FRIDO CONSULTING INC.

AN INVENTORY OF CREOSOTE IN ONTARIO

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BY

G.E. BRUDERMANN, M.Sc.F.

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8015 REDROOFFS ROAD, HALFMOON BAY, BC, CANADA, V0N 1Y1
TEL/FAX: (604) 885 9640; frido@sunshine.net

SUMMARY

Creosote has been used in wood preservation in Ontario for nearly 100 years. Its benefits to society have been well documented as has its environmental behaviour. Creosote use peaked shortly after World War II. In Ontario as of today its sole use is in railway ties. The only Canadian creosote manufacture is in Ontario, however, no creosote is directly sold into this Province, since the last treatment plant shut down in 2002.

As of 2007 a total of 3,674,200m^3 of creosoted wood is installed in Ontario, containing 179,891 tons of creosote (134,918 tons PAHs). The retentions in ties make up 89% of that amount, utility poles 8% and highway structures 3%. Other use volumes are negligible.

The only new creosoted materials installed annually are 535,500 ties containing an estimated 2,999 tons of creosote (2,249 tons PAHs). None of the other products removed from service are replaced with creosoted wood, so that installed poles and highway timbers will diminish in volume and likely be completely absent by 2028.

Creosoted wood ties are the choice material for the construction of rail lines due to their cost effectiveness and excellent service performance. For these reasons, alternative preservatives or substitute materials are likely not to make significant inroads in the foreseeable future.

The service life of creosoted wood structures has been estimated by the users to be between 40 and 50 years. Annual removal volumes in Ontario have been estimated at 53,248m^3 containing 2,456 tons of creosote (1,474 tons PAHs). Of this amount 85% is contained in ties, 12% in poles and 3% in highway timbers.

It appears as if the methods of disposal of treated wood have significantly changed during the past decade. At this time a full 66% of removed material is shipped to the USA for incineration in co-gen facilities. This volume is entirely made up of ties. Landfill accounts for 26% and reuse/recycling 8% of the disposal methods employed. Open burning and sale to third parties is no longer practiced. The move to increased landfilling as compared to 2000 is due, at least in part, to the regulatory climate that creates barriers for utilizing more desirable disposal methods.

In order to optimize the utilization of out-of-service creosoted wood the following is proposed:

- Treated wood removed from service should be considered a resource, not a waste;
- There is little reason to landfill used creosote treated wood in Canada. The technology for recycling this material as energy is proven and available;

- Facilitate the use of available and proven technology for recycling and disposal;
- Regulatory barriers for the application of this technology in Canada must be minimized;
- Governments must recognize the benefits of creosoted wood to society and must assume co-responsibility for the life cycle management, including disposal;
- Ensure continued political commitment to the proper management of post-use treated wood;
- Ensure that all governments and government departments maximize their collaboration;
- The low cost of landfilling represents a major barrier to the use of other waste management options. Both regulatory and economic factors favour landfilling at this time.
- Once the barriers to the more viable disposal options have been minimized, landfilling of treated wood residues should be discouraged.

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AN INVENTORY OF CREOSOTE IN ONTARIO

1. OBJECTIVES

To establish current use patterns, trends and fate of creosote treated wood in Ontario as well as to identify best means of disposal to minimize the impact of creosoted wood on the Great Lakes Basin.

2. BACKGROUND

Wood Preservation Canada (WPC) was contracted by Environment Canada Ontario Region to study the current use patterns and disposal methods for creosote treated wood in Ontario as per the objectives above. Since WPC does not have the staff to carry out such a study, FRIDO Consulting Inc. was employed by them to undertake it on their behalf. FRIDO Consulting Inc. was selected for their previously performed work during the wood preservation SOP, including studies on the use and impact of creosoted wood as well as the development of disposal strategies. In addition, the author has had a long-time involvement in the preservation industry and relations with the users of treated wood.

3. INTRODUCTION

Creosote has been used in the past for many applications, such as animal repellant, herbicide, insecticide, fungicide in cordage and canvas. However, its main use always was in wood preservation, either in heavy-duty preservation of railway ties, bridge trestles and marine piling or for field applications to wood by brush or dipping and bandage treatment of poles and posts. By far the largest volume of creosote is used in the pressure impregnation of railway ties, where it is blended in a 50:50 ratio with heavy oil. In neat form it is primarily used for marine piling and timbers. Its use for preservation of utility poles and other products became substantially reduced after the late 1950's. At this time, the main alternative use of creosote as a wood preservative would be as a fuel.

Creosote is a by-product from the manufacture of coke and pitch, which are primarily used by the steel and aluminum smelting industries. A typical coke oven produces 75% coke, 14% coke oven gas, 4% coal tar, and 1 % light oil, of which most is benzene (1). Creosote makes up about 11.5% of the coal tar fraction. For the use in wood preservation, coal tar-creosote is defined by the American Wood Preservers' Association as:

> "A mixture of various distillates of coal tar, heavier than water and having a continuous boiling range beginning at about 200°C."

It is a complex mixture of organic compounds, comprising approximately 85% polycyclic aromatic hydrocarbons (PAHs), 12% tar acids (e.g. phenols, cresol) and 3% tar bases (e.g. pyridine and chinoline) as described by Konasewich et al. (2) and anon. (3).

