Review of the Landfill Disposal Risks and the Potential for Recovery and Recycling of Preservative Treated Timber

Environment Protection Agency
Government of South Australia

Review of the Landfill Disposal Risks and Potential for Recovery and Recycling of Preservative Treated Timber

- prepared for the Environment Protection Agency
by

Sinclair Knight Merz Pty Ltd

November 1999

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Contents

Document History and Status

Issue	Rev.	Issued To	Qty	Date	Reviewed	Approved
Draft	1	AWP	1	15 June 1999	21 June 1999	AWP
	1A	Flinders Uni (Tech Review)	1	22 June 1999	28 June 1999	NMcC
	2	EPA	1	30 June 1999	6 Sept 99	JB
	3	AJH (Qual Review)	1	29 Sept 99	29 Sept 1999	AJH
Final		EPA	3	11 Nov 99		AWP
		Adel Office	1	11 Nov 99		AWP
		Melb Library	1	11 Nov 99		AWP

Printed:	5 October 1999 3:32 A10/P10
Last Saved:	4 November 1999 10:24 A11/P11
File Name:	\\SKM-ADEL1\VOL1\SKM\Jobs_adelaide\AD00555\Word\Report\AD00555 Public_Final.doc
Project Manager:	Andrew Pruszinski
Name of Organisation:	South Australian EPA
Name of Project:	Review Of The Landfill Disposal Risks and Potential For Recovery and Recycling of Preservative Treated Timber
Name of Document:	Public Report
Document Version:	
Job Number:	AD00555

Executive Summary

As part of future strategy, the South Australian Environment Protection Agency (SA EPA) determined that it was appropriate to consider the potential risks which may arise from the disposal of preservative treated timber.

Sinclair Knight Merz together with Flinders University, were selected to undertake a study to examine these risks.

The scope of the study was to investigate the possible environmental impacts from treated timber disposal by examining current utilisation and disposal practices. The outcome of the study was to provide recommendations and management options for the disposal, recovery, reuse and recycling of treated timber, with the aim to reduce any environmental impacts that were identified.

Types of Preservation

There are two main types of chemicals used for timber preservation in South Australia. They are Copper Chromium Arsenate (CCA) and Creosote. CCA is both an effective and economical preservation chemical and therefore widespread in use. However, it is toxic and has been banned in some countries due to issues associated with its use at production facilities.

Creosote is also effective, but is more expensive and is perceived by most to be less “environmentally friendly” than CCA. Pentachlorophenols (PCP) were used for preservation but are now banned and have not been used for many years. This study has found that the quantities of waste from PCP and creosote treated timber are minor.

Alternative chemicals such as ammonium derivatives of copper are commercially available and are becoming widely accepted in other States such as Tasmania and Queensland. Regulation is driving the use of the chemicals in these States. Such chemicals are understood to have far less environmental impact and have potential to be disposed of by incineration, as they do not contain arsenic. The incineration of CCA treated timber is prohibited in SA by legislation as arsenic can be released during the process.

Production

Production of CCA treated timber has remained relatively constant over the past three years, but it is understood to be significantly greater than ten years ago. This significant increase is a direct result of an increase in demand by the viticultural industry.

Creosote production in SA has also increased significantly in the past three years, in contrast to international trends. Again this is attributable to viticulture.

It is estimated that 250 000m^3 of treated timber will be produced in SA in 1999.

However not all of this timber will be sold in South Australia. It is estimated that 163 000m^3 of timber will be sold in SA during 1999. At least 50% of this timber is expected to be roundwood (posts and poles).

Disposal
It is unlikely that all of the treated timber being produced will require disposal in the near future as it has a predicted working life time of 30-40 years. However, the timber will eventually require disposal and this time may be significantly reduced should certain conditions change, such as a reduction in the viticulture industry.

Discussions with major treated timber purchasers in South Australia have determined that even if reduction in the industry were to occur, bulk disposal to landfill would be improbable due to cost of disposal and the potential for re-use of the surplus timber at a later date.

It is understood that predominant current disposal practises are by storage or burial on the purchaser’s land and sometimes by burning. All landfill operators interviewed reported receiving very low quantities of treated timber waste, thereby supporting the purchasers comments. If this were to change re-assessment of landfills and environmental monitoring procedures would be required.

Consideration of potential environmental impacts resulting from current disposal practises was undertaken. The greatest potential for environmental harm is considered to be from leaching of preservation chemicals from the treated timber to the soils thereby impacting on soil quality, surface water quality and possibly groundwater quality.

Studies have been undertaken outside Australia to address disposal issues.
Technologies such as incineration, reuse as particle board substrate, reuse as alternative products, bacterial fermentation and pyrolysis have all been trialed with various degrees of success. All are

expensive options and in some cases, can result in hazardous by-products. There are no examples to establish the feasibility of any of these options in a practical setting.

Reports worldwide suggest that the disposal to landfill of preservative-treated timber is at present an acceptable option. There is evidence to suggest that biological attenuation of organic (oil based) preservatives would result in minimal leaching. No research has identified the extent of leachability of chemicals from timber which is aged and may no longer provide an adequate substrate to retain the preservation chemicals. Provided sufficient lining material with a significant clay content is used in the construction of a landfill, the leaching of metals from CCA-treated timber outside landfills should also be minimal.

Conclusions

Hence, the conclusions identified as part of this study are:

- Tens of thousands of cubic metres of treated timber will need to be disposed of in South Australia, per annum in the future. This raises many issues such as disposal methodology, responsibility, and disposal locations.

- It is unlikely that the existing landfills will be able to accept increasing loads of preservative-treated timber without impacting on the environment. This is based on the fact that up to 160 000m^3 of treated timber is likely to require disposal each year, in approximately 20-30 years time. Presently there is insufficient research to predict optimum loadings of CCA and creosote treated timber for landfill.

- If safe loadings by weight for Creosote and CCA treated timber are similar to those for PCP-treated timber and if all currently used treated timber were disposed to landfill in the future, increased amounts of preservative chemicals are likely to result in environmental impact from landfills unless these landfills are suitably engineered.

- Currently disposal to non engineered landfills and storage of small volumes on site is adequate and research shows these disposal methods have minor environmental impact, however this will alter with large quantities of ageing timber.

