SWANA RECYCLING
TECHNICAL ASSISTANCE STUDY

FINAL REPORT

TIRE PROCESSING AT THE WAYNE TOWNSHIP LANDFILL

Wayne Township Landfill
Innovative. Responsible. Committed to You.

Prepared for:

CLINTON COUNTY SOLID WASTE AUTHORITY
CLINTON COUNTY, PENNSYLVANIA

Prepared by:

Gannett Fleming

HARRISBURG, PENNSYLVANIA

March 2008

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Table of Contents

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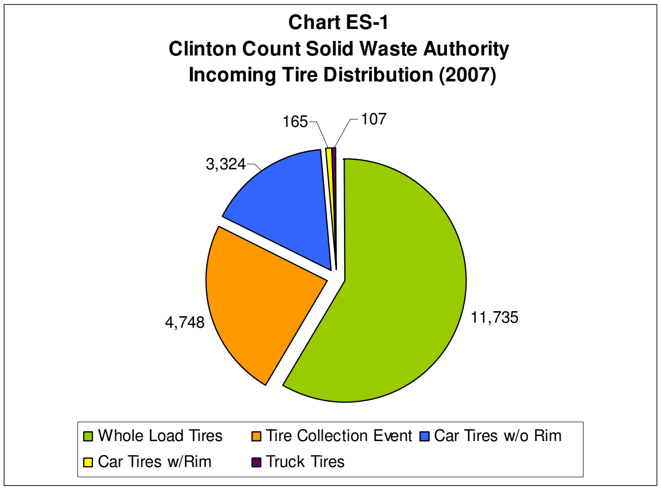
EXECUTIVE SUMMARY

TIRE PROCESSING AT THE WAYNE TOWNSHIP LANDFILL

The Clinton County Solid Waste Authority (CCSWA) received recycling technical assistance from Gannett Fleming, Inc. (GF) to evaluate tire processing and recycling methods for used tires at the Wayne Township Landfill located in McElhattan, Pennsylvania. The CCSWA serves as an outlet for tire recycling to the surrounding communities and can potentially expand its ability to assist other Pennsylvania Counties in managing their waste tires.

The CCSWA processes a small quantity of tires annually as shown in **Chart ES-1**. On-site tire processing includes baling tires that are currently used as barriers on site; however, the baler is not designed for tires. The CCSWA also ships some tires to other tire processors.



GF determined that although tire balers may be much less expensive than tire shredding equipment, baled tires are limited in the scope of their markets and the use of baled tires in certain construction/engineering applications raises long term questions about the environmental hazards. Tire shredding is the preferred process but the CCSWA can continue to bale tires on site using the universal horizontal baler as needed.

Although there are a wide variety of markets and end uses for processed waste tires, some of these do not appear feasible for the CCSWA at this time. Potentially profitable markets and end uses like Tire Derived Fuel (TDF) and steel extraction processors are only beginning to emerge in Pennsylvania. A notable tire market exception is the Northampton Generating Co-Gen facility that was approved by PADEP in 2007 to use up to **23 tons of waste-tires-per-hour** (over 2,000 tires per hour) as fuel. High fuel prices and rising steel costs will accelerate tire market growth in the next few years, but nearby markets (like industrial boilers) do not appear to be feasible outlets for the CCSWA in the immediate future. In light of market conditions and increased competition for used tires, local processors like Mohantango Enterprises and the Northern Tier Solid Waste Authority (NTSWA) may be able to negotiate cost effective processing arrangements allowing the CCSWA to take in more whole tires across the scales, have them processed off-site and returned as shreds as needed for engineering applications or possibly other end uses.

The CCSWA is in the process of submitting a landfill permit modification that includes a provision to use tire shreds as part of the landfill liner protective cover system. Contingent upon the permit modification approval, the use of shredded tires as part of the Wayne Township Landfill liner system protective cover layer could become a primary market/end use for processed waste tires during construction. This on-site market creates an economic scenario where the CCSWA could avoid the cost of purchasing 90,750 tons of 1.5” stone aggregate (**$1,361,250** at $15 per ton for aggregate) through the use of tire shreds placed at a depth of 12 inches over one foot of stone. If the CCSWA marketed itself successfully as a tire processor, it could increase the number of tires received and increase tip fee revenues to offset costs.

The density of compacted tire shreds is between 38 and 43 lb/ft^3 or 1,026 – 1,161 lbs. per cubic yard (GeoSyntec Consultants, 1997). Using 25 lbs. per tire for mixed tires, there are approximately 41 to 46 shredded tires per cubic yard. In order to replace 60,500 cubic yards of aggregate (or 90,750 tons) as estimated by the CCSWA for the Landfill liner system, over **2 million tires** will be needed. Clearly the CCSWA's current annual tire volume (~20,000 tires) is far less than is needed for the liner protective cover application and/or to optimize the use of an industrial tire shredder to realize a feasible return on investment. To increase the quantity of incoming tires, the CCSWA could lower its tire tip fees and market for tires outside of Clinton County. The CCSWA will need to mobilize the shredder, provide processing services at various locations (i.e. tire piles), and transport shredded tires back to the Landfill for on site applications and continue to research market opportunities. Mobile tire processing is an opportunity to generate revenues and tire shreds that may be used by the CCSWA and/or marketed.

GF recommends the CCSWA (refer to Section 8.0):

- Remain flexible in its approach to tire processing and processed tire marketing.
- Initiate contacts to further confirm the potential to increase the flow of tires to the Wayne Township Landfill that will generate tip fees. As needed, the CCSWA should evaluate tire tip fees rates to ensure the CCSWA creates an economic incentive that attracts tires to the facility.
- Consider future interests in marketing processed tires as tire derived fuel (TDF), and contact the Northampton Generating Co-gen facility to determine market potential.
- Pursue tire shredding over tire baling as the primary processing method.
- Unless the CCSWA can confirm a profitable end market in the near future for shredded tires, the CCSWA should proceed slowly with the procurement of tire processing equipment. Since the CCSWA will compete for tires with other processors, and because the potentially profitable TDF market is still emerging in PA, the CCSWA is encouraged to await PADEP approval of shredded tires as protective landfill cover to provide assurance that the CCSWA will have a secure, economically feasible end use for a large quantity of processed tires.
- Pursue <u>mobile</u> tire shredding equipment to improve operational flexibility and to promote offsite processing at distance sites. Initiate contacts to confirm the potential to provide processing services at tire piles.
- The CCSWA should continue to bale tires on site as needed.
- Maximize economic opportunities as a processor using a combination of the following:
  - marketing to Lycoming County and other areas to increase tire volumes
  - mobilizing the shredder to sites to process tires for a fee
  - avoiding costs by using tires for aggregate replacement
  - identify/confirmation of other profitable/evolving markets (which could include TDF)
  - continue to host tire collection events; possibly adding one or more events per year
  - shredder equipment rental
- Configure shredder to produce shreds that meet CCSWA's needs and specifications (e.g. minimum size for the protective layer specification).
- The CCSWA should review the equipment configurations and specifications provided in **Appendix D** and equipment cost estimates included in this Report.
- Carefully consider a wide variety of tire management options, including those that do not involve equipment procurement and on-site shredding.

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1.0 INTRODUCTION

Through the partnership with the Solid Waste Authority of North America (SWANA), the Pennsylvania State Association of Township Supervisors, and the Pennsylvania Department of Environmental Protection (PADEP), the Clinton County Solid Waste Authority (CCSWA), was approved for a Recycling Technical Assistance project to be provided by Gannett Fleming, Inc. (GF) to evaluate tire recycling at the Wayne Township Landfill in Clinton County, Pennsylvania.

1.1 Scope

Task #1 Gannett Fleming staff will work with the Authority to gather pertinent background information required about current operations that may affect this study and operation. GF will research tire baling and identify beneficial uses for baled tires. Task 1 will include a site visit to the CCSWA facility.

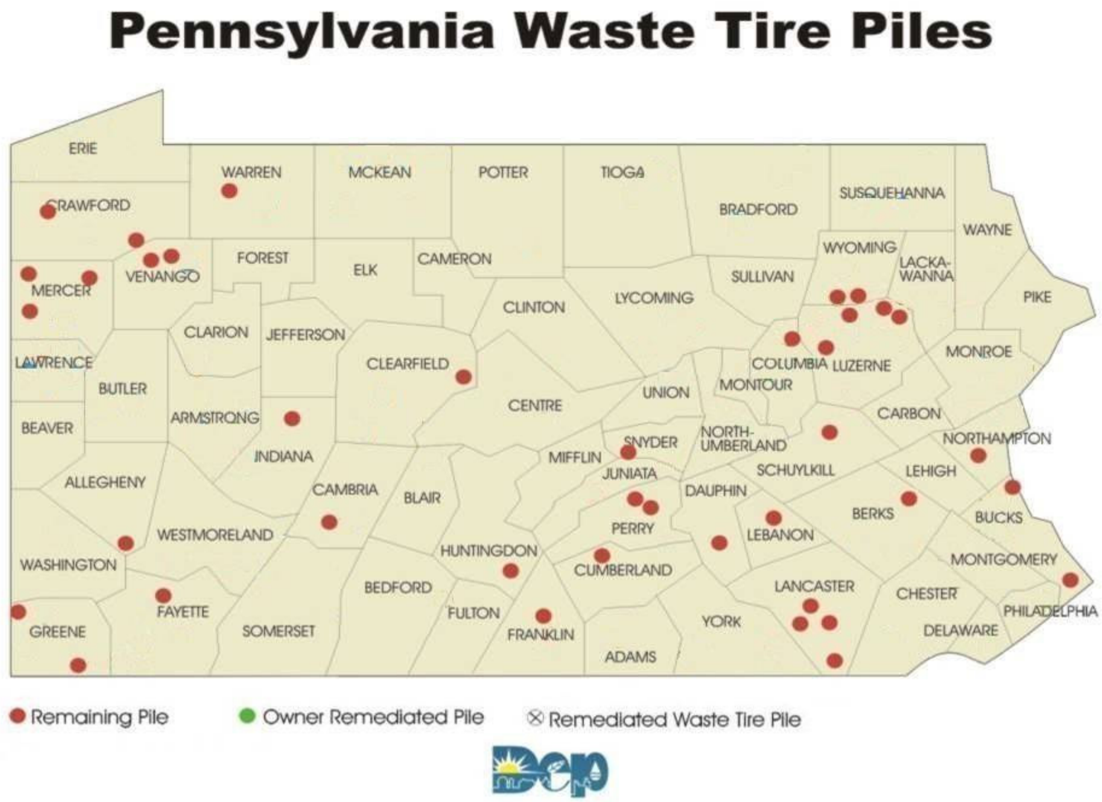
Task #2 Gannett Fleming will conduct a preliminary feasibility study of tire baling by the CCSWA and identify outlets/uses for tires collected by the CCSWA.

