Waste Tyre Recycling and Potential Rubber Products in Essex & Cambridgeshire

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We are keen to share research and discuss joint projects on this opportunity.

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Executive Summary

- It is estimated that over 500,000 lorry and car tyres (5,300 tonnes) in Essex and 153,000 (1,800 tonnes) in Cambridge were either landilled or illegally dumped in 2002.
- Over 35 million waste car tyres and over 4 million waste lorry tyres were estimated to have been produced in the UK in 2001.
- The total weight of these waste tyres was 481,000 tonnes, representing around 2% of the UK's domestic waste stream.
- Only 60% of these were recovered - the remaining 40% (192, 000 tonnes) were either landfilled or illegally dumped.
- The EU directive which bans the landfill of whole tyres from July '03 and shredded tyres by 2006 is changing tyre management but predicted future growth in motoring will increase the scale of the problem by around 60% in 2021.
- Tyre dumps are liable to catch fire and create substantial environmental problems.
- Tyres recovery includes reuse, retreading, recycling after grinding to rubber crumb, pyrolysis and incineration.
- Use of rubber crumb for manufacturing mats and other products appears to be the best option for social enterprises, with a wide range of potential uses as described in Appendix 4.
- Recycling 20 % of the unrecovered tyres in Essex and Cambridgeshire could produce sufficient rubber crumb to provide employment for at least 70 people.
- There may be opportunities for partnerships with industry given the potential obligations to reprocessing responsibility (see DTI reference below).

1. Background

The Used Tyre Working Group (UTWG) estimated that in 2001 39 million waste tyres, equivalent to 481,000 tonnes, were produced in the UK. Reuse, recycling and energy recovery are normally grouped together and described as recovery in the case of waste tyres. In 2001 60% of waste tyres (289,000 tonnes) were recovered and the remaining 40% (192,000 tonnes) were either landfilled, stockpiled or illegally dumped. This recovery rate compares to the figure of 63% achieved for 2000 (283,000 tonnes) and shows a downward

trend from a peak of 73% recovery in 1999. This is probably largely due to the closure of the SITA incineration plant at Wolverhampton. The average EU recovery rate for 2001 was 65% with 100% recovery rates achieved in Finland, Sweden and the Netherlands.

The number of tyres in use in the UK is expected to rise from 121 million in 1996 to 169 million in 2011 and to nearly 200 million by 2021. This rate of increase would suggest that around 60% or 314,000 more tonnes of waste tyres will be produced in 2021 than at present, making a total of almost 800,000 tonnes per year for disposal.

Tyres can be reused as so-called “part-worns” or retreaded. They are also increasingly being used at the base of new landfill sites to facilitate drainage. Around 16 million tyres were used for this purpose in 2002. Cynics might suggest that this is a convenient way of dodging the landfill ban. Whole tyres can also be used at sea to form artificial reefs and barriers to reduce land erosion. Tyres can be recycled by grinding to rubber crumb which can be used to make a variety of products and used as a material for road and playground surfaces. Incineration is widely used for energy recovery and pyrolysis can also be used to extract valuable raw materials. Appendix 2 provides more details about these options.

The EU Landfill Directive 99/31/EC contains specific targets for tyres and requires the UK to prohibit the landfill of whole tyres from 2003 and shredded tyres by 2006 in new landfill sites. In both cases, bicycle tyres and tyres with an outside diameter of 1.4 m are excluded. The landfill of whole tyres was supposed to be banned from 16th July 2003 but DEFRA have recently confirmed that a loophole allows them to be accepted at non-hazardous sites until these have Pollution, Prevention and Control (IPPC) permits. The Environment Agency have confirmed that the regulations only state that the disposal of whole tyres to hazardous landfills and new non-hazardous landfills is banned from July 2003. DEFRA claim that the EA have a timetable for issuing IPPC permits and hope this will clear up a problem which greatly concerns tyre reprocessors who have invested in recycling.

The End-of-Life Vehicles (ELV) Directive also sets a recovery target of 85% by 2006. Around 5% (50 kg) of the weight of an ELV is rubber, of which 3.5% comes from tyres, so they can be expected to play an important role in achieving the target.

The DTI issued a consultation paper to the tyre industry in April 2002 seeking how best to meet the Landfill Directive. This proposed statutory producer responsibility arrangements and included a Tyre Recycling Note (TRN) system similar to the Packaging Recovery Note (PRN). A second consultation paper was issued in March 2003 for response by June 2003. This stepped away from imposing statutory charges and called for views on the following:

- How the tyre industry might provide clear accountability for the recovery of all tyres.
- The introduction of statutory powers to ensure businesses report exactly how tyres are being recovered.
- Improving the representation, transparency and effectiveness of the Used Tyre Working Group.
- The benefits and possible structure of a centrally held database to help crack down on tyre fly-tipping.
- Possible interim targets for tyre recovery, for example 85% for 2004 and 92% for 2005.

Four tyre industry trade associations have responded jointly to the second consultation paper – the British Rubber Manufacturers' Association, the Imported Tyre Manufacturers Association, the National Tyre Distributors Association and the Retread Manufacturers Association. The main proposals of the tyre industry included:

- Setting a statutory obligation for manufacturers and importers to recover tyres related to market share.
- The setting up of a statutory reporting requirement for tyre recovery data whether a statutory obligation is set or not.
- The creation of a non-profit arms length body to act as a compliance scheme through which obligations are collectively discharged.
- The Used Tyre Working Group to be reconstituted to fit the circumstances of a producer responsibility regime.

2. Estimated Quantities Available for Recycling

Table 1 shows estimated quantities of car and lorry tyres available in 2002 in Essex, Cambridgeshire and the Eastern Region. The figures have been calculated on a population basis using predicted data for the whole UK (Dufton, P. W. End of Life Tyres, RAPRA, 2001 Table 10.2). Similar figures can be calculated for other local areas. This data is particularly useful because it contains a precise breakdown of figures for cars and lorries. The RAPRA data gives a total estimate of 453,000 tonnes for waste car and lorry tyres in the UK for 2002. Data for 2001 from the UTWG presented to the Government in Mar. '03 indicated that 481,000 tonnes of waste tyres in total arose in 2001, with a recovery rate of 60%. In the absence of any major new initiatives, the estimates presented in Table 1 are therefore likely to be on the low side by around 6%.