Recommendations

Sinclair Knight Merz provide the following recommendations for the management and disposal of treated timber:

- Large volumes of non re-useable treated timber requiring disposal should be placed in an engineered[1] landfill;
- Further research is required on the potential for toxic metals to leach from ageing timber to soils. The EPA should consider a joint program with other bodies to examine this issue;
- A study should be undertaken to determine where soils in SA are not suitable for the storage of small quantities (<1000m^3) of treated timber and where such activities may impact on the environment. Local government should be informed of these areas;
- The EPA should nominate landfills which are suitable and not suitable for the disposal of treated timber;
- Wineries/vineyards should become involved in developing a statewide Code of Practise for land care. The Code of Practise must address the bulk storage of treated timber and the curtailing of site burial and other methods of disposing treated timber products which are potentially harmful to the environment.
- Individual wineries/vineyards should be encouraged to develop their own environmental management plans. If they already have such plans they should be developed so as to incorporate consideration for the appropriate disposal and storage of treated timber;
- The EPA should advise local government, wineries and other relevant bodies (such as farm suppliers) that burial of CCA timber in a non licenced landfill is not allowed by Legislation;
- Local and State Government should review current landfills and instigate improvements or develop new "engineered" landfills which could accept larger loads of treated timber products without degradation to the natural environment;
- The EPA should examine ways of implementing the use of ammonium based compounds as substitutes to CCA and creosote preservatives. Even though the implementation of such measures are not likely to be seen for many years, these preservation chemicals will be far more suitable for the reduction in heavy metal disposal issues for the State;
- Local and State Government should augment legislation to ensure the safe disposal of treated timber

[1] "engineered landfill" is used in this document to describe landfills with clay or other similar linings to reduce contamination from leachate.

products within South Australia and to encourage the use of more environmentally suitable alternatives;

- The EPA should consider advising wineries who are unaware of alternatives to treated timber that there are benefits in using these products such as an improved “greener” image for the winery;
- The EPA licence conditions for all landfills currently monitoring groundwater, should include assessment for copper, chromium (III and VI) and arsenic, phenols and PAH;
- The EPA should instruct all other landfills receiving treated timber to monitor groundwater (where appropriate) for copper, chromium (III and VI) and arsenic, phenols and PAH.
- The EPA should establish a working group consisting of suitably qualified persons to monitor and develop future strategies for the disposal of treated timber.

1. Introduction

1.1 Background

As part of future strategy, the South Australian Environment Protection Agency (SA EPA) determined that it was appropriate to consider the potential risks which may arise from the disposal of preservative treated timber.

In order to assess this risk, the SA EPA prepared a tender specification to quantify the amount of treated timber currently being disposed of, and to review current and potential future disposal practices in South Australia (SA). In response to an invited tender, Sinclair Knight Merz was selected to undertake the study and hence examine these risks.

The scope of the study undertaken was to investigate the possible environmental impacts from treated timber disposal by examining current utilisation and disposal practices for treated timber. The proposed outcomes were to provide recommendations and review options for future management of the disposal, recovery, reuse and recycling of treated timber products aimed at reducing these impacts.

1.2 Timber Preservation - Chemicals

Preservative treated timber, for the purposes of this study, refers to timber treated by surface applications or impregnation of timber preservative chemicals. Creosote and Copper Chromium Arsenate (CCA) are the two most commonly used treatment products in South Australia.

Creosote treated timber is dark brown in colour, although the treated timber fades with age. When fresh, it is recognisable by its oily appearance and distinctive odour, characteristic of the hydrocarbon component.

CCA treated timber is green in colour (due to oxidised copper compounds) and also fades in colour with age. CCA treated timber does not have a distinctive odour as its main constituent is water (~97%).

Other chemicals have been used in SA in the past. These include pentachlorophenol (PCP) which is now banned, primarily because of contamination of PCP formulations with highly toxic chlorinated dioxins and dibenzofurans. It is understood that Tributyltin Oxide (TBO) and Copper Napthanate have also been used but in very low quantities.

Other chemicals such as fluorides, boron and fluoroborates can be used, but are not believed to have been used in SA.

A detailed discussion of preservation chemicals is provided in **Section 2**.

1.3 Timber Preservation - Process

The preservative treatment of timber is carried out by impregnating stable chemicals into the wood structure in order to prevent it from attack by termites, insects and microorganisms, especially fungi. CCA and creosote treatment is carried out in a controlled manner by introducing a known concentration of the chemical under elevated pressure. In the case of creosote, the temperature is elevated. Both processes have been in use for many decades.

1.4 Preserved Timber - Usage

Treated timber has many applications. These include both structural and non structural use. Structural use includes beams, retaining walls, railway sleepers, and columns. Non structural uses include pergolas, trellis, posts, and fencing.

It is considered that the use of preservative treated timber will continue to increase in South Australia due to the continued growth of a significant primary purchaser, the viticultural industry. Viticulture practices rely on preservative treated timber due to its moderate price and excellent durability.

Unfortunately treatment chemicals have been shown in some situations to leach into soils and groundwater causing potential environmental harm. The use of such products in other countries, such as Germany, Japan, Scandinavia and parts of the United States, has been restricted and in some cases banned due to "environmental concerns" (Crimp 1999).

Within Australia efforts have been made to restrict use of certain preservative chemicals and tighten regulations on production processes. Most concern relates to production sites not the end product.

In Tasmania chemical producers must allow at least five days, depending on the weather, for fixation to occur and for the timber to be kept on a drip pad during this period. Negotiations are continuing as to where timber can and cannot be stored but currently all treated timber must be stored on impervious surfaces within the plant until well fixed (in Tasmania this takes approximately one month).

Use of alternatives to CCA has been attributed to the impact of the Hazardous Waste listings on current administrative, compliance and disposal practices (CSI 1992). In particular the use of ammoniacal copper quat (ACQ) instead of CCA in most states due to ACQ not being listed on hazardous chemicals registers and so does not have special disposal requirements.

In New South Wales draft guidelines do not require specific disposal requirements for ACQ (NSW EPA 1995). Fernz Timber Protection asserts that improved residual strength of the ACQ-treated wood (modulus of elasticity) over CCA-treated wood may improve service life (Crimp 1999). NSW EPA Guidelines stipulate disposal options for CCA and creosote treated wood but not for ACQ-treated timber (NSW Assessment, Classification and Management of Liquid and Non-Liquid Wastes 1999). They require that treated timber be disposed of to landfills with currently operating leachate management systems that are licensed to receive this waste.

In South Australia, studies into the impact on soils and groundwater where preservation plants operate, are ongoing as a SA EPA license requirement. The environmental management procedures for plant operators are increasing to ensure conformance with the ANZECC Guidelines (Australian Environmental Guidelines for CCA Timber Preservation Plants, September 1996).

There is no record of any studies in South Australia that have been undertaken to determine the impact from the storage or disposal of treated timber.

1.5 Methodology of the Study

As a component of this study, a literature review of preservative treated timber and the potential impacts of disposal to landfill was undertaken. The review was undertaken by Flinders University.

In parallel with this review, an interview process was instigated involving discussions with principle chemical producers, treated timber manufacturers, distributors, purchasers, landfills and industry bodies. The rationale behind interviewing all major players was to quantify the volumes of material being produced for the South Australian market and to identify current disposal quantities and methods.

The outcome of these reviews is provided in **Sections 3** to **8**.