Task #3 Task 3 will include the preparation of a Report containing findings and recommendations. This task includes a Draft Report review and comment period by PADEP.

2.0 BACKGROUND

The CCSWA has implemented a number of programs committed to reducing, reusing, recycling and managing solid wastes. The CCSWA has emphasized improving recycling efforts in the County (www.waynetwplandfill.com), and this study continues these efforts by evaluating alternative methods for processing and using old tires. The CCSWA will be submitting an addendum for use of shredded tires for landfill protective cover as part of a major permit modification. If approved, using shredded tires to replace a portion of the aggregate used in the protective cover layer will be a cost effective solution for managing tires. Additionally, the CCSWA wishes to evaluate tire market/recycling opportunities beyond on-site engineering applications.

Historically, Pennsylvania and many other states have been plagued with ongoing problems from accumulating waste tires at unauthorized sites. A map of Pennsylvania Waste Tire Piles, as documented by the PA Department of Environmental Protection (PADEP), is shown below. **Appendix A** provides a more detailed listing of these waste tire piles, including the estimated number of tires per pile. Potentially, the CCSWA could be an outlet to process waste tires from these tire piles.

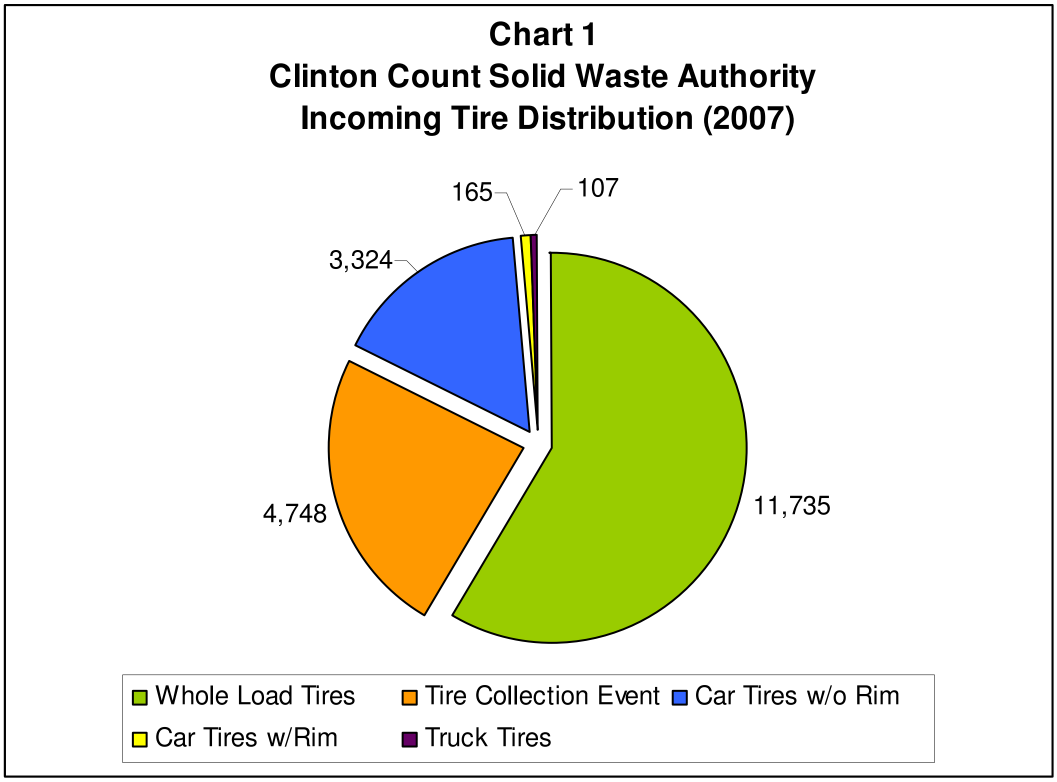


Source: www.depweb.state.pa.us

2.1 Current Waste Tire Handling AT CCSWA

The CCSWA accepts waste tires as part of routine daily operations at the Wayne Township Landfill. The CCSWA has collected of over 27,000 waste tires since 2003 from two-day sponsored tire collection events. In addition to collection events, the CCSWA receives whole loads of tires plus a small quantity of tires that are removed from incoming waste loads. The quantities and revenue for tires processed by the CCSWA are included in **Appendix B**. **Chart 1** below shows the number and distribution of incoming tires in 2007. The number of "whole load" tires was estimated using the number of tons reported in 2007 (146.69 tons) multiplied by 80 tires per ton as an averaged weight of 25 lbs. per tire for mixed tires.

Many of the tires received by the CCSWA are sent offsite to tire processors for shredding or other processing. In some cases, the shredded tires are returned to the landfill for utilization in approved civil engineering applications. Tires baled by the CCSWA are used on site. The CCSWA is requesting assistance to evaluate the feasibility of baling/shredding tires on site and wishes to identify other beneficial uses of tires.



3.0 WASTE TIRE STATUTES & REGULATIONS

Whole tires cannot be disposed of in Pennsylvania landfills according to Municipal Waste Regulations. In response to accumulated waste tires that present environmental, health, and safety hazards, PADEP has increased regulatory oversight of tires. PADEP fines haulers, landowners and facilities for improper disposal and storage of waste tires and supports legislation to prohibit improper waste tire disposal.

3.1 Act 190 of 1996

In Pennsylvania, waste tires are regulated as residual waste. Some Construction & Demolition (C& D) Landfills in Pennsylvania are permitted to take tires (e.g. Milton Grove Landfill in Lancaster County). The Waste Tire Recycling Act or Act 190 of 1996 is the primary piece of legislation that governs tire handling. It is "*An Act relating to the recycling and reuse of waste tires; providing for the proper disposal of waste tires and the cleanup of stockpiled tires; authorizing investment tax credits for utilizing waste tires; providing remediation grants for the cleanup of tire piles and for pollution prevention programs for small business and households; establishing the Small Business and Household Pollution Prevention Program and management standards for small business hazardous waste; providing for a household hazardous waste program and for grant programs; making appropriations; and making repeals, further providing for the definition of "waste tire"; defining "recycled tire product" and "waste tire recycling facility"; and further providing for the disposal of whole waste tires, for Environmental Quality Board regulations, for waste tire registry and for remediation liens*.

Act 190 of 1996 was amended by Act 11 in 2002 including the following amendments:

- **Waste Tire Hauler Authorization Program**
- **Waste Tire Hauler Registry**
- **Remediation Liens**
- **Waste Tire Collection Grant Program**
- **Commonwealth Recycling and Use of Waste Tires**

These amendments and Title 25, PA Code regulations pertaining to tires are included in **Appendix C**. Waste tires are also subject to the Standards for Storage of Residual Waste. A Waste Tire Transporter Authorization Application and Annual Report Form can be downloaded from www.depweb.state.pa.us.

3.2 Federal Regulations for Alternative Daily Cover

Federal requirements for alternative daily cover (ADC) at MSW landfills are contained in Part 258 of Title 40 of the Code of Federal Regulations. These Subtitle D requirements took effect on the 9th of October 1993. The federal requirements allow the owner or operator of a facility to apply for ADC to be used at a landfill. §258.21(b) of Subtitle D states that:

"Alternative materials of an alternative thickness (other than at least six inches of earthen material) may be approved by the director of an approved state if the owner or operator demonstrates that the alternative material and thickness control disease vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment."

4.0 EPA OVERVIEW OF NATIONAL WASTE TIRE MARKETS

According to the U.S. Environmental Protection Agency (EPA) the three largest scrap tire markets are:

Tire derived fuel (TDF) – Refers to tires used as fuel in shredded form, however, whole tires can be burned for fuel in some facilities. Tires produce BTU values equivalent to oil, burn cleaner than coal, and produce 25 percent more energy than coal.

Civil engineering applications - Scrap tires can be used to replace other materials used in construction applications and commonly are used for fill, insulation blocks, drainage aggregate, soil replacement or clean fill. The U.S. Department of Transportation (DOT) Federal Highway Research Center has User Guidelines for Tire Shreds as Embankment or Fill (www.tfhrc.gov).

Ground rubber applications/rubberized asphalt - Asphalt rubber, an application where ground rubber is blended with asphalt for highway construction, is the largest U.S. market for ground rubber. Size-reduced scrap tire rubber can be used as part of the asphalt rubber binder, seal coat, cap seal spray, as joint and crack sealant, and\or an aggregate substitution (rubber modified asphalt concrete).

Other applications identified by GF as potential markets include:

Whole Tires and Cut, Stamped, and Punched Products - Scrap tires may be recycled by cutting, punching, and\or stamping them into various rubber products after removal of the steel bead. Products include floor mats, belts, gaskets, shoe soles, dock bumpers, seals, muffler hangers, shims, and washers.

