, and 5% is exported to European countries.

Royal Mat would be willing to enter into a long term contract with the Province of Nova Scotia for the collection and processing of all waste tires into usable secondary products.

6.3.1 Comments

The committee members agree that Royal Mat does offer a reliable option for the recycling of waste tires for Nova Scotia. They have a proven track record with a secured market for all of their products. However, the transportation of the tires to Quebec could be viewed as an additional cost in the processing of the tires; also job creation with this option would be limited to the people involved with the collection and transportation to Quebec.

7.0 Options for Used Tires which could potentially be available within the Province of Nova Scotia

7.1 MedNova Tech International Ltd.

The committee chair was invited to meet with Mrs. Wendy Yeung-Chen and Mr. Robert Spencer, representatives of MedNova Tech International Ltd., to obtain information on their proposal to establish a used-tire processing plant in Nova Scotia. The Technology which is being proposed by MedNova involves a pyrolysis system which is currently being used in China. The proponents of the technology would be willing to open a plant in Nova Scotia and they

would be willing to process all of the used tires currently produced, this would include heavy industrial tires and the smaller off-road and light industrial tires.

MedNova Tech International is a Canadian company based in Halifax which presently employs six full-time employees. Wendy Yeung-Chen started the business under Richwin Holdings Inc. nine years ago. At present MedNova Tech is involved with a number of exporting venues with China. One of its primary projects is the exporting of dried crab shell to China for the extraction of Chitosan.

The technology and processing method they project to use would be conducted within an oxygen free furnace. The Micro negative pressure process would ensure pyrolysis efficiency and thus reduce the risk of gas build up. The system would process entire tires and there would be no need to remove the steel belts prior to the process. The system proposed would involve two pyrolysis production lines with a high efficient gas recycling furnace. Gas from the pyrolysis process would be reused within the furnace and the excess would be used to run the generators within the plant. The excess energy could be sold to the Provincial grid.

The plant when established would employ between 30 to 44 individuals. If additional tires could be obtained from Newfoundland and Labrador and Prince Edward Island, they project employing between 50 and 65 individuals. The total cost for the plant start-up would be in the vicinity of 3.5 million US dollars excluding land and buildings. The proponents claim to have investors with the capital to build the plant. They would be willing to implement a province wide collection system. To be viable, the plant would need a million tires per year; this would provide approximately 10,000 MT of rubber.

Using their proprietal pyrolysis techniques, they are projecting to convert 10,000 MT of used tires into:

- 4500 MT (= 5,355,000 l) fuel/petrol/diesel;
- 3500 MT carbon black;
- 1000 MT of steel;
- 100MT combustible gas.

They claim to have markets for all of these products. They have profiled their project within the Canadian and Chinese foreign affairs offices and they have obtained the necessary permit to export their technology to Canada.

7.2 Comments

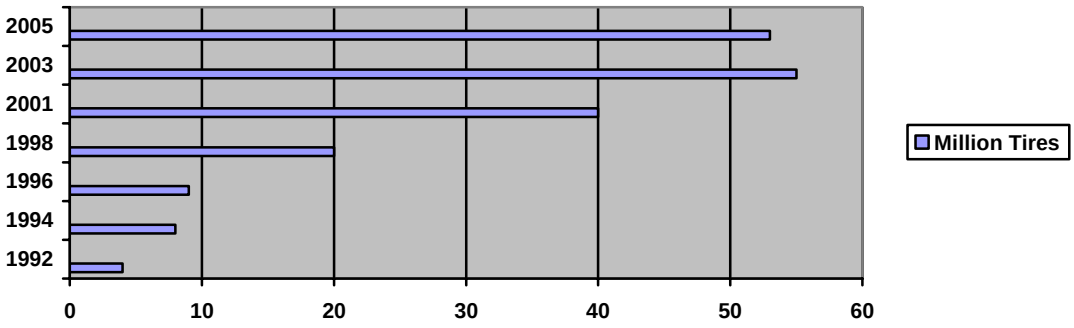
The committee members agree that the proposed pyrolysis operation could be considered as an option for the management of waste tires for Nova Scotia. However, given the scope and mandate of the committee, we were not in a position to assess the technical and economic feasibility of the project. Should this option be considered by Government, it should be submitted to a technical and economic feasibility review. The energy requirements to process the tire by pyrolysis can be demanding; however, the representatives of the company did indicate that they could procure all the energy they need for the processing from gas by-product, thus rendering their process energy neutral. The representatives of MedNova Tech indicated that they would be willing to bring representatives from Nova Scotia to Shanghai and Taiwan to visit the operating plants. The committee would also suggest that an assessment of the stack by-products should also be included in the feasibility study.

The representatives of MedNova Tech indicated to the committee chair that they were not in a position to reply to the RFP as they were not in a position to confirm that they had access to the technology and the required funding to proceed with the project. They currently have secured access to the technology under licensing and they have financing available to proceed with the project.

8.0 Use of used-tire shred in Civil Engineering Applications

Scrap tire shreds have been used as a replacement for conventional construction material. It acts as a substitute for gravel, sand, and other lightweight backfill materials. It’s commonly referred to as tire derived aggregate (TDA). ASTM guidelines were developed and approved in 1997 for TDA. Since its initial use in 1992, the use of Civil Engineering applications for used tires has gone from 1million tires in 1992 to 53 million tires in 2003. This trend is expected to continue as more States move towards the use of tires shreds as a substitute for natural aggregates. One advantage in producing TDA from waste tire is the lower amount of energy need to produce the crumbs versus the production of manufactured products.

Chart 1. Million of Waste Tires Used in Civil Engineering Project from 1992 to 2005[14]



Tire shreds have properties which civil engineering projects need, they are:

- Lightweight, one third the weight of sand;
- Low earth pressure, one half that of soil;
- Good thermal insulation, eight time the capacity of soil;
- Good drainage, 10 times the capacity of soil.

The properties of lightweight and low earth pressures are beneficial to enhance poor soil structure. They can serve to increase slope stability and thus offer protection against landslides.

8.1 Civil engineering applications where tire shreds could be used

Civil engineering applications where tire shreds could be used are:

- Lightweight fill for high embankments
- Retaining wall backfill
- Insulation to limit frost penetration
- Septic system drainage medium
- Vibration attenuation
- Drainage material in land fills
- Backfill in gas venting systems
- Alternative material which can be used when a daily cover base is required
- Used in conjunction for certain types of landfill liners

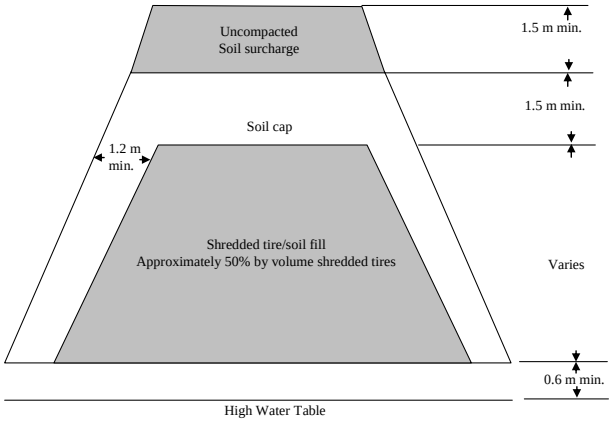
[14] Beneficial use of Tire Shreds in Civil Engineering Applications, USEPA, January 23, 2007.

Various studies have been conducted on the leachate from engineered use of tire shreds and the studies both above and below the water table have demonstrated that tire shreds do not have any effects on the environment.

8.2 Use of rubber from used tires for the lightweight engineering fill

Use of tires as a lightweight fill is particularly suited for roadway work across soft materials such as muskeg and swampy areas; also beneficial for backfill against highway abutments and retaining walls. The technology of using tires as backfill is well established particularly in Minnesota, Virginia, Colorado, Oregon, Washington, North Carolina, and Wisconsin. Monitoring that has been performed indicates low soil pressures, ease of compaction, good drainage and overall good performance[15]. In Nova Scotia a premium is currently being paid for lightweight aggregate to serve the same purpose.

Tires are shredded to a maximum size of 6 to 8 inches and placed and consolidated similar to granular materials. Fills are generally limited to a height of 6 meters and the fills should start above the water table. Conventional highway rollers are used to consolidate the tire shreds in place. A soil cover not less than 1 meter is required over the top and slopes of the fill. Lightweight fill is comparable or better in performance than conventional sands and gravels.



The use of shredded tires in highway embankments does not create an adverse environmental impact on groundwater quality. No evidence was found that tire shreds increase the

[15] Field study of a Shredded-Tire Embankment in Virginia.

concentration of metals within the primary drinking water standard[16]. The energy requirement for shredding, trucking and consolidating tire shreds in a lightweight fill would be considered to have the same energy requirements as crushing and processing aggregate for the same purpose. Shredded tire chips are very inert in most environments. In high acidic (pH <3.5) environments, tires below the water table are known to show an increase in manganese, iron and zinc[17]. Tires above the water table in a neutral environment indicated no increase in the concentration of metals beyond acceptable drinking water standards.

At the current time there are no sources of lightweight fill to compete with tire shreds in Nova Scotia. Maine, USA, is the closest source of lightweight granular material. Synthetic material such as Styrofoam is imported as embankment fills at high costs. It would not displace the use of any available materials within Atlantic Canada. It would displace the import of expensive lightweight aggregate and/or synthetic materials. In Nova Scotia, a premium is currently being paid for lightweight aggregate to serve the same purpose. Once tire shredding capabilities are available in Nova Scotia, this is a highly feasible option.

Recently the New Brunswick Department of Transportation used 16,000 tonnes of rubber shreds in stabilizing the road bed approaches for the international bridge in St. Stephen. The Government of Newfoundland and Labrador is pursuing a number of pilot project applications for potential implementation in 2008, in partnership with the Department of Transportation and Works and the Department of Municipal Affairs, as a means of determining the most appropriate and effective civil engineering applications over the longer term within the Province of NL.

The use of shredded rubber has also been used in developing road beds in Nova Scotia, the post-construction tests have indicated that the tire shreds have proven to be effective in both applications. One kilometre of road bed could use close to 200,000 tires. Considerable research has been undertaken at the University of Maine on the development of approved protocols and standards for the use of the rubber shreds in road building. Tire shred can be used as a durable and frost inhibiting material in the construction of roads, as lightweight fill for highway embankments and retaining walls, as a drainage material in a wide variety of public works and

[16] Construction and Performance of Virginia Transportation Research Council Shredded Waste Tire Embankment, Transportation Research Board Record 1345.

[17] Using Shredded Waste Tires as a Lightweight Fill Material for Road Subgrades, Minnesota Department of Transportation.

municipal infrastructure projects, and it can also be used as a capping material for landfills that are being permanently closed.

The use of shredded tires in lightweight fills is environmentally safe. In adverse conditions such as high acidity, some metals are released but not beyond the safe limits established by the EPA of USA. ASTM standards exist for the use of tire shreds in highway embankments. For example, these standards were recently used for a highway embankment containing 16,000 tonnes of shredded tires for a highway project in New Brunswick (near St. Stephens)[18]. This option can use all of the waste tires produced annually in Nova Scotia in a very short section of highway.

The use of used shredded tires in highway embankments is a practical method to rid Nova Scotia of a problematic waste material that by shredding produces a value-added material for construction.

8.3 Use of rubber from used tires for the production of asphalt rubber

The technology of using crumb rubber modified (CRM) asphalt as a value added addition to liquid asphalt for roadway construction is well established particularly in California, Arizona, Florida and Texas. Monitoring that has been performed indicates a durable pavement, enhanced drainage, improved frictional characteristics and increased resistance to rutting and overall good performance[19].

Tires are crumbed to a maximum size of several millimetres and mixed with liquid asphalt to provide a uniform blend. The mixing temperature is somewhat higher than conventional asphalt, which is necessary to blend the two materials. A retention time of approximately 45 minutes is required for completion of the blending process. The end product is a durable pavement with enhanced drainage characteristics and increased resistance to rutting and hydroplaning. The energy requirement for crumbing, trucking and mixing in a CRM asphalt would be considered to have the same energy requirements as producing liquid asphalt, mixing and storage as conventional asphalt.

[18] ASTM D6270-98 (2004). Standard Practice for Use of Scrap Tires in Civil Engineering Applications.

[19] Asphalt Rubber Usage Guide – State of California Department of Transportation.

CRM asphalt requires equipment suitable for producing crumb rubber, which is not currently available in Nova Scotia. A storage silo and material transport mechanism at the asphalt plant is required. Also, a retention storage facility would be required.

The use of CRM asphalt in highway paving does not create an adverse environmental impact on groundwater quality. Studies in Rhode Island have shown that levels of detectable leachate were too low to be environmentally significant or dangerous. Mercury was shown to be released at a level above the detection limit; however, the level detected was below EPA limits. Only parts of tires suitable for crumbing could be used in asphalt. This excludes the steel belts and polyester fibres.

CRM asphalt has proven to be economically feasible in California, Arizona and Texas. There is an extra cost associated with the production of CRM asphalt, due to the extra equipment required at the point of production. The use of CRM asphalt can be justified by a life cycle cost analysis. A large number of kilometers of highway is constructed or overlain in Nova Scotia each year. A year's collection of used tires in Nova Scotia could be used in less than 20 miles of highway construction.

It would displace the use of approximately 18 to 20 percent liquid asphalt which is a costly petroleum material to produce. The CRM asphalt is more durable and longer lasting than conventional asphalt. At the end of its useful life, it would be disposed of in a manner similar to that of conventional asphalt in a land fill.

CRM asphalt pavement is very inert in most environments. Pollution would not increase with the use of CRM asphalt. The material does have a distinct odour that may trigger concerns about emissions. Testing in Arizona and California determined that plant emissions were well below mandated levels and "there were no new health risks"[20].

8.4 Use of Tire Chips for On-Site Domestic Wastewater Systems

Shredded tire chips would be in the construction of on-site domestic wastewater systems. This would replace stone aggregate providing a method of distributing the effluent across the bottom of the disposal trench, and also provide structural support.

[20] Use of Scrap Tire Rubber – State of California Department of Transportation.

A study by Richard Scott from the Centre for Water Resources Studies indicates that this is technically feasible[21]. A series of material specifications for tire chip use in Nova Scotia was outlined within the study. Additionally, a study by Envirologic, Inc. compared the physical characteristics of nominal 2-inch tire chip and ¾ - 1½ inch crushed stone for use in distribution system construction. The study concluded through following a series of bench tests that shredded tires would perform as well, if not better than crushed aggregate. Tire chips compared favorably with the current stone aggregate option. Chipped tires did pose a question with regard to compaction, but all studies indicate that this is not necessary and pose no long term problems. There have been many examples of uses of this process in the United States all cited as part of the literature review in the Richard Scott study (Dalhousie University). The technologies has been proven acceptable and in fact in some instances preferable to stone aggregate.

Following a review of the existing literature on the use of shredded tires, it would appear that the only concern in using tire chips in the construction of domestic septic field could be an elevation of iron and manganese which could potentially leach from the tire chips. In the two case studies carried out in Nova Scotia, the concentration of iron was six times greater than the recommended limit reported in the Canadian Drinking Water Guidelines. However, this was not considered a health hazard and further testing was recommended in this area. Both iron and manganese are not considered to be elements of concerns for ground water pollution.

The energy requirement for shredding, trucking, and utilization of tire chips in this application would be considered to have approximately the same energy requirements as crushing and processing aggregate for this purpose; however, if aggregate needed to be blasted and crushed, rubber shreds would prove to be a more energy efficient option.

Based on the study by Richard Scott, it would appear that using tire chips in septic fields presents a significant economic saving in relation to trucking and material costs[22]. In 2006, there were 3,500 applications for septic systems in the Province of Nova Scotia. However, one of the

[21] Scott, R. (April 2002). Use of Tire Chips as a Distribution System Aggregate in On-site Wastewater Systems in Nova Scotia. Centre for Water Resources Studies, Dalhousie University.

[22] Scott, R. (April 2002). Use of Tire Chips as a Distribution System Aggregate in On-site Wastewater Systems in Nova Scotia. Centre for Water Resources Studies, Dalhousie University.

major drawbacks for the use of shredded tire chips is the lack of a tire chipping facility. Also consideration should be given to the storage and distribution issues associated with the production of tire chips. There is no evidence of social opposition to this process. If tire chips are to be used as an alternative to crushed aggregate for the construction of domestic sewage system, the Provincial Government will need to entice homeowners and contractors to use rubber shreds as a sustainable construction option.

8.5 Use of recycled waste tires for the manufacture of landscaping mulch

Rubber landscape mulch (RM) is produced in a variety of ways from used tires, e.g. shaving the surface to produce a rubber, flake-like, material that resembles natural bark mulch (Figure 1); or grinding tires into 1" chips. The 1" chips are passed through magnets to remove steel wire (Figure 2). The latter is also referred to as 'nuggets'.

Figure 1. Rubber Mulch Flakes

Figure 2. 'Nuggets'

Landscaping RM is available in a variety of colors. RM to be used for landscaping is required to be 99% free of steel wire, where as that used for playing surfaces has to be 99.9% free of steel wire. The advantages of using RM over bark mulch (BM) touted the industry are as follows:

- does not float or blow away
- cost effective
- reduces weed growth
- drastically reduces maintenance time and expense
- non-toxic, odorless, minimizes dust
- does not provide a food source for most insects or termites
- available in a variety of colors
- made from 100% recycled rubber

The chief advantage of RM over BM is that it only needs to be applied once; where as natural BM needs to be re-applied every year. However, RM is currently more expensive than BM but in the long term it saves money. For this reason and the other advantages listed, it is beginning to find a larger share of the landscaping mulch market. Kent Building Supplies are currently using RM for landscaping their premises in Nova Scotia.