From the information gathered, an assessment of the timber treatment industry was undertaken. Future management options for the collection, reuse, recycling and disposal of treated timber in South Australia are considered in **Section 9**.

1.6 Acknowledgments

Sinclair Knight Merz acknowledge the work undertaken by Flinders University Staff, in particular those who worked on the project, Dr Nick McClure and Dr Richard Bentham.

We also acknowledge the assistance of those who provided information from the timber treatment industry. The companies who provided information are referenced throughout this report.

2. Timber Preservation Chemicals

2.1 Introduction

A range of products have been used as timber preservatives worldwide, in particular pentachlorophenol (PCP), creosote and copper chrome arsenate (CCA) (Soong and Emmett 1993). Old timber preservation sites are often highly contaminated due to practices such as the use of unlined timber treatment cylinders, disposal of wastes in unlined lagoons and long term dripping of preservatives from treated timber onto site soils.

In many countries the use of various wood preservatives is either banned or tightly regulated due to concerns over environmental persistence and toxicity. This is thought to be the result of the poor production practises described above.

Options for disposal or recycling of treated timber vary depending upon the formulation and application. Currently disposal to landfill is the preferred option for treated timber.

New technologies for disposal, re-cycling and preservative reclamation have been investigated experimentally. Doubts exist with regard to the feasibility or economic viability of these technologies. This chapter reviews the major timber preservative formulations used or in service in Australia and discusses their environmental persistence and toxicity.

2.2 Copper-Chrome-Arsenate (CCA)

Currently CCA is the most widely used timber preservative in Australia and New Zealand (Victorian EPA 1981, Soong and Emmett, 1993). Global trends in timber preservatives indicate that since the 1980's CCA application has continued to increase as creosote and pentachlorophenol applications have declined (McQueen and Stevens 1998). CCA is a waterborne timber preservative as opposed to oil borne preservatives such as pentachlorophenol and creosote (see sections below).

CCA is the most widely used timber preservative as it is inexpensive, binds to timber leaving a dry paintable surface and is relatively resistant to leaching (Lebow 1996). As a result of these characteristics CCA tends to be used in applications where human contact is more likely such as in fence posts in agriculture, fencing and decking (Soong and Emmett 1993).

Constituents of CCA are known to be toxic to humans, aquatic life and plants (Mclaren and Smith 1996, Yeates *et al*. 1994) and contamination of both soils and groundwater with CCA constituents at timber preservation sites is a major problem.

Although chromium (Cr) has some preservative activity, its primary role in CCA treatment is in the fixation of the formulation to the timber cells (Lebow 1996, Norton 1998). This involves the reduction of Chromium from the hexavalent (Cr(VI)) to trivalent (Cr(III)) state. Cr(III) becomes strongly bound to the cell structure and is much less mobile than the Cr(VI) form. In this form it has reduced environmental toxicity (USEPA 1997, Rouse 1997).

Copper (Cu) is a potent fungicide, whereas Arsenic (As) provides protection from insects, as well as copper tolerant fungi (Lebow 1996, Norton 1998).

Relative concentrations of the three metals may vary between formulations but generally Cr is present in the highest concentration followed by As and then Cu.

The time required for CCA fixation after timber treatment is variable dependent on the timber species and application and fixation temperatures. Treated timber should be allowed sufficient fixation time to minimise the Cr(VI) content before being put into service (Lebow 1996, Zahora, Lathan and Lippincott 1993). Although conversion of Cr(III) to Cr(VI) may occur in the soil environment, increasing mobility and toxicity, such transformations do not occur in the treated timber. It follows that properly fixed treatments will result in minimal leaching of CCA to the surrounding environment whilst in service (Lebow 1996).

A study of the uptake of metals from grapevines in proximity to CCA-treated timber has shown no evidence for accumulation of metals in leaf and stem tissue over a three year period (Levi, Huisingh and Nesbitt 1974).

2.3 Pentachlorophenol (PCP)

Pentachlorophenol (PCP) is a broad spectrum oil based biocide, used extensively in the treatment of timber since the 1920s. Though predominantly used as a timber preservative, PCP has also been used as a biocide in oils and paints (Häggblom and Valo 1995). The solubility of PCP in most organic solvents and solubility in alkaline solutions has led to diverse applications as a herbicide, bactericide, fungicide, algicide, insecticide and molluscide (Häggblom and Valo 1995, McAllister *et al* 1996).

More recently the use of PCP has been restricted or banned in some countries including Australia and production has decreased substantially (Häggblom and Valo 1995).

The extensive use of PCP as a fungicide in sawmills and timber yards has resulted in contamination of surrounding soil and water environments. This contamination has been attributed to accidental spills, stormwater run-off, and leaching from treated timber in service, as well as the treatment processes used (McAllister *et al* 1996, Laine and Jorgensen 1997).

Several reports have documented the persistence of PCP in soil and water some years after the contamination had ceased (Häggblom and Valo 1995, van Leeuwen *et al* 1996).

The US EPA has listed PCP as a priority toxic pollutant. It is considered recalcitrant to degradation, and is suspected to have carcinogenic, teratogenic, and mutagenic properties. Chronic exposure has been linked to lymphoma and soft tissue sarcoma (Häggblom and Valo 1995). Mammalian contact may result in burns and blistering accompanied by elevated temperature and respiration rates, hypoglycaemia and cardiovascular distress (McAllister *et al* 1996).

2.4 Creosote

Creosote is a complex mixture of organic compounds produced from the distillation of coal and blast furnace tar. It may be applied as a timber preservative directly or diluted in oil (USEPA 1997). Major components (approximately 85%) are polycyclic aromatic hydrocarbons (PAHs), phenolic and heterocyclic compounds (Mueller *et al* 1989).

The biological treatment of PAHs has been the subject of a number of comprehensive reviews (Wilson and Jones 1993, Pollard *et al*. 1994). There are many examples published of the successful remediation of creosote contaminated and creosote/PCP-contaminated soils at a variety of scales and using a number of different processes, including white rot fungi, soil washing and slurry phase systems (Lamar *et al*., 1994, Jerger and Woodhull, 1995).

Successful removal of PCP, pyrene and total carcinogenic polycyclic aromatic hydrocarbons (TC-PAH’s) in land treatment units without bioaugmentation has been demonstrated at the Champion International Superfund timber preservation site in Libby, Montana, U.S.A. (Huling *et al*., 1995).

Pilot scale composting of heavily creosote - and CCA-contaminated soil has been demonstrated in Finland with degradation of 2 to 3 ringed PAHs and 4 to 6 ringed PAHs of 97% and 55%, respectively (Valo, 1997).

The leaching of mobile fractions of creosote from preserved timber is minimal and unlikely to produce significant environmental contamination *in situ* (Greaves 1997).