Reuse-Retreading - Retreading involves removing the outside, or tread, of the tire and adding a new tread. Retreading saves millions of gallons of oil each year, because it takes only 7 gallons of oil to retread a used tire compared to 22 gallons to produce a new tire.

Pyrolysis – A chemical process that breaks tire material down into usable products including oil, gas, and carbon black through pyrolysis. At this time, tire pyrolysis has not been shown to be commercially viable due to cost.

Habitat - Used tires have also been used to form habitat for fish and other organisms.

Pennsylvania's tire markets and uses for waste tires are not entirely consistent with EPA's broad assessment of the national waste tire market. Pennsylvania has a limited number of industries (e.g. paper mills, cement manufacturers, etc.) using TDF. Pennsylvania is also behind many states in their use of tires in roadway/asphalt/rubber applications. Various engineering applications, usually at landfills, are a primary use of recovered tires in Pennsylvania. However, increasing fuel and material costs are improving the markets for used tires in Pennsylvania.

5.0 LOCAL AND REGIONAL TIRE MARKETS AND PROCESSORS

Along with regulations prohibiting landfill disposal and accumulation of tire piles throughout Pennsylvania, a number of programs, markets and local uses are emerging for managing used tires. The following Sections describe some of the tire markets in Pennsylvania. With the competition for tires increasing in Pennsylvania and the surrounding regions, tire tip fees (ranging $70 - $130 per ton) will be on the decrease as various processors try to get more tires to their facilities. GF focused its research on tire markets in close proximity to the CCSWA with consideration of tire uses/applications and opportunities believed to be beneficial to the CCSWA.

5.1 Penn State Center for Dirt and Gravel Road Studies

Penn State's Center for Dirt and Gravel Road Studies in Centre County received a grant from PADEP and is baling old waste tires from the Star Tire Pile to use as a fill and base for rural road construction. A hydraulic compressor bales the tires into one-ton building blocks, bound together with nine-gauge wire. Each block contains 100 tires and measures approximately 30" x 50" x 60". This case-by-case application may be a potential ongoing outlet for CCSWA for baled used tires and is located in nearby Centre County.

Source: www.rps.psu.edu

Source: www.rps.psu.edu

5.2 Mahantango Enterprises Inc.

Mahantango Enterprises, Inc. (Mahantango) (www.mahantango.com) is located about 70 miles from Lock Haven in Liverpool, Pennsylvania. Mahantango is a tire processing company that accepts loose tires for processing into a rubber granule that is used for many products including:

- Horse Arena Turf
- Rubber Mulch
- Tire Derived Fuel Chips
- Foundation Rubber Drainage Material
- Playground Surface

Standard rates for loose tires are:

$80 per ton (passenger – tractor trailer tires)
$125 per ton (dirty passenger tires)
$125 per ton (oversized/tractor tires)

GF contacted Mahantango in February, 2008. Mohantango was very favorable to meeting and working with the CCSWA to work out a mutually beneficial arrangement to handle and process tires and to discuss tire management strategies that could help the operation of both the landfill and Mahantango.

One scenario that was discussed included the collection of tires by the CCSWA in a clean, possibly paved area where incoming tires could be kept free of dirt and debris. After a load of tires were accumulated at the Wayne Township Landfill, Mahantango could send (or even spot) a walking floor trailer to pick up the accumulated tires. Walking floor trailers can carry up to 20 tons of tires. After pickup, Mahantango would deliver and process the loose tires at its facility (particularly tires graded a #2 or #3 – a lower grade designation by Mahantango) and return tire shreds to CCSWA as needed for use in landfill engineering applications.

5.3 Pennsylvania Department of Transportation (PennDOT)

PennDOT is working on the Tarrtown Road Bridge ramp project in Armstrong County. More than 750,000 old tires were collected from the area and shredded to create a lightweight fill necessary because of soft soils. Recycled shreds were used to create new approaches for the bridge.

PennDOT also has the ability to use shredded tire rubber by combining it with asphalt and applying it to roadways and through other civil engineering applications. PennDOT has reached the conclusion that rubber performs best in asphalt when used in lesser amounts. Rubber modified asphalt with 10 to 15 percent replacement of the standard materials showed significant problems. Newer technologies that incorporate less than five percent replacement of standard materials have performed well for this application. However, these mixtures, with only a small percentage of rubber, use few tires and in most cases, no tires from tire piles due to quality specifications.

Through a Memorandum of Understanding (MOU) with DEP, new rubber-modified product testing is done annually, specifications are updated, and evaluations of new projects and materials are made. PennDOT is testing a blacktop mix using a higher percentage of asphalt and stone chips no larger than 4.75 millimeters in size, plus a small percentage of recycled tires. The material is applied 0.75 inches thick.

Based on GF's review of roadway applications for used tires in other U.S. states, PennDOT lags behind in the utilization of waste tires as a cost effective resource in highway construction/applications. The California Integrated Waste Management (CIWM) Board indicates that the use of a two-inch-thick rubberized asphalt concrete (RAC) overlay can save as much as $50,000 per lane mile when compared to a four-inch-thick conventional asphalt overlay. CIWM reports that RAC is long lasting, resists cracking and case studies demonstrate RAC can often last 50 percent longer than conventional materials, further minimizing ongoing maintenance costs.

The ability of the CCSWA to develop a suitable arrangement with PennDOT for tires processed by the CCSWA could not be determined in this evaluation.

5.4 Northampton Generating Company

The boilers at the Northampton coal-fired plant in eastern Pennsylvania burn about 545,000 tons per year of anthracite culm (coal mining waste). Steam is supplied to an adjacent pulp and paper plant. The plant is owned by Cogentrix. In September 2007, PADEP approved waste tires as a fuel supplement at Northampton Generating Company's co-gen operation. Up to **23 tons of waste-tires-per-hour** may be used as fuel. Northampton Generating Company is also required to use enclosed trucks and unload the waste tires in its enclosed fuels building. No chipping or shredding of tires is permitted to be conducted on the property.

Photograph: Foster Wheeler (2005)

A list of Pennsylvania's coal-fired power plants can be found at the following website: www.industcards.com/st-coal-usa-pa.htm.

The CCSWA would needed to invest in shredding equipment capable of producing TDF chips in order to make Northampton's facility or other similar facilities a potential market for CCSWA-processed tires.

5.5 Northern Tier Solid Waste Authority

The Northern Tier Solid Waste Authority (NTSWA) has been in the business of shredding tires since the late 80's when they purchased a shredder made by SSI Shredding Systems, Inc. through an Army Surplus contract. The NTSWA has shredded tires from the CCSWA and returned them for on-site applications at the Wayne Township Landfill. A second tire shredder, an Extec 3640, purchased in 1997 by the NTSWA, produces a smaller shred than original shredder made by SSI. With accumulated tire piles in the region and ongoing tire disposal, the NTSWA has been able to generate revenues through tire tip fees and use the tire shreds for various approved civil engineering functions and select fill at the landfill. Although permitted to do so, the NTSWA does use tire shreds as part of the liner system protective cover.

Use of tires in on-site engineering applications at the NTSWA has contributed to cost savings, including as a replacement to fill and/or aggregate. The NTSWA cited this example: On four (4) acres they will replace 10 inches of low carbonate stone (difficult to get in the area) with 1' of 2-inch tire shreds and save about $100,000.

The NTSWA is currently looking into the procurement of a new tire shredder and is in the development of a contractual arrangement for TDF at one or more waste to energy facilities approved for accepting tire chips and shreds for fuel. Typically, boilers can't accept shreds or chips much larger than 2" x 2". Industries in the Northern Tier region rely on natural gas and are not currently using tire chips; hence industry does not appear to be a viable market for tires in the Northern Tier. One particular barrier for using tires in industrial boilers in Pennsylvania is the negative public perception to burning tires. Additionally Pennsylvania air quality regulations for using TDF can be a barrier to some facilities that must incur costly retrofits to meet the current regulatory requirements.

The NTSWA is willing to work with the CCSWA as needed to be an outlet for tires or to make a mutually agreeable arrangement for tire shredding and possibly equipment sharing.

5.6 Industries Accepting Tires for Fuel

In Pennsylvania, there are few industries accepting waste tires as fuel. This is in large part due to negative public perception to burning tires and because the aging industries and boilers can require costly retrofits to meet applicable federal emissions standards, state air quality standards, and other applicable PADEP requirements.

GF identified the following PA-based cement plants that accept tires:

Essroc Cement Co. – Bessemer, PA
Lehigh Cement Co. – Fleetwood, PA
Lafarge, Corp. – Whitehall, PA

Trucking tires to these locations would be labor and resource intensive for CCSWA, however, these may be viable outlets for tires should other market conditions change in the future.

5.7 CCSWA Landfill Engineering Applications

The CCSWA uses baled and shredded tires on site. Provided that the CCSWA is approved to use tire shreds for protective cover, this application of tires to replace aggregate will be a primary use for the shredded tires. Some general applications at landfills can include:

- lightweight backfill (e.g. in gas venting systems)
- leachate collection systems
- operational liners
- capping and closures
- protective cover

5.7.1 Aggregate Replacement & Estimating Tire Quantities and Volume

Understanding the quantity of tires in a cubic yard of material and how this relates to stone aggregate replacement is useful in estimating the quantity of tire shreds needed for an engineering project. **Appendix C** includes an analysis of stone aggregate replacement (for nitrification) in several southeastern states. The study was conducted by Barbara Hartley Grimes, Ph.D., Steve Steinbeck, P.G., and Aziz Amoozegar, Ph.D. The General Tire Composition Chart from this analysis summarizes tire composition and was used as a basis to estimate tire quantities potentially needed by the CCSWA for on-site engineering projects.

The maximum size the CCSWA is permitted to use for engineering applications is 4"x12" shreds. The dimensions for shreds proposed as part of the protective cover layer for landfill liner will need to be 4"x12" or smaller. 4"x12"shreds can be produced in one pass by tire shredders, including the Extec 3600.