Creosote experienced its peak usage in the post World War II construction boom. A significant decline came with the replacement of creosote for utility poles in the mid 1950s and another decline started in the 1980s with the reduction of railway trackage. Current use in Canada is approximately 30% of that in the post war years (2).

Historically, the main use was for the treatment of railway ties. Several treatment facilities were employed by the railway companies in Ontario, usually located in strategic locations along the rail lines. Railways did develop their own treatment criteria and generally owned the wood and the treating chemicals. Preservation companies provided land for the seasoning of the untreated ties, as well as the services for machining, such as adzing, incising and boring, and performed the impregnation treatment. In the recent past this changed, inasmuch as preservation companies now provide the finished product to the railways.

Concerning the disposal, historically, the main means employed for railway ties were reuse in secondary trackage, recycling for landscaping and burning along the rail right of way. Use as a fuel in co-gen plants has become the main method during the past decade.

4. STUDY METHOD

The study was to be based on information from the literature, e.g. historical use data and creosote loss from wood in service, as well as on a survey of creosote manufacturers/suppliers and the end users of creosoted wood, who are relatively limited in numbers.

Hence, relevant literature was reviewed, much of which had been prepared for the Strategic Options Process conducted by Environment Canada and Health Canada for the wood preservation industry.

Questionnaires were prepared for the various target organizations, such as the railways, utilities, Ontario Ministry of Transport and the creosote manufacturer (attached in Appendix II). These questionnaires were reviewed by the study authority (Environment Canada). Subsequently contacts in the target organizations were approached by phone to discuss the project, whereafter they were supplied the appropriate questionnaire. Once a response was received, it was analyzed and follow up phone conversations were conducted to clarified any remaining issues.

The obtained data were then compiled, analyzed and compared to the available historic data. The information received from the study participants was generally complete and showed a good fit with the information found in the literature.

5. THE MANUFACTURE OF CREOSOTE IN ONTARIO

VfT Canada Inc. is the only manufacturer of creosote in Ontario, in fact this is the sole manufacturer in Canada. VfT Canada Inc. operates under the *Responsible Care Program.* They are also the only source of creosote registered in Canada by the *Pest Management Regulatory Agency (PMRA)* and hold several registrations for heavy-duty and brush-grade creosote.

In 2007 the creosote volume produced was 12,000 metric tons, which compares to an average annual production in the previous 5 years of 14,850 metric tons. This represents a reduction of about 24%. A similar lower level of output is expected over the next 5 year period.

The company does not sell any creosote directly into Ontario, since there have been no creosote preservation plants operating in this Province, after the last one in Thunder Bay was mothballed in 2002. In the rest of Canada, a total of 5 creosote treating plants operate out of Nova Scotia, Quebec and British Columbia. Some creosote is sold outside the province to formulators of registered brush-grade creosote.

6. VOLUMES OF CREOSOTED WOOD IN ONTARIO

Table 1: Trend of creosote treated wood installed in Ontario. All figures are in cubic meters (m^3).

PRODUCT	1992	2007	2012
TIES	3,100,000(2)	3,360,000	3,300,000
HIGHWAY TIMBERS	64,500*	54,000	44,550**
POLES	371,250(4)	259,900	194,906^{++}
OTHER	4,500^{+}	300^{+}	248**
TOTAL	3,540,250	3,674,200	3,539,704

*Value estimated based on past removal rates.
$^{+}$Value estimated.
** Assuming a 3.5% annual retirement rate.
$^{++}$ Assuming a 5% annual retirement rate.

Unless otherwise noted, figures for 2012 are projections based on data provided by the respondents.

Railway ties make up about 91.4% of all creosoted wood products installed in Ontario. Their portion will increase to 93.2% by 2012 as the volumes of all other creosoted structures are on a decline. The volumes of ties should remain relatively stable in the future, since new installations closely match tie removals and represent normal maintenance rather than the construction of new rail lines. Essentially all creosoted structures other than railway ties will be removed without being replaced by creosoted wood.

As can be seen, the volumes of all products other than ties have been declining since 1992 and will continue to do so. The volume of installed ties seems to have increased slightly between 1992 and 2007, which perhaps is the result of the activities of the smaller railway companies. Over the next 5 years, tie volumes are expected to remain quite stable.

Utility poles make up the second largest volume of creosoted material in service in Ontario. Given the age of the current creosote pole plant, it can be expected that all these poles will have been removed within the next 15 to 20 years, rendering railroad ties virtually the only creosoted wood material in the province by 2028.

None of the respondents indicated that they used brush-grade creosote for field applications.

6.1 Railway Ties

The two major railways CN and CP responded to the study survey and have relatively good records of tie use and disposal. They also provide trackage to a number of other railways, including VIA and local railway companies. Nevertheless, there are smaller railway companies, who maintain their own trackage. Although no firm numbers for these are available, it has been estimated, that this trackage represents only about 5% of the total track installed in Ontario. Track miles, after the considerable rationalization in the 1980's, have remained relatively stable since. This is reflected in the numbers of ties removed and disposed of annually closely matching those being purchased. Purchases amount to approximately 535,500 new ties annually. No new trackage has been installed over the last 5 years and none is expected to be constructed over the next 5 years.