2.5 Other Formulations

As discussed previously, CCA timber treatments are banned in some European countries, and more recently in Indonesia (Permadi, DeGroot and Woodward 1989). This is believed to be the result of poor production practices significantly impacting on the environment.

A range of alternatives to CCA for timber preservation exist, these include: ammoniacal copper zinc arsenate (ACZA), ammoniacal copper citrate (ACC), ammoniacal copper quat (ACQ), ammoniacal copper azole (CuAZ), copper dimethyl dithiocarbamate (CDDC) (Lebow 1996, USEPA 1997).

Of these alternatives only ACQ is used in significant amounts in Australia (Greaves 1997). ACQ requires a shorter fixation time and lower active concentrations than CCA for timber preservation (Permadi, DeGroot and Woodward, 1989). The absence of As and Cr from the formulation is accompanied by a reduced mammalian toxicity (Chen and Randall 1998).

Reduced metal content and lower arsenic concentrations in ACQ treated timber, may make incineration a more practical option for disposal than for CCA-treated timber (Fernz Timber Protection communication 1999).

ACQ timber preservation processes results in the elimination of Cr and As emissions but increased emissions of other environmental contaminants namely ammonia and organics (quaternary ammonium compounds) (Chen and Randall 1998).

3. Chemical Producers

3.1 Assessment

There are two preservation chemical producers in Australia.

They are Fernz Timber Protection (formerly Laporte Timber Preservatives); and Koppers–Hickson Timber Protection (formerly Koppers).

The South Australian offices for both of these companies are in Mount Gambier. Fernz manufacture CCA in their plant at Mount Gambier. Koppers provide both creosote and CCA from interstate.

It was reported that consumption trends are not uniform between types of treated timber. The volume of CCA used over the past three years has not altered dramatically, whereas the use creosote has increased.

4. Treated Timber Manufacturers

4.1 Assessment

A total of seven manufactures were interviewed as part of the study.

They were:
- □ Auspine Limited;
- □ Tarmac;
- □ Recut Industries;
- □ Carter Holt Harvey;
- □ SA Sawmilling;
- □ Miland Timber; and
- □ CSR Timber Products.

As the data provided is commercially sensitive it is not published.

From the data provided by these companies, the volume of treated timber (both CCA and creosote) produced per annum was estimated by extrapolation. The volumes are presented in **Table 4.1** below.

Table 4.1 Estimated Volume of Treated Timber SA

Product	1997 total *estimate* (m^3)	1998 total *estimate* (m^3)	1999 *estimate* (m^3)
Total Treated Timber	210 000	240 000	250 000

Hence the volume of treated timber produced by South Australia is approximately 250 000m^3 per annum. We estimate approximately 50% of this volume will be roundwood (that is posts and poles). However, not all of the product is sold into South Australia. It estimated that only 70% of the product is sold in the State. There is also some timber imported into the State.

Hence the volume of timber sold in South Australia is approximately
163 000m^3 per annum.

It is reasonable to expect that the life cycle of the treated timber is 30-40 years. However for some use, for example viticulture, this life cycle may be significantly reduced. Reduction could be caused by breakage or removal from service due to economic changes. However it is worth noting that the volume of treated timber is significantly increased in the past three years due to viticulture.

The next stage of the study was to assess the volume of timber that is likely to have a reduced life cycle. This was undertaken by assessing the distribution of the products and the final users (**Section 5**).

5. Purchasers

5.1 Distributors and Resellers

In order to determine where the products are sold a questionnaire was sent to five major distributors.

They were:
- Iama
- Elders
- CRT
- Irymple Packing
- CSR

A generally poor response was received from the from the Distributors. Hence no strong conclusions could be developed from the information provided.

5.2 Viticulture Industry

As wineries were identified as being a significant purchaser of treated timber, numerous wineries were selected for interview. However some were not willing to provide any information as they considered it may inform their competitors of the size of their future vineyards. In addition to requesting volumes of timber purchased, the winery operators were also asked to provide information relating to disposal practises.

Those wineries interviewed were:
- Hardy’s M^{c} Laren Vale
- Hardy’s Naracoorte
- Hardy’s Banrock Station
- Hardy’s Cullulleraine Lake
- Hardy’s Coonawarra
- Hardy’s Padthaway
- Orlando
- Yalumba
- Mildara Blass, Eden Valley
- Mildara Blass, Langhorns
- Mildara Blass Dorien
- Mildara Blass, Lyndoch
- Taylor’s
- Pike’s
- Peter Lehmann, Barossa
- Peter Lehmann, Clare
- Southcorp

5.3 Discussion of Results

Currently the largest purchasers of preservative treated timber in South Australia are wineries. The value of wine grapes has increased 350% in the last decade and being at it’s highest growth rate ever, it appears that the wineries will further continue to dominate the market of preservative treated timber.

Of the seventeen vineyards interviewed only two currently purchase creosote treated timber, the rest relying on CCA treated posts. Although CCA treated posts have a poor reputation in regards to strength they were more popular mostly due to the ease of handling compared to the protective measures required for handling creosote, and reduced costs.

Volumes of posts extracted from vineyards were comparatively low, in the range of 1% of the total number of posts per purchased per year. This is expected for the younger vineyards, while large numbers of posts are required to construct the vineyards, few posts require replacement due to their designed lifespan equalling that of the vineyard, that is around thirty years. The most common cause of replacement was from mechanical harvesting techniques for which volumes were estimated by the vineyards, to be approximately 1.0 m^3 per year.

Some general trends in the disposal of the posts in the vineyards became obvious throughout the course of the study. Most vineyards hadn’t previously considered the disposal of posts to be of serious concern, although many considered that problems could arise in the future when volumes of waste timber increased.

The most common method of disposal, practiced by twelve of the vineyards, involved allowing the posts to pile up on the vineyard site. Reasons for this were to avoid the costs of landfill disposal and to allow the posts to be accessible in times when they might be of use for vineyard trellising, surrounding gardens, or for personal use. Once used for these purposes most wineries had little remaining which required disposal.

Some of the vineyards interviewed sold the broken posts to locals or gardening/landscaping businesses but see this as a limited market, suitable for present quantities only. The ten vineyards that did dispose of posts to a landfill did so only for posts which had been broken to impractical sizes, hence constituting very small yearly quantities.

Only three vineyards admitted to the prohibited practice of burning the waste timber. One vineyard did so due to the fact that they had previously used untreated red gum posts for which burning had been common practice, the other after whole vineyards were extracted and separation of the vines, wires and posts for separate disposal was not time and cost effective.

Burial of posts occurred on only one of the sites and this was a last resort option.

Three vineyards considered that they had significant numbers of posts accumulating on site, without plans for future use with piles of approximately 100, 150 and 2800 posts. The build up of large numbers of posts on site could be considered a potential fire hazard. In the event of a fire, unless the soil surface is lined with an impermeable layer, contamination of soil from the release of heavy metals is likely.