The density of compacted tire shreds is between 38 and 43 lb/ft3 or 1,026 – 1,161 lbs. per cubic yard (GeoSyntec Consultants, 1997). Using 25 lbs. per tire for mixed tires; there are approximately 41 to 46 shredded tires per cubic yard. In order to replace 60,500 cubic yards of aggregate (or 90,750 tons) as estimated by the CCSWA for the Landfill liner system, over **2 million tires** would be needed. This estimate may be low depending on actual shred sizes produced and compaction rates achieved from equipment used by the CCSWA. There are approximately 47 car tires per cubic yard at a 2" chip size (uncompacted). Since the CCSWA collects about 20,000 tires annually, it will need to actively seek tires from the region and from other areas across Pennsylvania to meet their aggregate replacement needs in a reasonable time frame.

Based on quantity estimates provided by the CCSWA, as much as 60,500 cubic yards or 90,750 tons of aggregate material could be replaced with tire shreds. The cost for 1.5” aggregate is currently $15 per cubic yard. Should the quantity of aggregate be totally eliminated, the cost savings for using tire shreds would be $1,361,250. However, the actual cost savings would be reduced by:

- Operating costs (fuel, labor, etc.) for processing the tires to a relatively uniform shape and size.
- Operating costs for placing 1 foot of stone down initially and then working on this stone surface to place 12 inches of tire shreds. This activity will be time consuming.
- Shredding equipment maintenance costs.

5.8 Tire Market Summary

Pennsylvania has a vast quantity of tires that require processing. Although Clinton County is in a rural area where incoming tire quantities at the Landfill are low, the Wayne Township is conveniently located near I-80 and this increases the opportunity for soliciting tires from further distances. Tip fees for tires are expected to decrease as the market demand increases and processors compete to for tires.

Although Pennsylvania tire processing and end uses lag behind a number of states, markets will continue to evolve as fuel and other material prices (e.g. steel) continue to rise. Although TDF is not a strong market in Pennsylvania now, it will improve in the next few years. Pennsylvania industries that use tires in their boilers are very limited and will not be a primary end market in the near future for tires collected and processed by the CCSWA. The negative public perception to burning tires for fuel in our factories is a formidable barrier and will slow the emergence of industries as a waste tire end market. Additionally, boilers that use TDF typically require the production of 2” chips; this requirement can double the cost for chip producing shredding equipment. Notably, the smaller teeth design currently used in some of the non-TDF tire shredders can produce clean cut shreds that may be suitable for use as TDF. Unless a TDF market arrangement is confirmed and a detailed cost analysis is performed to verify economic viability, it is not recommended the CCSWA procure shredding equipment targeted for the TDF market.

The use of tire bales for road construction, cement block formation, and other engineering applications does not appear to be an economically viable long-term market, especially when compared to shredded tires. The cost of handling, processing, transporting and installing baled tires degrades the cost-benefit relationship of the product and does not appear feasible for a material that has a high value as a fuel or can be shredded and used on or off site for a wide variety of applications. As a guiding principle, the CCSWA should remain flexible in its marketing approach as a tire processor: 1) market itself to Lycoming County and other areas to increase the volume of incoming tires that generate tip fees; 2) mobilize the shredder to sites to process tires for a fee; 3) avoid costs by using tires for as aggregate replacement; 4) identify other profitable markets (which could include TDF); 5) continue to host tire collection events with consideration of adding one or more events per year; and 6) consider shredder equipment rental.

Prior to procuring tire processing equipment, the CCSWA should market itself as a disposal facility that is interested in getting into tire processing to gauge the response from local counties and/or other entities. The CCSWA should develop relationships with private entities that may fund tire pile clean ups and work with PADEP on this initiative so that the CCSWA can project if a sufficient quantity of tires can be processed to justify the economic investment.

5.8.1 Environmental Concerns

Public concerns about long-term environmental harms caused by using baled tires in construction applications may become a real barrier to the baled tire market. Concerns exist about environmental harms particularly when tires are buried in direct contact with soils and/or water. Tires contain toxic materials and chemicals that do break down over time (see Appendix C, tire composition).

Uses of tires in certain engineering applications does not have zero environmental impact as evidenced in a number of projects. A 100-foot stretch of State Highway 100 in Ilwaco, Washington began emitting oil and gas after cracks appeared in the asphalt of the roadway. The Washington State Department of Transportation (WSDOT) rebuilt the portion of the road in October 1995 using approximately 10,000 cubic yards of used tire chips as fill for the roadbed. An incident on a 300-foot stretch of road in Garfield County, Washington began exhibiting similar problems. A few months after its placement, the fill began to heat up and smolder. Cracks soon appeared in the pavement and the road surface failed. Finally, the flames flared through the road surface cracks and oil began to run off at the bottom of the ravine. The burning material was deep-seated and attempts at surface fire extinguishment were not successful. The only alternative was to excavate the roadway until the seat of the fire was reached, then to extinguish the fire. The extinguishment effort was protracted and required heavy equipment with a coordinated firefighting effort. The original road construction cost was 1 million dollars; 3 million dollars was required for fire extinguishment and cleanup.

6.0 TIRE BALING & SHREDDING EQUIPMENT

For this evaluation, GF considered two processing methods: baling and shredding. GF focused the equipment analysis on tire shredders since our market analysis determined that tire bales are limited in their scope applications and does not appear to be the preferable processing method. Shredded material has been approved for certain engineering applications at the Wayne Township Landfill and will be used as protective cover at the landfill upon permit approval. Shredding offers considerable size reduction, which can benefit storage, handing and transportation (potentially reducing costs). The existing baler operated by the CCSWA is not ideal for baling, but can be used to bale tires as/if needed. Additionally, the tire fuel market in Pennsylvania is starting to see some light and other tire shred markets are evolving.

Specifications for tire processing equipment and the contact list for equipment vendors are both contained in **Appendix D**. These two different processes will influence equipment selection, capital costs, ongoing operation costs, program strategy, and on-site use and handling of material, and the marketing of the processed materials to local and regional end users. Equipment selection and its mobility will also determine the ability to share/rent equipment to other users or to process material at regional tire piles or other tire consolidation points.

Accurately estimating the operating costs could not be calculated without confirmation of the specific shredding equipment that will be used, and confirmation of the tire processing methods employed, labor, fuel, actual markets and equipment maintenance costs. This level of cost analysis was beyond the scope of this Report and is premature at this stage of the planning process. Clearly the CCSWA will need to process many more tires (~20,000 per year currently) to offset capital investment costs for equipment in a reasonable time frame.

6.1 Tire Baling Equipment – Encore Systems

Encore Systems
1813 S. 25th Street
Moorhead, MN 56560
Phone: 218-284-3901
Fax: 218-284-3903
www.tirebaler.com

GF contacted Encore Systems (www.tirebaler.com) concerning tire balers. A new mobile vertical tire baler like the one shown below costs $55,000 to $60,000, compresses about 100 whole passenger, light and commercial truck tires into 30" x 50" x 60" bales weighing one ton. Three people operating the baler can make four to six bales per hour.

6.2 Tire Shredding Equipment, Manufacturers, and Vendors

Based on discussions with the NTSWA, the operating cost for tire shredders is high. In the late 1990's the NTSWA conducted a preliminary cost analysis for the Extec Tire Shredder. Based on the NTSWA analysis it cost $38 per ton to operate the shredder. Operating costs have increased significantly since that time. Recently, the NTSWA contacted their parts vendor for a cost estimate to replace the teeth and combs for the Extec Shredder. The estimate for the parts exceeded $140,000 and this did not include installation. The NTSWA said it usually takes about two weeks for a full replacement of all the teeth and combs, which they did about five years ago.

6.2.1 American Pulverizer Company

American Pulverizer Company
1319 Macklind Ave.
St. Louis, MO 63110
Telephone: (314) 781-6100
Fax: (314) 781-9209
Email: american@ampulverizer.com
GF representatives contacted regarding low speed shredders. This company builds the units to the needed specifications depending on the tires per hour needed to conduct the operation and the size of the end product. This company stresses a built to fit the criteria of the project.

The American Pulverizer representative indicated that he had no preference or recommendations regarding a mobile unit versus a stationary one. He felt that there were good products of both options. He conceded that the mobile units inherently were subjected to more "abuse" and would require more maintenance than a stationary one. This is also dependent on the operator(s), cleanliness of the product and routine maintenance. A mobile unit from this company would also require a diesel generator to provide power to the unit which would be an additional cost, whereas a stationary shredder could be hard wired to an electric source on site. This company does not have a local dealer (Pennsylvania) handling tire shredders at this time, hence it would be most efficient to deal directly the Missouri branch at the above address. Reconditioned equipment is available from time to time.

6.2.2 United Resources Corporation (URC)

United Resources Corporation (URC) - Vendor
1088 CR 1745
Cairo, MO. 65239
Telephone: (660) 295-4204
Fax: (660) 295-4871
www.urrecycle.com

URC is strictly a rebuild/ used equipment dealer. Their specialty is buying used equipment and rebuilding to suit a particular client or application. They typically replace worn parts like bearings, shafts, and knives, but can and have done total rebuilds.
Recommendations:

- Truck Tires – URC recommended a 72" X 52" hopper opening and URC builds a chute that positions tires more efficiently in the hopper. It would take at least 200 horsepower to be able to process truck tires effectively. 400 horsepower units are the standard HP for tire shredding.
- The decision to purchase a mobile unit should be carefully considered. There are many more used (and new) stationary shredders on the market because of the additional costs for mobile units. Mobile units are typically $75,000 higher in up-front costs because of the trailer and generator unit.

In March 2008, URC had two units that may fit the needs for the CCSWA to process tires. Estimated prices are provided for reference for the used equipment. Availability will change, so it will be necessary to contact URC directly.