Flammability tests by Steward et al (2003) showed that the application of cigarettes to RM failed to cause ignition. Other trials conducted also showed that out of 13 mulch materials, RM was the last material to catch fire when exposed to a propane torch flame[23].

There is little or no toxic hazard associated with landscaping RM or nuggets[24,25]. There are a number of standards and certifications that pertain to RM products. These include: ASTM D 2859 (Flammability) and AATCC Test Method (Colorfastness to Light).

The production of RM requires equipment to shave, shred and grind waste tires to produce the mulch of the correct size and type. Magnets are also required to remove the steel wire. Colored RM requires further processing equipment and coloring chemicals. The colored RM is cured at 430°K to fix the dye to the rubber.

9.0 The use of rubber crumb to produce secondary manufactured products

Rubber crumb can be effectively transformed into usable secondary product. The transformation of rubber crumb into usable products serves to displace the use of virgin rubber and thus serves as an effective means of recycling the used tire. Various products are currently being produced by TRACC and Royal Mat which serve to meet an ever expanding market. Many of these products are focused on providing products for emerging markets.

[23] Steward, L.G., Sydnor, T.D. and Bishop, B. (2003). The ease of ignition of 13 landscaping mulches. Journal of Arboriculture 29(6), November, pp 317-321.

[24] Groenevelt, P.H. and Grunthal, P.E. (1998). Utilisation of crumb rubber as a soil amendment for sports turf. Soil and Tillage Research 42(1-2): 169-172.

[25] Birkholz, D.A., Belton, K.L. et al. (2003). Toxicological Evaluation for the Hazard Assessment of Tire Crumb for Use in Public Playgrounds. Journal of the Air and Waste Management Association, 53: 903-907.

9.1 Use of recycled waste tires for the manufacture of construction & transportation associated products

In the construction, oil & gas exploration and transport sectors, there are many niche products that can be produced from recycled waste tires. There are currently many companies producing products to fill these niche markets. Generally, products are manufactured from crumb rubber with the steel and polyester fibre removed. The crumb rubber is mixed with virgin rubber; plastic grinds or recycled plastic grocery bags and then molded to form the end product. Virgin rubber is also required to 'cure' the final product, as crumb rubber cannot be re-cured. In essence, curing is a means where by the constituents in the mold are glued together to produce the end product. The products manufactured for niche markets include, but are not limited to[26,27]:

- Roof-Guard pads
- Machinery pads
- Anti-Vibration pads
- Anti-Fatigue pads
- Sound proofing
- Carpet underlay
- Solid rubber tires for forklift trucks and machines
- Bases for road delineation reflection cones
- Portable construction access mats
- Cable guards
- Equipment cushions
- Oil rig drilling pipe thread protectors
- Entrance mats
- Specialized baffles and gaskets
- Anti-slip mats
- Traction mats
- Wheel chocks
- Automobile parts

[26] Scrap tire recycling in Canada, from scrap to value. The Canadian Association of Tire Recycling (CATRA), pp 1-18.

[27] Beck, R.W. (2005). Analysis of New York Scrap Tire Markets. Prepared for the New York State Department of Economic Development: 1-150.

Figures 3 to 6 provide a few examples of these products that can be manufactured from recycled waste tires.

Figure 3. Traffic reflection cone base

Figure 4. Specialized gasket

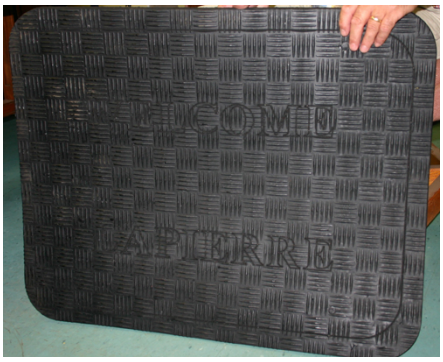


Figure 5. Entrance mats

Figure 6. Drilling rig pipe thread protectors

There are many successful companies globally who produce this type of product. In neighboring Provinces there are Royal Mat (Quebec)[28] and Tire Recycling Atlantic Canada Corporation (TRACC) (New Brunswick)[29]. TRACC have been in operation for 11.5 years and are now profitable. Royal Mat has been in operation since 1983 and is a successful company. TRACC produces a number of products that serve these nice markets, including traffic delineation reflective cone bases, drilling rig pipe thread protectors, specialized gaskets and surface protection access mats. TRACC currently sell all their traffic delineation bases to New Brunswick Department of Transportation. The traffic delineation reflective cone bases shown in Figure 3 were observed by the committee to be used in Halifax. Royal Mat produces mud flaps that come with a lifetime guarantee. The range of mud flaps produced by Royal Mat include the models Trapeze, Tribiner, Square, Plain and Mini. Royal Mat offers a wide choice of solid tires

[28] Royal Mat, Quebec. http://www.royalmat.com/

[29] Tire Recycling Atlantic Canada Corporation (TRACC). http://www.recycle.net/tracc/

made from recycled waste tires. One such product is the Royal PhoenX. The solid tires can also be pressed onto wheel hubs for forklift trucks. Royal Mat also manufactures a soundproofing panel from recycled rubber called NEUTRA-PHONE®. Pathway Mats (Alberta) produce access mats from crumb rubber to protect soft surfaces from pedestrian and vehicular traffic[30].

Producing these products from recycled waste tires displaces the need to use oil and other associated natural resources, which is extremely desirable. However, in comparison with other recycling options such as engineering aggregate applications, the manufacture of these products requires an extra processing step and finer crumb mesh which ultimately requires more energy and larger outlay of capital investment.

9.2 Use of recycled waste tires for the manufacture of playground and other sports related tracks

The product range includes playground, equestrian, ice rink access mats, sports field and athletic track surfaces. Playground surfaces generally take one of three forms:

1. As uncompressed tire shred, mulch or crumb (also known as a nugget) comprising a rakeable surface. Tire crumb nuggets are available in a variety of colors. Playground and equestrian mulch is ground into ½“ chips before passing through a magnet or a series of magnets to remove the steel wire.
2. As rubber tire shreds that are poured-in-place along with a binder, hardening into a permanent surface.
3. As tiles molded in the factory from tire shreds and binder, which are then transported to the playground and locked or glued into place, forming a permanent surface.

Athletic track applications use the method used in No. 2[31]. An example of colored rubber mulch and ‘nuggets’ used for playground surfaces is illustrated in Figures 1 and 2.

One of the key advantages of using RM as a playing surface, as opposed to other surface materials, is that it has superior shock absorbency compared with other traditional surfacing

[30] Pathway Mats. http://www.pathwaymats.com/

[31] Scrap tire recycling in Canada, from scrap to value. Canadian Association of Tire Recycling Agencies (CATRA).

materials, e.g. pea gravel or wood mulch[32]. Playing fields use approximately 3.5 lbs rubber/ft^2. A typical sports field is 80,000 ft^2. 50,000 PTE would be required to produce a sports field of this size, which is approximately 10% of Nova Scotia's waste tires produced annually.

There are many successful companies globally who produce this type of product. TRACC produce colored nuggets for playground surfaces, ice rink entrance mats and doorstep mats[33]. Royal Mat produce sport facility mats, e.g. playground surfaces, gym flooring, Golf tee-off mats and ski resort mats[34]. U.S. Rubber manufacture sports mats[35]. All of the companies are currently experiencing a high demand for their products.

9.3 Use of recycled waste tires for the manufacture of animal mats

Within the European Union, mats are now legally required in animal stalls to improve the living conditions of livestock. It has been seen in many studies that animals kept on stall mats are healthier and longer-lived than livestock stalled on bare concrete. This equates to an extra two cows over the lifetime of the animal due to the addition of a stall mat compared to a bare concrete stall. Livestock also sustain fewer injuries compared to un-matted stalls. In the dairy industry, dairy cows also produce greater quantities of milk when stalled on animal mats[36,37]. Because of the animal welfare and economic benefits and also the legal requirement for animal stall mats, there is subsequently a large global demand for these products. There are many companies internationally who manufacture animal mats from recycled waste tire crumb rubber. The range of products includes padded, solid sheet and mesh stall mats (for increased stall drainage)[38]. Solid sheet animal stall mats are made from mixing 3/8" mesh crumb rubber with

[32] Vidair, C., Haas, R., et al. (2007). Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products. Office of Environmental Health Hazard Assessment Publication #622-06-013.

[33] Tire Recycling Atlantic Canada Corporation (TRACC). http://www.recycle.net/tracc/

[34] Royal Mat, Quebec. http://www.royalmat.com/

[35] U.S. Rubber. http://www.usrubber.com/index.html

[36] Chaplin, S.J., Tierney, G., et al. (2000). An evaluation of mattresses and mats in two dairy units. Applied Animal Behaviour Science 66(4): 263-272.

[37] Tierney, G. and Thomson, R.D. (2001). Animal Production Technology: The Role of Finite-element Analysis in Predicting the Injury-reduction Potential of Dairy Cow Cubicle Synthetic Beds. Journal of Agricultural Engineering Research 80(4): 373-379.

[38] Humane Manufacturing Company LLC. http://www.humanemfg.com/animal.html

virgin rubber and then cut to shape using an ultra high-pressure water jet. The solid sheet mats can also be cut to have interlocking sides and with motifs on the surface if desired. Figure 7 shows the 3/8" crumb rubber that is used in the padded animal mat produced by TRACC. Figure 8 illustrates an example of a padded animal mat manufactured by TRACC.

Figure 7. Animal mat 3/8" crumb rubber

Figure 8. Padded animal mat

There are many successful companies globally who produce this type of product. TRACC produce a 0.5" solid rubber sheet mat for stalls (max size 45" x 70"). TRACC cut their sheets to size using high-pressure water-cutting equipment that can be programmed to produce mats with interlocking sides and surface motifs. TRACC also produce a padded animal mat that is produced by filling a cloth-pocketed mat with crumb rubber (Figure 7). The crumb rubber can still have the polyester fibre present but the steel wire is removed. TRACC sell this animal mat to the dairy and equine sector at present. TRACC's animal mats are marketed in North America and Europe by Promat Ltd (Ontario). TRACC has existing markets in Canada, USA, EU, Russia and Australia. Currently TRACC cannot meet demand for these mats. TRACC will also require further stocks of waste tires to produce the crumb rubber needed to meet the projected demand for their animal mats. TRACC stated that only 0.5% of the market has currently been penetrated[39]. Royal Mat (Quebec) produces two animal mats, the ISOMAT and ERGONOMIC MAT. The ISOMAT is an interlocking mat designed as a highly durable product that protects young animals from injuries caused by falls. ISOMAT carpeting insulates the floors from the cold and damp, both of which are sources of fatigue and rheumatism in dairy animals. The ERGONOMIC MAT is especially designed for milk cows. It has a grooved design similar to the TRACC product[40]. Humane Manufacturing Company LLC produces interlocking animal mats for dogs, horses, cattle and zoos. Humane Manufacturing Company manufactures their products

[39] TRACC, personal communication.

[40] Royal Mat, Quebec. http://www.royalmat.com/

from truck tread bushings[41]. North West Rubber produces equine and bovine mats. North West Rubber markets stall, bed, trailer floor, wall mats, mesh drainage mats and modular cushioned mats[42].

9.4 Use of recycled waste tires for the manufacture of roofing shingle and shakes

Crumb rubber and plastic re-grinds are blended and injected into a mold. TRACC manufactured their own blending machine for this purpose. TRACC grind their own plastic but cannot grind enough to meet demand so they have to buy in pre-ground plastic from a company in Ontario. The shingle injection mold was bought from a Chinese company, Nanron. The mold is capable of producing 4 shingles per minute and operates 24 hours a day, 7 days per week. TRACC rubber shingles are currently available in Atlantic Canada through a distributor in Fredericton.

There are many companies who manufacture roofing shingles and shakes from recycled waste tires[43]. The sizes of typical shingles on the market are 12” wide, 18” long and1/4” thick and are available in up to nine colors and four different designs, e.g. Traditional, Beaver Tail, Chisel Point and Beveled Edge. Shingles are designed to look and feel like natural slate but with the added advantages of:

- high impact resistance that provides protection from hail, falling branches, foot traffic, ice and snow damage.
- installation is up to eight times faster than natural stone slate.
- most rubber roofing shingles have warranties for up to 50 years.
- they can be recycled to produce further shingles[44].

An example of ‘Beveled Edge’ and ‘Beaver Tail’ shingles produced by TRACC, NB, is shown in Figure 9.

[41] Humane Animal Mats. http://www.humanemfg.com/animal.html

[42] North West Rubber. http://www.northwestrubber.com/index.html

[43] Scrap tire recycling in Canada, from scrap to value. Canadian Association of Tire Recycling Agencies (CATRA).

[44] EcoStar (2007). www.ecostar.carlise.com

Figure 9. ‘Beveled Edge’ and ‘Beaver Tail’ recycled tire and plastic roofing shingle

Roofing shingles can last 50 years. However, they can be recycled after use to make further shingles. This is a very good recycling option for waste tires and fulfills all the objectives of the three R’s and environmental sustainability. Roofing shingles cost twice that of ordinary shingles. They do however last twice as long. Contrary to the industries advertising information, roofing shingles made from re-cycled tires and plastic take twice as long to apply as traditional shingles as they require special screws to attached them to the roof[45]. However, specialized equipment is required such as shingle molds, associated blenders, conveyors and mold injectors.

9.5 Assessment of alternatives

Table 4 summarizes the results obtained from applying the *Screening Model for the Assessment of Alternative Options to TDF*. Each alternative was assessed against the set of approved criteria and awarded a ranking from 1 to 4. In its final assessment, the committee members decided to place a greater emphasis on the alternatives which produced a rubber based product from used tires while using the least amount of energy to produce. The products also had to fill an existing need within the Province and they had to reduce the need of processing virgin material. It is evident from the results of the analysis that most of the options could potential be considered as an alternative to the TDF option; however, certain alternatives were assessed as having a higher sustainable ranking given their potential to produce a usable

[45] TRACC, personal communication.

product with a limited amount of energy. In the view of the committee, there are no alternative which offer a complete pollution free process. As is the case with any human activities there will always be an impact on the natural environment. The final choice remains for the decision makers to select the sustainable alternative which demonstrate the greatest degree of balance between the environmental, economic and social implications.

Table 4: Assessment of alternatives options to TDF

Description of alternative	Technically Feasible	Equipment Available	Energy Requirement	Waste Recycled	Employment in Province	Market for Product	Economically Viable	Replace Material	Bill 146 meets GPSG	Socially Accepted	Proven Technology	Environmentally Safe	Health & Safety Issues	Emerging Sustainable Technology	Viable Alternative to TDF	Ranking	Remarks
Tire Retreading	Yes	Yes	Average	Yes	Yes	Yes Limited to trucks	Yes	Yes	Yes	Yes	Yes	Yes	No Average Industrial Processing	No	No Limited to trucks	2	The main reuse Limited to commercial truck tires
TRACC, Minto, N.B.	Yes	Yes	Average	Yes all	No	Yes Emerging markets	Yes	Yes	Yes	Yes	Yes	Yes	No Average Industrial Processing	Yes for some aspects	Yes	1	Tires need to be collected and trucked to New Brunswick
Royal Mat, Quebec	Yes	Yes	Average	Yes all	No	Yes Emerging markets	Yes	Yes	Yes	Yes	Yes	Yes	No Average Industrial Processing	Yes for some products	Yes	1	Tires need to be collected and trucked to Quebec
Lightweight Engineering Fill	Yes	Yes but not in Province	Low	Yes	Yes	Yes Emerging markets	Yes	Yes	Yes	Yes	Yes	Yes	No Average Industrial Processing	Yes for specific products	Yes	1	Need processing facility in Province Opportunity for Province
Domestic Waste System Fill	Yes	Yes but not in Province	Low	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No Average Industrial Processing	Yes could be in Province	Yes	2	Needs a processing facility in Province
Landscaping Mulch	Yes	Yes but not in Province	Low	Yes	Yes	Yes Currently sold in Province	Yes	Yes	Yes	Yes	Yes	Yes	No Average Industrial	Yes	Yes	2	Need processing facility Currently sold in Province - Kent, etc.
Roofing Shingles “Shakes”	Yes	Yes but not in Province	High	Yes	Yes	Yes Specialty markets	Niche market	Yes	Yes	Yes	Yes	Yes Shakes can be recycled	No Industrial Processing	Yes	Yes Limited	3	Emerging niche market Restoration High end homes
Animal Mats/ Commercial Mats	Yes	Yes but not in Province	High	Yes	Yes	Yes Emerging market High global demand	Yes Product in high demand	Yes	Yes	Yes	Yes	Yes	Limited to Industrial Processing	Yes	Yes High potential	3	Energy requirements are high Large market demand Limited supply
Playground and Sport Mats	Yes	Yes but not in Province	High	Yes	Yes	Yes Limited for sports	Yes Niche market in Province	Yes	Yes	Yes	Yes	Yes	Limited to Processing	Yes for athletic field	Yes Limited market in Province	3	Limited market Sport field constituent Stadium mats
Construction & Transportation Products	Yes	Yes but not in Province	High	Yes	Yes	Yes Variety of products	Yes	Yes	Yes	Yes	Yes	Yes	Limited to processing	Yes for many	Yes	3	Emerging market for many products
Asphalt	Yes	Yes but not in Province	High	Yes	Yes	Yes Limited to road building	Yes needs Gov. legislative incentives	Yes	Yes	Yes	Yes	Yes	High	Yes for Atlantic	Yes Needs political incentives	3	Needs storage for processed rubber
Pyrolysis	Yes	No	High with energy recovery could be cost efficient	Possible stack emission	Yes	Yes Selected item market	Needs a market assessment	Yes	Yes	Stack commission Need to be assessed	Yes	Stack emerging Energy regulation	Stack emissions	No	Possibly, need to assess the emissions	4	Needs economic, environmental and social assessment
TDF	Yes	Yes needs modification	Low: as the energy would be restricted to the transportation of tires	Possible stack and landfill emissions	Yes	Yes	Yes	Yes, replaces fuel	Yes	Pollution associated problems with residents of area	Yes	Stack emissions TKD contamination metals, monitoring program	Stack emissions ground water contamination concerns from residents.	No	Not applicable	4	Needs environmental review of environment and social issues

10.0 Conclusion

The committee members concluded that there are additional options to the TDF option which was the final choice of the RFP process. TRACC have demonstrated that with approximately 800,000 tires they are running a profitable operation while employing 35 to 45 individuals in an area of chronic high unemployment. They have aggressively developed niche markets for their products and currently all of the tires which are produced in New Brunswick are being processed on a regular basis. Given the expanding markets for some of their products, particularly the commercial and industrial rubber mats, they will need to find an additional supply of tires to meet these emerging demands. TRACC and Royal Mat officials indicated that they currently supply only 0.5% of the demand for industrial and commercial mats. Given the current high price of oil, it is conceivable that the use of crumb rubber for these products will remain strong over the coming years.