Table 1

Tyres Available for Recycling In Cambridge and the East of England (Tonnes)

	Cars & Vans	Lorries and Buses	Total
Essex	*2991	2309	*5300
Cambridge	880	939	1819
E & C	*3871	3248	*7119
Eastern Region	*8199	6198	*14397

*includes additional factor (0.383) to account for higher car ownership in Essex relative to UK average (based on 1991 census).

Figures allow for estimated current 60% recovery rate and assume an average weight of 6.5 kg for waste car tyres and 52.5 kg for lorry and bus tyres.

3. Financial Overview

Government has created new start-up funding for effective community recycling projects. Although it is recognised that grants may be essential at the beginning, the aim is to create sustainable businesses that no longer need them. WasteWISE will assist organisations to win funding for projects in the two counties, including in Thurrock, Southend and Peterborough. There is plenty to bid for, including: New Opportunities Funding: The CRED scheme, SEED funding, Fair Share projects and the new Government £100 million/year sustainable waste funding package managed by WRAP. EEDA/DTI may also offer funding opportunities for some aspects.

4. Social Employment Opportunities

(i) Tyre Collection
(ii) Rubber Crumb Production
(iii) Manufacturing Products from Rubber Crumb

(i) Tyre Collection

One opportunity or expanded employment is tyre collection from garages, civic amenity sites and existing dumps. This is currently financially impractical in most cases, since without equipment for shredding or crumbing there are few outlets for the tyres other than delivery to commercial retreaders or shredders. The latter is probably uneconomic, since gate fees of around £90 per tonne are charged. This translates to around 60p per car tyre which is approximately equal to the fee currently charged for disposal by garages. Collectors have to be registered with the Environment Agency. It may be possible to sell the whole tyres for use in landfill engineering or coastal defence work or use them to make products such as the Lily Plant pot (see Appendix 4).

Recovery of tyres that are fly-tipped can cost councils considerably more per tonne. For example, in Wales last year £2.3 million was spent recovering tyres from fly-tipping. During the same period 11,500 tonnes of tyres were landfilled. Precise tonnages for the fly-tipped tyres are difficult to obtain but in the unlikely event that as many tyres were fly-tipped as landfilled these figures indicate that recovery from fly-tipping costs councils at least £200 per tonne. It is likely that far fewer are tipped, so the true cost is probably many times this amount. If councils were willing to pay a realistic sum for collection,

this could represent a part-time social enterprise as detailed in Appendix 3. However, a fee of around £300 per tonne or around £2 per car tyre would have to be charged and the operation would only begin to make a profit if around 650 kg of tyres a day (equivalent to around 100 car tyres) could be collected on a sustained basis. In 2001 Essex county council estimated the costs of tyre removal at only 75p per tyre, or around £115 per tonne, which would make the operation uneconomic as almost 6 tonnes or over 900 car tyres per day would have to be collected. In conclusion, this would only be a viable opportunity if a financially attractive contract could be obtained from the local authority.

It appears that the 2006 landfill ban has led to a lack of investment by industry in shredding equipment which could lead to the danger that social enterprises conducting this kind of operation could themselves be saddled with an unwanted tyre mountain or be forced to spend a lot of time an money transporting tyres to processors. The exception is probably the collection of large lorry and earth-moving tyres for which there is a good retreading market. A list of retreaders is presented in the Appendix. These tyres are also sought after by crumbing operations because of their valuable high natural rubber content. Some have such a low steel content and can be manually shredded. There is only a single company in Essex currently shredding tyres – Tyre Shred in Felsted. They are currently operating at full capacity and cannot obtain the £250,000 needed to expand. They do not produce rubber crumb – the shred is currently transported up to World Rubber in Northants for crumbing.

(ii) Rubber Crumb Production

Equipment for producing rubber crumb is very expensive, costing at the very least £100,000 and more probably £1.25 million for reasonably versatile new plant. Further details can be obtained from Rubber Recovery at www.rubber-recovery.com/ or one of the US manufacturers at sales@ssiworld.com or www.granutech.com. Wastechange.net are currently advertising a used mobile shredder for £55,000 which claims to have a throughput of 800 tyres per day – equivalent to around 1,250 tonnes per year in the case of car tyres. The equipment is fairly massive, uses large amounts of energy and needs constant maintenance – for example blades quickly become blunt cutting the steel belts and beading. Waste steel and fabric need to be disposed of and there are a number of health and safety issues and regulations such as noise and dust etc. A large amount of space is also required for the waste tyres and

various stages of crumb production. This appears to be a high risk investment for a social enterprise to undertake – Local Authorities and Government should perhaps lead the way here. Working Herts in Borehamwood is a social enterprise with a permanent staff of 15 which currently provides training for disadvantaged youngsters insulating houses and conducting various other projects within Hertfordshire. They are currently considering tyre recycling and have been consulting with the Local Authority, Business Link and Rubber Recovery on whether to buy a crumbing machine. They are still awaiting a detailed financial analysis but and although keen to embark on what could be a ground-breaking project are at present hesitant because of the uncertainties described above and plan to start by collecting tyres from local garages to provide training and experience. In conclusion, prospective enterprises should wait to see how the Working Herts proposal develops because the capital investment is so risky.