One vineyard did extract a small number ($14m^3$) of posts in one year, however the posts were removed with the intention of transferring them from one vineyard to another in order to reuse them for different purposes, thus not requiring disposal.

Although most of the vineyards interviewed currently are able to recycle and reuse most of their broken posts concern was expressed as to future problems relating to the disposal of posts. When whole vineyards must be redeveloped after the lifespan of the vines currently being planted (25-30yrs), old posts will be removed in quantities much larger than the present amount currently broken in the harvesting process. Many felt that this would become a problem and were interested in the reflected outcome of the study.

Concern was also raised in regards to the possible uptake of leached treatment chemicals by the vines and the potential affect on grape quality. However the literature study appears to dispel this concern.

In order to confirm that neither the wineries or other purchasers were disposing of treated timber to landfill, various landfill operators were interviewed. The results of the interviews are provided in **Section 6**.

6. Landfills

6.1 Assessment

A list of licensed landfills was provided by the SA EPA. In addition a map of protected water areas was also provided. A total of fourteen operators were selected who operated a landfill or landfills in areas where the groundwater resource is sensitive.

A summary of the data gathered from the landfill operators is provided as **Table 6.1**.

Table 6.1: Landfills and Landfill Operators

Waste Depot / Contractor	Amounts of waste treated timber received per year	Source of the waste	Disposal Methods	Recycled ?
Alexandrina Council	<1 tonne	Only from public/ personal use	Buried in normal landfill	No
Strathalbyn Council	Unsure as come in with other materials	Unsure	Buried in normal landfill	No
Southern Waste Landfill – Maslins	Negligible amounts	Public	Buried in normal landfill	No
Barossa Council	<1 tonne	Unsure	NS	NS
Clare and Gilbert Valleys Council	Negligible amounts	Receive from wineries	Buried in normal landfill	No
District Council of Berri	Unsure as come in with other materials	Unsure	if more than a truck-load arrives, redirected to another site to burn	
Renmark Paringa Depot	not willing to comment	Not willing to comment	People free to sort through rubbish and reuse the wood for landscaping.	Some
Jamestown Depot: Gregories Transport and Recycling	Unsure as come in with other materials	Unsure	Buried in normal landfill	No
Georgetown, Gownea and Yacka Waste Depots	None that they are aware of	N/A	N/A	N/A
Wattle Range Davernport St Millicent Council: Cleanaway	Approx 260	Auspine Kalagadoo Site	Buried in normal landfill	No
Cleanaway: Transport only	1300m^3 max	Wattle Range Council	Millicent, Cannunda Landfill, and buried in normal landfill	No
City Of Mount Gambier Council (Caroline	Arrives infrequently in low quantities	NS	Buried in normal landfill	No

Landfill)				
Telford's Mt Gambier (Gambier Earth Movers)	Not known to have rec'd any	Public	Buried in normal landfill	No
Wattle Range Davernport St Millicent Council:	NR, think small quantities	NR	Buried in normal landfill	No

note- all figures listed for volumes refer to CCA treated waste, and all comments on volumes refer to both CCA and creosote treated timber in this table.
NR =Depot / contractor had no record of this information
NS = not supplied

6.2 Discussion of Results

As shown in **Table 6.1**, only one Contractor (Cleanaway) which removed waste from timber producers handled significant quantities of treated timber. All of the landfills claimed not to have received significant quantities of treated timber. The landfill operators indicated that this is mostly due to the costs and inconvenience of landfill disposal. This supports the conclusions determined from discussions with major purchasers (**Section 5**).

The treated timber waste presented at landfills is usually mixed with other materials and was therefore deposited on the landfill face. From the interviews it was determined that no special methods of disposal have been carried out for the timber, and accordingly no recycling has occurred. Except for the Paringa Depot, where landscapers are permitted to remove the timber for commercial use.

Representatives of major composting facilities adjacent to wine growing areas (Van Schaiks at Mount Gambier and Peats Soil and Garden Supplies at Willunga) also reported receiving negligible quantities of preservative-treated timber.

6.3 Potential Risks To Groundwater

The EPA can require that a licenced landfill monitors groundwater quality for a range of parameters. This is of particular importance for landfills which are situated above a protected groundwater resource.

Landfills in lieu of protected waters include the Jamestown, Naracoorte, Wattle Range Davernport St Millicent Council Depot, City of Mount Gambier Council Depot in the South East Water Protection area, the Alexandrina Council Depot, Berri Renmark Paringa

Council Depot in the River Murray proclaimed surface runoff protection areas, and the Barossa and Strathalbyn Council Depots in the Mount Lofty Ranges Water Protection area (note the Barossa depot could also lie on the North Para River Water protection area).

From the studies undertaken, current volumes of CCA and creosote disposed to landfill appear low and hence pose very little threat to groundwater.

However, it is possible that a significant increase in disposal volumes may occur, with volumes in the order of up to 100 000-160 000 m^3 being disposed of per annum within 25-30 years (see **Figure 6.1** below). This may be caused by the rapidly changing winery industry or the end of timber life. However it is likely that this volume will be offset by the disposal cost and convenience factors previously discussed.

If the volume of treated waste timber placed in landfills increases, close examination should be given to water quality results obtained from the depots situated over protected water zones.

Currently, there are no figures available that would suggest an optimum or maximum loading of CCA-treated timber into landfill. Landfill design and clay content of capping materials would determine the loading limits (Lebow 1996). The consequence of overloading would be detection of the free metals in the leachate. Leaching of metals from the treated timber would follow the order of mobility of the metals previously discussed (As<Cu<Cr) (Gifford, Marvin and Dare 1996, Lebow 1996).

Adopting a precautionary approach, especially as the impact from aged timber is unknown, the need for disposal to a properly engineered and managed landfill is very high.

Landfill loadings of 2% of landfill by weight for PCP-treated timber have previously been reported to have no adverse affects (EPRI 1990B). TCLP testing of creosote-treated suggest that similar amounts to PCP treated-wood could be safely disposed to landfill.