Used Unit 1 Specs $300,000
- 72" X 52" hopper opening
- 200 Horsepower
- 3 phase power
- Stationary unit with Classifier
- Rebuilt w/ warranty

Used Unit 2 Specs $330,000
- No warranty
- 6000 hours
- Mobile Unit – Mac Saturn
- Includes Generator Set and specialized tire hopper
- 200 Horsepower

6.2.3 Extec Inc.

Extec Inc.
P.O. Box 355
Essington, PA 19029-0355
610-521-1448
800-44-SCREEN
Fax: 610-521-0919

The local representative for Extec works for Commonwealth Equipment in Wilkes Barre, PA. Discussions about Extec tire equipment determined that the Model 3600 is the most suitable application for shredding tires. This unit is a self-contained mobile unit that operates on diesel fuel and does not require a generator set. This unit would produce a 3" X 5" chip, and any further reduction would require a second pass. Extec has mobile units in the United States. This unit does tires, scrap metal and a host of other materials like construction and demolition waste, mattresses, etc. This versatility can be an asset for addressing processing of other materials that might be recovered or even banned from the waste stream.

An estimated cost for the unit is $400,000 to $425,000.

Extec 3600S SHREDDER

6.2.3 SSI Shredding Systems, Inc.

SSI Shredding Systems, Inc.
9760 SW Freeman Drive
Wilsonville, Oregon 97070
1-800-537-4733
sales@ssiworld.com

Option 1:
Mobile **TDF** production system (2" chips). 6 tons per hour, priced at $900,000 with all options. This unit may be overweight in some states requiring permitting to transport.

Option 2:
Stationary **TDF** production system. 6 tons per hour, priced at $450,000 ($399,500 for shredder and screen + approximately $50K for conveyors). The equipment is easy to maintain compared to other options because of less features and moving components.

Additional option:
Mobile Rough shredder. Priced at $450,000 to $500,000 depending on trailer used. Processes mixed tires at 8-10 tons per hour and produces 3" wide "strips" 6"-18" long. The machine is fed with an excavator and would include a hydraulic fold-out discharge conveyor that could top-load trailers (approx. 15' head pulley height). The photo is of a trailer like this but the actual shredder available would be dual-shear and the conveyor would be longer than the one shown in the photo.

Freight costs range from $6,000 - $20,000 (stationary unit requires three freight trucks, and possible highway permitting).

6.3 Limited Tire Equipment Grant Funding

Tire shredders or balers may not be fundable under Act 101, Section 902 grants because tires are residual waste and not Act 101-designated recyclable material. Potentially, funding related to tire processing could be secured under an Act 198 Solid Waste-Resource Recovery Demonstration Grant or possibly under The General Appropriations Act of 1997, which has been used to fund tire remediation projects. There are few funds available in the Act 198 program and PADEP did not solicit grant applications in 2007. The NTSWA has received private funding for processing tire piles. It is noted that private sector competition (tire markets) may oppose the CCSWA when they try to purchase tire processing equipment, especially if it is funded through a grant program.

Eligible costs under Act 198 (www.dep.state.pa.us) include:

- The costs of acquiring vehicles used to collect recyclables, transport recyclables to processing facilities, vehicles used in the operation of a resource recovery facility and vehicles used to transport materials or fuel products to market.
- The costs of acquiring and/or renovating buildings to house processing and storage facilities.
- The costs of acquiring equipment used to process solid waste into energy, fuel products and/or usable materials.
- Improvements to land needed to operate a resource recovery facility.
- Inspection and supervision during the construction period.
- The cost of final engineering on a project.
- Testing of the project during the demonstration period.
- Costs associated with educating the public on special requirements placed upon them in implementing a resource recovery program; except that no part of a development agency's administrative costs associated with conducting an education program shall be considered as an eligible cost.

7.0 REQUEST FOR PROPOSAL FOR TIRES

Another approach to securing a competitive price for managing tires is the issuance of a Request for Proposal for Tire Processing/Recycling. The RFP can be very simple and as short as a couple pages. Key components of this RFP should include:

Background – Facility location(s), tire types, annual quantity that require processing.

Purpose – Agreement terms (years), starting and ending date.

Proposal – Request for costs. GF suggests the RFP asks for a cost per ton for the processing of tires PLUS a separate cost for transportation (to allow the proposer/CCSWA flexibility to provide the transportation if this is feasible).

The Lancaster County Solid Waste Authority has issued an RFP for Tire Processing/Recycling, and an example of their RFP is provided in **Appendix E**. This type of arrangement may be beneficial for the CCSWA if they do not process tires on a larger scale and need a cost-competitive way to manage tires from collection events and daily customers at the landfill.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusion

The Wayne Township Landfill is operated by the Clinton County Solid Waste Authority (CCSWA). Over the years the CCSWA has taken on a number of successful recycling activities: drop-off recycling for container recyclables; woody waste processing, electronics recycling, household hazardous waste, etc. Based on the research completed by GF during this evaluation, expanding the Landfill activities to include tire processing will, in some ways, be similar to these other recycling initiatives. Tire processing will include high initial capital costs plus operational and maintenance costs and the CCSWA will need to identify processing methods and markets that offset these costs. Tire processing will add on-site tasks that will have some impact to landfill operations and staffing and ongoing management responsibilities. Since whole tires are banned from landfill disposal, tire processing at the landfill will benefit local and regional communities that have accumulated tire piles and continue to generate tires at a rate of about one tire per person per year. Tire processing can be a source of revenue and can help to avoid costs when processed tires are used to replace materials like stone aggregate in approved engineering applications.

If the CCSWA moves forward with the capital investment of tire processing equipment, it will mean “getting into the tire business”. The current quantity of tires received annually is about 20,000 tires, a quantity that is far below what will be needed to realize a feasible return on the equipment investment for a new mobile tire shredder that may cost $400,000 to $600,000 or more depending on the manufacturer and features. Grant funding for tire processing equipment is not guaranteed. Some key conclusions from this study include:

- Long term markets and uses for baled tires and overall economics appear unfavorable for baled tires when compared to tire shreds.
- There are still many very large tire piles in Pennsylvania (**Appendix A**), which could be beneficial sources of material for CCSWA. The CCSWA’s location along I- 80 facilitates transportation and is favorable for increasing incoming tire quantities.
- Although the production of tire chips for TDF is an emerging market, current market conditions in Pennsylvania for TDF do not appear to justify the purchase of a mobile tire TDF tire shredder, which may exceed $900,000. The NTSWA has researched the TDF market and has not yet been successful at negotiating an arrangement involving the production of TDF that will justify the purchase of another tire shredder.
- In the near term, local processors like Mohantango Enterprise may be an outlet for whole and or shredded tires, but the arrangement and economics will need to be verified.
- Contingent upon PADEP approval, the use of shredded tires for use as protective cover will dramatically increase the CCSWA’s capacity to accept tires for on-site approved engineering applications and thus could serve as a primary market for shredded tires for period of time. The revenues from tire tip fees (from an increased number of incoming tires), minimized or eliminated transportation costs, plus the avoided costs from replacing

approximately 60,750 tons of aggregate with over 2 million shredded tires favors this on site application as an economically viable option.

- The per-ton tip fees (ranging from $60 - $130 per ton) currently paid to landfills and other tire processors are decreasing due to market competition for waste tires.
- If the CCSWA becomes a tire processing facility, it will compete for tires with other public and private sector tire processors in the region.
- The CCSWA can not accumulate tires speculatively for over one (1) year according to municipal waste regulations.
- Operational costs for tire shredders are high and have been increasing steadily. The NTSWA recently received a cost estimate of over $140,000 to replace the combs and teeth for their Extec tire shredder (not including installation). The actual per ton operating costs of shredder equipment was not verified in this study.
- To optimize the cutting ability of a tire shredder, dumping a large number of tires into the shredder is not practical. A slower, controlled feed of tires will improve the shredders ability to cut tires to specified lengths in a single pass.

8.2 Recommendations

GF has included information and a number of recommendations in the body of this Report. It is recommended that the CCSWA view tire processing as a business. Maximizing the economics of tire processing will require the CCSWA remain flexible in its marketing strategy. As a next planning step, the CCSWA is encouraged to initiate contacts to identify possible arrangements with tire markets, to build relationships with other tire processors, to identify sources of accumulated whole tires, and to work with PADEP and other affected parties to get a feel for the industry and the additional quantity of tires that can be flowed to the Landfill for processing.

GF has based some of our recommendations on Pennsylvania-specific markets and the proposed use of tire shreds at the Wayne Township Landfill. Emerging markets, economic variables, allowable quantities that can be used on-site, and market competition for tires in the region are changing and will continually influence annual revenues, cost savings, and expenses associated with a tire processing operation at the Landfill. As summarized, GF recommends the CCSWA:

- Initiate contacts to further confirm the potential to increase the flow of tires to the Wayne Township Landfill that will generate tip fees.
- Pursue tire shredding over tire baling as the primary processing method.
- Unless the CCSWA can confirm a profitable end market in the near future for shredded tires, the CCSWA should proceed slowly with the procurement of tire processing equipment. Since the CCSWA will compete for tires with other processors, and because the potentially profitable TDF market is still emerging in PA, the CCSWA is encouraged to await PADEP approval of shredded tires as protective landfill cover to provide assurance that the CCSWA will have at least one secure end use for processed tires.