(ii) Manufacturing Products from Rubber Crumb

In view of the problems involved with collecting and shredding/grinding tyres this is considered to be the most appropriate opportunity for potential social enterprises to consider, using bought rubber crumb to manufacture items for sale or, in the case of agriculturally based enterprises, using it to produce mulch or compost. In this way a number of the costs listed in section 8 can be avoided and other safety/regulatory requirements met at competitive costs. A range of items covering a diverse range that includes rubber mats, carpet underlay, traffic bollards, stable mats and equine surfaces can be produced, as listed in Appendix 4. One factor to consider is that there are a number of manufacturers nationally in this arena so there could be some competition. The operation involves mixing the rubber crumb with polymers and resins and setting it using a heat press within moulds designed for the particular product. Rubber Recovery in Suffolk, Eximlink (UK) Ltd in London or Fordberry in Wales can advise on prices, provide the necessary raw materials /moulding equipment and advise on health and safety issues. Contact details are listed in section 9.

It appears that a 250% profit margin is possible. Some products retail at surprisingly high prices – for example, £300 – £400 per item has been reported for the large, porous rubber mats used in milking sheds. An example of likely costs and income is given Appendix 3 for the manufacture of shock-absorbing rubber mats such as the Trailer Mat which allows the feet of a trailer to be set down without damage to a tarmac or concrete surface. This

shows that in principle there is sufficient waste to provide potential work for 70 people in Essex and Cambridgeshire and 144 for the Eastern Region using the estimates for both waste car and lorry tyres shown in Table 1 and assuming 20% of the available waste is crumbed. If only the higher quality rubber crumb from lorries is used these figures would be reduced to 32 and 62 respectively. Obviously the market for this particular product would become easily saturated but the example provides a rough estimate of potential for other items. It may be possible to reduce costs by sourcing rubber crumb from abroad but this would raise a number of ethical questions and contrary to the aim of WasteWISE. As an example, crumb prices in India currently range from half to two-thirds those charged in the UK.

It is important to note that there does not appear to be any facilities within Essex or Cambridgeshire for producing rubber crumb from tyres. Until local authorities and/or businesses can be persuaded to invest in equipment the use of crumb produced from waste tyres Essex and Cambridgeshire is largely hypothetical and involves inefficient routing from tyre collectors within the counties to Tyre Shred in Felsted then to World Rubber in Northants and back.

In conclusion, WasteWISE is willing to work with potential partners on a detailed local business plan on potential feasibilty and essential links to tyre processing.

5. Environmental Issues

(i) Pollution during manufacture and use

Tyres produce pollution during their manufacture and use. Around 200 MJ of energy, equivalent to burning 6 gallons of oil, is used to produce an average car tyre. A single car tyre deposits around 50 milligrams of rubber on the road for every mile travelled. This is equivalent to 2 kg per car per 10,000 miles travelled. This works out at over 3.5 kg per metre per year for roads used at a rate of 3,500 vehicles per hour, which is the average use for motorways in the Eastern Region or 0.6 kg per metre per year for minor roads used at a rate of 600 vehicles per hour, which is the average for built-up areas within the region. The rubber deposit also contains fine carbon particulates, zinc oxide, cadmium and other materials which are either blown or washed away to pollute the surrounding countryside. Although the chemicals are strongly bonded together within the rubber compound, extensive research into the

leaching effect into the environment from such fine particles has not been conducted. A recent Canadian report found that the leachate from rubber crumb used for playgrounds is toxic to a variety of organisms. The toxicity dissipates after 3 months and is considered minor when dilution effects are taken into account but the environmental effects of a continuous supply of leachate from fine rubber dust were not considered.

First steps towards reducing the environmental effects would be to encourage manufacturers to design more efficient tyres. A decrease in rolling resistance of 10%, which appears to be a reasonable target, would save almost a million tonnes of fuel annually in the UK and reduce annual CO_2 emissions by almost 3 million tonnes. A 10% increase in life-span would also reduce the number of waste tyres by 32,000 tonnes and save 6,000 tonnes of waste rubber from wear. An increase in life-span could be obtained by discouraging high-speed driving, fast cornering and kerb-scraping. Fuel savings could also be achieved by obtained by better education on the maintenance of correct tyre pressure.

Novamont and Goodyear recently anounced a “biotyre” which replaces part of the conventional carbon black and silica components with a biological polymer referred to as Mater-Bi which is derived from maize starch. Not only does this save pollution and energy requirements during manufacture but it also results in reduced rolling resistance and road noise.

(ii) Tyre dumps

Tyre dumps are unsightly and liable to catch fire or be intentionally set alight. Once the fires start they are difficult to extinguish as tyres have a high calorific value - a typical car tyre equates to around ten litres of fuel oil. Black smoke containing harmful particulates and toxic fumes with high aromatic hydrocarbon and sulphur dioxide concentration are produced. These pollute the air and soil with carcinogens which include benzene. The biggest tyre dump in the UK at Heyope in Wales, which contains 9 million tyres, caught fire in 1991 and as of June 2002 was still alight. It costs the emergency services £500,000 a year to deal with tyre fires. The pools of water trapped within tyres in dumps also provide breeding grounds for various insects which may include ticks and mosquitoes.

There is a black market in illegal tyre disposal exposing the public to risk from fire and pollution. A mountain of 680,000 tyres dumped at the Sculthorpe airfield in Norfolk has caused problems for over 3 years. The Environment

Agency responded to over 1,300 fly-tipping incidents involving tyres in 2002, although the actual figure is probably substantially higher as many incidents are reported directly to local authorities and do not feature in the EA statistics. Of these incidents 400 involved fires. The EA has complained about the low fines imposed by the courts: for example a man prosecuted for dumping 1.6 million tyres was given only 240 hours' community service. Local authorities spend £2 million per year dealing with illegal tyre dumping while land owners and industry pay more than £1 million per year.

(iii) Incineration

Energy recovery by incineration can cause problems. Sulphur is a vital component of the vulcanisation process used to make the raw rubber sufficiently durable for used in tyres. Incineration oxidises this to sulphur dioxide and atmospheric emissions can only be prevented by using flue gas de-sulphurisation, which must be continuously checked and maintained. This is costly, not only in terms of additional plant but as reduced net energy output since the process itself uses considerable electrical energy.