Royal Mat in Quebec has developed a more aggressive industrial model and they are currently producing a variety of products for the North American markets. Demands for truck mudguards along with commercial and industrial mats are currently using the greater majority of their tire. They are looking for additional tires and they have indicated that they are willing to take all of the used tires from Nova Scotia for their processing plant.

From the current demand for many of the products which are produced by TRACC and Royal Mat, it is conceivable that a well managed, innovative and aggressive company could transform the used tires produced in Nova Scotia into usable secondary products. However, given the recent trends in using used tire shred for civil engineering applications, the committee believes that the Province should explore the possibility of focusing its efforts in developing a niche product for this sector. There is a demand for light fill to fill a growing need of civil engineering products. Currently most of these products are imported from outside the Province at high costs. It is possible that the Province, if it chose to follow this option, could become the focal supply point for Atlantic Canada in providing lightweight engineering fill. This option would certainly support the goals and objective of the ***Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"***.

One of the benefits of such an option is that it uses a limited amount of energy as the process involves only the crushing of the tires in variable shred sizes. It is also conceivable that this type

of operation could be integrated within one of the larger aggregate companies in the Province and could serve as a value product added to their present productions. As a side benefit, tire shreds could also be provided for the landscaping industries.

The committee members agree that the following could serve as alternatives to the TDF option for the management of waste tires in Nova Scotia. The members have divided the alternatives in two groups, one which provides for an out of Province solution and the other which provides option for developing solutions within the Province.

Out of Province Alternatives:

- Tire Recycling Atlantic Canada Corporation (TRACC), Minto, New Brunswick.
- Royal Mat, Quebec.

In Province Alternatives:

Reuse Option:

- Tire Retreading Industry in Nova Scotia.

Recycle Options:

Lower energy input:

- Use of rubber from used tires for lightweight engineering fill.
- Use of Tire Chips for On-Site Domestic Wastewater Systems.
- Use of recycled waste tires for the manufacture of landscaping mulch.

Higher energy input:

- Use of recycled waste tires for the manufacture of roofing shingle and shakes.
- Use of recycled waste tires for the manufacture of animal mats.
- Use of recycled waste tires for the manufacture of playground and other sports related tracks.
- Use of recycled waste tires for the manufacture of construction & transportation associated products.
- Use of rubber from used tires for the production of asphalt Rubber.

Technology which need additional assessment for energy requirements and stack emissions:

- MedNova Tech International Ltd.

10.1 Recommendation

The committee members agree that there are alternatives to the proposed TDF which should prove to be viable and sustainable. These options support the goals and objectives expressed within the Provinces ***Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"*** which was approved by the Government in the last session of the legislature. Some of the options, if supported and endorsed by enabling legislation, could demonstrate how sustainable emerging practices can help reduce waste while providing options to turn spent items from our waste stream into viable commercial products. Producing commercial by-products from our waste stream does reduce the need to exploit virgin material.

Annex A

List of interview and site visits by the Committee Members

July 17, 2007 – Meeting with Mr. Bill Ring, CEO of RRFB.

July 17, 2007 – Meeting with Dr. Mike Pegg, Dalhousie University, Engineering Faculty.

July 17, 2007 – Meeting with Mr. Robert Anderson, NSDoEL.

July 18, 2007 – Conference call with Mr. Terry O'Leary.

July 18, 2007 – Conference call with Mr. Dean Porter.

July 25, 2007 – Conference call with Mr. John Leonard, CEO of TRACC.

July 17, 2007 – Meeting with Mr. Brian Miller (President), Miller Tire, Mr. Corey Miller (CEO), and Mr. Roger Scott (Sales Manager).

July 17, 2007 – Tour Miller Tire Plant, Burnside Industrial Park, Dartmouth, NS.

August 7, 2007 – Meeting with CABOT representatives at Sorflaten residence, Short Lake, NS. The members present were Mr. Allan Sorflaten, Mrs. Lydia Sorflaten, Mr. Don Murray, Mrs. Emily Keirstead, Mrs. Trudy Johnston, Mr. Fred Blois.

August 7, 2007 – Meeting with Lafarge representatives, Mr. James Kirkpatrick, Plant manager, Mr. Chris Richard, Environmental officer, Mr. Kim Unger, Brookfield, N.S.

August 7, 2007 – Tour Lafarge cement plant, Brookfield, N.S.

August 7, 2007 – Meeting with MedNova Tech International Ltd. representatives, Mrs Wendy Yeung-Chen, Director International Trade, and Mr. Robert Spencer, Sales manager, 867 Tower Road, Halifax, N.S.

August 13, 2007 – Conference call with Mr. Michel Houle, CEO, Royal Mat, Quebec.

August 14, 2007 – Meeting with Mr. John Leonard, President, TRACC, Mr Stephen Richard Manager.

August 14, 2007 – Tour TRACC Waste Tire Processing Facility, Minto, N.B.

Annex B

Summary of sustainable assessment of each option retained as an alternative to TDF

Option 1: Production of Asphalt Rubber as an addition to liquid asphalt

Description of option:

Use of crumb rubber as a value added addition to liquid asphalt for roadway construction using asphaltic concrete.

Technical Feasibility:

The technology of using crumb rubber modified (CRM) asphalt is well established particularly in California, Arizona, Florida and Texas. Monitoring that has been performed indicates a durable pavement, enhanced drainage, improved frictional characteristics and increased resistance to rutting and overall good performance[46].

Description of the process:

Tires are crumbed to a maximum size of several millimeters and mixed with liquid asphalt to provide a uniform blend. The mixing temperature is somewhat higher than conventional asphalt, which is necessary to blend the two materials. A retention time of approximately 45 minutes is required for completion of the blending process.

End products:

The end product is a durable pavement with enhanced drainage characteristics and increased resistance to rutting and hydroplaning.

Description and Availability of Equipment:

CRM asphalt requires equipment suitable for producing crumb rubber, which is not currently available in Nova Scotia. A storage silo and material transport mechanism at the asphalt plant is required. Also, a retention storage facility would be required.

Waste stream:

Only parts of tires suitable for crumbing could be used in asphalt. This excludes the steel belts and polyester fibres.

Toxic or hazardous waste:

The use of CRM asphalt in highway paving does not create an adverse environmental impact on groundwater quality. Studies in Rhode Island have shown that levels of detectable leachate

[46] Asphalt Rubber Usage Guide – State of California Department of Transportation.

were too low to be environmentally significant or dangerous. Mercury was shown to be released at a level above the detection limit; however, the level detected was below EPA limits.

Disposal procedure of waste stream:

The steel belts may have a value as recycled steel or other complimentary recycling program.

Energy requirements:

The energy requirement for crumbing, trucking and mixing in a CRM asphalt would be considered to have the same energy requirements as producing liquid asphalt, mixing and storage as conventional asphalt.

Economic feasibility of the option:

CRM asphalt has proven to be economically feasible in California, Arizona and Texas. There is an extra cost associated with the production of CRM asphalt, due to the extra equipment required at the point of production. The use of CRM asphalt can be justified by a life cycle cost analysis.

Life cycle analysis:

CRM asphalt is not competitive on first cast. Life cycle cost analysis is required. CRM asphalt can be recycled.

Relative cost of option:

The CRM asphalt is more durable and longer lasting than conventional asphalt. At the end of its useful life, it would be disposed of in a manner similar to that of conventional asphalt in a land fill.

Comparison of option with other options:

At the current time, there are no sources of crumb rubber in Nova Scotia. Minto, N.B. is the closest source of crumb rubber material. There are no firms producing CRM asphalt. Price would be 10 to 30 percent higher for CRM asphalt.

Fills an economic niche:

No, CRM asphalt would not likely form an economic niche since it is a value added product costing considerably more than conventional asphalt. The asphalt for the most part, in Nova Scotia is specified by the NSDOT/DPW.

Definite and proven market:

In the USA, the usage of CRM asphalt is a mature market. Monitoring of the many hundreds of applications has shown the process to be viable. Markets are not proven in Nova Scotia.

Employment opportunities:

Any direct employment as a result of using CRM asphalt would be in the production of crumb rubber. All other employment would be necessarily similar for any type of asphalt production.

Skills levels:

No skill levels beyond that which is normally used in construction would be required.

Rural vs. urban setting:

The requirements conventional asphalt is province wide. CRM asphalt can be used wherever conventional asphalt is used.

Environmental Sustainability:

A large number of kilometers of highway is constructed or overlain in Nova Scotia each year. A year's collection of used tires in Nova Scotia could be used in less than 20 miles of highway construction.

Serve:

Highway construction and paving industry.

Displacement of raw or virgin material:

It would displace the use of approximately 18 to 20 percent liquid asphalt which is a costly petroleum material to produce.

Pollution aspects:

CRM asphalt pavement is very inert in most environments. Pollution would not increase with the use of CRM asphalt. The material does have a distinct odor that may trigger concerns about emissions. Testing in Arizona and California determined that plant emissions were well below mandated levels and "there were no new health risks"[47].

Pollution reduction:

There is no reason to expect that CRM asphalt would show a reduction in pollution from equivalent conventional asphalt which is also highly inert.

Meets Gov Prosperity and Sustainability Goals:

Yes we are recycling a waste material and using a less quantity of non-renewable resources (crude oil).

Identify goals:

To find a practical, sound solution to handle used tires in Nova Scotia and at the same time develop a use which is sustainable.

Social acceptability:

In other jurisdictions, the use of CRM asphalt has been socially accepted. For the most part, the general public is unaware of the complex nature of asphalt.

[47] Use of Scrap Tire Rubber – State of California Department of Transportation.

Emerging sustainable technologies:

In Nova Scotia, this would be an emerging technology.

Proven technologies:

The technology of using CRM asphalt is well proven and accepted as a value added product in numerous states in the USA. Information from many CRM projects is widely distributed in the literature. Using the technology from other jurisdictions provides a sound baseline for usage elsewhere.

Environmentally safe:

The use of CRM asphalt is environmental safe. A 2.5 year study was performed in Southern California to assess the effects of "Exposure of Paving Works to Asphalt Emissions (when using Asphalt Rubber Mixes)". Researchers found that the results "clearly demonstrated that risks associated with the use of asphalt rubber products were negligible". "Emission exposures in asphalt rubber operations did not differ from those of conventional asphalt operations".

Standards and certifications:

ASTM standards exist for the use of crumb rubber in asphalt hot mix.

Serve as a demonstration for a sustainable technology:

Yes.

Viable option:

Yes: ✓

No:

Barriers to implementation:

- No established crumb rubber equipment in Nova Scotia.
- Additional equipment at an asphalt plant.
- Additional storage capacity.
- Government non-action on using recycled materials in construction.
- Incremental cost increase.

Rationale and recommendation:

This option can use all of the waste tires produced annually in Nova Scotia in a very short section of highway.

Ranking:

Feasible province wide: Yes, almost anywhere an asphalt pavement is required

Local applications: Yes

Out of Province solution: No

General Comments:

Only a viable option if life cycle costing is considered and a change in government philosophy to endorse recycled materials in construction (even at increased cost).

Option 2: Engineering Use of Tires - Lightweight Fill

Description of option:

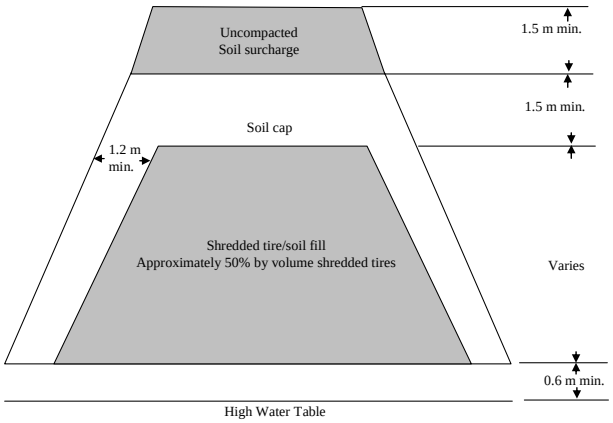
Use of tires as a lightweight fill particularly suited for roadway work across soft materials such as muskeg. Also beneficial for backfill against highway abutments and retaining walls.

Technical Feasibility:

The technology of using tires as backfill is well established particularly in Minnesota, Virginia, Colorado, Oregon, Washington, North Carolina, and Wisconsin. Monitoring that has been performed indicates low soil pressures, ease of compaction, good drainage and overall good performance[48].

Description of the process:

Tires are shredded to a maximum size of 6 to 8 inches and placed and consolidated similar to granular materials. Fills are generally limited to a height of 6 meters and the fills should start above the water table. Conventional highway rollers are used to consolidate the tire shreds in place. A soil cover note less than 1 meter is required over the top and slopes of the fill.



End products:

Lightweight fill comparable or better in performance than conventional sands and gravels.

Description and Availability of Equipment:

The lightweight fill option would require a tire shredder which is not currently available in Nova Scotia. All other equipment required is standard construction equipment which is widespread throughout Nova Scotia.

Waste stream:

There is no waste stream, all component of the tire once shredded may be used.

[48] Field study of a Shredded-Tire Embankment in Virginia.

Toxic or hazardous waste:

The use of shredded tires in highway embankments does not create an adverse environmental impact on groundwater quality. No evidence was found that tire shreds increase the concentration of metals within the primary drinking water standard[49].

Disposal procedure of waste stream:

There is no waste stream, the complete tire is used.

Energy requirements:

The energy requirement for shredding, trucking and consolidating tire shreds in a lightweight fill would be considered to have the same energy requirements as crushing and processing aggregate for the same purpose.

Economic feasibility of the option:

Lightweight fills using shredded tires have proven to be economically feasible in the USA jurisdictions. In Nova Scotia a premium is currently being paid for lightweight aggregate to serve the same purpose. Once tire shredding capabilities are available in Nova Scotia, this is a highly feasible option.

Life cycle analysis:

Lightweight shredded tire fills are inert to the environment. Unless the shreds are in a highly acidic environment, the shreds are highly durable and will not degrade with time.

Relative cost of option:

The lightweight tire fills are competitive with the cost of other types of lightweight fills. Currently in Nova Scotia, if shredding capabilities were available, the tire shreds would most likely be less costly.

Comparison of option with other options:

At the current time, there are no sources of lightweight fill to compete with tire shreds in Nova Scotia. Maine, USA, is the closest source of lightweight granular material. Synthetic material such as Styrofoam is imported as embankment fills at high costs.

Fills an economic niche:

Yes, tire shreds would fill an economic niche as there is no competitive product at the current time in Nova Scotia.

Definite and proven market:

In the USA, the usage of shredded tire as lightweight fill is a mature market for lightweight fill. Monitoring of the many hundreds of applications have shown the process to be viable.

[49] Construction and Performance of Virginia Transportation Research Council Shredded Waste Tire Embankment, Transportation Research Board Record 1345.

Employment opportunities:

Any direct employment as a result of using shredded tires for lightweight fill would be in the production of tire shreds. All other employment would be necessarily similar for any type of lightweight application.

Skills levels:

No skill levels beyond that which is normally used in construction would be required.

Rural vs. urban setting:

The requirements for lightweight fill are province wide.

Environmental Sustainability:

Yes. Lightweight fills would be sustainable. A very large number of tires are required for highway sections, for instance. A year's collection of used tires in Nova Scotia could be used in less than 0.5 mile of highway construction.

Serve:

Construction and logging industry.

Displacement of raw or virgin material:

It would not displace the use of any available materials within Atlantic Canada. It would displace the import of expensive lightweight aggregate and/or synthetic materials.

Pollution aspects:

Shredded tire chips are very inert in most environments. In high acidic (pH <3.5) environments, tires below the water table are known to show an increase in manganese, iron and zinc[50]. Tires above the water table in a neutral environment indicated no increase in the concentration of metals beyond acceptable drinking water standards.

Pollution reduction:

There is no reason to expect that shredded tires would show a reduction in pollution from an equivalent lightweight aggregate which is also highly inert. The pollution from such lightweight materials such as expanded polystyrene is unknown.

Meets Gov Prosperity and Sustainability Goals:

Yes, we are recycling a waste material and using less quantity of non-renewable resources (expanded shale for instance).

Identify goals:

To find a practical, sound solution to handle used tires in Nova Scotia and at the same time develop a use which is sustainable.

[50] Using Shredded Waste Tires as a Lightweight Fill Material for Road Sub grades, Minnesota Department of Transportation.

Social acceptability:

In other jurisdictions, the use of tires has been socially accepted. Initially there may be a slight stigma attached to the use by the public viewing it as a method of "burying" tires as opposed to their sound engineering use.

Emerging sustainable technologies:

In Nova Scotia, this would be an emerging technology.

Proven technologies:

The technology of using lightweight fills with shredded tires is well proven in numerous states in the USA. Information from many lightweight fills is widely distributed in the literature. Using the technology from other jurisdictions provides a sound baseline for usage elsewhere.