- Pursue mobile equipment to improve operational flexibility and to promote offsite processing at distance sites. Initiate contacts to confirm the potential to provide processing services at tire piles.
- The CCSWA should continue to bale tires on site using the universal horizontal baler as needed.
- Maximize economic opportunities as a processor using a combination of the following:
    - marketing to Lycoming County and other areas to increase tire volumes
    - mobilizing the shredder to sites to process tires for a fee
    - avoiding costs by using tires for as aggregate replacement
    - identify/confirmation of other profitable/evolving markets (which could include TDF)
    - continue to host tire collection events; possibly adding one or more events per year
    - shredder equipment rental
- If the CCSWA moves forward with purchasing tire processing equipment the shredder should be configured to produce shreds that meet the specifications for approved landfill engineering applications, including as aggregate replacement in the landfill liner system.
- As needed, the CCSWA evaluate their tire tip fees to ensure the CCSWA has an economic incentive that increases the number of tires that are delivered to the facility.
- Prior to final equipment purchase, the CCSWA should confirm its interests in marketing processed tires as tire derived fuel (TDF). Entering the TDF market may change the equipment needs, and could result in much higher capital investment on equipment, plus have other operational and marketing impacts.
- The CCSWA should identify and designate a tire processing area at the landfill. It is recommended a cement pad be placed that is sized to fit the tire processing equipment plus account for some open, clean storage of tires. It may be necessary to segregate tires (e.g. passenger, light truck, oversized), so this should be considered in the sizing, configuration and utilization of the improved tire processing area.
- The CCSWA should review the equipment specifications provided in **Appendix D**. New and used tire processing equipment are each valid equipment options. The CCSWA must confirm that used equipment produces the desired shreds and that replacement parts are available and affordable. Used shredders arrive on the market periodically and can be a viable equipment option, particularly if the CCSWA tire processing volumes remain low.
- The CCSWA should evaluate its tire management options, including those that do not involve equipment procurement. It appears, in light of market conditions and increased competition for used tires, that cost effective arrangements could be made with Mahantango, NTSWA and other processors that would allow the CCSWA to manage more tires and get tire shreds delivered back to the landfill for engineering applications.

APPENDICES

Appendix A

Pennsylvania Tire Pile Listing (2008)

List of Pennsylvania's Priority Waste Tire Piles (2008)

The following are the Department of Environmental Protection's priority enforcement lists of abandoned and commercial waste tire piles in Pennsylvania. Required by the Waste Tire Recycling Act, these lists are comprised of those sites in the Commonwealth with more than 10,000 waste tires. In order to qualify for state funded cleanup, a waste tire pile must be on the abandoned waste tire pile list. These lists will be periodically updated to reflect reductions in Pennsylvania's waste tire piles under the waste tire program.

Please contact the appropriate regional office to determine the current status of the waste tire pile. Please note that some waste tire piles may be known by several different names. When identifying or referring to a particular site, please provide all of the available information on that site in addition to the listed site name (such as the county, municipality, address, property owner, and any available location descriptions). Doing so will help reduce any confusion that may occur with the identification of a specific pile. The number of tires contained in each pile is an estimate and should not be construed as being an exact count.

January 3, 2008

Priority Enforcement List - Abandoned Waste Tire Piles

County	Township	Region	Status	Pile Name	Size (Previous)
Allegheny	Forward	SWRO	Aban.	Suchko Tire Site (Forward Ind. Dev. Corp.)	290,000
Columbia	Greenwood	NCRO	Aban.	Starr Tire Pile	300,000 (5,734,000)
Crawford	Beaver	NWRO	Aban.	Atrozskin	10,500
Crawford	Athen/Rome	NWRO	Aban.	Stanley Process Pile	<10,000 (16,400)
Fayette	North Union	SWRO	Aban.	Dandrea Brothers Salvage	50,000
Greene	Perry	SWRO	Aban.	Kiger	100,000
Greene	Rich Hill	SWRO	Aban.	Ray McClellan Junk Yard	100,000
Indiana	Armstrong	SWRO	Aban.	Walter Haggerty (Mowry)	28,000
Lancaster	Bart	SCRO	Aban.	John Smuckers	200,000
Lancaster	Fulton	SCRO	Aban.	McFadden Dump (Property)	500,000
Luzerne	Duryea Boro.	NERO	Aban.	Coxton/Scran	100,000
Northampton	Wind Gap Boro.	NERO	Aban.	Natrl Windgap	<10,000(1,200,000)
Perry	Tuscarora	SCRO	Aban.	Barry Mather	10,000
Venango	President	NWRO	Aban.	Rozum (Jerry Richards)	20,000

Priority Enforcement List - Commercial Waste Tire Piles

County	Township	Region	Status	Pile Name	Size (Previous)
Berks	Long Swamp	SCRO	Com.	Krauss	14,000
Bucks	Bristol	SERO	Com.	Braun Enterprises	10,000
Bucks	Falls	SERO	Com.	Tire Jockey Service	>10,000
Bucks	Springfield/Richland	SERO	Com.	Herman Moyer Salvage	20,000
Cambria	Susquehanna	SWRO	Com.	AES (Tire Visions, Inc.)	>10,000

Clearfield	Graham	NCRO	Com.	Segers Central Pa Tire	14,000
Crawford	Hayfield	NWRO	Com.	Hayes Auto Wrecking	10,000
Crawford	Wayne	NWRO	Com.	Patterson's Auto Wrecking, Inc.	25,000
Dauphin	Hummelstown	SCRO	Com.	Handwerk Contractors	50,000
Dauphin	Wisconisco	SCRO	Com.	One Stop Recycling	50,000
Franklin	Hamilton/Greene	SCRO	Com.	Myron Young	250,000 (500,000)
Huntington	Cromwell	SCRO		Gerald Booher	200,000
Lancaster	Clay	SCRO	Com.	Larry Gehr	25,000
Lancaster	Salisbury	SCRO	Com.	Earnest Barkman	10,000 (150,000)
Lebanon	East Hanover	SCRO	Com.	Mike Geesaman	30,000
Luzerne	Duryea	NERO	Com.	Hawk Recycling Services	180,000
Luzerne	Lake	NERO	Com.	Lamoreaux	70,000
Luzerne	Salem	NERO	Com.	Spencer Auto Parts	12,000
Mercer	Mercer Boro.	NWRO	Com.	Mercer Auto Wreckers	12,000
Mercer	Sandy Creek	NWRO	Com.	Scofield Auto Wrecking	35,000
Mercer	West Salem	NWRO	Com.	Fenton Auto Sales	35,000
Northampton	Stockertown	NERO	Com.	Einfalt's Recycling / Denco Tire Recycling	10,000
Perry	Carrol	SCRO	Com.	Perry County Metals	15,000
Schuylkill	North Manheim	NERO	Com.	Paul Wellers Tire Shop	10,600
Snyder	Perry	NCRO	Com.	Pyle Tire Pile	14,000
Snyder	West Perry	NCRO	Com.	Evendale Tire Shop	15,000
Venango	Sugar Creek	NWRO	Com.	Lowry Auto Recycling	30,000
Warren	Freehold	NWRO	Com.	Seamens Auto Wrecking & Salvage	50,000
Wyoming	Lemon	NERO	Com.	Martin Harvey	10,000
Wyoming	Noxen	NERO	Com.	Simons Auto Parts	20,000

For more information, contact the Division of Municipal and Residual Waste at 717-787-7381.

Appendix B

Clinton County Solid Waste Authority Tire Data

RpWs.rpt

Material: TIR1

WAYNE TOWNSHIP LANDFILL

Material Report

Transactions from 01/01/2007 through 12/31/2007
Inbound and Outbound Tickets
Third Party and Intercompany Customers
Recycle and Disposal Material
Material Summary

02/06/2008
2:12PM
User ID: STACI

	Yards	Units	Tons	Estimated Tons	Tax	Disposal Amount	Amount
TIR1 - CAR TIRE W/O RIM UNIT *675 tickets and 675 transactions*	0.00	3,324.00	0.00	0.00	$14.16	$3,342.00	$3,356.16
Report Grand Totals ***675 tickets and 675 transactions***	0.00	3,324.00	0.00	0.00	$14.16	$3,342.00	$3,356.16

Material: TIR2

WAYNE TOWNSHIP LANDFILL

Material Report

Transactions from 01/01/2007 through 12/31/2007
Inbound and Outbound Tickets
Third Party and Intercompany Customers
Recycle and Disposal Material
Material Summary

	Yards	Units	Tons	Estimated Tons	Tax	Disposal Amount	Amount
TIR2 - CAR TIRE W/RIM UNIT *37 tickets and 37 transactions*	0.00	165.00	0.00	0.00	$0.00	$247.50	$247.50
Report Grand Totals	0.00	165.00	0.00	0.00	$0.00	$247.50	$247.50

37 tickets and 37 transactions

RpWs.rpt

Material: TIR3

WAYNE TOWNSHIP LANDFILL

Material Report

Transactions from 01/01/2007 through 12/31/2007
Inbound and Outbound Tickets
Third Party and Intercompany Customers
Recycle and Disposal Material
Material Summary

02/06/2008
2:13PM
User ID: STACI

	Yards	Units	Tons	Estimated Tons	Tax	Disposal Amount	Amount
TIR3 - TRUCK TIRE UNIT *58 tickets and 58 transactions*	0.00	107.00	0.00	0.00	$0.00	$428.00	$428.00
Report Grand Totals	0.00	107.00	0.00	0.00	$0.00	$428.00	$428.00

58 tickets and 58 transactions

Material: TIR

WAYNE TOWNSHIP LANDFILL

Material Report

Transactions from 01/01/2007 through 12/31/2007
Inbound and Outbound Tickets
Third Party and Intercompany Customers
Recycle and Disposal Material
Material Summary

	Yards	Units	Tons	Estimated Tons	Tax	Disposal Amount	Amount
TIR - TIRES WHOLE LOAD *74 tickets and 74 transactions*	0.00	0.00	146.69	0.00	$1,540.38	$15,737.23	$17,277.61
Report Grand Totals	0.00	0.00	146.69	0.00	$1,540.38	$15,737.23	$17,277.61

74 tickets and 74 transactions

Appendix C

Tire Analysis & Tire Composition

Analysis of Tire Chips as a Substitute for Stone Aggregate in Nitrification Trenches of Onsite Septic Systems:

Status and Notes on the Comparative Macrobiology of Tire Chip Versus Stone Aggregate Trenches

By Barbara Hartley Grimes, Ph.D., Steve Steinbeck, P.G., and Aziz Amoozegar, Ph.D.