The environmental effect of the increasing incineration of tyres to produce energy in cement kilns is open to question. In 2000 leading air pollution and public health experts criticised tyre burning trials at Westbury's Blue Circle works in Wiltshire as using selective data, failing to reject flawed results and making statistically invalid comparisons. There was a good chance that fine particulate levels exceeded limits, arsenic and cadmium levels increased 3000 times and chromium 20,000 times. Several pressure groups, including Friends of the Earth and "The Campaign against the New Kiln" claim that dioxins and particulates are an unacceptable hazard from kilns. The EC Waste Incineration Directive (2000/76/EC) transposed into national law in 2002 imposes stricter limits on co-incinerated waste which include cement kilns using tyres as fuel.

6. Potential Partner Organisations

- WasteWISE and WISE - WISE provides detailed development and management training for recycling/other social enterprise managers in Essex, Cambridgeshire and neighbouring areas.
- Recycling social enterprises and community/environment groups
- Essex and Cambs county councils, district and unitary councils, and joint waste strategy and recycling initiatives.

- Essex ReMaDe, and other initiatives/umbrella organisations.
- External partners, e.g. UTWG, RAPRA, Rubber Recovery other tyre recovery companies listed at www.letsrecycle.com.
- Garages/tyre retailers
- Manufacturers, re trial schemes and other organisations covered by proposed producer responsibility, including the British Rubber Manufacturers' Association, the Imported Tyre Manufacturers Association, the National Tyre Distributors Association and the Retread Manufacturers Association.
- Local recycling, waste, and other businesses.
- New entrepreneurs/venture capital funders

7. Next Steps

Our standard two stage approach at WasteWISE is, with partners, to

A Consult on discussion drafts like this, then improve and publish a final 'overview report'

B To then consider undertaking a detailed feasibility study and financial analysis with partners on a real potential scheme covering a defined catchment area that is projected to deliver economic and successful recycling. This will normally cover at least two or three council districts in Essex and/or Cambs, and the study will be overseen by the creation of a 'task and finish' project group including key partners.

8. Detailed Financial Analysis

In the case of tyres, the issues to be costed in detail in a more detailed local business plan include:

A FIXED COSTS (** costs reduced by partnerships/links)

Capital investment
- recycling skips appropriate to categories such as earth-moving, lorry or car tyres.
- collection vehicles
- shredding/crumbing equipment
- moulding equipment and binding agents
- ** premises for sorting/crumbing/moulding/external storage

- ** Retail outlets

** Operating costs

– business rates, phones etc
– promotion/media

B VARIABLE COSTS

Staff costs

- Tyre collection
- Sorting
- Crumbing
- Moulding
- Waste steel/fabric disposal
- Delivery/transport to market

Operating costs

- Fuel/power/premises
- Maintenance of shredder/crumber (blade renewal, dust filters etc.)
- Cost of rubber crumb, moulds and binding agents
-

C INCOME

Price per item
Recycling credit per tonne (Tyre Recovery Notes [TRNs] or landfill saving from commercial tyre sources)
Potential financial support from local authority for trial
Staffing contribution re: placing people with learning disability/training support
Potential one-off assistance from industry compliance schemes
Local partners interested in reprocessing outputs
Potential grant aid and start up funding (WasteWISE has further analysis on these)

9. Further Contacts and Sources

(other contacts can also register with us to have their details added below)

Contacts

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www.hertsdirect.org/infoadvice/comvol/employ2y/emplyservice3/534025

Neil Thomson, Project Manager, Remade Essex, AMT Centre, Upper Chase, Writtle Road, Chelmsford, Essex. CM2 0BN. tel: 01245 259351, neil.thomson@eepartnership.co.uk.

Retread Manufacturers' Association, 2nd Floor, Federation House, Station Road, Stoke-on-Trent, ST4 2TJ. E-mail:retreads@ukonline.co.uk

Fordberry (UK) Ltd., Tyre Recycling D&E, Suite 2, Britannia House, Penny Lane, Cowbridge, South Wales. CF1 7AD. Tel: 01446 776464. E-mail: rob@fordberry.co.uk. www.fordberry.com/recycle.html

EximLink UK Ltd., 93-95 Commercial Road, London E1 1RD. Tel: 020 7377 5923. E-mail: office@eximlink.com. www.Eximlink.com/start.html

Lilly Plant Pot, 2nd Floor, 3 Trinity Road, Aston, Birmingham. B6 6AH. Tel: 01215549638, nevillelilly90@hotmail.com

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Appendix 1

What do Tyres Consist of?

An average car tyre weighs around 8 kg new and loses around 1.5 kg with wear during use. Tyres comprise between 80 and 85% rubber compound by weight, with the remainder made up of steel, fabric and cording. The rubber compound only consists of about 56% rubber by weight, the rest comprising fine carbon powder known as carbon black (30%), oil (10%) zinc oxide (2%) sulphur (2%) and other chemicals such as vulcanisation activators, processing aids, silica and inorganic fillers (1%). The rubber component is a mix of natural and synthetic polymers, the latter usually styrene butadiene or SBR. The precise ratio depends on the manufacturer, with lorry tyres generally richer in natural rubber than car tyres which commonly only comprise 25% natural rubber. During manufacture, the rubber compound is vulcanised using a high temperature process which results in strong bonding at a molecular level between the various components. This makes it difficult to separate them without using high temperatures and/or elaborate chemical procedures. Only a small amount of rubber from waste tyres – typically up to 2% - can normally used in the manufacture of new tyres.

Appendix 2

Options for Tyre Recovery

(i) Retreading
(ii) Reuse
(iii) Use for Engineering
(iv) Granulation to Produce Rubber Crumb
(v) De-Vulcanisation
(vi) Pyrolysis
(vii) Incineration

(i) Retreading

The Used Tyre Working Group favour retreading as the first recovery option as it is considered to be the best use of resources. The UK retreading industry, comprising around 50 companies, is currently calling for the government to recognise retreading as the Best Practice Environmental Option (BPEO). A list of retreaders is provided in the Appendix. The DTI consultation paper, April 2002, proposes that retreaders could issue Temporary Tyre Notes (TTNs) rather than Tyre Recovery Notes (TRNs) because a retreaded tyre will eventually re-enter the waste stream. A TTN would not demonstrate permanent evidence of recovery but would enable obligated parties to defer obligations from one reporting period to the next.