Good numbers for the types of ties installed seem not to exist. That is, the ratio between the main line No1. ties, secondary line No. 2 ties and the switch ties that vary in size, has not been established. Older studies for Canada (2) indicate a possible ratio of 8:2 for No 1. and No. 2 ties. This may no longer be true due to the track rationalization that took place since the time of that study. For the purpose of this study, an average volume of $0.1m^3$ per tie has therefore been used based on an average 8 foot long No. 1 tie.

6.2 Highway Timbers

Traditionally, creosote was used for a variety of highway structures in Ontario. Most prominently would be bridge foundations and bridge decking but culverts, sign posts, guard rail posts and fence posts, once made up significant volumes. Currently about 90% of the creosoted wood volume is in bridge foundations and decking, the remaining 10% in culverts. By the mid 1980s, bridge timbers had become virtually the only materials treated with creosote and by the mid 1990s this use was also all but stopped. Alternative treatments were CCA and ACA and more recently copper naphthenate for bridge timbers. No further use of creosote is anticipated by the Ministry of Transportation so that the volumes of installed creosoted wood will decline gradually as the installed wood reaches the end of the service life.

6.3 Utility Poles

Full-length treated utility poles used to be a very important market for creosote until the late 1950s. However, creosote was not very popular with linesmen, staining their clothes and causing skin problems due to the use of inadequate protective equipment. Hence, full-length creosote treated poles were gradually replaced by creosote butt-treated poles utilizing durable wood species, such as cedars, and full-length treatments with pentachlorophenol in oil, Ontario Hydro being one of the first utilities in Canada to make that conversion, and more recently by CCA. Although the volume of new installations of creosoted poles declined significantly since then, smaller lots, particularly butt-treated poles continued to be installed until recently.

The service life of these poles has been estimated at 40 to 50 years in Ontario (4), so that it is expected that, based on the age of the creosote pole plant, the retirement rate of creosoted poles would accelerate over the next ten years and thus diminish the creosote pole plant significantly in the future. An annual retirement rate of 5% has been assumed, which would result in the complete removal of all creosoted poles in Ontario by 2028.

6.4 Other

Amongst treated commodities, there would have been a certain volume of foundation piling, although treatment for these, like poles, changed to pentachlorophenol in the 1960’s and later to CCA or ACA treatments. Creosoted wood block floors were used in machine shops, etc. In addition, as long as creosote was available for brush and dip applications, farmers used it for the treatment of fence posts and other farm applications. This is no longer the case, resulting in a decline in the volumes of such creosoted structures, since, once past the service life, these will no longer be replaced with creosoted wood.

7. AMOUNTS OF CREOSOTE IN TREATED WOOD

7.1 Annual Input

As of now, there are no known new creosote treated wood volumes being installed in Ontario other than those by railways.

The specified amount of creosote in a new tie (average $0.1m^3$) is 56kg ($3.5lbs/ft^3$). This amount has been used here to calculate the totals of creosote in the annual installed ties in Ontario. The annual installation rate has been given by the respondents as 535,500. Hence the ties installed annually nominally contain:

$53,550m^3$ X 56kg = 2,999 tons creosote

This would represent the total annual amount of creosote used in Ontario wood structures as anticipated for the next 5 years.

7.2 Amounts of Creosote in Installed Products

Based on the calculations of the individual types of creosoted products currently installed in Ontario, the total amount of creosote in them is 179,891 tons.

Table 2 : Volumes of creosote in installed structures in Ontario in tons.

PRODUCT	1992	2007	2012
TIES	147,560	159,936	157,080
HIGHWAY TIMBERS	6,524	5,462	4,506
POLES	20,700	14, 492	10,868
OTHER	17	1	1
TOTAL	174,801	179,891	172,455

7.2.1 Railway Ties

It is estimated that currently 33.6 million ties are installed in Ontario comprising approximately 3.36 million m^3 . At $56kg/m^3$ and an average depletion of 15%, the amount of *creosote in all installed ties is calculated as 159,936 tons*.

7.2.2 Utility Poles

In the calculations, it has been assumed that an average pole would have a volume of $0.55m^3$ (e.g. red pine class 4/35ft). The original treatment of a full-length pressure treated pole would have been $128kg/m^3$. Assuming an average creosote depletion of 15% of all age groups in the current pole plant then the remaining average retention would be $108.8kg/m^3$.

Similarly, in a butt-treated pole the treated volume would approximately be 25% of its total volume. Assuming treatment to 128kg/m^3 and a 15% depletion then a cubic meter of a butt-treated pole would contain 27.2kg.

Hydro One estimates that the current volume of creosoted poles is 259,900 m^3 . Of this 65% are butt-treated and 35% are full-length treated.

Hence, the total creosote in the pole plant is estimated at:

Butt-treated poles:	259,900 x 0.65 x 27.2 = 4,595 tons
Full-length treated poles:	259,900 x 0.35 x 108.8 = 9,897 tons

Total poles: 14,492 tons

7.2.3 Highway Timbers

The total volume of creosoted wood installed has been given as 54,000m^3. Of this, about 10% are in culverts that are all in ground contact. The remaining 90% are in bridges. Of this volume about 35% is in ground contact (e.g. foundations) and 65% above ground (e.g. decking). As per the CSA 080 standard the creosote retentions vary for ground contact and above-ground applications and for lumber and timber between 110 and 140kg/m^3 . An average of 119kg/m3 retention and a 15% depletion has been assumed for the calculation of the installed creosote volume. *This results in 5,462 tons of creosote.*

7.2.4 Other

As indicated above, much of the miscellaneous products would have been brush or dip treated resulting in relatively low creosote retentions in the wood. An average of 45kg/m^3 has been assumed as the retention in new products. When applying a 15% depletion, then the creosote remaining in these products are as follows: *300 m^3 X 45kg X 0.85 = 1.15 tons*.