Environmentally safe:

The use of shredded tires in lightweight fills is environmental safe. In adverse conditions such as high acidity, some metals are released but not beyond the safe limits established by the EPA of USA.

Standards and certifications:

ASTM standards exist for the use of tire shreds in highway embankments. For example these standards were recently used for a highway embankment containing 16,000 tonnes of shredded tires for a highway project in New Brunswick (near St. Stephens)[51].

Serve as a demonstration for a sustainable technology:

Yes, very much so.

Viable option:

Yes: ✓

No:

Barriers to implementation:

- No established tire shredding equipment in Nova Scotia.
- Perception of burying tires in fills.
- Lack of uniform engineering standards.
- Government non-action on using recycled materials in construction.

Rationale and recommendation:

This option can use all of the waste tires produced annually in Nova Scotia in a very short section of highway.

[51] ASTM D6270-98 (2004). Standard Practice for Use of Scrap Tires in Civil Engineering Applications.

Ranking:

Feasible province wide: Yes anywhere a lightweight fill or embankment is required

Local applications: Yes

Out of Province solution: No

General Comments:

The use of used shredded tires in highway embankments is a practical method to rid Nova Scotia of a problematic waste material that by shredding produces a value-added material for construction.

Option 3: Use of Tire Chips for On-Site Domestic Wastewater Systems

Description of option:

Tire chips would be used in distribution system construction for on-site wastewater systems. This would replace stone aggregate providing a method of distributing the effluent across the bottom of the disposal trench, and acts as structural support for both the disposal pipe and the soil trench.

Technical Feasibility:

A study by Richard Scott from the Centre for Water Resources Studies indicates that this is technically feasible[52]. A set of material specifications for tire chip use in Nova Scotia was outlined in the study. Additionally, a study by Envirologic Inc. compared the physical characteristics of nominal 2-inch tire chip and ¾ - 1½ inch crushed stone for use in distribution system construction. The study concluded through a series of bench tests that shredded tires would perform as well, if not better than stone.

Description of the process:

Used tires would be collected and chipped for septic system application. The chips would be shipped for application to required areas.

End products:

The end product would be the tire chips.

Description and Availability of Equipment:

To utilize tire chips in this application would require a tire shredder, which is not currently available throughout Nova Scotia

Waste stream:

Toxic or hazardous waste:

From the studies available it would appear that the only concern in using tire chips in the septic field would be an elevation of iron and manganese leached from the tire chips. In the two case studies carried out in Nova Scotia, the concentration of iron was six times greater than the recommended limit reported in the Canadian Drinking Water Guidelines. This was not considered a health hazard and further testing was recommended in this area. There is no research available at this time to address the question of manganese.

[52] Scott, R. (April 2002). Use of Tire Chips as a Distribution System Aggregate in On-site Wastewater Systems in Nova Scotia. Centre for Water Resources Studies, Dalhousie University.

Disposal procedure of waste stream:

This process offers an opportunity to reuse tires preventing them from entering the waste stream.

Energy requirements:

The energy requirement for shredding, trucking and utilization of tire chips in this application would be considered to have the same energy requirements as crushing and processing aggregate for this purpose.

Economic feasibility of the option:

Based on the study by Richard Scott, it would appear that using tire chips in septic fields presents a significant economic saving in relation to trucking and material costs[53]. However, there are many unknowns in this area: cost of chipping tires, storage costs, equipment amortization and willingness of installers to use the material.

Life cycle analysis:

This option does not close the loop in tire re-cycling. You take the used tire, chip it and utilize the chips forever. At the end of the cycle you are still left with a disposal issue – tire chips. However, as the tire chips do not break down, they can be used repeatedly.

Relative cost of option:

This option would have some economic benefit when replacing the current stone aggregate option.

Comparison of option with other options:

Tire chips compared favorably with the current stone aggregate option. Chipped tires did pose a question with regard to compaction, but all studies indicate that this is not necessary and pose no long term problems.

Employment opportunities:

Potential exists for creation of one – two jobs in the shredding of the tires.

Skills level:

No skill beyond that which is normally used in construction would be required.

Rural vs. urban setting:

Most septic fields exist or are constructed in more rural areas.

Environmental Sustainability:

Displacement of raw or virgin material:

Will replace crushed rock or gravel.

[53] Scott, R. (April 2002). Use of Tire Chips as a Distribution System Aggregate in On-site Wastewater Systems in Nova Scotia. Centre for Water Resources Studies, Dalhousie University.

Pollution aspects:

The only pollution concern would be the potential for groundwater contamination. In all the literature reviews for the Richard Scott study, there does not appear to be any significant effect on groundwater in the short term, with the exception of iron and manganese. Even though levels are high, they do not pose a threat to human health or the environment.

Pollution reduction:

Since most of the studies were conducted over a relatively short time (5 year), it may be the potential for these elements causing concern will diminish over time.

Meets Gov Prosperity and Sustainability Goals:

Identify goals:

a) The solid-waste disposal rate will be no greater than three hundred kilograms per person per year by the year 2015 through measures that include the development of new programs and product stewardship regulation.

I) the implementation of technological changes

II) co-operation on technology development, demonstration and deployment.

Social acceptability:

There does not appear to be any social opposition to this.

Emerging sustainable technologies:

Proven technologies:

There have been many examples of uses of this process in the United States, all cite as part of the literature review in the Richard Scott study (Dalhousie University). The technologies has been proven acceptable and in fact in some instances preferable to stone aggregate.

Environmentally safe:

None of the literature cites any environmental concerns.

Standards and certifications:

Suggested standards for the tire chips have been outlined in the Richard Scott study. They are:

Aggregate:

1. Chips are to be a nominal 5 cm (2”) in size and may range from 1.25 cm (1/2”) to a maximum of 10 cm (4”) in any on dimension.
2. Exposed wire may protrude to no more than 1.25 cm (1/2”) from the chip.
3. Chipped material must be free of loose wire.
4. At least 95% of the aggregate by weight shall comply with the technical specifications listed.
5. Fines, defined as material less that 2 mm in size, are prohibited.

Application: Design and construction of trenches remains unchanged. When using tire chips, the dept of aggregate shall be a total of 30.5 cm (12”) with 15 cm (6”) below the distribution pipe and 5 cm (2”) above the pipe. The aggregate layer must be covered with an approved geotextile fabric.

Permitting procedures, for the most part, are the same as those when using stone.

Serve as a demonstration for a sustainable technology:

Two provincial demonstrations have been undertaken in the Province of Nova Scotia. While both projects experienced some minor issues, they were felt to be successful.

Viable option:

Yes: If the economics of this issue prove viable, this is a good potential option.

Barriers to implementation:

At the present time there is no one chipping tires in the Province. Now that the environmental study has been conducted, it would appear that a good business case needs to be developed for this option.

In 2006, there were 3,500 applications for septic systems in the Province of Nova Scotia. An analysis of the math surrounding these applications would be part of the business case.

Also a factor would be the start-up cost of chipping and storing tires for use in this option. Once the business case has been completed, economic viability can be determined.

Rationale and recommendation:

This option very much depends on determination of economic viability in relation to supply of chipped tires. As a stand alone business opportunity, I am not sure there is enough volume in Nova Scotia for this to be viable. It is a good option for tires and the study certainly indicates it is doable from an environment and community perspective.

Ranking:

Feasible province wide: yes

Local applications: yes

Out of Province solution: no

General Comments:

Option 4: Use of recycled waste tires for the manufacture of construction & transportation associated products

Background

In the construction, oil & gas exploration and transport sectors, there are many niche products that can be produced from recycled waste tires. There are many companies globally producing products to fill these niche markets. Generally products are manufactured from crumb rubber with the steel and polyester fibre removed. The crumb rubber is mixed with virgin rubber; plastic grinds or recycled plastic grocery bags and then molded to form the end product. Virgin rubber is also required to 'cure' the final product, as crumb rubber cannot be re-cured. In essence, curing is a means where by the constituents in the mold are glued together to produce the end product. The products manufactured for niche markets include, but are not limited to[54,55]:

- Roof-Guard pads
- Machinery pads
- Anti-Vibration pads
- Anti-Fatigue pads
- Sound proofing
- Carpet underlay
- Solid rubber tires for forklift trucks and machines
- Bases for road delineation reflection cones
- Portable construction access mats
- Cable guards
- Equipment cushions
- Oil rig drilling pipe thread protectors
- Entrance mats
- Specialized baffles and gaskets
- Anti-slip mats
- Traction mats
- Wheel chocks

[54] Scrap tire recycling in Canada, from scrap to value. The Canadian Association of Tire Recycling (CATRA), pp 1-18.

[55] Beck, R.W. (2005). Analysis of New York Scrap Tire Markets. Prepared for the New York State Department of Economic Development: 1-150.

- Automobile parts

Figures 3 to 6 provide a few examples of these products that can be manufactured from recycled waste tires.

Production of construction and transportation associated products

To manufacture these products considerable investment in plant infrastructure and equipment has to be made initially. There is the cost of purchasing crumbing machines, shredders and granulators that range between $400,000 and $1M for each unit. Additionally, there will be the requirement to purchase conveyor belts, particle size sieving machines and magnets to remove steel wire from the crumbed rubber. There will also be a need for heavy moving equipment. A plant building will need to be built to contain offices and the other plant equipment that need to be housed indoors. Additionally, a storage area for waste-tires, crumb rubber and the final products prior to delivery will be essential. The production of crumb rubber requires large amounts of energy, especially the cryogenic process that uses liquid nitrogen. Rubber curing takes place at a temperature range of 403 to 433°K. This process requires a considerable amount of energy. Surface protection and access mats require cutting to shape using an ultra high-pressure water jet, which also consumes energy.

Approximately 60% of a waste tire is used in the production of these products. The remaining steel wire, beads, polyester fibre and rubber particles can be recycled. Very little waste remains. A number of studies have shown that the final products are deemed to be environmentally safe[56,57]. The industrial standards that pertain to these products include CCMC 12921-R, ASTM D 2859. Further investigation is required to determine whether there are other industrial standards associated with these products.

[56] Birkholz, D.A., Belton, K.L., et al. (2003). Toxicological Evaluation for the Hazard Assessment of Tire Crumb for Use in Public Playgrounds. Journal of the Air and Waste Management Association, 53: 903-907.

[57] Vidair, C., Haas, R., et al. (2007). Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products. Office of Environmental Health Hazard Assessment Publication #622-06-013.

Economic viability

There are many successful companies globally who produce this type of product. In neighboring Provinces there are Royal Mat (Quebec)[58] and Tire Recycling Atlantic Canada Corporation (TRACC) (New Brunswick)[59]. TRACC have been in operation for 11 years and are now profitable. Royal Mat has been in operation since 1983 and is a successful company. TRACC produces a number of products that serve these nice markets, including traffic delineation reflective cone bases, drilling rig pipe thread protectors, specialized gaskets and surface protection access mats. TRACC currently sell all their traffic delineation bases to New Brunswick Department of Transportation. Royal Mat produces mud flaps that come with a lifetime guarantee. The range of mud flaps produced by Royal Mat include the models Trapeze, Tribiner, Square, Plain and Mini. Royal Mat offers a wide choice of solid tires made from recycled waste tires. One such product is the Royal PhoenX. The solid tires can also be pressed onto wheel hubs for forklift trucks. Royal Mat also manufactures a soundproofing panel from recycled rubber called NEUTRA-PHONE®. Pathway Mats (Alberta) produce access mats from crumb rubber to protect soft surfaces from pedestrian and vehicular traffic[60].

With careful market research and a sound business plan, a production plant for these products could be viable in Nova Scotia, given the increase market demand for many of these products. There is a potential to fill an economic niche which could produce employment in Nova Scotia. The skill levels required by employees would not be beyond that which is normally seen in the manufacturing industry. The production plant could be situated in either a rural or urban location. The plant could also produce other niche waste tire recycling products, e.g. rubber landscaping mulch, playing surfaces and roofing shingles.

Environmental Sustainability

Producing these products from recycled waste tires displaces the need to use oil and other associated natural resources, which is extremely desirable. However, in comparison with other recycling options such as engineering applications (Section 8.0), the manufacture of these products requires an extra processing step and finer crumb mesh which ultimately requires more energy and larger outlay of capital investment. More energy ultimately equates to more

[58] Royal Mat, Quebec. http://www.royalmat.com/

[59] Tire Recycling Atlantic Canada Corporation (TRACC). http://www.recycle.net/tracc/

[60] Pathway Mats. http://www.pathwaymats.com/

greenhouse gases and associated pollution. Therefore the production of these products may be considered less environmentally sustainable than producing engineering applications from recycled waste tires. However, it should still be considered as a viable option as it has the potential to create jobs and wealth in Nova Scotia. The recycling of a solid waste such as scrap tires compliments the objectives of the Province's **Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"** which highlights sustainable options for all Government initiatives[61]. Producing these products from waste tires compliments the concept of the three R's of solid waste management (Reuse, Recycle and Reduce). After tire retreading, the State of Ohio's scrap tire management alternatives ranking index scale has recycling of waste tires ranked above using tires for fuel[62]. Therefore producing these products from recycled waste tires should be considered a sound environmental, economically viable and socially acceptable option for the recycling of waste tires in Nova Scotia.

Occupational Hygiene

As in any manufacturing or industrial process there may be associated releases of toxic material into the air, elevated noise levels, and/or other related issues that could be of concern to the employee's health and safety. The production of recycled waste tire products has a number of associated health and safety issues that should be addressed when operating a plant. During the crumbing, mixing and molding process, inhalable fine airborne particles ($PM_{2.5}$) and volatile organic carbon compounds are produced. Both of these pollutants are known to be harmful to health[63,64,65]. The installation of efficient air extraction systems and the use of a rubber particle collection and recovery systems would ensure that concentration of these products remain within safe limits. Some processes within these plants can be noisy.

[61] Bill No. 146 "Environmental Goals and Sustainable Prosperity Act" proclaimed by the Government of Nova Scotia, April 2007.

[62] Scrap tire management alternatives ranking index, Scrap Tire Resources Ohio Department of Natural Resources.

[63] Sorahan, T. (1994). Bladder tumours among U.K. rubber workers. Ann Occup Hyg 38(1): 103-104.

[64] Chien, Y.-C., Ton, S., et al. (2003). Assessment of occupational health hazards in scrap-tire shredding facilities. The Science of the Total Environment 309(1-3): 35-46.

[65] NIOSH (2000). Health effects of occupational exposure to asphalt. DHHS (NIOSH) Publication No. 2001–110.

Pollution issues

There is potential at any waste tire recycling plant for air pollution emissions and fugitive dusts re-suspended by vehicle movement on roadways and outside surfaces to be advected onto communities and ecosystems downwind of the plant. There may also be issues of surface and ground water pollution due to surface run off. To reduce the impact of fugitive dust during dry, windy, weather water sprays should be used on plant and access roads. To mitigate for surface and ground water pollution associated with plant activities, surface water runoff from the facility should be collected and treated prior to release into surrounding watercourses. Before the plant becomes operational, baseline monitoring of air, water, and soil should be conducted. When the plant is operational, there should also be regular air quality, noise, and surface water monitoring conducted on site and in the surrounded area to protect the environment, employee and public health.

Recommendation

With reference to Section 2.1.7, Table 3 'Hierarchal ranking scale for waste tire disposal and recycling options', these products have a ranking of 2. The committee's screening analysis also delivers a ranking of 2.

In the short term, an out of Province solution is the only available option for the production of these products as currently there is no facility within Nova Scotia. At present 40% of Nova Scotia's waste tires are shipped to Royal Mat to be recycled. The Province could therefore continue with this option or increase the amount of waste tires shipped to Royal Mat. Alternatively, the Province may wish to consider identifying a suitable company close to Nova Scotia to take the remainder. The out of Province company should have a profitable plant that can take all of Nova Scotia's waste tires, produce the necessary crumb rubber and has secure markets for the final product. TRACC has intimated that they are in a position to take all of Nova Scotia's waste tires by 2008. Royal Mat has also said they can take more waste tires for the production of animal mats and other products. This may also be a solution to the Province's waste tire problem. The above options could be a short-term or permanent solution depending upon economic viability and other factors such as whether the Province wishes to have a 'made in Nova Scotia' solution. However, an out of Province solution would not create wealth or jobs in Nova Scotia (excluding the waste tire collection process).

In the long term, the Province may wish to explore the possibility of creating a similar production facility in Nova Scotia. It would take approximately 3 years to build the plant and secure markets. The obvious advantages would be job and wealth creation within Nova Scotia. However, for this to be realized, it may be necessary to give assistance via financial and/or property incentives provided by the Province. The business may benefit from one centralized plant, nearest to the markets with good transport routes, which would produce the construction and transportation associated products. One confounder may be that any new Nova Scotia company would be in direct competition with other established companies that have secure and established markets for these products, e.g. Royal Mat and TRACC. This may impact the potential success of a new plant in Nova Scotia as these companies already have established markets which may be difficult to break into. A feasibility study, business plan and environmental impact assessment would be required to determine whether this is a viable option for a within Province solution.

Option 4: Summary of template analysis of Construction and transportation alternatives

Description of option:

Use of recycled waste tires for the manufacture of construction & transportation associated products.

Technical Feasibility:

There are numerous companies globally who produce these type of products.

Description of the process:

Crumb rubber with the steel and fibre removed is mixed with virgin rubber and plastic, which is then molded to form the end product.

End products:

- Roof-Guard Pads
- Machinery Pads
- Anti-Vibration Pads
- Anti-Fatigue Pads
- Sound proofing
- Carpet underlay
- Solid rubber tires for forklift trucks and machines
- Bases for road delineation reflection cones
- Portable construction access mats

- Cable guards
- Equipment Cushions
- Oil rig drilling pipe thread protectors
- Entrance mats
- Specialized baffles and gaskets
- Door mats
- Anti-slip mats
- Traction mats
- Wheel chocks

Description and Availability of Equipment:

Require crumbing equipment, mixing blenders for the crumb, plastic and virgin rubber and various molds. For industrial mats, there will be a need for cutting equipment.