Manufacturing a retread for an average car saves around 75% of the energy used to make a new tyre, equivalent to around 4.5 gallons of oil. The saving increases to the equivalent of around 15 gallons of oil on average in the case of lorry tyres. Although around 40% of lorry tyres are retreaded, the car tyre retread market is in sharp decline, currently standing at only around 5%. In the 1970's retreads comprised 20% of the market but this dropped to only 10% in 2001 and is declining at the rate of 30% a year. This is mainly due to the proliferation of cheap new tyre imports and the widespread public perception that retreads are inferior, even though they are individually inspected, manufactured to equally high standards as new tyres and considered sufficiently safe by airlines as to be universally used on commercial aircraft. As from January 1st 2004, retreads will have to be marked with the new retreaders' E-mark in accordance with ECE Regulations 108 (for cars) or 109 (for lorries) as opposed to the previous BS mark. There

is concern within the industry that the new regulations might further reduce the number of retreads produced because there are only limited testing facilities in the UK. The test is also seen as irrelevant as it was devised years ago for cross-ply tyres which are now almost non existent.

Tyres collected for retreading are first inspected and if found suitable the old tread is mechanically removed by a process called buffing. This produces rubber granulate which can be used for other products. The new tread is applied using one of two processes. In the pre-cure process the tread rubber has already been vulcanised with the new tread prior to application. In the mould-cure process unvulcanised rubber is applied to the buffed tyre before the tread is vulcanised onto it.

(ii) Reuse

Around 16% of tyres (78,000 tonnes) had sufficient tread as to be suitable for reuse in 2001 without further treatment. Tyre safety regulations apply to the sale of such “part worns” and the Tyre Industry Council (TIC) has developed a voluntary code of practice under its Responsible Recycler Scheme. The regulations state that tyres should have a minimum tread depth of 2 mm across the entire breadth of the tyre and should be clearly marked as part-worn at the point of sale.

(iii) Use for Engineering

In 2001 around 4% of waste tyres (16,000 tonnes) were used for landfill engineering. These are usually used whole to line the base of new landfill sites to provide for drainage. Around 5% (20,000 tonnes) of used tyres were also used for various applications including dock fenders, artificial reefs and barriers and playground swings. New engineering uses include the community buildings and houses which have recently been constructed using whole tyres in the walls by the Earthship project, South Downs, Sussex.

(iv) Granulation to Produce Rubber Crumb

Rubber crumb is the main source of material for items produced from waste tyres. In 2001 around 22% of waste tyres (107,000 tonnes) were recycled, mostly in the form of rubber crumb. The term “crumb” is generally used to describe any rubber compound which has been reduced to a powder but in this context it refers to the granular material produced from waste tyres

which ranges in size from a few millimetres to a few thousands of a millimetre. There are three main types:

Buffed crumb is produced from part-worn tyres submitted for retreading. This is free of fabric or steel and comprises a high quality, abrasion-resistant rubber compound. This was the traditional source of crumb in the UK until direct crumbing started to increase in the last few years.

Whole tyre crumb is produced at room temperature directly from scrap tyres. These are first shredded to about 3-5 cm in size then passed through a coarse mill then through finer mills and screens. The shredding of steel-containing tyres, now almost universal, is energy intensive with rapid wear and tear of equipment. Zero-waste systems have been developed which make use of all the waste steel and other components. The cost of the operation increases dramatically the finer the crumb required. The equipment itself is very expensive – ranging from £100,000 to £1.25 million – and its operation poses many health and safety considerations. New water-jet crumbing equipment is currently being tested in the UK which should be cleaner, cheaper and easier to operate but prices for this are expected to be higher. A further advantage of the water-jet equipment is that any size crumb can be produced down to the finest powder with a single process and it may be possible to fabricate small items such as washers directly.

Rubber Recovery in Suffolk will offer advice for producing rubber crumb from tyres over 1.4 m in diameter which could use this method. They have recently installed the World's first grinding machine for tyres up to 2.3 m in diameter for VHE construction in the North East which is expected to be operational in Autumn 2003. Large tyres from earth-moving equipment produce valuable crumb yet are still allowed to be landfilled under the current EU directive. Crumbing operations generally seek to use lorry tyres because their higher natural rubber content is more sought after. In 2000 80,000 tonnes of waste tyres, mostly lorry tyres, were used to produce a total of around 60,000 tonnes of rubber crumb, and Colway Tyres in Co. Durham, part of the Environmental Waste Services Group, was believed to be the only direct granulator handling car tyres. The amount of crumb produced from car tyres appears to have increased recently, although precise figures are difficult to obtain. The German company MeWa is currently building a tyre crumbing plant for SIMS in Newport along the lines of an advanced plant it has already built in Austria. This will be able to process around 40,000 tonnes of car and lorry tyres per year, producing rubber crumb in a three-stage process ranging

in size from 6 mm down to 50 μm powder. There do not appear to be any crumbing operations in Essex or Cambridgeshire.

Cryogenic techniques can also be used to produce crumb. With these, tyre fragments are cooled, usually using liquid nitrogen, to make them brittle. They can then be much more easily reduced to powder. Such processes are rare in the UK but common in the USA where the price of refrigerants is much lower.

The cost of rubber crumb in the UK ranges from around £180 per tonne for mm size crumb to £1000 or more for fine powder. Savings can be made buying overseas – the cheapest source appears to be India with prices of around £120 per tonne.

Rubber crumb can be used to make a variety of products, as listed in Appendix 4. It is increasingly being used in the USA to make road surfaces and experiments are currently being conducted in the UK in this area – £ 0.5 million has recently been awarded by the EPSRC to Nottingham and Liverpool Universities for this purpose. It has been estimated that all the waste tyres in the USA could be used for road surfaces, replacing just 6% of the asphalt currently used but saving 60 trillion Btus (63,000 GJ) of energy annually. The crumb is combined with asphalt in one of a number of ways and a more hard-wearing surface results which results in about 4-7 dB less road noise and better grip and braking performance. The crumb is only added as a small percentage of the total material but the current price of around 20 times the cost of normal aggregate and 6 times the cost of glass cullet presents a difficult decision between possible long-term benefits and short term savings.