8. VOLUMES OF CREOSOTE TREATED WOOD TAKEN OUT OF SERVICE

Tie service life was estimated by the railways to be 5 to 11 years for untreated ties, 29 years in high density core lines, 37 years average in primary main lines and 60 years in branch lines (5). The importance and benefit of the creosote treatment to the railways and our entire Canadian transportation system is therefore quite clear. Creosoted poles have been reported to have an average 40 years of service life (4). Other products, such as fence posts and bridge foundations can be expected to have similar long service, although no specific information seems to exist. Nevertheless at the end of the service life, these commodities need to be removed and disposed of.

Table 3: Annual volumes of creosoted wood materials removed from service in Ontario in m^3.

PRODUCT	1992 (2)	2007	2012
TIES	80,735	47,250	52,500*
HIGHWAY TIMBERS	700	700	300
POLES	11,900	5,198	9,745*
OTHER	200	100*	0*
TOTAL	93,535	53,248	62,545

*assuming a 3-4% annual replacement rate for ties; annual retirement rate of 5% for poles and 3-4% for other products, since those are no longer replaced by creosoted materials.

Current creosote volumes estimated to be removed annually amount to 2,456 tons (Table 4). The 20 year trend from 1992 to 2012 indicates a decline of removals by 33%, although the current level (2007) indicates a dip, which is likely due to the fact that products other than ties are reaching the ends of their service lives and therefore would be removed at a greater rate in the future than is the case today. The long-term decline in removal volumes would be indicative of the declining creosote product volumes installed over the past 30 to 50 years.

Table 4: Annual volumes of creosote in materials removed from service in Ontario in tons (assuming a 20% creosote depletion at the time of removal).

PRODUCT	1992	2007	2012
TIES	3,617	2,117	2,352
HIGHWAY TIMBERS	67	67	28
POLES	695	272	569
OTHER	0.01	0.01	0
TOTAL	4,379	2,456	2,949

8.1 Railway Ties

Ties contain the bulk of creosote in treated product removed from service amounting to 2,117 tons or 86% of the total volume removed in 2007. A depletion of 20% at the time of removal has been assumed. This is a value cited in a number of publications (e.g. 2 and 9). It should be noted, that no controlled study is available that compares the actual retentions in individual new ties to the retentions at removal time in the same ties. So the 20% remains a best estimate.

8.2 Utility Poles

It is estimated that 5,198m^3 are currently removed. In calculating the creosote volumes in poles being removed from service, it was assumed that a 20% creosote depletion took place during the service life and the same ratio of full-length and butt-treated poles was used as for installed poles. In addition, it was assumed that all pole butts were extracted from the ground, which may not necessarily be the case.

In 2007:

Butt-treated poles:	5,198 x 0.65 x 0.25 x 128 x 0.8 = 86 tons
Full-length treated poles:	5,198 x 0.35 x 128 x 0.8 = 186 tons

Total creosote in removed poles in 2007: 272 tons

8.3 Highway Timbers

Here also a depletion rate of 20% was assumed at the time of removal. Based on the mix of lumber and timber in ground contact and above ground, an average retention of 119kg/m^3 has been used in the calculation.

700 x 119 x 0.8 = 67 tons

8.4 Other

As noted above, the use of miscellaneous creosoted wood products had not been very significant, since the time that creosote became essentially replaced in heavy-duty preservation by other preservatives, namely pentachlorophenol, CCA and ACA. This change started in the mid 1950s, so that today very little volume is expected to be still in service. Wood block floors are likely the only other pressure treated products remaining. Somewhat more significant might be the volumes of brush or dip-treated agricultural fence posts and other minor farm structures. Brush treating or dipping would render products with low creosote loadings.

As can be seen in Table 4, the creosote volumes from “other products” removed from service are insignificant. At service lives between 20 and 40 years, no miscellaneous creosoted wood is expected to require disposal by 2012.

9. METHODS OF DISPOSAL

Table 5: Disposal methods currently used (m^3).

METHOD	TIES	POLES	HIGHWAY	OTHER	TOTAL	%
REUSE			280		280	
RECYCLE	1,000	2,534			3,534	7
SALE					0	
ENERGY RECOVERY (INCINERATION)	35,250				35,250	66
OPEN BURNING					0	
NATURAL DEGRADATION				80	80	
LANDFILL	11,000	2,664	420	20	14,104	26

Disposal methods have significantly changed over the last two decades (9,10). For example, in the 1980's and earlier a significant number of removed ties was reused in secondary trackage or recycled as landscaping ties. Some open burning still occurred in areas remote from habitation or ties were left to degrade on the rail right of way. In the past many of the removed poles were either resold or given away as compared to the current practices of recycling or landfilling.

It may be assumed that fence posts and other agricultural structures would be utilized for maximum service life and that most would be allowed to decompose on site.

There is no record of wood block floor installations and it is assumed that obsolete floors would be placed into landfills.