Waste stream:

Toxic or hazardous waste:

Steel wire belts, steel beads, fluff and polyester fibre. Rubber fume and rubber particles are known to cause respiratory illness and are known to cause cancer[66,67]. Associated plant equipment and application vehicles engine exhaust emissions are known to cause ill health[68]. Suitable mitigation measures need to be put in place.

Disposal procedure of waste stream:

The metal beads and belts can be recycled. Rubber particles can be collected and recycled.

Energy requirements:

Lots of energy is required to crumb rubber, especially the cryogenic process that use liquid nitrogen. The rubber curing (430^{o}K) and cutting process also requires considerable energy.

Economic feasibility of the option:

There is huge market potential for these products[69].

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[66] Chien, Y.-C., Ton, S., et al. (2003). Assessment of occupational health hazards in scrap-tire shredding facilities. The Science of the Total Environment 309(1-3): 35-46.

[67] Dost, A.A., Redman, D., et al. (2000). Exposure to rubber fume and rubber process dust in the general rubber goods, tyre manufacturing and retread industries. 10.1093/annhyg/44.5.329. Ann Occup Hyg 44(5): 329-342.

[68] Burnett, R.T., Brook, J., Dann, T. (2000). Association between particulate and gas-phase components of urban air pollution and daily mortality in eight Canadian cities. Inhal Toxic (Suppl), pp 15-39.

[69] TRACC, personal communication.

Life cycle analysis:

Approximately 60% of the waste tire is used in the production of these products. The remaining steel wire, beads, polyester fibre and rubber particles can be recycled. Very little waste remains.

Relative cost of option:

There is the initial cost of purchasing crumbing machines. Shredders and granulators cost between $400,000 and $1M. Additionally, there will be the requirement to purchase conveyor belts, particle size sieving machines and magnets. There will also be a need for heavy moving equipment. A plant building will need to be built to contain offices and the other plant equipment that need to be housed indoors. Also, a storage area for waste-tires, crumb and the final product will be required.

Comparison of option with other options:

Re-cycling waste tires for use as animal mats should be seen as a sound environmental, economic and socially acceptable option. However, these products require an extra process step and finer crumb mesh compared with engineering applications and which do not require further processing.

Fills an economic niche:

Yes. With careful market research and a sound business plan, a plant could be developed in Nova Scotia to produce these products in the long-term. There is potential to fill an economic niche that would produce wealth in Nova Scotia.

Definite and proven market:

There are many successful companies globally who produce products of this type.

Employment opportunities:

Proven viable businesses in neighboring Provinces, e.g. Royal Mat, Quebec, and Tire Recycling Atlantic Canada Corporation (TRACC), New Brunswick. A new plant producing these products would employ at least 10 people.

Skills levels:

No skill levels beyond that which is normally seen in the manufacturing industry.

Rural vs. urban setting:

The plant could be situated in a rural or urban location and could be part of other waste tire recycling production processes, e.g. rubber landscaping mulch, playing surfaces and roofing shingles.

Environmental Sustainability:

Sustainable as long as there are markets to accept these products.

Serve:

Construction, oil and gas and transportation sectors.

Displacement of raw or virgin material:

Displace the need to use oil.

Pollution aspects:

Fine airborne particulates and volatile organic carbon compounds produced by the production process. Both of these pollutants are known to be harmful to health[70]. Some machinery is extremely noisy. Air pollution emissions from the plant and fugitive dusts re-suspended by vehicle movement on roadways and outside surfaces may blow onto communities and ecosystems downwind of the plant. There may also be issues of surface and ground water pollution from surface run off from production plants.

Pollution reduction:

Install efficient plant dust and fume extraction systems. Use a rubber particle collection and recovery system. Use of water sprays on plant roads during dry weather to reduce fugitive dust. Install a surface water runoff collection and/or treatment facility. Make available employee ear and eye protection. Make available efficient and appropriate respirators for employees working on processes that generate fume and dust. Conduct baseline air quality and water monitoring and plant process air quality and noise monitoring.

Meets Gov Prosperity and Sustainability Goals:

Yes.

Identify goals:

In the short term, identify a suitable company close to Nova Scotia that already has an existing profitable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber and has secured markets for these products. In the long term, explore the possibility of creating a similar plant in Nova Scotia.

Social acceptability:

Yes.

Emerging sustainable technologies:

Technology in place and improving all the time.

Proven technologies:

Yes, many producers of these products globally.

[70] Sorahan, T. (1994). Bladder tumours among U.K. rubber workers. Ann Occup Hyg 38(1): 103-104.

Environmentally safe:

Yes.

Standards and certifications:

One standard that may pertain to these products is ASTM D 2859 (Flammability).

Serve as a demonstration for a sustainable technology:

Yes.

Viable option:

Yes: ✓

No:

Barriers to implementation:

- No plant in Nova Scotia producing these products.
- A plant in Nova Scotia would be in direct competition with companies in neighboring Provinces, e.g. TRACC (New Brunswick) and Royal Mat (Quebec) who also produce these products. This may impact the potential success of a new plant in Nova Scotia as these companies already have established markets which may be difficult to break into.

Rationale and recommendation:

Currently Royal Mat take 40% of Nova Scotia's waste tires to produce some of these products. Royal Mat and TRACC could take all of Nova Scotia's tires between them. In the short term, identify a suitable company close to Nova Scotia that already has an existing profitable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber, and has secure markets for these products. In the long term, explore the possibility of creating a similar plant in Nova Scotia.

Ranking:

2

Feasible province wide:

Yes.

Local applications:

Yes.

Out of Province solution:

Yes, companies already exist that can take Nova Scotia's waste tires and produce playing surfaces, e.g. Royal Mat and TRACC.

General Comments:

Currently 40% of Nova Scotia's waste tires are being shipped to Royal Mat for recycling to produce products for this sector. The simplest solution would be to continue, and possibly

increase the amount of waste tires shipped to Royal Mat for recycling. Alternatively, waste tires could also be sent to TRACC in New Brunswick as they could take all Nova Scotia's waste tires by 2008[71]. In the long term, Nova Scotia may want to explore the possibility of creating a similar operation to Royal Mat or TRACC in Nova Scotia. Recycling of a solid waste such as scrap tires compliments the objectives of Nova Scotia **Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"** which highlight sustainable options for all Government initiatives. After tire retreading, the State of Ohio's scrap tire management alternatives ranking index scale has the recycling of waste tires ranked above using tires for fuel[72].

[71] TRACC, personal communication.

[72] Scrap tire management alternatives ranking index, Scrap Tire Resources Ohio Department of Natural Resources.

Option 5: Use of recycled waste tires for the manufacture of playground and other mats

Background

There are many companies globally who produce these products from recycled waste tires. The product range includes playground, equestrian, ice rink access mats, sports field and athletic track surfaces. Playground surfaces generally take one of three forms:

1. As uncompressed tire shred, mulch or crumb (also known as a nugget) comprising a rakeable surface. Tire crumb nuggets are available in a variety of colors. Playground and equestrian mulch is ground into ½" chips before passing through a magnet or a series of magnets to remove the steel wire.
2. As rubber tire shreds that are poured in-place along with a binder, hardening into a permanent surface.
3. As tiles molded in the factory from tire shreds and binder, which are then transported to the playground and locked or glued into place, forming a permanent surface.

Athletic track applications use the method used in No. 2[73]. An example of colored rubber mulch and 'nuggets' used for playground surfaces is illustrated in Figures 1 and 2.

One of the key advantages of using RM as a playing surface, as opposed to other surface materials, is that it has superior shock absorbency compared with other traditional surfacing materials, e.g. pea gravel or wood mulch[74]. Playing fields use approximately 3.5 lbs rubber/ft^2. A typical sports field is 80,000 ft^2. 50,000 PTE would be required to produce a sports field of this size, which is approximately 10% of Nova Scotia's waste tires produced annually.

Economic viability

There are many successful companies globally who produce this type of product. TRACC produce colored nuggets for playground surfaces, ice rink entrance mats and doorstep mats[75]. Royal Mat produce sport facility mats, e.g. playground surfaces, gym flooring, Golf tee-off mats

[73] Scrap tire recycling in Canada, from scrap to value. Canadian Association of Tire Recycling Agencies (CATRA).

[74] Vidair, C., Haas, R., et al. (2007). Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products. Office of Environmental Health Hazard Assessment Publication #622-06-013.

[75] Tire Recycling Atlantic Canada Corporation (TRACC). http://www.recycle.net/tracc/

and ski resort mats[76]. U.S. Rubber manufacture sports mats[77]. Humane Manufacturing Company LLC produce sports facility mats[78]. North West Rubber Mats, Ltd (British Columbia) produce playground fall protection systems made from recycled waste tires[79]. Target Technologies International produce playing and sports surface mats[80]. American Rubber Technologies (ART) recently signed an agreement with Wal-Mart to carry 'Rubberstuff' a playground safety surfacing made from recycled tires. According to ART, 'Rubberstuff' absorbs impact from falls providing 300% better protection from injuries when compared with sand, mulch, pea gravel or wood chips[81]. Additional companies producing playing and sports surfaces from recycled waste tires include Child Safe Products Inc. (Amityville, NY), North Brook Inc. (Weedsport, NY), Safeguard Surfacing (St. James, NY) and Surface America (Williamsville, NY)[82]. There are a number of standards and certifications pertaining to playing surface products. These include, ASTM F1292-96 "Standard specification for impact attenuation of surface systems under and around playground equipment", ASTM D-2047-93 Static coefficient of friction", ASTM F 1951-99 "Surface Accessibility Test", ASTM D 2859 "Flammability (Pill) Test", CRI TM-101 "Creating Surface Appearance Changes in Pile Yarn Floor Covering from Foot Traffic", Wear Retention Test, AATCC Test Method "Colorfastness to Light (Xenon)".

With careful market research and a sound business plan a production plant for these products may be viable in Nova Scotia.

Environmental Sustainability

Producing these products from recycled waste tires displaces the need to use bark mulch, pea gravel, oil and other associated natural resources, which is extremely desirable from an environmental sustainability stand point. However, in comparison with other recycling options such as engineering applications (Section 8.0), the manufacture of these products requires an

[76] Royal Mat, Quebec. http://www.royalmat.com/

[77] U.S. Rubber. http://www.usrubber.com/index.html

[78] Humane Animal Mats. http://www.humanemfg.com/animal.html

[79] North West Rubber. http://www.northwestrubber.com/index.html

[80] Target Technologies International Inc. http://www.ttiionline.com/crumb_rubber_products.htm

[81] Scrap Tire News Article. http://www.scraptirenews.com/article.html

[82] Beck, R.W. (2005). Analysis of New York Scrap Tire Markets. Prepared for the New York State Department of Economic Development: 1-150.

extra processing step and finer crumb mesh which ultimately requires more energy. More energy ultimately equates to more greenhouse gases and associated pollution. Therefore the production of these products may be considered less environmentally sustainable than producing engineering applications from recycled waste tires. Producing these products from waste tires compliments the concept of the three R's of solid waste management (Reuse, Recycle and Reduce). After tire retreading, the State of Ohio's scrap tire management alternatives ranking index scale has recycling of waste tires ranked above using tires for fuel[83]. Therefore producing these products from recycled waste tires should be considered a sound environmental, economically viable and socially acceptable option for the recycling of waste tires in Nova Scotia.

Recommendation

With reference to Section 2.1.7, Table 3 'Hierarchal ranking scale for waste tire disposal and recycling options', these products have a ranking of 2. The committee's screening analysis also gave a ranking of 2.

In the short term, an out of Province solution is the only available option for the production of these products as currently there is no facility within Nova Scotia. Royal Mat is currently taking 40% of Nova Scotia's waste tires for recycling. The Province could therefore continue with this option and/or increase the amount of waste tires shipped to Royal Mat. Alternatively, the Province may wish to consider identifying a suitable company in a neighboring Province to take the remainder. The out of Province company should have a profitable and sustainable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber and has secure markets for the final product. TRACC has intimated that they are in a position to take all of Nova Scotia's waste tires by 2008. Royal Mat have also said they can take more waste tire.

Option 5: Summary of template Economic feasibility of the option

Proven technology and many viable companies selling playground, equestrian, sports field, accesses mats and running track surfaces.

[83] Scrap tire management alternatives ranking index, Scrap Tire Resources Ohio Department of Natural Resources.

Life cycle analysis:

Approximately 60% of the waste tire is used in the production of the product. The remaining steel wire, beads, polyester fibre and rubber particles can be recycled. Very little waste remains.

Relative cost of option:

There is the initial cost of purchasing crumbing machines. Shredders and granulators cost between $400,000 and $1M. To cover the entire range of crumb particle sizes that may be required to produce the range of playing and sports surface products, approximately three different crumbing systems may need to be purchased. Additionally, there will be the requirement to purchase conveyor belts, particle size sieving machines and magnets. There will also be a need for heavy moving equipment. A plant building will need to be built to contain offices and the other plant equipment that need to be housed indoors. Also, a storage area for waste-tires, crumb and the final crumb product will be required. Finally there will be the cost of subsidiary equipment to lay the surface product. It may be possible to use an outside contractor for this purpose. This process is expensive to set up but once operational and markets secured, it has been proven to be a viable business. Expensive when compared with engineering applications that do not require further processing.

Comparison of option with other options:

Recycled waste tires used to produce playground and sports facility surfaces are a proven and safe alternative to using other surfacing materials such as bark mulch and pea gravel. Re-cycling waste tires for use as a surfacing product should be seen as a sound environmental, economic and socially acceptable option. Some of the surfacing products can be recycled to be used again in other re-cycled tire products.

Fills an economic niche:

Yes, currently there is no plant in Nova Scotia. It the long-term, with careful market research and good plant management, there is potential to fill an economic niche that may produce wealth in Nova Scotia.

Definite and proven market:

There are many successful companies globally who produce mats of this type. TRACC have been in operation for 11.5 years and are now profitable. Royal Mat in Quebec has been in operation since 1983. TRACC produce colored nuggets for playground surfaces, ice rink entrance mats and doorstep mats[84]. Royal Mat produce sport facility mats, e.g. playground

[84] Tire Recycling Atlantic Canada Corporation (TRACC). http://www.recycle.net/tracc/

surfaces, gym flooring, golf tee-off mats and ski resort mats[85]. U.S. Rubber manufacture sports mats[86]. Humane Manufacturing Company LLC produce sports facility mats[87]. North West Rubber Mats Ltd, British Columbia, produce playground fall protection systems made from waste tires[88]. Target Technologies International produce playing and sports surface mats[89]. Pathway Mats, Alberta produce access mats from crumb rubber to protect soft surfaces from pedestrian and vehicular traffic[90]. Additional companies producing playing and sports surfaces include Child Safe Products Inc. (Amityville, NY), North Brook Inc. (Weedsport, NY), Safeguard Surfacing (St. James, NY), Surface America (Williamsville, NY)[91]. American Rubber Technologies (ART) recently signed an agreement with Wal-Mart to carry 'Rubberstuff' a resilient playground rubber safety surfacing made from recycled tires. According to ART, 'Rubberstuff' absorbs impact from falls providing 300% better protection from injuries when compared with sand, mulch, pea gravel or wood chips[92].

Employment opportunities:

Proven viable businesses, e.g. Royal Mat, Quebec, and Tire Recycling Atlantic Canada Corporation (TRACC), New Brunswick. A new plant producing these products would employ at least 10 people.

Skills levels:

No skill levels beyond that which is normally seen in the manufacturing industry.

Rural vs. urban setting:

The plant could be situated in a rural or urban location and could be part of other waste tire recycling production processes, e.g. rubber landscaping mulch, roofing shingles and shakes.

Environmental Sustainability:

Sustainable as long as there are markets to accept the playing and sports surface product. Also require a secure and sustainable supply of waste tire crumb.

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[85] Royal Mat, Quebec. http://www.royalmat.com/

[86] U.S. Rubber. http://www.usrubber.com/index.html

[87] Humane Animal Mats. http://www.humanemfg.com/animal.html

[88] North West Rubber. http://www.northwestrubber.com/index.html

[89] Target Technologies International Inc. http://www.ttiionline.com/crumb_rubber_products.htm

[90] Pathway Mats. http://www.pathwaymats.com/

[91] Beck, R.W. (2005). Analysis of New York Scrap Tire Markets. Prepared for the New York State Department of Economic Development: 1-150.

[92] Scrap Tire News Article. http://www.scraptirenews.com/article.html

Serve:

Construction and specialist surfacing industries

Displacement of raw or virgin material

Displace the need to use natural surfacing material such as pea gravel or bark mulch.

Most of the new playing or sports surface product uses re-cycled waste tires. There is however a need to use some virgin rubber to bind the crumb particles together. Virgin rubber is however carbon neutral, so this is not as detrimental to the environment as using non-renewable virgin resources of material. Additionally, there is also a need for a polyurethane binder in the surfacing process.

Pollution aspects:

During the crumbing, mixing and molding process, inhalable fine airborne particulates and volatile organic carbon compounds are produced. Both of these pollutants are know to be harmful to health[93]. Some machinery is extremely noisy. Air pollution emissions from the plant and fugitive dusts re-suspended by vehicle movement on roadways and outside surfaces may blow onto communities and ecosystems downwind of the plant. There may also be issues of surface and ground water pollution from surface run off from production plants. A toxicological evaluation by Birkholz et al, showed that there is an extremely small (10^{-6}) or zero health hazard posed to adults or children from using playing surface, sports field, access mat or other surface matting product made from recycled tires[94].