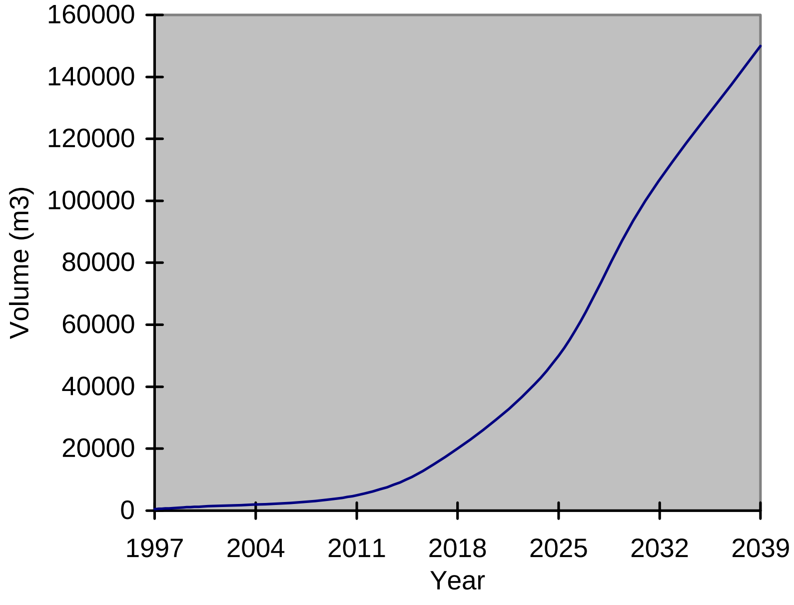
If safe loadings by weight for Creosote and CCA treated timber are similar to those for PCP-treated timber and if all currently used treated timber were disposed to landfill in the future, increased amounts of preservative chemicals are likely to result in

environmental impact from landfills unless these landfills were suitably engineered.

Impact on surrounding groundwater and soils is likely to occur if these levels were exceeded and leachate from the landfill contained significantly high levels of PAH's, pyrene, PCP, chromium, copper or arsenic.

Figure 6.1 provides an estimate of volumes of timber that are likely to require disposal at landfill in the future.

Figure 6.1 Predicted Volumes of Treated Timber Disposed Yearly



7. Other Information

7.1 Industry Bodies

A number of Industry Bodies involved in either the timber production industry or relating to major timber purchasers were interviewed to gain an overall perspective of treated timber movements within the State.

Bodies involved in timber production included the Timber Preservers Association of Australia and Timber Treaters WA. They were able to confirm major players within the timber treating industry of whom have been interviewed as part of this study.

The South Australian Wine and Brandy Association (SAWBA) stated that the issue of CCA or creosote treated timber had only ever been raised in the interest of minor occupational health and safety issues and that it’s disposal had never been an issue at their level.

The SAWBA were, however, interested in this study, and brought the issue to the attention of various heads of the viticultural industry. General opinion was that, due to the rapid growth of the industry currently taking place, there would be a problem with the wood disposal when the vineyards currently being developed were at the end of their lifespan, and large numbers of posts would require disposal. They believed that it would be advantageous to set guidelines now for future disposal methods of preservative treated timber to reduce the likelihood of it developing into a serious problem.

SAWBA were able to list the major vineyards within South Australia who, subsequently, were interviewed.

7.2 Vine Disease

The issue of premature disposal of treated timber caused by disease of the vines was also raised with some vineyard managers. They all concluded that should a vine or series of vines be diseased, the vine would be removed and the site treated accordingly. Removal of the timber posts would be very unlikely.

7.3 Steel and Plastic alternatives to Treated Timber

Many of the vineyards interviewed have used alternative materials for their vineyard posts, with varied success.

One vineyard tried both steel and plastic but were not satisfied with the results of either. They claim that the plastic didn't last long enough and the steel posts weren't as strong as the treated timber posts. Another vineyard has experimented with using steel posts, but have found the creosote posts more stable, resistant to wind, and able to be driven deeper into the ground.

Similarly another vineyard found the steel posts less stable and stated that they could be used but in conjunction with the timber posts, with a ratio of two to one, respectively, at most.

In contrast, a Clare vineyard found steel posts the more preferable choice but also required them to be used along side treated timber posts in a ratio to of 3:1. They found that the steel posts lasted longer had more flexibility and were cheaper to install.

One vineyard has installed a trial of 400 plastic posts and appear to satisfied with their durability so far.

7.4 Omnipol

Omnipol SA has been producing recycled plastic posts for the last four years and have supplied wineries for three years, fifteen wineries being in South Australia. They claim through their experience with the vineyards that the posts endure the mechanical harvesting much better than their timber counterparts but that the lack of marketing and resistance to change has made it hard for them to break into the marketplace.

Omnipol have found that the wineries who have tried the posts have had no major problems with them except for the installation which is more difficult due to their flexibility. They have, however, overcome this by developing a metal sleeve which enables them to be driven into the ground more effortlessly.

The other less attractive aspect of the plastic posts is the extra cost. The posts sell for approximately $5.50 which is about $1 more than treated timber posts (approximately $4.60 per post). When wineries purchase for a whole vineyard numbers of up to 1000 posts are purchased, making the plastic option an expensive option. This initial high cost could, however, be seen as an investment if, as claimed by Omnipol, they last "forever" and can be reused again and again after successive vine generations.

Another potential advantage of Omnipol posts is that there is a high potential for recycling damaged posts in the future.

7.5 Summary

There are alternative products commercially available as replacements for treated timber. Steel products are familiar to South Australian wineries but newer alternatives such as recycled plastic are less well known. These products have been used with varying degrees of success. Clearly if the products were a suitable alternative and were competitive in cost, lifespan and strength they would impact on the treated timber market.

It appears that more wineries need to be made aware of these “greener” options and their long term benefits in order to make a well-informed choice.

However, even if these products were to commence replacing treated timber immediately, significant volumes of treated timber exist today will still require disposal in the future.

8. Disposal Options

8.1 CCA-Treated Timber

Currently the primary methods for disposal of CCA treated timber are re-use, disposal on site or disposal to landfill. The recommended methods of disposal is reuse, and when the timber is no longer suitable for reuse due to it's size or condition it should be disposed at a suitable landfill site. Large size timber such as power poles may be re-cut and re-treated to produce reasonable quality timber (Cooper *et al* 1996). More often CCA treated timber re-use options are limited by the small sizes of pieces commonly used. Fence post and trellis-work are too small for re-milling or use in other applications.

Options such as comminution and the manufacture of timber composites such as particle-board or flake board, have also been proposed (DeGroot and Felton 1995, Vick *et al.*, 1996). Mixtures of 50% recycled furnish (CCA-treated wood chips) with fresh furnish can be used to produce particle board of a good quality (Munson and Kamdem 1998).

Mechanical properties of recycled CCA-treated timber products may be inferior to products composed of fresh untreated timber (Vick *et al.*, 1996). Mixtures of recycled CCA treated timber with fresh material may overcome these mechanical limitations (Munson and Kamdem 1998). A survey of the timber composite industry in the US reported that manufacturers were reluctant to adopt these technologies. This was due to concerns over worker safety and environmental problems associated with preservative contaminated materials (Smith and Shiau 1998).

Combustion or incineration as treatment options are not widely accepted due to the toxicity of the ash (Norton 1998). Incineration concentrates the metals and releases them from the timber matrix increasing mobility. As a consequence the ash contains high levels of extremely mobile metal ions. Between 22 and 70% of As, 15% Cr and 11% Cu may be volatilised during burning of CCA treated wood, the degree of volatilisation will depend upon temperature. High temperature incineration leads to greater metal volatilisation (Connell and Nicholson 1990).