As shown in Table 5, from a total of 53,248 m^3 wood disposed, 66% is shipped to the USA for recovery of its intrinsic energy in co-gen plants. This was considered a high value disposal option through a well developed and environmentally accepted technology (11).

10. ALTERNATIVES TO CREOSOTED TIES

Wood ties treated with creosote, have a long history of good performance. In fact, the treatment of ties created the Canadian preservation industry. The attributes are a combination of the wood being a very resilient and strong material, providing support and flexibility for the rolling stock, and creosote that extends the service life by protecting the wood against decay, insects and environmental degradation. Aside from its excellent preservation characteristics, the oily nature imparts water repellency to the wood, rendering it dimensionally more stable, and also providing lubrication in the tie plate areas, which delays the crushing of the wood in those areas (6).

The Canadian railways have been testing a number of alternative preservatives, composite and laminated wood ties as well as several types of concrete and steel ties for many years. As to preservatives, the only potentially technical viable might be Copper Naphthenate in an oil carrier. However, this preservative is relatively expensive and, due to the inconsistency of the composition of the naphthenic portion in the formulation, may affect the performance of the treated ties (7). Pentachlorophenol in heavy oil has been discontinued for tie treatments over a decade ago.

Both steel and concrete ties are installed in track areas of special requirements, such as either where heavy loads and high traffic frequencies are involved or on the other hand, for light load passenger trains. Wood generally outperforms alternative materials in cost and, except in specialty situations, also in performance and service life.

Neither of the two major Canadian railways expects a change from their current practices of creosoted wood tie use and no major installations of steel or concrete ties are forecast for the immediate future.

11. PAH EMISSIONS DURING MANUFACTURE AND DEPLETION FROM TREATED WOOD DURING SERVICE

Creosote is a blend of several hundred compounds, whose ratios may vary from batch to batch. The PAH level of interest in creosote was assumed at 75% by the Issue Table of the Strategic Options Process (SOP) and emissions from its manufacture and losses from the treated wood were calculated accordingly (12). The PAHs in creosote range from low molecular weight to very high molecular weight compounds. In general it can be said that the former are more volatile and water soluble, whereas the latter are relatively stable and immobile. Hence, emissions would preferentially contain compounds like naphthalene and fluorene, whereas B(a)P would largely be retained in the matrix. This fact was neither considered in the calculations made in the SOP report nor is it here. Obviously any potential environmental effects would therefore not be well represented by this generalized presentation of the data.

11.1 Emissions During Manufacture

VfT Canada Inc. is located in Hamilton and is the only manufacturer of creosote in Canada. In their NPRI submission of 2006 they report a total PAH emission of 1,264 kg. Of this Naphthalene makes up 1,038.9 kg (82%) and Acenaphthene 113.5 kg (9%).

11.2 Depletion From Treated Wood During

The mechanisms of creosote loss from treated wood have been described in various documents (e.g. 2,13). Volatilization, bleeding with subsequent gravity migration or wash off and gravity migration from wood directly are likely the most significant modes, whereas actual leaching, in contrast to what various background literature implies, is likely only of secondary importance, given that creosote is oily and water-repellent by nature and, in the case of its prime application on railway ties, is blended with a heavy oil that further enhances its water-repellency. Furthermore, creosote undergoes biodegradation, photo-degradation and chemical breakdown, contributing to the losses encountered during service.

It has been shown that the loss of creosote from poles is generally greater than from railway ties (13), likely due to a greater tendency for gravity migration and the higher surface to volume ratio exposed to the elements. In the case of ties, any creosote other than the portion volatilized would be lost into a “sterile” road bed , with little effect on the surrounding environment considering the degradation rates inherent to the mobile creosote components.

As to actual losses of creosote during service, there is no known controlled study that relates measured retentions prior to service to that at the end of service. Studies usually assume that a commodity was treated to a nominal retention and take this as the baseline. Such an assumption could be far from reality, especially in the case of ties, where very refractory species are used, e.g. white oak or Jack pine, that do not readily accept preservative. In such cases the losses would be over estimated. In this document an average depletion of 20% has been adopted as an average creosote loss value during service. Literature cites losses between 10% and 50%, depending on the commodity, its size, creosote type and retention level and exposure conditions. It has also been stated that about 10% of the losses may actually already occur at the treatment plant site during product storage after treatment (12).

In the Final Report of the SOP Issue Table (13) creosote “release” levels were calculated for the five lifecycle stages: manufacture, treating, in-service, disposal and treatment plant sites. For this report the current emissions from the creosote manufacture were indicated in Section 8.1 above. Similar assumptions have been made here, calculating creosote losses and depletion from treated wood as have been made in the SOP report. As this report deals only with Ontario and no treatment plants exist here using creosote, no current emissions from plants and from plants sites are applicable to the following calculations. It must be noted that the SOP report states that "*the approach taken to calculate the releases was extremely rudimentary and does not take into account the fact that natural degradation processes account for some loss of PAHs at all stages of the lifecycle."* This means that the amounts calculated are higher than those actually encountered. This also means that the term "release" is misleading and does not take into consideration all depletion modes taking place during the in-service and disposal stages of treated wood. Therefore the term "release" should be more appropriately be replaced by the terms "depletion" or "loss".

On calculating the depletion volumes here the same gross assumptions have been made as in the SOP report, i.e. that creosote contains 75% PAHs of interest. These PAHs include a wide range of individual compounds with a great range of volatility, leachability and affinity to wood that would lead to a preferential depletion of the light weight compounds and retention of the heavier compounds that are associated with greater environmental concerns, e.g. B(a)P.