Note: This white paper has been reviewed by North Carolina's OnSite Wastewater Section—Department of Environmental Health (DEH-OSWS) and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of DEH-OSWS. The mention of trade names or commercial products does not constitute an endorsement or recommendation for use.

It is estimated that at least 250 million tires (about one tire per person) are discarded annually in the United States (21). This high number of used tires presents a significant problem for disposal and has led to intense research and development for reusing and recycling tires. In a two-year period (1999 and 2000), counties in North Carolina reported receiving 9.5 million tires (136,536 tons in monolandfills) (10). Because of the high volume of waste tires, problems associated with their disposal, aesthetic problems, and the expansion and innovation of reuse of used tire products is being addressed aggressively. Chipped or shredded tires are being used for a wide variety of products, including playground covers, doormats, roadbed, fill, shoes, and aggregate substitute in septic system drainfields. This paper will describe and analyze the current available information on the use of tire chips as a substitute for stone aggregate in septic system drainfields.

In more than 17 states, tire chips/shreds are currently permitted for use or are under experimental evaluation as an aggregate substitute for stone aggregate in septic system drainfields. Some of the scrap tires in North Carolina are being chipped and exported to

A tire chip processor in action in Cameron, North Carolina. Photo courtesy of Tim Warren.

South Carolina for use in septic systems. Tire chips have recently been approved as an aggregate for septic systems in North Carolina. (See Approval: **www.deh.enr.state.nc.us/oww**).

The number of discarded tires used in onsite systems can be significant. For example, approximately 2.3 million passenger tire equivalents in Georgia, 300 tons of tire chips in Iowa, 100 million tires in Florida, and about 30 percent of used tires in Oklahoma are being used in septic systems.

Specifications and Definitions: General Description of Tire Chips

Tires can be cut into small pieces called *tire chips* or *tire shreds* by various techniques. The New York State Roundtable defines chips as "*A classified scrap tire . . . which is generally two inches (50.8mm) or smaller and has most of the wire removed* ..." and shreds as "*Pieces of scrap tires that . . . are generally between 50mm (1.97") and 305 mm (12.02") in size*"(11). The physical characteristics of the tire chips, such as size, wire protrusion, and fines are controllable factors in the processing of tire chips. Based on this, the term tire "chips" is more suitable as a substitute for stone aggregate than the term tire "shreds."

According to the Texas Natural Resource Council Commission (TNRCC), while passenger tires may vary in size and shape, they have similar general physical and chemical characteristics and are composed approximately of 85 percent carbon, 10 to 15 percent ferric material, and 0.9 to 1.25 percent sulfur (20). (More specific information on rubber, metals, and other compounds in tires can be found in Appendix I.) For example, studies have shown that new versus used tire chips have similar performance when used as aggregate in septic systems (18).

The relatively stable structure of tire chips makes them a suitable substitute for stone aggregate in the septic system. In addition, tire chips are three times lighter than stone aggregate (e.g., a cubic yard of stone aggregate is 2,800 pounds and a cubic yard of tire shreds is 800 pounds). Also, in many cases, tire chips have shown to be one-third the cost of stone aggregate for use in septic systems (18).

Regulations in states where tire chips are approved as a substitute for stone aggregate in onsite systems require them to be of similar size as stone aggregate (approx 2 inches), with wire protrusion of 0.5 inches or less. These regulations also require a "no fines limit" and geotextile fabric to cover the tire chips before ground covering. This is a general overview, and examples of specific regulations in some southeastern states can be found in Appendix II.

Top: Tire chips before installation. Bottom: Tire chips excavated from system eight years later shows growth of biofilm and lack of tire chip decomposition. Photos courtesy of Barbara Grimes.

The major differences in state regulations are in the percent of tire chips meeting specification required (80 percent, 90 percent, etc.) and the oversight, inspection and /or certification of the tire chip specifications (Appendix II). Few states address the bead wires, cleanup, and any limits on depth to groundwater, other than standard installation requirements.

Main Issues in Tire Chip Substitution (Demonstration/Experimental Projects)

Concerns for tire chip use include storage, handling of chips with protruding wires, post-installation cleanup of stray tire chips, potential for compression or compaction, and durability of the chips. In storage, the accumulation of dirt and stray materials needs to be prevented. Persons handling the chips should use care, wear thick gloves and appropriate clothing (including thick-soled shoes), and have current tetanus protection. Cleanup must be addressed in the post-installation inspection.

Research has shown that compaction is not a significant problem, and our inspection of tire chips in the trenches of a number of 8-year-old drainfields in South Carolina revealed that the tire chips were not degraded or damaged by wear. These demonstrate the durability of tire chips in septic system drainfields. Recommendations have been made from several research/demonstrations projects that tire chips should be firmly compacted prior to covering with geotextile fabric.

One field survey conducted in South Carolina did not show a significant number of failures in tire chip systems that were greater than 10 years old or evidence of settling problems over the drainfields. Porosity was found to be higher with tire chips than stone (60 percent for tire chips; 40 percent for stone) (13, 16–18).

Sewage Distribution, Performance, and Biomat Formation

Performance studies comparing stone aggregate drainlines and tire chip aggregate drainlines in various combinations of alternating drainfields and alternating drainlines show in all cases equivalent or similar wastewater dispersal to the soils within the trenches filled with stone aggregate and tire chips drainfields (2,13,16–18). Permeability of tire chips was found to be equal to that of stone aggregate. In some cases, less ponding was recorded in the tire chip systems than systems that were constructed using stone aggregate (13,16–18).

Waste treatment efficiency in all studies using tire chips was equivalent to that achieved in stone aggregate drainfields. Wastewater treatment testing in more than one project examined BOD_5, COD, TSS, ammonia-nitrogen, nitrate, fecal coliforms, and pH, and showed equivalent treatment, except that the wastewater treatment efficiency in tire chip trenches sometimes took several months to reach the same rates. Conductivity profiles demonstrated little precipitation in either type of aggregate (13,16–18).

Biomat formation and macrobiology of tire chips in comparison to stone aggregate systems examined in North Carolina and South Carolina (Appendix III) demonstrated a thicker biomat and a surprising level of supported invertebrates in the tire chip trenches. Only nematodes were found in a two-year-old system in North Carolina. demonstrating an aerated system that allows them to provide an additional treatment of waste constituents.

In the South Carolina systems (older than 8 years), we found more trophic levels (feeding types) of micro- and macro-organisms, which indicated a stable ecological wastewater treatment community (1, 5, 14, 15, 22). The organisms included grazers, saprophytic feeders, and filter feeders. This complexity and diversity of organisms demonstrates the potential for additional levels of wastewater treatment in tire chip aggregate, keeps the biomat pores open, promotes healthy biomat regrowth by grazing, and indicates a healthy and diverse ecosystem in the tire chip trenches (1, 5, 14, 15, 22).

In comparison, only a few protozoa were found in a stone aggregate system in South Carolina. Evaluation of both stone aggregate and tire chip systems that were overloaded (i.e. high level of ponding) showed that the healthy ecosystem was not present in tire chip trenches when overloaded.

A Question of Leachates

Major in-depth studies of leachate from tire chip versus stone aggregate drainfields, include: Amoozegar and Robarg, 1999 (2) in North Carolina; Burnell and Omber, 1997 (3); Envirologic, 1990 (6); Liu. Mead, and Stacer, 1998 (8); Robinson, 2000 (13); Sengupta and Miller, 1999 and 2000 (16, 17); and Spagnoli, Weber, and Zicari, 2001 (18).

One of the major questions raised in using tire chips as a substitution for stone aggregate is the potential leaching of various constituents from the tire chips. Bench studies and field testing have examined tire chip leachate under normal and "worst case scenario" conditions (2, 3, 6, 8, 13, 16, 17, 18). The pollutants of interest in these studies indicate that volatile and semi-volatile compounds do not enter the leachate. Other studies have demonstrated that ground rubber and tire chips actually remove some of the organic compounds from fluids percolating through them (7, 18).

Studies under typical septic system conditions have shown that tire chip leachate and stone aggregate leachate contain high concentrations of iron (16, 17). The levels of iron, which is a secondary drinking water contaminant (aesthetic), however, does not seem to pose a health problem. The studies at the Chelsea Center showed that tire chips were actually a sink for iron when compared to the influent concentration (16, 17).

This demonstration installation of tire chips in a septic system in North Carolina featured the use of a steel brace for supporting the distribution pipe while the chips were loaded into the trench. Photo courtesy of Tim Warren.

In some studies, manganese (secondary drinking water standards) was higher in the tire chip leachate than in the aggregate leachate (18). In the Chelsea Center studies, on the other hand, manganese concentration was mostly constant in the effluent in the D-box, but was of equivalent concentrations in stone aggregate and tire chips in the trenches although fluctuating in both—being sometimes higher in the aggregate and sometimes higher in the tire chips (16, 17).

In the Chelsea studies, zinc leachate was lower than secondary drinking water standards; in both trench types, zinc concentrations were lower than in the distribution box while paralleling D-box fluctuations (17).

As for the effluent macrobiology in the trenches, it appears that the iron in the presence of some unknown factor(s) in tire chips enhances macrobiological growth. Accumulation of harmful trace metals does not appear to occur as evident by the biological growth in the South Carolina systems.