Rubber crumb and devulcanised rubber (see section 5) can be combined with various thermoplastic materials to produce reduced cost materials without sacrificing critical properties or processing characteristics. The rubber can be used to modify Linear Low Density Polyethylene (LLDPE), Polypropylene (PP) , Polyurethane (PU) and Polyvinylchloride (PVC) among others. The rubber particles are blended at levels of around 5-70%.

Another use for rubber crumb and shredded tyres is as mulch and compost. This has been used experimentally at Hampton Court, the Eden Project and elsewhere. The crumb confers good drainage qualities and the shredded rubber looks very similar to mulch produced from bark.

(v) De-vulcanisation

A number of experimental processes are being investigated for producing de-vulcanised rubber from tyres in which the sulphur links are broken, enabling the rubber to be reprocessed and cured like virgin rubber compound. These include ultrasonic and microwave techniques. If shown to be economically viable, these could greatly increase the potential for tyre recycling.

(vi) Pyrolysis

Pyrolysis is defined as thermal decomposition in an inert atmosphere. Depending on the conditions used, tyres can be pyrolised to produce a wide range of gaseous and liquid hydrocarbon mixtures together with varying amounts of char. There have been numerous attempts worldwide to produce economically viable techniques for tyre pyrolysis over the last 25 years but commercial-scale plants have tended to fail because of the low value of the end products in relation to capital and operational costs. However, development continues in many countries. A feasibility study conducted at the University of Kentucky reported that a pyolysis plant (www.cffls.uky.edu/C1/chemtech.pdf) processing 100,000 tonnes of tyres per year could provide a return on investment of around 38% if a gate fee of $75 per ton was charged and a return of $25 per ton obtained for the oil and $200 per ton for the carbon black produced. Since gate fees of around £90 per tonne are currently being charged by tyre processors in the UK and the July '03 spot price for crude oil is $30.24 per barrel and for carbon black $760 per tonne, current economics would indicate that even higher returns could be made. However the analysis used figures of $830,000 for the tyre shredder and $9.8 million for the pyrolysis plant, so major investment is required.

Beaven Recycling, Oxford, have developed an experimental batch process which can process around 500,000 tyres (ca. 3,000 tonnes of used car tyres) per year. This can generate 1,300 tonnes of carbon, 900 tonnes of oil, 500 tonnes of gas and 500 tonnes of steel per year. Emissions are claimed to be well within current UK guidelines. The system has been analysed by Dr Paul Williams at Leeds University and shown to be capable of recovering a higher proportion of material and latent energy content than incineration. Aromatic

chemicals produced include limonene, toluene and xylene which have wide industrial applications.

Coalite Tyre Services in Derbyshire operate a plant with a capacity of 15,000 tonnes a year and are currently converting this to accept 90,000 tonnes of shredded tyres a year.There are also advanced proposals for a pyrolysis plant in Staffordshire which would utilise 65,000 tonnes of used tyres per year and generate approximately 15.5 MW of electricity.

Pyrolysis produces a small quantity of light oil which may be suitable for use as a replacement for diesel fuel provided the potentially high sulphur content can be reduced. However, to put this in perspective, the entire 192,000 tonnes of unrecovered tyres produced in 2001 would only produce around 16,000 tonnes of diesel which is only equivalent to 0.09% of current UK diesel consumption of almost 20 billion litres. For comparison, the use of waste cooking oil to produce bio-diesel (see WasteWISE report no. 2) could more easily replace 0.5% of conventional diesel with a sulphur-free, more environmentally friendly fuel.

(vii) Incineration

Incineration produces high levels of energy recovery as tyre rubber has a calorific greater than top-grade coal (32.5 MJ/kg compared to 29 MJ/ kg for coal). The SITA Elm works in Wolverhampton used to incinerate *ca.* 40 million tyres per annum but was closed in 2000 after various problems emerged. In the UK tyres are currently incinerated in cement kilns, where high levels of heat energy are required. The tyres are normally shredded first to produce so-called tyre-derived fuel, known as TDF. They replace around 25% of the coal which would otherwise be used. Three cement operators operate kilns in 20 locations, although only five or so are suitable for tyre use. There are reports that a kiln in Kent is now accepting tyres. In 2002 around 8% of waste tyres (40,000 tonnes) were used for energy recovery. The UTWG predicts that this figure will double in the near term and reach 50% in the long term, leading to 100% recovery by 2006. However, there are a number of environmental concerns surrounding incineration, as mentioned in section 5 of the main report.

Appendix 3.

Analysis of costs/income for potential social enterprises

1. Potential for collecting fly-tipped tyres
2. Potential for manufacturing products from rubber crumb

It is difficult to accurately predict the potential income for social enterprises involved in tyre recovery but estimates of potential costs from two possible scenarios are presented in the following sections. As Paul Watkinson from Working Herts points out, these costings are minimal and items such as life-long training costs, pensions and other items should be included, together with higher salaries than 10K per annum for sustainable projects. It should be emphasised that the following analyses are only a guide – future research will look in more details at these and other demands.

1. Potential for a social enterprise collecting fly-tipped tyres

Table 1 presents an estimate of costs/income for a social enterprise providing a fly-tipping collection service. This could probably only operate part-time, so other profitable uses for the van and employees would have to be found on days when there were no tyres to collect. The table shows that part-time employment for two people and an annual surplus of over £6,000 could be provided by the collection of around 100 tonnes of tyres per year as long as a fee of £300 per tonne could be charged. This would be reasonable considering the costs councils presently incur, however, it is difficult to estimate the number of fly-tipped tyres available in Essex and Cambridgeshire and it is uncertain whether there would be a sustainable supply.