It is clear that due to the lack of actual data a lot of assumptions have to be made to calculate PAH depletion from creosoted wood in service and PAH from disposed wood that ends up in landfills or is recycled. Hence, the data obtained from the following calculations must be viewed in that light.

For the calculation of PAH depletion from creosoted ties the following assumptions have been made in Table 6:
Nominal retention of creosote in new ties: 56kg/m^3 or 42kg/m^3 PAHs;
Average service life: 40 years;
Average current creosote depletion in all installed ties: 15%;
Average depletion at time of removal: 20%;
First year creosote depletion: 10%.

For the calculation of PAH depletion from creosoted highway timbers the following assumptions have been made in Table 6:
Average current retention: 119kg/m^3
Average service life: 40 years;
Average depletion at time of removal: 20%;
Average current creosote depletion in all installed highway timbers: 15%;

For the calculation of PAH depletion from creosoted poles the following assumptions have been made in Table 6:
Average current retention: 55kg/m^3
Average service life: 40 years;
Average depletion at time of removal: 20%;
Average current creosote depletion in all installed poles: 15%;

Table 6: Assumed PAHs depletion from creosoted wood installed in Ontario using 2007 data.

PRODUCT	Wood in Service (m^3)	Total PAH In Use (10^6 kg)	PAH Depletion (10^6 kg/year)
TIES INSTALLED	3,360,000	120	0.15
LESS REMOVED	47,250	1.6	0
PLUS NEW	53,550	2.2	0.22
TOTAL TIES	3,366,300	120.6	0.37
HIGHWAY TIMBERS	54,000	5.5	0.007
LESS REMOVED	700	0.007	0
TOTAL HW TIMBERS	53,300	5.49	0.007
POLES INSTALLED	259,900	10.9	0.01
LESS REMOVED	5,198	0.2	0
TOTAL POLES	254,702	10.7	0.01
OTHER	300	0.001	insignificant
TOTAL	3,674,602*	136.791*	0.387

*Including net of installed materials, annually removed, and annually replaced materials.

Table 7 shows the PAHs contents of creosoted materials removed from service annually and disposed of in Canada. For this study it was not ascertained, how much of this material is actually disposed of in Ontario with the exception of the 75% of removed ties that are shipped to the USA for incineration in co-gen plants. Their PAHs volumes are not included in the data contained in this table.

Table 7: Creosoted wood volumes removed from service and disposed of in Ontario and their associated PAH contents by disposal method.

PRODUCT	Wood Removed (m^3)	Total PAH Removed (10^3 kg)	PAH Reused (10^3 kg/year)	PAH Recycled (10^3 kg/year)	PAH Degraded (10^3 kg/year)	PAH Landfilled (10^3 kg/year)
TIES	12,000*	537.6		44.8		492.8
HIGHWAY	700	66.6	26.7			40.0
POLES	5,198	228.7		111.5		117.2
OTHER	100	3.6			2.9	0.7
TOTAL	17,998	836.5	26.7	156.3	2.9	650.7

*Portion of ties disposed of in Ontario (USA shipments not included)

The table shows that nearly 78% of the disposed PAHs end up in landfills, the least desirable disposal option. This is due to the lack of available local incineration facilities and the relative convenience of landfilling as an alternative.

12 DISCUSSION AND RECOMMENDATIONS

The use of creosote as a preservative is its highest value application. Since creosote is only a by-product in the manufacture of coal tar pitch, it would have to be put to alternative use, should it not be available for preservation. The most likely alternative would be as a fuel.

The benefits of wood preservation have been described in detail for the Strategic Options Process of Environment Canada (8). By prolonging the useful life of wood by up to 10 times, preservation allows wood, Canada's most important renewable resource, to be used in a variety of applications, where otherwise more expensive or less desirable materials would be the alternatives. Preservation of wood reduces the cost of transportation (e.g. ties, bridge timbers), communications (telephone poles), energy transmission (utility poles) and affects the lives of all Canadians. In addition, preservation conserves our precious forest resource, reducing the need for cutting substantial volumes of wood.

Creosoted ties, depending on the severity of service, may perform between 29 and 60 years, creosoted utility poles in Ontario have an average service life in excess of 40 years. Untreated wood may last only between 4 to 10 years in the same applications.

The use of creosote has been on a decline since the late 1950's. Alternative preservatives that are cleaner to handle have replaced it in Ontario for essentially all uses, except rail ties, for which it is preferred due to its intrinsic properties. Nevertheless, there are significant volumes of creosoted wood in service, although none are being replaced, except for ties, so that the volumes of creosoted wood in service are diminishing. It is anticipated that by 2028 or sooner, all creosoted wood other than ties would have been removed.

The volume of creosoted material removed from service in 2007 amounts to 53,248m^3 and contains an estimated 2,456 tons of creosote or 46kg/ m^3 (34.5kg/ m^3 PAHs) of wood. Essentially the entire volume is generated by large user entities, namely the railways, Hydro One and the Ministry of Transportation. All of them have relatively sophisticated retrieval and disposal programs in place.

A full 66% of all removed material, i.e. 75% of all ties removed, is shipped by the railways to the USA for use as fuel in co-gen plants. This is a significant increase in employing this disposal option over the year 2000, when only about 10% of all ties in Canada were disposed of via this mean (11).