Combustion as a means of recovering Cu, Cr and As has been investigated. The method involves controlled combustion (pyrolysis) and it may be used as a method to re-cycle the metals (Gifford, Marvin and Dare 1996). However, the volatility of As is a problem. It has been suggested that suitable fuel sources and good control of the process may reduce this problem (Degroot and Felton 1995, Marvin and Dare 1996). It has also been reported that metal recoveries from pyrolysis is low and may not be practical on an economic basis (Gifford, Marvin and Dare 1996).

Combined steam explosion, acid extraction and bacterial fermentation of comminuted CCA-treated timber has recently shown recoveries of between 80-100% of metals (Clausen and Smith 1998). These technologies are not currently available at field scale.

Disposal to landfill is the recommended option in Canada and the US (McQueen and Stevens 1998). An investigation in New Zealand of the leaching of the individual metal components of CCA has suggested that landfill disposal is a safe option. This conclusion was based upon the low mobility of Cu, As and Cr and the adsorptive capacity of soil in capping layers to minimise concentrations in leachates (Gifford, *et al.,* 1997).

Other investigations of CCA mobility also suggest that soils with a significant clay content will greatly reduce or prevent leaching. Leaching has been recorded as least in soil with pH of 6-7 (Lebow 1996). Well managed landfills, using capping materials with a significant clay content, should minimise the potential for leaching of CCA and subsequent environmental contamination (Victorian EPA 1981).

The rapid conversion of Cr(VI) to Cr(III) in soils, particularly those with clay or humic contents suggests that environmental contamination from preserved wood *in situ* is unlikely (Gifford *et al.,*1996; Greaves,1997). Toxicity Characteristic Leachate Procedure (TCLP) determinations of CCA-treated wood have resulted in the material being classified as non-hazardous waste by the US EPA (Connell and Nicholson 1990).

Comparison of CCA concentrations in above and below ground sections of treated wood have shown significant leaching of arsenic but not copper and chromium in both sandy clay and light clay soil. Studies consistently report that the elevated metal concentrations are confined to the soil immediately surrounding (<150mm) the timber (Lebow 1996).

Lysimeter studies report that Cu, Cr and As are not highly mobile in the soil environment (Gifford *et al.,* 1997). Leaching of arsenic into the soil environment from treated timber has been reported as the greatest of the three metals (Gifford *et al.,* 1996, Lebow 1993). Greatest mobility of metals has been noted in sandy soils, and least mobility in loam/clay soils.

Peat has been reported to enhance copper mobility, possibly due to complexation with organic acids and forming water soluble salts (Gifford *et al* 1997, Lebow 1996). Soils with high organic content may adsorb or mobilise the metals, depending on pH and organic acid contents. Soils with low pH and high organic acid content are likely to show increased mobility of the metals (Lebow 1996, Rouse 1997).

We understand that one of the major manufacturers is considering a trial of using CCA treated timber for moisture retention in the viticulture industry. The intention is to chip the timber and mix it with soil at through out the vineyard. However, studies into plant uptake and residual soil contamination are yet to occur.

8.2 Pentachlorophenol-Treated Timber

A number of options for the disposal of PCP contaminated timber exist. These include combustion, extraction or bio-processing, catalytic decontamination and disposal to landfill (Degroot and Felton 1995).

Combustion is technically feasible but may not be economically viable due to high cost of incineration partly due to exacting combustion requirements.

Extraction, bioprocessing and catalytic technologies have been developed at laboratory scale but are not developed sufficiently for field applications (Degroot and Felton 1995).

A recent study (Pohland *et al* 1998) investigated the co-disposal to landfill of PCP treated timber with municipal solid wastes. The study concluded that this disposal option resulted in low PCP leachate levels which were not inhibitory to the normal methangenic activity in the landfill. Analysis of PCP and metabolites in the leachate demonstrated microbial degradation in the landfill. No adverse effects were noted at loadings of up to 2% of landfill by weight. Consequently landfill co-disposal was suggested as a feasible management strategy. TCLP testing has demonstrated leaching characteristics of PCP treated timber below the threshold for classification as hazardous waste by the US EPA (EPRI 1990b).

In New Zealand there are stockpiles of PCP-treated timber awaiting disposal / treatment. In most cases high levels of PCP are only present in the surface layers of timber and some operators are considering the option of shaving the surface off to reduce volumes of material for disposal / treatment. The underlying timber which has not been impregnated with the chemical can then be disposed of by conventional means.

Hence, even though PCP is no longer used in South Australia, disposal of PCP timber to landfill is not considered to be of environmental concern.

8.3 Creosote Treated Timber

Options for disposal and re-use of creosote treated timber also exist. Railway sleepers have historically been almost exclusively creosote treated. In the US combustion of used sleepers has been used as a means of energy recovery (Degroot and Felton 1995). Used sleepers have been successfully marketed in South Australia through gardening and landscaping suppliers for use in home garden applications, however most of these are untreated.

Technologies for extraction and re-use of creosote are not well developed and the value and future of the re-claimed creosote product is questionable.

A reduction in concentrations of PAHs in weathered creosote-treated timber has been reported. This was accompanied by reductions in more volatile and water soluble components. This suggests that release of toxic leachate from weathered timber is less likely to occur than from recently treated wood (Cooper *et al* 1996). TCLP testing has demonstrated leaching characteristics of creosote-treated timber below the threshold for classification as hazardous waste by the US EPA (EPRI 1990a).

8.4 Summary

Current options for the re-use and disposal of preservative treated timber in South Australia are limited by technologies available and the nature of the timber waste.

Technologies for reclamation of preservatives are not fully developed and some may not become available as an economically viable proposition.
Further research and commercialisation of these processes is necessary.

Incineration as a disposal option is expensive because of the high degree of control required to minimise volatilisation of metals and hydrocarbons. In the case of CCA treated timber the resultant ash, high in metal content, poses a further handling and disposal problem.

Re-use of treated timber is viable dependent upon the size of the section and the preservative treatment used. Production of particleboard from milled CCA treated timber is a viable option but has been met with some reluctance from the industry. Large pieces of timber may be re-milled and given secondary preservative treatment to produce reasonable quality timber. This option is not applicable to smaller items such as fence posts and trellising.

Reports worldwide suggest that disposal to landfill for preservative-treated timber is at present an acceptable option. There is evidence to suggest biological attenuation of organic (oil based) preservatives resulting in minimal leaching. Provided sufficient capping material with a significant clay content is used the leaching of metals from CCA-treated timber in landfills should also be minimal.

However we are not aware of any research undertaken on timber which is quite old and may no longer provide an adequate substrate to retain the preservation chemicals. Hence adopting the precautionary principle, this timber should be considered as more likely to impact on the environment.