Pollution reduction:

Install efficient plant dust and fume extraction systems. Use a rubber particle collection and recovery system. Use of water sprays on plant roads during dry weather to reduce fugitive dust. Install a surface water runoff collection and or treatment facility. Make available employee ear and eye protection. Make available efficient and appropriate respirators for employees working on processes that generate fume and dust. Conduct baseline air quality and water monitoring and plant process air quality and noise monitoring.

Meets Gov Prosperity and Sustainability Goals:

Yes.

[93] Sorahan, T. (1994). Bladder tumours among U.K. rubber workers. Ann Occup Hyg 38(1): 103-104.

[94] Birkholz, D.A., Belton, K.L., et al. (2003). Toxicological Evaluation for the Hazard Assessment of Tire Crumb for Use in Public Playgrounds. Journal of the Air and Waste Management Association 53: 903-907.

Identify goals:

In the short term, identify a suitable company close to Nova Scotia that already has an existing profitable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber and has secured markets for the sports, access and playground products. In the long term explore the possibility of creating a similar plant in Nova Scotia.

Social acceptability:

Yes.

Emerging sustainable technologies:

Technology in place and improving all the time.

Proven technologies:

Yes, many examples of playing and sports surfaces in globally and in Nova Scotia, e.g. Dalhousie University Sports Field.

Environmentally safe:

Tests have shown that there is little toxic leachate from playing surfaces, especially when sealed[95,96].

Standards and certifications:

There are a number of standards and certifications that playing surface products need to adhere. These include, ASTM F1292-96 "Standard specification for impact attenuation of surface systems under and around playground equipment", ASTM D-2047-93 Static coefficient of friction", ASTM F 1951-99 "Surface Accessibility Test", ASTM D 2859 "Flammability (Pill) Test", CRI TM-101 "Creating Surface Appearance Changes in Pile Yarn Floor Covering from Foot Traffic", Wear Retention Test, AATCC Test Method "Colorfastness to Light (Xenon)".

Serve as a demonstration for a sustainable technology:

Yes.

Viable option:

Yes: ✓

No:

Barriers to implementation:

- No plant in Nova Scotia to produce playing and sports surfaces and mats

[95] Nelson, S.M., Mueller, G., Hemphill, D.C. (1994). Identification of Tire Leachate Toxicants and a Risk Assessment of Water Quality Effects Using Tire Reefs in Canals. Bulletin of Environmental Contamination and Toxicology 52(4): 574-581.

[96] Groenevelt, P.H. and Grunthal, P.E (1998). Utilisation of crumb rubber as a soil amendment for sports turf. Soil and Tillage Research 42(1-2): 169-172.

- Limited markets in Nova Scotia
- A plant in Nova Scotia would be in direct competition with neighboring companies in New Brunswick (TRACC) and Quebec (Royal Mat) who also produce these products. This may impact the potential success of a new plant in Nova Scotia as these companies already have established markets which may be difficult to break into.

Rationale and recommendation:

This option could use Nova Scotia's waste tires to produce playing and sports surfaces. The volume of waste tires that could be used for this purpose is unknown at present. Markets would need to be found for the products. In the short term, identify a suitable company close to Nova Scotia that already has an existing profitable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber, and has secured markets for the sports, access and playground products. In the long term explore the possibility of creating a similar plant in Nova Scotia.

Ranking:

2

Feasible province wide:

Yes, but the market will eventually be saturated as all immediate surfaces are replaced with recycled tire crumb product. Cost benefit analysis will need to be carried out to assess whether this is a viable solution. In the short-term, it may be more practical to ship Nova Scotia waste tires to an existing playing surface manufacturer. Currently Royal Mat take 40% of Nova Scotia's waste tires for the manufacture of playing surfaces and other products. Additionally there is TRACC in N.B., who could also take N.S. waste tires to produce playing surface and other products.

Local applications:

Yes, but the market will eventually be saturated.

Out of Province solution:

Yes, companies already exist that can take Nova Scotia's waste tires and produce playing surfaces, e.g. Royal Mat in Quebec take 36,000 (40%) of Nova Scotia's tires already.

General Comments:

This may well be worth exploring as one of the viable options for recycling Nova Scotia's waste tires. The simplest and most environmentally sustainable solution would be to continue to ship Nova Scotia's waste tires to Royal Mat in Quebec. Alternatively, waste tires could also be sent to TRACC in New Brunswick as they could take all Nova Scotia's waste tires by 2008. In the long term, Nova Scotia may want to explore the possibility of creating a similar operation to

Royal Mat or TRACC in Nova Scotia. However, this will take time to secure markets for the playing surface and mat products. The plant itself will take time to establish and begin operation. The plant will need to be managed carefully. Its location will also need to be chosen with care. After cost benefit and environmental impact assessment, it may be that an out of Province solution is still the most economic and environmentally sustainable option. In the long term, the Province may wish to explore the possibility of creating a similar production facility in Nova Scotia. This would take approximately 3 years to build the plant and secure markets. The obvious advantages would be job and wealth creation within Nova Scotia. One confounder may be that any new Nova Scotia company would be in direct competition with other established companies that have secure and established markets for these products, e.g. Royal Mat and TRACC. This may impact the potential success of a new plant in Nova Scotia as these companies already have established markets which may be difficult to break into. A feasibility study, business plan and environmental impact assessment would be required to determine whether this is a viable option within Province solution.

Option 6: Use of recycled waste tires for the manufacture of animal mats

Background

In the European Union, mats are now legally required in animal stalls to improve the living conditions of livestock. It has been seen in many studies that animals kept on stall mats are healthier and longer-lived than livestock stalled on bare concrete. This equates to an extra two cows over the lifetime of the animal due to the addition of a stall mat compared to a bare concrete stall. Livestock also sustain fewer injuries compared to un-matted stalls. In the dairy industry, milk cows also produce greater quantities of milk when stalled on animal mats[97,98]. Due to these reasons, and also peoples desire to improve the welfare of their animals, horses and pets, there is an ever-increasing demand for animal mats globally. There are many companies internationally who manufacture animal mats from recycled waste tire crumb rubber to satisfy this increasing demand. The range of these products includes padded, solid sheet and mesh stall mats (for increased stall drainage)[99]. Solid sheet animal stall mats are made from mixing 3/8" mesh crumb rubber with virgin rubber and then cut to shape using an ultra high-pressure water jet. The solid sheet mats can also be cut to have interlocking sides and with motifs on the surface if desired. Figure 7 shows the 3/8" crumb rubber that is used in the padded animal mat produced by TRACC. Figure 8 illustrates an example of a padded animal mat manufactured by TRACC.

Production of animal mats

The equipment required, plant facilities and energy requirements to manufacture animal mats is virtually the same as that described in Section 9.1. However, to manufacture the padded animal mat there is also a need for additional equipment such as a device to fill the padded mat with crumb rubber and a sewing machine to seal the ends of the padded mat after filling. The manufacture of animal mats also requires two extra workers to operate the specialist equipment.

[97] Chaplin, S.J., Tierney, G., et al. (2000). An evaluation of mattresses and mats in two dairy units. Applied Animal Behaviour Science 66(4): 263-272.

[98] Tierney, G. and Thomson, R.D. (2001). Animal Production Technology: The Role of Finite-element Analysis in Predicting the Injury-reduction Potential of Dairy Cow Cubicle Synthetic Beds. Journal of Agricultural Engineering Research 80(4): 373-379.

[99] Humane Manufacturing Company LLC. http://www.humanemfg.com/animal.html

Economic viability

There are many successful companies globally who produce this type of product. TRACC produce a 0.5" solid rubber sheet mat for stalls (max size 45" x 70"). TRACC cut their sheets to size using high-pressure water-cutting equipment that can be programmed to produce mats with interlocking sides and surface motifs. TRACC also produce a padded animal mat that is produced by filling a cloth-pocketed mat with crumb rubber (Figure 7). The crumb rubber can still have the polyester fibre present but the steel wire is removed. TRACC sell this animal mat to the dairy and equine sector at present. TRACC's animal mats are marketed in North America and Europe by Promat Ltd (Ontario). TRACC has existing markets in Canada, USA, EU, Russia and Australia. Currently TRACC cannot meet demand for these mats. TRACC will also require further stocks of waste tires to produce the crumb rubber needed to meet the projected demand for their animal mats. TRACC stated that only 0.05% of the market has currently been penetrated[100]. Royal Mat (Quebec) produces two animal mats, the ISOMAT and ERGONOMIC MAT. The ISOMAT is an interlocking mat designed as a highly durable product that protects young animals from injuries caused by falls. ISOMAT carpeting insulates the floors from the cold and damp, both of which are sources of fatigue and rheumatism in dairy animals. The ERGONOMIC MAT is especially designed for milk cows. It has a grooved design similar to the TRACC product[101]. Humane Manufacturing Company LLC produces interlocking animal mats for dogs, horses, cattle and zoos. They are manufactured from Truck tread bushings[102]. North West Rubber produces equine and bovine mats. They market stall, bed, trailer floor and wall mats and wash rack meshed drainage mats and modular cushioned mats[103].

With careful market research and a sound business plan a production plant for these products may be viable in Nova Scotia.

Environmental Sustainability

Producing these products from recycled waste tires displaces the need to use oil and other associated natural resources, which is extremely desirable. However, in comparison with other recycling options such as engineering applications (Section 8.0) the manufacture of these

[100] TRACC, personal communication.

[101] Royal Mat, Quebec. http://www.royalmat.com/

[102] Humane Animal Mats. http://www.humanemfg.com/animal.html

[103] North West Rubber. http://www.northwestrubber.com/index.html

products requires an extra processing step and finer crumb mesh which ultimately requires more energy. More energy ultimately equates to more greenhouse gas emissions and associated pollution. Therefore, the production of these products may be considered less environmentally sustainable than producing engineering applications from recycled waste tires. However, it should still be considered as a viable option as it has the potential to create jobs and wealth in Nova Scotia. The recycling of a solid waste such as scrap tires compliments the objectives of the Province's **Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"** which highlights sustainable options for all Government initiatives[104]. Producing these products from waste tires compliments the concept of the three R's of solid waste management (Reuse, Recycle and Reduce). After tire retreading, the State of Ohio's scrap tire management alternatives ranking index scale has recycling of waste tires ranked above using tires for fuel[105]. Therefore, producing these products from recycled waste tires should be considered a sound environmental, economically viable and socially acceptable (especially from the animal welfare point of view) option for the recycling of waste tires in Nova Scotia.

Recommendation

With reference to Section 2.1.7, Table 3 'Hierarchal ranking scale for waste tire disposal and recycling options', these products have a ranking of 2. However, the committee's screening analysis gives a ranking of 3 due to it being more of a niche market.

In the short term, an out of Province solution is the only option available for the production of these products as currently there is no facility within Nova Scotia. Currently 40% of Nova Scotia's waste tires are shipped to Royal Mat to be recycled. The Province could therefore continue with this option or increase the amount of waste tires shipped to Royal Mat. Alternatively, the Province may wish to consider identifying a suitable company in a neighboring Province to take the remainder. The out of Province company should have a profitable and sustainable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber, and has secure markets for the final product. TRACC has intimated that they are in a position to take all of Nova Scotia's waste tires by 2008. Royal Mat has also said they can take more waste tires for the production of animal mats and other products. This may also be a solution to the

[104] Bill No. 146 "Environmental Goals and Sustainable Prosperity Act" proclaimed by the Government of Nova Scotia, April 2007.

[105] Scrap tire management alternatives ranking index, Scrap Tire Resources Ohio Department of Natural Resources.

Province's waste tire problem. The above options could be a permanent or a short-term solution depending upon economic viability and other factors such as whether the Province wish to have a 'made in Nova Scotia' solution. However, an out of Province solution would not create wealth or jobs in Nova Scotia.

In the long term, the Province may wish to explore the possibility of creating a similar production facility in Nova Scotia. This would take approximately 3 years to build the plant and to secure the markets for the animal mats. The obvious advantages would be job and wealth creation within Nova Scotia. One confounder may be that any new Nova Scotia company would be in direct competition with other established companies that have secure and established markets for these products, e.g. Royal Mat and TRACC. This may impact the potential success of a new plant in Nova Scotia as these companies already have established markets which may be difficult to break into. A feasibility study, business plan and environmental impact assessment would be required to determine whether this is a viable option within Province solution.

Yes, but the market will eventually be saturated.

Out of Province solution

Yes, companies already exist that can take Nova Scotia's waste tires and produce playing surfaces, e.g. Royal Mat in Quebec take 36,000 (40%) of Nova Scotia's Tire already.

General Comments

This may well be worth exploring as one of the viable options for recycling Nova Scotia's waste tires. The simplest and most environmentally sustainable solution would be to continue to ship Nova Scotia's waste tires to Royal Mat in Quebec. Alternatively, waste tires could also be sent to TRACC in New Brunswick as they could take all Nova Scotia's waste tires by 2008. In the long term, Nova Scotia may want to explore the possibility of creating a similar operation to Royal Mat or TRACC in Nova Scotia. However, this will take time to secure markets for the playing surface and mat products. The plant itself will take time to establish and begin operation. The plant will need to be managed carefully. Its location will also need to be chosen with care. After cost benefit and environmental impact assessment it may be that an out of Province solution is still the most economic and environmentally sustainable option.

Option 6: Summary of template analysis for the construction of animal mats

Description of option:

Use of recycled waste tires for the construction of animal mats.

Technical Feasibility:

There are numerous companies globally who produce animal mats from crumb rubber.

Description of the process:

Crumbed tires with the steel removed but with polyester fibre remaining are used to fill animal mats.

End products:

Padded and solid sheet animal mats. 0.5" sheet animal stall mats are made from mixing 3/8" mesh crumb rubber with virgin rubber and then cutting to shape. TRACC produce a rubber 0.5" sheet mat for stalls (max size 45" x 70"). TRACC cut their sheets to size using a water cutting equipment that can be programmed to produce interlocked edges. TRACC also produce a padded animal mat is produced by filling a cloth pocketed mat with crumb rubber. The crumb rubber can still have the polyester fibre present but the steel wire must be removed. TRACC sell this animal mat to the dairy and equine sector. TRACC's animal mats are marketed by Promat Ltd (Ontario) in North America and Europe. In addition to TRACC, there is Royal Mat (Quebec) who produces two animal mats, ISOMAT and ERGONOMIC MAT. Humane Manufacturing Company LLC produces interlocking animal mats for dogs, horses, cattle and zoos. They manufacture them from Truck tread bushings[106]. North West Rubber produces equine and bovine mats. They market stall, bed, trailer floor and wall mats and wash rack meshed drainage mats and modular cushioned mats[107].

Description and Availability of Equipment:

Require crumbing equipment, mixing blenders for the crumb and virgin rubber and subsidiary equipment to fill the padded animal mats. For solid interlocked sheet stall mats there will be a need for cutting equipment.

[106] Humane Animal Mats. http://www.humanemfg.com/animal.html

[107] North West Rubber. http://www.northwestrubber.com/index.html

Waste stream:

Toxic or hazardous waste:

Steel wire belts, steel beads, fluff and polyester fibre. Rubber fume and rubber particles are known to cause respiratory illness and are known to cause cancer[108,109]. Associated plant equipment and application vehicles engine exhaust emissions are known to cause ill health[110]. Suitable mitigation measures need to be put in place.

Disposal procedure of waste stream:

The metal beads and belts can be recycled. Rubber particles can be collected and recycled.

Energy requirements:

Lots of energy is required to crumb rubber, especially the cryogenic process that use liquid nitrogen. The rubber curing (430^{o}K) and cutting process also requires considerable energy.

Economic feasibility of the option:

There is massive market potential for animal mats made from recycled waste tires as only 0.05% of the current market is being covered[111].

Life cycle analysis:

Approximately 60% of the waste tire is used in the production of the product. The remaining steel wire, beads, polyester fibre and rubber particles can be recycled. Very little waste remains.

Relative cost of option:

There is the initial cost of purchasing crumbing machines. Shredders and granulators cost between $400,000 and $1M. Additionally, there will be the requirement to purchase conveyor belts, particle size sieving machines and magnets. There will also be a need for heavy moving equipment. A plant building will need to be built to contain offices and the other plant equipment that need to be housed indoors. Also, a storage area for waste-tires, crumb and the animal mats will be required. Animal mats require an extra process step and finer crumb mesh compared with engineering applications and which do not require further processing.

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[108] Chien, Y.-C., Ton, S., et al. (2003). Assessment of occupational health hazards in scrap-tire shredding facilities. The Science of The Total Environment 309(1-3): 35-46.

[109] Dost, A.A., Redman, D., et al. (2000). Exposure to rubber fume and rubber process dust in the general rubber goods, tyre manufacturing and retread industries. 10.1093/annhyg/44.5.329. Ann Occup Hyg 44(5): 329-342.

[110] Burnett, R.T., Brook, J., Dann, T. (2000). Association between particulate and gas-phase components of urban air pollution and daily mortality in eight Canadian cities. Inhal Toxic (Suppl), pp 15-39.

[111] TRACC, personal communication.

Comparison of option with other options:

Recycling waste tires for use as animal mats should be seen as a sound environmental, economic and socially acceptable option.

Fills an economic niche:

Yes, currently there is no plant in Nova Scotia. In the long-term, with careful market research and good plant management, there is potential to fill an economic niche that may produce wealth in Nova Scotia.

Definite and proven market:

There are many successful companies globally who produce animal mats of this type.

Employment opportunities:

Proven viable businesses, e.g. Royal Mat, Quebec, and Tire Recycling Atlantic Canada Corporation (TRACC), New Brunswick. A new plant producing these products would employ at least 10 people.

Skills levels:

No skill levels beyond that which is normally seen in the manufacturing industry.

Rural vs. urban setting:

The plant could be situated in a rural or urban location and could be part of other waste tire recycling production processes, e.g. rubber landscaping mulch, roofing shingles and shakes.

Environmental Sustainability:

Sustainable as long as there are markets to accept animal mats.