Other significant disposal methods are landfill at 26% and reuse and recycling at 7%. Comparing these numbers to those for Canada in 2000, it appears as if the percentage for landfilling has at least tripled and the reuse/recycle option has been reduced about six-fold. Not a very desirable change.

A hierarchy for the disposition of out-of-service treated wood has been presented in several publications (10, 11). The methods in terms of decreasing desirability are listed as follows:

- Reuse: wood removed from its initial point of service and its application in its original form at another point of service;
- Recycling: use of the fiber, the preservative and solvent for alternative products and also the use of these constituents for the recovery of energy;
- Treatment: this precludes any recovery of energy, fiber or preservative but involves the destruction of the material to make it harmless;
- Landfill: deposition of material in designated landfill facilities.

Each of these methods involves technical and/or regulatory restrictions. These are described in detail in (11).

Clean incineration technology in co-gen plants, boilers, cement kilns, etc. to destroy creosote treated wood does exist and is widely used in the USA with the benefit of recovering the energy contained in the wood, creosote and heavy oil. Unfortunately, there is no permitted facility operating in Ontario. This situation leads to increased cost for shipment, lost energy benefits and to the alternative disposal in landfills.

In the past, considerable volumes of removed wood were sold to third parties, such as farmers, landscapers and others for reuse/recycling. These volumes have been reduced significantly, in part due to the concern that such wood might be put to improper use. Again a significant portion of this volume is being diverted to landfills. On the other hand, it is noteworthy that limited programs do exist in Ontario to reuse or recycle suitable materials. These methods account for 7% of all removed material.

It appears that the regulatory climate has not been conducive to utilizing the best disposal methods available. It has been stated by Konasewich et al. (11):"*The major barrier to more wide-spread use of co-generation facilities is regulatory related, whereby the approval process for the incineration of treated wood might be labyrinthine and further complicated by high approval costs and regulatory uncertainties."* This statement still seems to be true today. In addition, newly introduced regulation that requires obsolete ties to be handled as "hazardous waste" under CEPA's Export/Import of Hazardous Waste and Hazardous Recyclable Materials Regulation, increases the bureaucratic administration and cost of shipping ties into the USA. This is the only regulation in North America that designates waste ties as hazardous, even after those ties were not considered hazardous in the Environment Canada background study on creosote impregnated waste materials (2). Such designation appears to be irrational in view that removed ties would constitute a lesser environmental hazard than new ties, since they contain less creosote and the creosote residues in them are less mobile than new creosote. A similarly restrictive regulation is planned for the interprovincial shipment of creosoted wood waste, which will further impede the movement of out-of-service wood and lead to increased use of the landfill option.

The author agrees with the main conclusions reached in the document “National Industrial Treated Wood Waste Management Strategy” prepared for the Federal Strategic Options Process for the Wood Preservation Industry (11):

- Treated wood removed from industrial service should be considered a resource, not a waste;
- There is little reason to landfill used creosote treated wood in Canada. The technology for recycling this material as energy is proven and available;
- The low cost of landfilling represents a major barrier to the use of other waste management options. Both regulatory and economic factors favour landfilling at this time.

In view of the current situation and the conclusions reached in the national management strategy (11) as well as the responses to the survey in this study, the following recommendations are put forth:

- Efforts should be maximized to ensure wood is reused and recycled as products that remain under stewardship as treated wood;
- Facilitate the use of available and proven technology for recycling and disposal;
- Regulatory barriers for the application of this technology in Canada must be minimized;
- Ensure continued political commitment to the proper management of post-use treated wood;
- Governments must recognize the benefits of creosoted wood to society and therefore must assume co-responsibility for the life cycle management, including disposal;
- Once the barriers to the most viable disposal options have been minimized, landfilling of treated wood residues should be discouraged;
- Ensure that all governments and government departments maximize their co-ordination and collaboration.

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APPENDIX I

CONTACTS

Ms. E. Akkerman	CN Rail	514-399 4651	erika.akkerman@cn.ca
Mr. R. Krisciunas	Ontario Ministry of Transportation	807-473 2064	ray.krisciunas@mto.gov.on.ca
Mr. M. Giesbrecht	CN Rail	514-399 7057	mark.giesbrecht@cn.ca
Mr. G. Gilmet	VfT Canada Inc.	905-548 5524	ggilmet@vftinc.com
Mr. M. Lowenger	Canadian Railway Association	613-564 8088	mikel@railcan.ca
Mr. K. Roberge	CP Rail	403-319 6466	Ken_roberge@cpr.ca
Anonymous	Hydro One		

APPENDIX II

FRIDO CONSULTING INC.

8015 REDROOFFS ROAD, HALFMOON BAY, BC, CANADA, V0N 1Y1
TEL/FAX: (604) 885 9640; frido@sunshine.net

Survey questionnaire for establishing a creosote inventory in Ontario, conducted on behalf of Environment Canada, Ontario Region.