Table 1 Estimated costs/income from collecting fly-tipped tyres

Item	Cost per day	Income
Van	£16.70	
Fuel	£18.60	
Driver + assistant	£95.60	
Admin	£10.00	
Total	£140.90	
Fee for collection/tonne		£300
Gate fee for disposal/tonne	£90	
Net daily income 0.5 tonne/day		-£25.9
Net daily income 0.67 tonnes/day		0
Net daily income 0.75 tonnes/day		£16.6
Net daily income 1 tonne/day		£69.1
Net annual income 1 tonne/day		£6,633
(96 days/100 tonnes in total)		

Notes on Table 1:

Van costs assume use of Ford Transit van leased at £300 per month (www.castleleasing.co.uk) used 240 days per year, insured at £400 per year and used for 100 miles per day (20 mpg diesel at 82p per litre). Figure reduces to £1,570 using bio-diesel produced from waste cooking oil (see WasteWISE report 2). If mileage is increased to 200 miles/day, fuel costs double and break-even point becomes 760 kg per day. Driver and assistant costs assume each earning £10,000 per year + 15% on-costs.

1 tonne is equivalent to approximately 150 car tyres at average 6.5 kgs each or 18 lorry tyres at average 55 kgs each. Charge of £300 for collection would be equivalent to on average £2 per car tyre or £17 per lorry tyre. £90 gate fee appears average charged by shredders.

Costs of premises for storage are not allowed for, neither are costs for waste

collection licence.

Introduction of Tyre Recycling Notes (TRNs) would increase income,

Break-even point is reached for daily collection of 670 kg of tyres, equivalent to around 100 average car tyres or 12 average lorry tyres.

Annual income assumes part-time collection, 96 days in total throughout the year with wage and van costs for other periods borne by other business.

2. Potential for a social enterprise manufacturing products from rubber crumb

Table 2 shows an estimate of costs/income per person taking for example the manufacture of the 1 m square Trailer Mat recommended by Rubber Recovery, who have demonstration samples. The calculations indicate that a total production per person of 1,440 mats per year could be produce a sales revenue of £21,600. After deduction costs this would provide a profit of £3.19 per mat and an annual surplus of around £4,500, some of which could contribute towards other expenses such as premises, sales overheads etc. An enterprise could employ 2 people for the work before reaching the VAT threshold of £55,000 so this need not be charged. The total consumption of rubber crumb would be around 20 tonnes per person per year. Table 2 in the main report shows that sufficient rubber crumb could be produced from 20% of the waste tyres in Essex to provide employment for 52 people. The figure for Cambridge indicates that there could be enough material to provide employment for 18 people at this rate.

Table 2 Estimated costs/income from rubber mat manufacture

Item	Cost/day	Income
Rubber crumb	£15.12	
Binder	£18.00	
Electricity	£0.72	
Labour	£27.30	
Equipment depreciaton	£3.75	
Admin	£6.00	
Total	£70.89	
Sales Revenue (6 mats)		£90
Net daily income		£19.11
Net annual income (1450 mats)		£4586

Notes on Table 2:

All costs for daily production of 6 mats with dimensions 1 m x 1m x 0.04 m.

The mats would be expected to weigh approximately 14 kg taking the density of rubber crumb as 0.35 gm/cm^3.

A typical price is used for UK sourced 1-3 mm (-20 mesh) crumb of £180 per tonne. An allowance of £3 per mat for the binder (2l [*ca.* 5%] at £3 per l) is made. Electricity use is estimated at 2kWh per mat at £0.06 per kWh.

A production rate of 6 mats per day per person, 48 weeks a year is assumed. A salary of £10,000 per year + 15% on-costs are assumed. £1 per mat for administrative costs are allowed. No allowance is made for the costs of premises.

Equipment costs of £3,000 are assumed at 30% depreciation.

The typical profit margin of 250% quoted by Rubber Recovery gives a nominal selling price of £19.74 per mat. A more cautious lower price of £15 per mat, representing only 155% profit margin over the basis material cost of £5.64 is used in these calculations. VAT is not added, assuming that turnover is less than the current £55,000 VAT threshold – as would be possible if enterprises comprises two full-time employees.

[all estimates awaiting further verification by Rubber Recovery and other organisations]

Appendix 4

Products that be can manufactured from whole or shredded/ground tyres.

A. Products using whole tyres

Plant Pots

B. Products using shredded tyres

Mulch for horticultural use
Fuel for cement kilns

C. Products using rubber crumb

(list mostly derived from www.profit-from-waste-com/crumb.html)

The Automotive Industry

· Trailer mats
· Floor liners for lorries and vans
· Floor mats for cars and lorries
· Belts
· Brake disk pads
· Brake linings
· Bumpers
· Car body under-seal & rust-proofing materials
· Shock absorbers
· Seals
· Splash and mud guards
· Tyre rubber and tyre inner tube rubber.

Construction/Equipment

· Adhesives and sealants
· Bin liners

· Custom Extruded Products
· Custom moulded goods
· Dam, Ponds, Waste Disposal Sites, Roof Liners & Covers
· Foundation waterproofing
· Roof and walls waterproofing compounds
· Insulation
· Livestock stable mats
· Non-skid surfaces
· Paint
· Concrete block fillers.
· Roofing products
· Sheet Goods
· Vibration dampers
· Gaskets
· Vehicle wheel chocks
· Speed bumps and curb ramps
· Dock bumpers
· Parking wheel stops
· Safety garage stops
· Crash barriers on highways

Geotechnical / Asphalt applications

· Drainage pipes
· Porous irrigation pipes
· Shock absorbing pads for rails and machinery
· Roadway joint sealants
· Rubberised asphalt for roads
· Soil conditioner / Ground cover/ Mulch
· Subsoil drainage
· Traffic cone bases
· Traffic / People barricades
· Sound barriers for highways

Thermoplastic and Elastomeric Products

· Automotive shaped forms
· Cable jackets
· Trays, bins and buckets
· Moulded construction products