Serve:

Agricultural, equine, zoo and pet owners.

Displacement of raw or virgin material:

Displace the need to use natural materials such as straw and saw dust. Easier to clean and maintain than traditional flooring materials.

Pollution aspects:

During the crumbing, mixing and molding process, inhalable fine airborne particulates and volatile organic carbon compounds are produced. Both of these pollutants are know to be harmful to health[112]. Some machinery is extremely noisy. Air pollution emissions from the plant and fugitive dusts re-suspended by vehicle movement on roadways and outside surfaces may blow onto communities and ecosystems downwind of the plant. There may also be issues of surface and ground water pollution from surface run off from production plants.

[112] Sorahan, T. (1994). Bladder tumours among U.K. rubber workers. Ann Occup Hyg 38(1): 103-104.

Pollution reduction:

Install efficient plant dust and fume extraction systems. Use a rubber particle collection and recovery system. Use of water sprays on plant roads during dry weather to reduce fugitive dust. Install a surface water runoff collection and or treatment facility. Make available employee ear and eye protection. Make available efficient and appropriate respirators for employees working on processes that generate fume and dust. Conduct baseline air quality and water monitoring and plant process air quality and noise monitoring.

Meets Gov Prosperity and Sustainability Goals:

Yes.

Identify goals:

In the short term, identify a suitable company close to Nova Scotia that already has an existing profitable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber, and has secured markets for animal mats. In the long term, explore the possibility of creating a similar plant in Nova Scotia.

Social acceptability:

Yes.

Emerging sustainable technologies:

Technology in place and improving all the time.

Proven technologies:

Yes, many animal mat producers globally.

Environmentally safe:

Yes.

Standards and certifications:

One standard that may pertain to animal mats is ASTM D 2859 "Flammability (Pill) Test". This requires further investigation.

Serve as a demonstration for a sustainable technology:

Yes.

Viable option:

Yes: ✓

No:

Barriers to implementation:

- No plant in Nova Scotia producing animal mats
- A plant in Nova Scotia would be in direct competition with neighboring companies in New Brunswick (TRACC) and Quebec (Royal Mat) who also produce these products.

This may impact the potential success of a new plant in Nova Scotia as these companies already have established markets which may be difficult to break into.

Rationale and recommendation:

Currently Royal Mat accepts 40% of Nova Scotia's waste tires to produce products that include animal mats. Royal Mat and TRACC could take all of Nova Scotia's tires between them. In the short term, identify a suitable company close to Nova Scotia that already has an existing profitable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber and has secured markets for animal mats. In the long term, explore the possibility of creating a similar plant in Nova Scotia.

Ranking:

3 – Niche Market

Feasible province wide:

Yes.

Local applications:

Yes.

Out of Province solution:

Yes, companies already exist that can take Nova Scotia's waste tires and produce playing surfaces, e.g. Royal Mat in Quebec take 36,000 (40%) of Nova Scotia's Tire already. TRACC could take all of Nova Scotia's waste tires by 2008.

General Comments:

Currently 40% of Nova Scotia's waste tires are being shipped to Royal Mat for recycling to produce animal mats and other products. The simplest solution would be to continue, and possibly increase the amount of waste tires shipped to Royal Mat for recycling. Alternatively, waste tires could also be sent to TRACC in New Brunswick as they could take all Nova Scotia's waste tires by 2008[113]. In the long term, Nova Scotia may want to explore the possibility of creating a similar operation to Royal Mat or TRACC in Nova Scotia. Recycling of a solid waste such as scrap tires compliments the objectives of Nova Scotia **Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"** which highlight sustainable options for all Government initiatives. After tire retreading, the State of Ohio's scrap tire management alternatives ranking index scale has the recycling of waste tires above using tires for fuel[114].

[113] TRACC, personal communication.

[114] Scrap tire management alternatives ranking index, Scrap Tire Resources Ohio Department of Natural Resources.

Option 7: Use of recycled waste tires for the manufacture of roofing shingle and shakes

There are many companies globally who manufacture roofing shingles and shakes from recycled waste tires[115]. The sizes of typical shingles on the market are 12" wide, 18" long and1/4" thick and are available in up to nine colors and four different designs, e.g. Traditional, Beaver Tail, Chisel Point and Beveled Edge. Shingles are designed to look and feel like natural slate but with the added advantages of:

- high impact resistance that provides protection from hail, falling branches, foot traffic, ice and snow damage.
- installation is up to eight times faster than natural stone slate.
- most rubber roofing shingles have warranties for up to 50 years.
- they can be recycled to produce further shingles[116].

An example of 'Beveled Edge' and 'Beaver Tail' shingles produced by TRACC, NB, is shown in Figure 9.

Production of roofing shingles

Crumb rubber and plastic re-grinds are blended and injected into a mold. TRACC manufactured their own blending machine for this purpose. TRACC grind their own plastic but cannot grind enough to meet demand so they have to buy in pre-ground plastic from a company in Ontario. The shingle injection mold was bought from a Chinese company, Nanron. It produces 4 shingles per minute and operates 24 hours a day, 7 days per week. Various sizes of crumb rubber can be used as long as the metal has been removed[117]. The crumbing equipment, plant facilities and energy requirements to manufacture roofing shingles is virtually the same as that described in Section 9.1 (Production of the construction and transportation associated products). However, there is the need for a shingle mold and associated blends, conveyors and mold injectors. This extra equipment requires additional energy to operate.

[115] Scrap tire recycling in Canada, from scrap to value. Canadian Association of Tire Recycling Agencies (CATRA).

[116] EcoStar (2007). www.ecostar.carlise.com.

[117] TRACC, personal communication.

Economic viability

There are many viable companies selling roofing shingles and shakes to global markets. TRACC sell the shingles shown in Figure 9. TRACC guarantee their shingle for 50 years[118]. Penfolds Roofing (British Columbia) market roofing shakes under the brand name 'EcoRoof® Rubber Shakes". Penfolds Roofing also guarantees their shingle product for 50 years[119]. DaVinci Roofscapes, (KS, US) produce a rough-hewn cedar shake and quarried slate (identical to TRACC)[120]. Hi-Tek Rubber Inc. (Iowa, US) manufacture a rubber slate and cedar shake shingle made from recycled EPDM rubber from waste tires. Hi-Tek Rubber Inc.'s shingles have been approved by the National Register for Historic building restoration. Hi-Tek Rubber Inc.'s shingle comes in two colors, Autumn Brown or Rustic Gray. The slate comes in a traditional gray color, similar to British, Welsh slate. The latter is very similar to TRACC & the DaVinci Roofscapes product[121]. EcoStar (PA, US) produce a recycled rubber (EPDM) and plastic roofing shingle range called Majestic Slate™. EcoStar are one of the market leaders in the production of roofing shingles and shakes from waste tires[122]. Roofing shingles can last 50 years. However, they can be recycled after use to make further shingles. This is a very good recycling option for waste tires and fulfills all the objectives of the three R's and environmental sustainability. Roofing shingles cost twice that of ordinary shingles. They do however last twice as long. Contrary to the industries advertising information, roofing shingles made from re-cycled tires and plastic take twice as long to apply as traditional shingles as they require special screws to attached them to the roof.

With careful market research and a sound business plan, a production plant for these products may be viable in Nova Scotia. There is a definite potential to fill an economic niche that would produce wealth and employment in Nova Scotia. A new plant producing these products would employ at least 10 people. There may be subsidiary spin off employment in the roofing industry. The skill levels required by employees would not be beyond that which is normally seen in the manufacturing industry. The production plant could be situated in either a rural or urban

[118] Tire Recycling Atlantic Canada Corporation (TRACC). http://www.recycle.net/tracc/

[119] Penfolds Roofing. http://www.penfoldsroofing.com/eco-rubber-roof.html

[120] DaVinci Roofscapes. http://www.davinciroofscapes.com/

[121] Hi-Tek Rubber. http://www.rubburconcepts.com/

[122] EcoStar. http://www.ecostar.carlise.com

location. The plant could also produce other niche waste tire recycling products, e.g. rubber landscaping mulch, animal mats and playing surfaces.

Environmental Sustainability

Producing these products from recycled waste tires displaces the need to use wood shingles, quarried slate, metal and oil and other associated natural resources. However, in comparison with other recycling options such as engineering applications (Section 8.0), the manufacture of these products requires extra processing steps which ultimately requires more energy. More energy ultimately equates to more greenhouse gas emissions and associated pollution. Therefore, the production of these products may be considered less environmentally sustainable than producing engineering applications from recycled waste tires. However, it should still be considered as a viable option as it has the potential to create jobs and wealth in Nova Scotia. The recycling of a solid waste such as scrap tires compliments the objectives of the Province's **Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"** which highlights sustainable options for all Government initiatives[123]. Producing these products from waste tires compliments the concept of the three R's in solid waste management. After tire retreading, the State of Ohio's scrap tire management alternatives ranking index scale has recycling of waste tires ranked above using tires for fuel[124]. Therefore, producing these products from recycled waste tires should be considered a sound environmental, economically viable and socially acceptable option for the recycling of waste tires in Nova Scotia.

Recommendation

With reference to Section 2.1.7, Table 3 'Hierarchal ranking scale for waste tire disposal and recycling options', these products have a ranking of 2. However, the committee's screening analysis ranks roofing shingles as 3rd due to it being more of a niche market.

In the short term, an out of Province solution is the only option available for the production of these products as currently there is no facility within Nova Scotia. Royal Mat does not currently manufacture roofing shingles so that option is ruled out. The Province may wish to consider identifying a suitable company in a neighboring Province to take the remainder. TRACC is

[123] Bill No. 146 "Environmental Goals and Sustainable Prosperity Act" proclaimed by the Government of Nova Scotia, April 2007.

[124] Scrap tire management alternatives ranking index, Scrap Tire Resources Ohio Department of Natural Resources.

currently the closest producer of roofing shingles made from recycled waste tires. TRACC has intimated that they are in a position to take all of Nova Scotia's waste tires by 2008 to manufacture a range of products that include roofing shingles. Royal Mat has also said they can take more waste tires for the production of animal mats and other products. The above option could be a permanent or a short-term solution depending upon economic viability and other factors such as whether the Province wish to have a 'made in Nova Scotia' solution. An out of Province solution would not create wealth or jobs in Nova Scotia.

In the long term, the Province may wish to explore the possibility of creating a similar production facility in Nova Scotia. This would take approximately 3 years to build the plant and secure markets. The obvious advantages would be job and wealth creation within Nova Scotia. One confounder may be that any new Nova Scotia company would be in direct competition with other established companies that have secure and established markets for these products, e.g. TRACC. This may impact the potential success of a new plant in Nova Scotia as these companies already have established markets which may be difficult to break into. A feasibility study, business plan and environmental impact assessment would be required to determine whether this is a viable option within Province solution.

Option 7: Summary of template assessment for shingles and shakes options

Description of option:

Use of recycled waste tires for the manufacture of roofing shingles and shakes.

Technical Feasibility:

There are numerous companies globally who produce these products.

Description of the process:

Waste tire crumb mixed with virgin rubber and plastic and molded into form to produce roofing shingles or shakes[125].

End products:

The sizes of typical shingles on the market are 12" wide, 18" long and1/4" thick and are available in up to nine colors and four different designs, e.g. Traditional, Beaver Tail, Chisel Point and Beveled Edge. Shingles are designed to look and feel like natural slate (see Figure 9) but with the added advantages of:

[125] Scrap tire recycling in Canada, from scrap to value. Canadian Association of Tire Recycling Agencies (CATRA).

- high impact resistance that provides protection from hail, falling branches, foot traffic, ice and snow damage.
- installation is up to eight times faster than natural stone slate.
- most rubber roofing shingles have warranties for up to 50 years.
- they can be recycled to produce further shingles[126].

Description and Availability of Equipment:

Crumb rubber and plastic re-grinds are blended and injected into a mold. TRACC, N.B., made their own blending machine. TRACC grind their own plastic but can't grind enough to meet demand so they buy in pre-ground plastic from a company in Ontario. The shingle injection mould was bought from a Chinese company, Nanron. It produces 4 tiles per minute and operates 24 hours, 7 days per week. Various sizes of crumb rubber can be used as long as the metal has been removed[127].

Waste stream:

Steel wire belts, steel beads, fine rubber particles and fluff. Rubber particles – Repairable fraction < 2.5 microns of health concern. Rubber fume and rubber particles are known to cause respiratory illness and are known to cause cancer[128,129]. Associated plant equipment and application vehicles engine exhaust emissions are known to cause ill health[130]. Suitable mitigation measures need to be put in place.

Disposal procedure of waste stream:

The metal beads and belts can be recycled. Rubber particles can be collected and recycled.

Energy requirements:

Lots of energy is required to crumb rubber and heat the mold.

[126] EcoStar (2007). Recycled tire roofing shingle supplier. www.ecostar.carlise.com

[127] TRACC, personal communication.

[128] Chien, Y.-C., Ton, S., et al. (2003). Assessment of occupational health hazards in scrap-tire shredding facilities. The Science of the Total Environment 309(1-3): 35-46.

[129] Dost, A.A., Redman, D., et al. (2000). Exposure to rubber fume and rubber process dust in the general rubber goods, tyre manufacturing and retread industries. 10.1093/annhyg/44.5.329. Ann Occup Hyg 44(5): 329-342.

[130] Burnett, R.T., Brook, J., Dann, T. (2000). Association between particulate and gas-phase components of urban air pollution and daily mortality in eight Canadian cities. Inhal Toxic (Suppl), pp 15-39.

Economic feasibility of the option:

Proven technology and many viable companies selling this type of product. TRACC, N.B. sells shingles, as shown in Figure 9. TRACC guarantee their shingle for 50 years[131]. Penfolds Roofing (British Columbia), market roofing shakes under the brand name 'EcoRoof® Rubber Shakes'. Penfolds Roofing also guarantees their shingle product for 50 years[132]. DaVinci Roofscapes (KS, US) produce a rough-hewn cedar shake and quarried slate (identical to TRACC)[133]. Hi-Tek Rubber Inc. in Iowa, U.S., manufacture a rubber slate and cedar shake shingle made from recycled EPDM rubber from waste tires. Hi-Tek Rubber Inc.'s shingles have been approved by the National Register for Historic building restoration. Hi-Tek Rubber Inc.'s shingle comes in two colors, Autumn Brown or Rustic Gray. The slate comes in a traditional gray color, similar to British, Welsh slate. The latter is very similar to TRACC & the DaVinci Roofscapes product[134]. EcoStar (PA, US) produce a recycled rubber (EPDM) and plastic roofing shingle range called Majestic Slate™. EcoStar are one of the market leaders in the production of roofing shingles and shakes from waste tires[135].

Life cycle analysis:

The shingles can last 50 years. They can be recycled after use to make further shingles. This is a very environmentally sound product.

Relative cost of option:

Roofing shingles cost twice that of ordinary shingles. They do, however, last twice as long. Contrary to the industries advertising information, roofing shingles made from re-cycled tire and plastic take twice as long to apply as they require special screws to attach them to the roof. Need crumb rubber and plastic (waste plastic bags). Additionally, there will also be the need for a shingle injection molding and blending equipment to mix the plastic and rubber crumb prior to injecting into the mould. The shingle mould typically costs $1M.

Comparison of option with other options:

Recycled tire shingle, slate and shakes products are environmentally sustainable, fill an economic niche can create employment and are socially acceptable. The market for shingles is

[131] Tire Recycling Atlantic Canada Corporation (TRACC). http://www.recycle.net/tracc/

[132] Penfolds Roofing. http://www.penfoldsroofing.com/eco-rubber-roof.html

[133] DaVinci Roofscapes. http://www.davinciroofscapes.com/

[134] Hi-Tek Rubber. http://www.rubburconcepts.com/

[135] EcoStar. http://www.ecostar.carlise.com.

established and is growing. The market for shingles is seasonal. TRACC have found that the fall is their busiest month for orders of shingles. This is a viable and sustainable option.

Fills an economic niche:

Yes.

Definite and proven market:

Many companies globally who produce roofing shingles and shakes from recycled waste tires and plastic.

Employment opportunities:

Proven viable businesses that could employ 10 or more people.

Skills levels:

No skill levels beyond that which is normally seen in the manufacturing industry.

Rural vs. urban setting:

The plant could be situated in either an urban or rural setting.

Environmental Sustainability:

Sustainable as long as there are markets and reliable supply of waste tires to produce crumb rubber of the desired particles size.

Serve:

Roofing industry.

Displacement of raw or virgin material:

Displaces the need to quarry slate and cut down trees to produce shingles.

Pollution aspects:

During the crumbing, mixing and molding process, inhalable fine airborne particulates and volatile organic carbon compounds are produced. Both of these pollutants are know to be harmful to health[136]. Some machinery is extremely noisy. Air pollution emissions from the plant and fugitive dusts re-suspended by vehicle movement on roadways and outside surfaces may blow onto communities and ecosystems downwind of the plant. There may also be issues of surface and ground water pollution from surface run off from production plants.

Pollution reduction:

Install efficient plant dust and fume extraction systems. Use a rubber particle collection and recovery system. Use of water sprays on plant roads during dry weather to reduce fugitive dust. Install a surface water runoff collection and or treatment facility. Make available employee ear and eye protection. Make available efficient and appropriate respirators for employees working

[136] Sorahan, T. (1994). Bladder tumours among U.K. rubber workers. Ann Occup Hyg 38(1): 103-104.

on processes that generate fume and dust. Conduct baseline air quality and water monitoring and plant process air quality and noise monitoring.

Meets Gov Prosperity and Sustainability Goals:

Yes.

Identify goals:

In the short term, identify a suitable company close to Nova Scotia that already has an existing profitable plant that can take Nova Scotia's waste tires, produce the necessary crumb rubber, and has secured markets for the shingles and roofing shakes. In the long term, explore the possibility of creating a similar plant in Nova Scotia.