1. RESPONDENT

NAME:	ORGANIZATION: VfT Canada Inc.
TITLE:	Date:
ADDRESS:	
TEL:	e-mail:

2. CURRENT STATUS

Average creosote volume produced over the past 5 years:
Creosote volume produced in 2007:
How much of this volume is used for: Heavy duty preservative: Brush grade: Fuel: Other:
How much creosote is sold into Ontario as: Heavy duty preservative: Brush grade: Fuel: Other:
Under which Health/Safety and Environmental Programs is the creosote produced:
Are there recent analyses results available for your creosote (within the last 3 years), please supply:

3. FUTURE PROJECTIONS

Do you expect the creosote production volumes to change over the next 5 to 10 years?

How:

4. COMMENTS

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Survey questionnaire for establishing a creosote inventory in Ontario, conducted on behalf of Environment Canada, Ontario Region.

1. RESPONDENT

NAME:	ORGANIZATION: Canadian Railway Association
TITLE:	Date:
ADDRESS:	
TEL:	e-mail:

2. CURRENT STATUS

Which railway companies operating in Ontario maintain their own trackage:
Total track km in Ontario:
Total number of ties installed in Ontario trackage: No. 1: No. 2: Switch ties:
Average annual number of ties installed in Ontario during the last 5 years:
Annual use volume of field applied creosote in Ontario:
Average annual number of ties removed in Ontario over the past 5 years:
Current disposal methods for removed ties (approximate % of reuse, landscape, incineration, etc.):
Road blocks and challenges for tie disposal in Ontario:

3. FUTURE PROJECTIONS

Estimated number of annual tie installations in Ontario over the next 5 to 10 years:
Estimated annual volumes of creosoted materials to be removed from service in Ontario over the next 5 to 10 years:
Expected future changes in disposal methods:

Expected future changes in preservative or tie materials:
Technical challenges with the use of creosoted ties:

4. COMMENTS

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Survey questionnaire for establishing a creosote inventory in Ontario, conducted on behalf of Environment Canada, Ontario Region.

1. RESPONDENT

NAME:	ORGANIZATION: Railway Companies
TITLE:	Date:
ADDRESS:	
TEL:	e-mail:

2. CURRENT STATUS

Total number of ties installed in Ontario trackage: No. 1: No. 2: Switch ties:
Number of ties installed in Ontario in 2007:
Average annual number of ties installed in Ontario over the last 5 years:
Annual use volume of field applied creosote in Ontario:
Average service life of ties:
Average annual number of ties removed in Ontario by your company over the last 5 years:
Current disposal methods for removed ties (approximate % of reuse, landscape, incineration, landfill, etc.):
Road blocks and challenges for disposal in Ontario:

3. FUTURE PROJECTIONS

Estimated number of annual tie installations in Ontario by your company over the next 5 to 10 years:
Estimated annual volumes of creosoted materials to be removed from service in Ontario by your company over the next 5 to 10 years:

Expected future changes in disposal methods:
Expected future changes in preservative or materials (% of steel, concrete or other ties):
Technical challenges with the use of creosoted ties:

4. COMMENTS

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TEL/FAX: (604) 885 9640; frido@sunshine.net

Survey questionnaire for establishing a creosote inventory in Ontario, conducted on behalf of Environment Canada, Ontario Region.

1. RESPONDENT

NAME:	ORGANIZATION: MTO
TITLE:	Date:
ADDRESS:	
TEL:	e-mail:

2. CURRENT STATUS

Number of installed bridges and other structures containing creosote: Bridges: Other (please name):
Average volume of creosote containing components in these structures: Ground contact: Above ground:
Average annual number of installations containing creosote: Bridges: Other:
Annual use of field applied creosote:
Expected service life of structures (bridges/other):
Average annual wood volume containing creosote and removed over the last 5 year period:
Current disposal methods of removed creosoted structures (approximate % of reuse, landfill, incineration, etc.):
Road blocks and challenges for disposal:

3. FUTURE PROJECTIONS

Estimated number of annual installations containing creosote components over the next 5 to 10 years:
Estimated annual volumes of creosoted materials to be removed from service over the next 5 to 10 years:

Do you expect the disposal methods to change over the next 5 years? If yes, please indicate how:
Expected future changes in preservative or materials used:
Technical challenges with the use of creosoted structures:

4. COMMENTS

E-MAIL INQUIRY TO HYDRO ONE

Many thanks for your prompt response. I have been asked by Wood Preservation Canada (formerly CITW-Henry Walthert) to carry out on their behalf a study on creosote inventories in Ontario, which they were contracted for by Environment Canada, Ontario Region. EnCan initiated the study as part of their obligations to the Great Lakes Joint Commission updating the information on PAHs.

As I have done several studies along those lines in the past, I am relatively familiar with the issues and the historical use and disposal methods of creosoted poles in Ontario. The study at hand is meant to shed light on the current situation.

The questions for Hydro One are as follows:

1. How many creosoted poles are still in service in Ontario (% full length and butt treated)?
2. What has been the approximate annual removal rate over the past 5 years?
3. Is this rate going to change over the next 5 years? How?
4. What are the current disposal methods (% reuse, sale, incineration, landfill,etc.)?
5. Are these methods going to change within the next 5 years?
6. Are there any roadblocks (regulatory or other) that may affect preferred disposal methods?
7. Any comments on treated pole use, alternatives, etc.

The information provided will assist greatly in preparing a realistic report to EnCan. An early response would be much appreciated. Should you have any questions, please contact me by phone (604-885 9640) or email.

Many thanks and best regards,

Friedl Brudermann, M.Sc.F.

Note: Respondent requested to remain anonymous.