Presently there is insufficient research data to predict optimum loadings for landfill however it is unlikely that current landfills will have the capacity to meet increasing loads of preservative-treated timber in the future without impacts to the environment due to the nature of their design. To cope with increased volumes of preservative treated timber new landfills would need to be “engineered” to include clay or artificially lined bases. Regular monitoring of the sites is also recommended to safeguard against possible leachate contamination.

9. Conclusions

There are two main types of timber preservation techniques in South Australia, CCA and creosote. The majority of timber preservation is undertaken in the South East of the State, particularly in Mount Gambier, which is at the centre of a timber producing region. CCA is an effective preservation chemical and is very economical, hence its widespread use. However, the toxicity of its component chemicals has caused concern and its use has been banned in some countries.

CCA is an effective and economic preservation chemical therefore widespread in use. However the toxicity of it’s component chemicals has caused concern and it’s use has been banned in some countries.

Creosote is also effective, but is more expensive and is perceived to be less “environmentally friendly” than CCA. PCP is banned in Australia and has not been in use for some time. Quantities of waste PCP and non-CCA or creosote treated timber are considered to be minor.

Alternative chemicals such as ammonium derivatives of CCA components are commercially available and are becoming widely accepted in other States such as Tasmania and Queensland. It is understood from discussions with chemical suppliers, that regulators are encouraging the use of the chemicals in these States. Such chemicals are understood to have far less environmental impact as they do not contain Arsenic or Chromium. They also have potential to be disposed of by incineration, as they do not contain arsenic which can be released by incineration of CCA-treated products.

Production of CCA treated timber has remained relatively constant over the past three years, but it is understood to be much greater than ten years ago. The significant increase is due to an increase in the viticulture industry.

Creosote production in SA has increased significantly in the past three years, in contrast to international trends.

It is estimated that 250 000m^3 of treated timber will be produced in 1999. However not all of this is sold in the South Australia. A total volume of 175 000m^3 of treated timber is estimated to be sold into the State for 1999.

It is unlikely that all of this product would be disposed of in the near future as it has a predicted working life time of 30-40 years. However, it will require disposal in the future and disposal time may be significantly reduced should certain conditions change, such as a reduction in the viticulture industry. Discussions with major treated timber purchasers in South Australia have suggested that even if reduction in the industry were to occur, bulk disposal to landfill would be unlikely. This is because of the cost of disposal and the potential that re-use of the product may occur again in the future.

It is understood that predominant current disposal practises are by storage or burial on the purchaser's land and sometimes by burning, even though this method contravenes Legislation. Certainly all landfill operators interviewed reported receiving very low quantities of treated timber waste. If this were to change re-assessment of landfills and environmental monitoring procedures would be required.

Considering the current disposal practises, research into the potential environmental impacts resulting from these activities was undertaken. The greatest potential for environmental harm is from leaching of preservation chemicals from the timber to the soils impacting on soil quality, surface water quality or groundwater quality.

Studies have been undertaken outside Australia to address these issues.
Technologies such as incineration, reuse as particle board substrate, reuse as alternative products, bacterial fermentation and pyrolysis have all been trialed with various degrees of success. All are expensive options and in some cases, can result in hazardous by-products. There are no examples to establish the feasibility of any of these options in a non-laboratory setting.

Reports worldwide suggest that disposal to landfill for preservative-treated timber is at present an acceptable option. There is evidence to suggest that biological attenuation of organic (oil based) preservatives would result in minimal leaching. Provided sufficient lining material with a significant clay content is used the leaching of metals from CCA-treated timber in landfills should also be minimal. No research was revealed on timber which is extensively aged and may no longer provide an adequate substrate to retain the preservation chemicals.

It is unlikely that existing landfills will be able to accept increasing loads of preservative-treated timber without impacting on the environment. This is based on the fact that up to 160 000m^3 of treated timber is likely to require disposal each year, in approximately 30 years time. Presently there is insufficient research data to predict optimum loadings of CCA and creosote treated timber for landfill. However if optimum loadings of CCA and Creosote treated timber are similar to recommended loadings of PCB treated timber, then environmental impact is considered likely if all future treated timber is disposed to landfills in their current form.

10. Future Management Options

The State of South Australia will need to dispose of tens of thousands of cubic metres of treated timber per annum in the future.

This raises many issues such as disposal methodology, responsibility, and disposal locations.

Currently disposal to non engineered landfills and storage of small volumes on site is adequate and research shows these disposal methods have minor environmental impact, however this is likely to alter with large quantities of ageing timber.

Sinclair Knight Merz provide the following recommendations for the management and disposal of treated timber:

- Large volumes of non re-useable treated timber requiring disposal should be placed in an engineered[2] landfill;
- Further research is required on the potential for toxic metals to leach from ageing timber to soils. The EPA should consider a joint program with other bodies to examine this issue;
- A study should be undertaken to determine where soils in SA are not suitable for the storage of small quantities (<1000m^3) of treated timber and where such activities may impact on the environment. Local government should be informed of these areas;
- The EPA should nominate landfills which are suitable and not suitable for the disposal of treated timber;
- Wineries/vineyards should become involved in developing a statewide Code of Practise for land care. The Code of Practise must address the bulk storage of treated timber and the curtailing of site burial and other methods of disposing treated timber products which are potentially harmful to the environment.
- Individual wineries/vineyards should be encouraged to develop their own environmental management plans. If they already have such plans they should be developed so as to incorporate consideration for the appropriate disposal and storage of treated timber;
- The EPA should advise local government, wineries and other relevant bodies (such as farm suppliers) that burial of CCA timber in a non licenced landfill is not allowed by Legislation;
- Local and State Government should review current landfills and instigate improvements or develop new "engineered" landfills which could accept larger

[2] "engineered landfill" is used in this document to describe landfills with clay or other similar linings to reduce contamination from leachate.

loads of treated timber products without degradation to the natural environment;

- The EPA should examine ways of implementing the use of ammonium based compounds as substitutes to CCA and creosote preservatives. Even though the implementation of such measures are not likely to be seen for many years, these preservation chemicals will be far more suitable for the reduction in heavy metal disposal issues for the State;
- Local and state government should augment legislation to ensure the safe disposal of treated timber products within South Australia and to encourage the use of more environmentally suitable alternatives;
- The EPA should consider advising wineries who are unaware of alternatives to treated timber that there are benefits in using these products such as an improved “greener” image for the winery;
- The EPA licence conditions for all landfills currently monitoring groundwater, should include assessment for copper, chromium (III and VI) and arsenic, phenols and PAH;
- The EPA should instruct all other landfills receiving treated timber to monitor groundwater (where appropriate) for copper, chromium (III and VI) and arsenic, phenols and PAH.
- The EPA should establish a working group consisting of suitably qualified persons to monitor and develop future strategies for the disposal of treated timber.

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