Social acceptability:

Yes.

Emerging sustainable technologies:

Technology in place and improving all the time.

Proven technologies:

Yes.

Environmentally safe:

Yes. What little information there is available on this subject, it appears that there are little or no environmental pollution issues associated with roofing shingles.

Standards and certifications:

There are recognized industries standards including, but not limited to:

- Class A Fire resistance (UL 790)
- Class C Fire resistance (UL 790)
- Class 4 Impact Resistance (UL 2218)
- Nail pull through (ASTM D3163)
- Prolonged UV Exposure ASTM G26-95
- 110-mph wind warranty available
- 50-year product warranty available

Serve as a demonstration for a sustainable technology:

Yes.

Viable option:

Yes: ✓

No:

Barriers to implementation:

- No plant in Nova Scotia to produce rubber/plastic roofing shingles and shakes

- Immature markets for rubber/plastic roofing shingles and shakes in Nova Scotia

Rationale and recommendation:

This option could use Nova Scotia's waste tires to produce RM. The volume of waste tires that could be used for this purpose is unknown at present.

Ranking:

3 – Niche Market

Feasible province wide:

Yes, anywhere roofing is required.

Local applications:

Yes.

Out of Province solution:

Yes (TRACC, NB).

General Comments:

This may well be worth exploring as one of the alternative viable options for recycling Nova Scotia's waste tires. The simplest and most environmentally sustainable solution would be to continue to ship Nova Scotia's waste tires out of Province to TRACC who currently produce roofing shingles from recycled waste tires. In the long term, Nova Scotia may want to explore the possibility of creating a similar operation to TRACC in Nova Scotia. However, this will take time to secure markets for the roofing shingles. The plant itself will take time to establish and begin operation. The plant will need to be managed carefully. Its location will also need to be chosen with care. After cost benefit and environmental impact assessment it may be that an out of Province solution is still the most economic and environmentally sustainable option.

Option 8: Use of recycled waste tires for the manufacture of landscaping mulch

Background

There are numerous companies producing rubber mulch (RM) for landscaping applications. Rubber landscape mulch is produced a number of ways, e.g. shaving the surface of 'off highway tires' to produce a rubber, flake-like, material that resembles natural bark mulch (Figure 1); or grinding tires into 1" chips. The 1" chips are passed through magnets to remove steel wire (Figure 2). The latter is also referred to as 'nuggets'.

Landscaping RM is available in a variety of colors. RM to be used for landscaping is required to be 99% free of steel wire. Where as that used for playing surfaces has to be 99.9% free of steel wire. The advantages of using RM over bark mulch (BM) touted the industry are as follows:

- does not float or blow away
- cost effective
- reduces weed growth
- drastically reduces maintenance time and expense
- non-toxic, odorless, minimizes dust
- does not provide a food source for most insects or termites
- available in a variety of colors
- made from 100% recycled rubber

The chief advantage of RM over BM is that it only needs to be applied once; where as natural BM needs to be re-applied every year. However, RM is currently more expensive than BM but in the long term it saves money. For this reason and the other advantages listed, it is beginning to find a larger share of the mulch market. Kent Building Supplies are currently using RM for landscaping their premises.

Flammability tests by Steward et al (2003) showed that the application of cigarettes to RM failed to cause ignition. Other trials conducted also showed that out of 13 mulch materials, RM was the last material to catch fire when exposed to a propane torch flame[137].

[137] Steward, L.G. Sydnor, T.D., and Bishop, B. (2003). The ease of ignition of 13 landscaping mulches. Journal of Arboriculture 29(6), November, pp 317-321.

There is little or no toxic hazard associated with landscaping RM or nugget's (apart from a choking hazard which is comparable with other landscaping materials)[138,139]. There are a number of standards and certifications that pertain to RM products. These include, ASTM D 2859 (Flammability) and AATCC Test Method (Colorfastness to Light).

Production of landscaping rubber mulch

The production of RM requires equipment to shave, shred and grind waste tires to produce the mulch of the correct size and type. Magnets are also required to remove the steel wire. Colored RM requires further processing equipment and coloring chemicals. The colored RM is cured at 430°K to fix the dye to the rubber.

Economic viability

There are many companies selling RM in North America. Currently, RM produced in Florida is being sold in Nova Scotia at Kent Building Suppliers. The RM sold at Kent building suppliers is '*Everlast Mulch',* Rubber Resources Ltd. (Florida, US). It retails at $12.99 per bag ($19.99 at the beginning of the summer season). This is $10 more expensive than cedar mulch. '*Everlast Mulch'* is available in 30 lb bags, which will cover approximately 7.5 ft^2 when applied at a recommended depth of 2". A 30 lb bag of RM contains approximately 2.5 recycled PTE after steel and fabric are removed. Kent began selling *'Everlast'* RM in 2006. However, sales of RM have not met expectations. Kent feel the price is too high compared to cedar mulch and people are reluctant to try something new when they are familiar with BM, plus BM is a cheaper product. Kent indicated that it is younger age groups who tend to purchase RM as opposed to older members of the population who they say prefer BM. Kent has stated that they will review stocking RM if sales do not improve[140]. TRACC produce colored mulch that has the appearance of bark mulch (Figure 1) and colored nuggets (Figure 2). Other companies selling RM include, but not limited to, Target Technologies International Inc. (B.C., Canada)[141], RB Rubber Products

[138] Groenevelt, P.H. and Grunthal, P.E (1998). Utilisation of crumb rubber as a soil amendment for sports turf. Soil and Tillage Research 42(1-2): 169-172.

[139] Birkholz, D.A., Belton, K.L., et al. (2003). Toxicological Evaluation for the Hazard Assessment of Tire Crumb for Use in Public Playgrounds. Journal of the Air and Waste Management Association 53: 903-907.

[140] Kent, personal communication.

[141] Target Technologies International Inc. (TTII). http://www.ttiionline.com/index.html

Inc. (OR, US)[142], American Rubber Technologies Inc. (Florida, US)[143] to name but a few. Theoretically RM will last for many years but may become a waste issue if the mulch has to be removed. However, it should be possible to grind the waste RM into a smaller mesh size crumb which could then be re-used to produce other recycled waste tire products.

With careful market research and a sound business plan, a production plant for these products may be viable in Nova Scotia. There is a definite potential to fill an economic niche that would produce wealth and employment in Nova Scotia. A new plant producing these products would employ at least 10 people. There may also be spin-off employment in the landscaping industry. The skill levels required by employees would not be beyond that which is normally seen in the manufacturing industry. The production plant could be situated in either a rural or urban location. The plant could also produce other niche waste tire recycling products, e.g. playground surfaces, animal mats and roofing shingles.

Environmental Sustainability

Producing these products from recycled waste tires displaces the need to use wood bark. However, in comparison with other recycling options such as engineering applications (Section 8.0) the manufacture of these products requires extra processing steps which ultimately requires more energy. More energy ultimately equates to more greenhouse gas emissions and associated pollution. Therefore, the production of these products may be considered less environmentally sustainable than producing engineering applications from recycled waste tires. However, it should still be considered as a viable option as it has the potential to create jobs and wealth in Nova Scotia. The recycling of a solid waste such as scrap tires compliments the objectives of the Province's **Bill No. 146 "Environmental Goals and Sustainable Prosperity Act"** which highlights sustainable options for all Government initiatives[144]. Producing these products from waste tires compliments the concept of the three R's of solid waste management (Reuse, Recycle and Reduce). After tire retreading, the State of Ohio's scrap tire management alternatives ranking index scale has recycling of waste tires ranked above using tires for fuel[145].

[142] RB Rubber Products Inc. http://www.rbrubber.com/

[143] American Rubber Technologies Inc. http://www.americanrubber.com/index.html

[144] Bill No. 146 "Environmental Goals and Sustainable Prosperity Act" proclaimed by the Government of Nova Scotia, April 2007.

[145] Scrap tire management alternatives ranking index, Scrap Tire Resources Ohio Department of Natural Resources.

Therefore, producing these products from recycled waste tires should be considered a sound environmental, economically viable and socially acceptable option for the recycling of waste tires in Nova Scotia.

Recommendation

With reference to Section 2.1.7, Table 3 'Hierarchal ranking scale for waste tire disposal and recycling options', these products have a ranking of 2. However, the committee's screening analysis ranks landscaping RM and nuggets 3rd due to it being more of a niche market.

In the short term, an out of Province solution is the only option available for the production of these products as currently there is no facility within Nova Scotia. Royal Mat does not currently manufacture landscaping RM and nuggets so that option is not available. The Province may wish to consider identifying a suitable company in a neighboring Province to take the remainder. TRACC is currently the closest producer of landscaping RM and nuggets made from recycled waste tires. TRACC has intimated that they are in a position to take all of Nova Scotia's waste tires by 2008 to manufacture a range of products that include landscaping RM and nuggets. Royal Mat has also intimated that they could take more waste tires; although they do not produce landscaping mulch. The above option could be a permanent or a short-term solution depending upon economic viability and other factors such as whether the Province wish to have a 'made in Nova Scotia' solution. An out of Province solution would not create wealth or jobs in Nova Scotia.

In the long term, the Province may wish to explore the possibility of creating a similar production facility in Nova Scotia. This would take approximately 3 years to build the plant and secure markets for rubber landscaping mulch. The obvious advantages would be job and wealth creation within Nova Scotia. One confounder may be that any new Nova Scotia company would be in direct competition with other established companies that have secure and established markets for these products, e.g. TRACC. This may impact the potential success of a new plant in Nova Scotia as these companies already have established markets which may be difficult to break into. A feasibility study, business plan and environmental impact assessment would be required to determine whether this is a viable option within Province solution.

Option 8: Summary of template assessment for Landscaping Rubber Mulch

Description of option:

Use of waste tires to produce a product that has the appearance of bark mulch, commonly referred to as rubber mulch (RM)[146].

Technical Feasibility:

There are numerous companies producing RM for landscaping applications, e.g. TRACC (N.B., Canada)[147], Rubber Resources Ltd. (Florida, US) [148], Target Technologies International Inc. (B.C., Canada)[149], RB Rubber Products Inc. (OR, US)[150], American Rubber Technologies (operational for 11 years) Inc. (Florida, US)[151] to name but a few.

Description of the process:

Rubber landscape mulch is produced a number of ways, e.g. shaving the surface of off highway tires to produce a rubber, flake-like, material that resembles natural bark mulch; or grinding tires into 1" chips. The 1" chips are passed through magnets to remove steel wire. The latter is also referred to as 'nuggets'.

End products:

Landscaping RM in a variety of colors. RM to be used for landscaping is required to be 99% free of steel wire. The advantages of using RM over bark mulch (BM) touted suppliers are as follows:

- does not float or blow away
- cost effective
- reduces weed growth
- drastically reduces maintenance time and expense
- non-toxic, odorless, minimizes dust
- does not provide a food source for most insects or termites
- available in a variety of colors
- made from 100% recycled rubber

[146] Scrap tire recycling in Canada, from scrap to value. Canadian Association of Tire Recycling Agencies (CATRA).

[147] Tire Recycling Atlantic Canada Corporation (TRACC). http://www.recycle.net/tracc/

[148] Rubber Resources Ltd., Florida, US. http://www.stopmulching.com/index.html

[149] Target Technologies International Inc. (TTII). http://www.ttiionline.com/index.html

[150] RB Rubber Products Inc. http://www.rbrubber.com/

[151] American Rubber Technologies Inc. http://www.americanrubber.com/index.html

The chief advantage of RM over BM is that it only needs to be applied once; where as natural BM needs to be re-applied every year. However, RM is currently more expensive than BM but in the long term it saves money. For this reason and the other advantages listed, it is beginning to find a larger share of the mulch market. Rubber Resources Ltd supplies '*Everlast'* RM to Kent Building Supplies in three different colors, Cedar Red, Black Onyx, and Mocha (brown). Kent began selling *'Everlast'* RM in 2006[152].

Description and Availability of Equipment:

RM requires equipment to shave, shred and grind waste tires to produce the mulch of the correct size. Magnets are also required to remove the steel wire. Colored RM requires further processing equipment and coloring chemicals. The colored RM is cured at 500°C to fix the dye to the rubber.

Waste stream:

Little waste. Steel wire and beads from the tires are recycled.

Toxic or hazardous waste:

Little or none.

Disposal procedure of waste stream:

Steel wire and beads recycled. Atmospheric rubber particles can be collected and recycled to make other products.

Energy requirements:

Shredding and grinding uses a considerable amount of energy. The coloring process requires a curing temperature of 500°C. This process will also require a significant amount of energy.

Economic feasibility of the option:

The economic feasibility of producing landscaping RM has been shown globally. Currently, RM produced in Florida is being sold in Nova Scotia. Kent Building Suppliers currently uses RM to landscape their commercial premises.

Life cycle analysis:

Waste tires are converted to RM. Theoretically the mulch will last for many years but may become a waste issue if the mulch has to be removed for whatever reason. However, it should be possible to grind the waste RM into a smaller mesh size to be re-used to produce other recycled waste tire products.

[152] Kent, personal communication.

Relative cost of option:

Comparison of option with other options:

In Nova Scotia, '*Everlast Mulch',* Rubber Resources Ltd, Florida, US is sold at Kent for $12.99 per bag ($19.99 at the beginning of the summer season). This is $10 more expensive than cedar mulch. '*Everlast Mulch'* is available in 30 lb bags, which cover approximately 7.5 cubic feet when applied at a recommended depth of 2". A 30 lb bag of RM contains approximately 2.5 recycled PTE after steel and fabric are removed (~30% of the PTE mass).

Fills an economic niche:

Yes.

Employment opportunities:

Potential for creating jobs in the manufacturing process to produce RM. There is also potential to create jobs in the waste tire collection and product delivery process.

Skills levels:

No skill levels beyond that which is normally seen in the manufacturing industry.

Rural vs. urban setting:

The plant could be situated in a rural or urban location and could be part of other recycling production processes, e.g. mat products and roofing shingles and shakes.

Environmental Sustainability:

The production of RM would remove scarp tires from the waste stream in Nova Scotia and remove the need to use BM. However, considerable energy is needed to produce the RM, which ultimately creates greenhouse gases. The RM could be recovered and re-cycled if necessary.

Serve:

Landscaping industry and domestic gardening.

Displacement of raw or virgin material:

Eliminates the need to use BM.

Pollution aspects:

Potential for fine atmospheric particles ($PM_{2.5}$) and toxic gases to be produced inside and outside the plant during the manufacture of the RM. Additionally, there is potential for fugitive dust to be produced on site and from plant access roads due to vehicle movement. Water runoff from the plant may pollute surrounding surface and ground water. Some of the plant processes are noisy and have the potential to damage hearing. A toxicological evaluation by Birkholz et al. showed that there is an extremely small (10^{-6}) or zero health hazard posed to adults or children

from coming into contact or swallowing RM made from recycled tires[153]. Flammability tests by Steward et al (2003) showed that the application of cigarettes to RM failed to cause ignition. Other trials conducted also showed that out of 13 mulch materials, RM was the last material to catch fire when exposed to a propane torch flame[154].

Pollution reduction:

Install efficient plant dust and fume extraction systems. Use a rubber particle collection and recovery system. Use of water sprays on plant roads during dry weather to reduce fugitive dust. Install a surface water runoff collection and or treatment facility. Make available employee ear and eye protection. Make available efficient and appropriate respirators for employees working on processes that generate fume and dust. Conduct baseline air quality and water monitoring and plant process air quality and noise monitoring.

Meets Gov Prosperity and Sustainability Goals:

Yes, Recycling waste and removing the need to use a natural material (bark mulch).

Identify goals:

To initiate an environmentally sound facility to recycle Nova Scotia's waste tires (amount unknown) converting them into RM.

Social acceptability:

Some sectors of society are skeptical of the benefits of using RM for landscaping. This may improve with education/advertisement and as the product becomes more accepted.

Emerging sustainable technologies:

Currently there is no facility in Nova Scotia.

Proven technologies:

There are many global produces of RM.

Environmentally safe:

Yes, virtually zero toxicity[155].

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[153] Birkholz, D.A., Belton, K.L., et al. (2003). Toxicological Evaluation for the Hazard Assessment of Tire Crumb for Use in Public Playgrounds. Journal of the Air and Waste Management Association 53: 903-907.

[154] Steward, L.G., Sydnor, T.D., and Bishop, B. (2003). The ease of ignition of 13 landscaping mulches. Journal of Arboriculture 29(6), November, pp 317-321.

[155] Groenevelt, P.H. and Grunthal, P.E (1998). Utilisation of crumb rubber as a soil amendment for sports turf. Soil and Tillage Research 42(1-2): 169-172.

Standards and certifications:

There are a number of standards and certifications that RM products need to adhere. These include, ASTM D 2859 "Flammability (Pill) Test" and AATCC Test Method "Colorfastness to Light (Xenon)".

Serve as a demonstration for a sustainable technology:

Yes.

Viable option:

Yes: ✓

No:

Barriers to implementation:

- No plant in Nova Scotia to produce RM
- Government policy on using RM for Province landscaping projects
- Immature markets for RM in Nova Scotia

Rationale and recommendation:

This option could use Nova Scotia's waste tires to produce RM. The volume of waste tires that could be used for this purpose is unknown at present. A guaranteed and sustainable market for RM would be created if the Government moved to endorse the use of RM for its landscaping projects in the Province. Public and private markets within and without the Province could lead on from this.

Ranking:

3 – niche market

Feasible province wide:

Yes, anywhere landscaping is required.

Local applications:

Yes.

Out of Province solution:

Yes (TRACC, N.B.).

General Comments:

For this to be carried out in Nova Scotia, a plant would have to be built. This may take government incentives to achieve. A change in Government policy to endorse RM for landscaping would create an immediate market for this product. A life cycle analysis, business plan and environmental impact assessment would need to be undertaken.

Annex C

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