· Hoses
· Seals
· Ducting
· Semi pneumatic tyres
· Solid industrial tyres
· Plastics
· Trucks, vans and Pick-Up floor liners
· Car and lorry bumpers

Sport Surfaces

· Athletic tracks
. Football surfaces
· Golf tee areas and driving ranges
· Playground surfaces & recreation areas
· Equine surfaces
· Lawn bowling greens
· Non-slip boat dock surfaces
· Footpaths
· Swimming pool surrounds
· Tennis and basketball courts
· Sub-base for horse racing tracks

Domestic products

· Swimming pool and spa areas
· Hospital, industrial and residential flooring
· Flooring tiles
· Carpet underlay
· Barn mats, car mats, door mats and sports mats
· Fence Posts
· Mats / Flooring components and accessories
· Flower pots
· Garbage cans and refuse bins
· Shoe soles and heels

Appendix 5

Rubber Crumb Producers/Suppliers

Alruba Manufacturing Co Ltd Airfield Industrial Estate
Derby Road
Ashbourne
Derby
DE6 1HA
Contact: Mr Johnson Telephone: 01335 342994 Fax: 01335 346399
Processes: Granulation / Crumbing
Grades:Granulate - finely dispersed particles 1-10mm

Bedwell Park Limited Bedwell Avenue
Essendon
Near Hatfield
Herts
AL9 6AA Contact: Dave Peters Telephone: 01707 273828 Fax: 01707 268140
Processes:Granulation / Crumbing Grades: Shred - irregular pieces 50-300mm
Chips - irregular pieces 10-50mm

Boynton Brothers & Hallam (Ranskill) Ltd Access Road
Ranskill
Nr Retford
Notts
DN22 8LE
Contact: John Boynton
Processes: Granulation / Crumbing
Grades: Granulate - finely dispersed particles 1-10mm

Charles Lawrence Recycling Jessup Way
Newark Industrial Estate
Newark
Notts
NG24 2ER
Telephone: 01636 610777 http://www.clgplc.co.uk/cl_recyc
Comments: Processes around 10,000 tonnes of truck tyres per year.
Grades: Chips– irregular shaped pieces of approx 10mm to 50 mm in size.
Granulate– finely dispersed particles between approx 1mm to 10mm.

Powder– finely dispersed particles of under 1mm.
Processes: Granulation / Crumbing
Grades: Chips - irregular pieces 10-50mm Granulate - finely dispersed particles 1-10mm Powder - finely dispersed particles < 1mm

Credential Tyre Recycling Ltd,
18 Stevenson Road,
Attercliffe Sheffield
S9 3XG
Contact: Mike Jordan Telephone: 0114 242 1620 Fax: 0114 242 1650
Email: info@credtyres.co.uk Web: www.credtyres.co.uk
Processes: Granulation / Crumbing
Grades:
Chips - irregular pieces 10-50mm
Granulate - finely dispersed particles 1-10mm

DME Tyres Ring Road
Chase Terrace
Walsall
West Midlands
WS7 8JQ
Contact: Paul Buick Telephone: 01543 677758 Fax: 01543 677993
Processes: Granulation / Crumbing
Grades: Shred - irregular pieces 50-300mm Chips - irregular pieces 10-50mm

Duralay Ltd Littleburn Industrial Estate
Langley Moor
Durham
DH7 8HJ
Telephone: 01706 213131 http://www.duralay.co.uk
Processes: Granulation / Crumbing
Grades: Granulate - finely dispersed particles 1-10mm

Kingpin Remoulds Ltd Unit C8
Wem Industrial Estate, Soulton Road
Wem
Shropshire
SY4 5SD
Contact: Rikki ProudloveTelephone: 01939 232156 Fax: 01939 233889
Processes: Granulation / Crumbing

Grades: Chips - irregular pieces 10-50mm

UK Tyre Processors Unit 11
Whitelands Road
Ashton Under Lyne
Lancashire
OL6 6UG
Telephone: 01636 3432316 Fax: 01636 3432372
Processes: Granulation / Crumbing
Grades: Chips - irregular pieces 10-50mmGranulate - finely dispersed particles 1-10mm

World Rubber Upper Higham Lane
Rushden
Northants
NN10 0SU
Contact: Nick Mason Telephone: 01933 627167
Processes: Granulation / Crumbing
Grades: Granulate - finely dispersed particles 1-10mm

Appendix 6

Authorised tyre collectors in Essex

South East Recycling,
Units 5-6 Marshalview Estate,
Ferry Lane,
Rainham,
Essex.
RM13 9BU
Tel: 01708 533622

A & C Tyres & Collection Service,
Hall Lane Farm,
Little Warley,
Hall Lane,
West Horndon,
Brentwood,
Essex
CM13 3EN
Tel: 01474 355864

Grove Road Tyres,
2, Grove Road,
Chadwell Heath,
Romford
Essex
RM6 4AG
Tel: 0181 5989625

Appendix 7

Local Tyre Retreaders

Environmental Tyre Disposal Ltd.,
Phoenix Wharf,
Stonehill Business Park,
Angel Road,
Edmonton,
London.
N18 3LD
Tel: 020 8345 6115

P&A Tyres,
47, King Street,
Wimbledon,
March,
Cambridgeshire
PE15 OQF
Tel: 01354 740568

This report has been compiled to the highest accuracy using the best available information, but prospective users should check details prior to setting up a new social enterprise and produce a detailed business plan. The WasteWISE team requests anyone using this analysis or other assistance to set up a new enterprise to acknowledge the role/contribution of WasteWISE and other partners e.g. councils, to such projects.

RESEARCHED AND WRITTEN BY: Andrew Stevens, July 2003

Previous WasteWISE reports:

1. Expanding Plastic Bottle recycling in Essex and Cambridgeshire (Feb '03)
2. Waste Vegetable Oil Recycling for Bio-diesel Production in Essex and Cambridgeshire (March '03)
3. Waste Wood Recycling and Reuse in Essex and Cambridgeshire (May '03)