Overall, it appears that tire chip substitution for stone aggregate is an excellent alternative for onsite systems in regard to wastewater treatment, durability, and economics. Using tire chip aggregate in septic systems also provides a viable solution to recycling used tire waste. As a result of the data, a 1:1 substitution was recommended and approved for use in North Carolina. Because of the biological studies (and other researchers' recommendation (18) and, we do not recommend tire chips be used for areas with seasonal high water tables, using less than one foot separation for Group 1 (sand, loamy sand) (1.5 feet in sandy soils), or conditions (e.g., undersizing) that result in overloading the drainfields. Additionally, physical hazards, worker safety, and compliance with the specifications must be addressed.

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APPENDIX I

General Tire Composition
(Modified 1999 TNRCC Fact Sheet):

Weight: Passenger Tire 18.7–20.0 pounds
Truck tire about 100 pounds

Volume:

Number of Tires Needed for One cubic yard:

Car Tires	10
Truck Tires	3
Shredded car tires (1 pass)	33
Shredded truck tires (1 pass)	7
Shredded car tires (2 inch chips)	47

Basic Ingredients:

Fabric: Steel, nylon, aramid fiber, rayon, fiberglass, or polyester (usually a combination)
Rubber: Natural and synthetic (hundreds of polymer types)
Reinforcing chemicals: Carbon black, silica, resins
Anti-degradants: Antioxidants/ozonants, paraffin waxes
Adhesion Promoters: Cobalt salts, brass on wire, resins on fabrics
Curatives: Cure accelerators, activators, sulfur
Processing aids: Oils, tackifiers, peptizers, softeners

Composition of One Popular All-Season Passenger Tire:

Weight : 21 pounds

Composition:

30 different synthetic rubbers	5 lbs
8 types of natural rubber	4 lbs
8 types of carbon black	5 lbs
steel cord for belts	1 lb
polyester and nylon	1 lb
steel bead wire	< 1 lb
40 chemicals, waxes, oils, etc	3 lbs

Approximate composition Percentages:

85% carbon
10-15% ferric material
0.9-1.25% sulfur

Typical Percentages of Rubber Mix in Some Types of Tires:

	Synthetic Rubber	Natural Rubber
Passenger tire	55%	45%
Light Truck Tire	50%	50%

TRNCC Information :

Using Tire Shreds in Onsite Sewage Facilities (Septic Systems)
Shreds are three times lighter than stone aggregate:
Cubic yard of stone aggregate: 2,800 pounds
Cubic yard of tire shreds: 800 pounds

APPENDIX II

TIRE CHIP AGGREGATE SUBSTITUTION FOR GRAVEL IN ONSITE SYSTEMS:

Examples of Southeastern State Rules

STATE	TERM USED: Chips or Shreds	Bead Wire	Fines	Dimensions	Wire Protrusions	Percent Compliance	Geotextile Fabric	Meeting Specifications	Other Requirements	Other Restrictions	Processors Approval	Approval Continued
GEORGIA F-19: Tire chip approval when installed on conventional septic tank system criteria and absorption field methods	Tire Chips	X	The aggregate must be free of balls of wire and fine rubber particles. The chips must be clean and free of any soil particles either adhering to the chips or floating loose within the chips.	The size of the tire chip aggregate shall be one-half to two inches in diameter	The percentage of tire chip aggregate with greater than one-half inch exposed wire shall not exceed ten percent	The percentage of tire chip aggregate with greater than one-half inch exposed wire shall not exceed ten percent	The absorption line with tire chip aggregate must be covered with an approved geotextile fabric or silk screen prior to back filling	The minimum depth of aggregate shall be twelve inches with six inches below				
SOUTH CAROLINA Revised, 1995	Tire Chips	X	Fines are prohibited	Chips may not be smaller than one-half inch or larger than four inches in size	Wire strands may not protrude more than one-half inch from the sides of the chips	At least 90% of the chips must meet the technical specifications	Absorption trenches must be covered with geotextile (synthetic) fabric prior to backfilling	Tire recyclers may, at their option, submit chip samples to the Division for evaluation. The results will not constitute a general or blanket approval for any producer. The actual, final approval of tire chips occur at each septic system job site				
VIRGINIA Revised 1997	Tire Chips	X	DEQ < 2mm are prohibited	DEQ Nominal two (2) inches in size may range from 1/2 inch to a maximum of four (4) inches in any one direction	DEQ Exposed wire may protrude no more than one-half inch from the chip	DEQ At least 95% of the aggregate by weight shall comply with specifications routinely, Processors inspected regularly. Semi annual contractors	Department of Health Regulation Application Untreated building paper or geotextile (synthetic) fabric cover shall be used to cover the tire chips before backfilling	Each installation must have a valid VDH permit ; must be authorized by the property owner and certified by VDH and the installation contractor using the 4 part VDH-DEQ Certification of Use of Tire Chips in a Res-idential Septic Drainfield				
NORTH CAROLINA NEWLY APPROVED OCT. 2002	Tire Chips	X	Shall be clean and free (98% or better by weight) of any soil particles (fines) either adhering to the chips or floating loose within the chips;	1. Shall be nominally two (2) inches in size and may range from _ inch to a maximum of four (4) inches in any one direction (95% or better by weight); 2. Shall be graded or sized in accordance with size numbers 2, 3, and 24 of ASTM D-448 (standard sizes of coarse aggregate)	Shall not contain wire protruding more than one-half inch from the sides of the chips (95% or better by weight); and	OSWS At least 95% of the aggregate by weight shall comply with the sizing standards;Tire processors must be approved by OSWS yearly	The tire chip aggregate shall be covered with a single and continuous layer of non-woven filter fabric extending across the top of the tire chip aggregate before backfilling. The fabric shall have a unit weight of at least 3.0 oz./yd2 (per ASTM D-5261), a permittivity of at least 1.0 sec-1 (per ASTM D-4491), a trapezoid tear strength of at least 35 lbs. (per ASTM D-4533), and have a mesh size equal to U.S. Sieve No. 70 (A.O.S.)(ASTM D-4751).	Tire chip aggregate for subsurface sewage effluent absorption systems shipped from approved tire processors shall be accompanied by a freight bill of lading labeled as drainfield aggregate . The bill-of-lading shall certify that the material meets the specifications for drainfield use. Contractors purchasing tire chip coarse aggregate shall retain a copy of the freight bill-of-lading as documentation of the tire chip aggregate size and quality. A copy of the bill of lading shall be provided to the local health department prior to issuance of the operation permit, and shall be retained with the operation permit filed with the local health department.	"1. All tire chips not used in the nitrification trench shall be removed from the site by the installer or contractor for the onsite wastewater system. 2. No soil shall contaminate the tire chips during installation.	1. For LPP systems, the orifices shall be protected from aggregate shadowing by sleeving the discharge pipe laterals within the perforated pipe [which meets Rule .1955(e)] typically used for conventional nitrification lines. 2. The minimum vertical separation required by Rule 15A NCAC 18A .1955(m) shall not be reduced, notwithstanding the use of any advanced wastewater treatment system.	1. Any tire processor wishing to provide tire chip aggregate for use in onsite sewage treatment and disposal system drainfields in the state of North Carolina shall receive written approval from DENR-DEH-OSWS. Tire Processors must provide proof that they can continuously produce a tire chip coarse aggregate in conformance with the specifications in II of this approval ; Tire processors shall submit a representative sample of tire chips to DEH OSWS ; The processor shall have samples analyzed by a third party laboratory qualified to conduct particle size analysis for compliance with the above specifications ;	Documentation of tire processors' product meeting the above specifications, shall be submitted as requested, at least yearly, to OSWS ; Noncompliance with this approval may subject a tire processor to suspension or revocation of their approval

FLORIDA (tire chip only)	**Rules:** Tire chip coarse aggreg. (Or tire aggreg.)	At least 80% of the bead wire must be removed from the tires to be chipped	NA	Gradations shall conform to the following requirements*	Exposed wire may protrude no more than one-half (1/2) inch from 90% of the chips	In addition to gradation requirements not more than 3.75% by weight of the aggregate material at the point of use shall pass through a #200 sieve	No specs for geotextile fabric	county health department / inspection	domestic strength waste only; tire chip aggregate systems shall be limited to new or repaired domestic onsite systems, and those in which the bottom surface of the drainfield is at least 12 inches above the water table at the wettest season of the year	**Manufacturer Approval & Labeling (A)** Any manufacturer wishing to provide tire chips for use in onsite sewage treatment and disposal system drainfields in the state of Florida must first receive a letter of approval from the State Department of Health, Bureau of water and OnSite Sewage Programs. Manufacturers must provide proof that they can produce a tire chip coarse aggregate in conformance with the standards in Section I, Physical properties	**Manufacturer Approval & labeling (B)** Tire chip aggregate from approved manufacturers shall be labeled as a drainfield aggregate on the freight bill-of-lading. The bill-of-lading shall clearly certify that the material meets the requirements for drainfield use. Contractors purchasing tire chip coarse aggregate shall retain a copy of the freight bill-of-lading as documentation of the aggregate size and quality. Contractors shall retain bill-of-lading records and shall make them available for department review for a period of two years from the date of purchase.
FLORIDA (tire chip and mineral aggregate mix)	Use of mixed tire and mineral aggregate is approved	—	—	—	—	—	—	county health department / inspection			
	*Sieve Size	2in	1 1/2 in	1 in	3/4 in	1/2 in	3/8 in	no. 4 (4.75mm)			
	Percent passing	90-100	35-100	15-100	0-70	0-50	0-30	0-5			

APPENDIX III

Macrobiology

__*Macrobiology Methodology*__: 2–8 years post-installation: hand digging in trenches; Evian water to wash out organisms from biomat. Dissecting microscope used to examine the biomat and tire chips. Identification to taxonomic class.

NC Experimental wastewater system (1): NC rules of conventional installation. (Approval online OSWS) Dr. Aziz Amoozegar Soil Science NCSU System with alternating stone aggregate trenches and tire chip trenches. Results of sampling the biomat for protozoa and metazoa (higher forms)

__*Excavation*__

Tire chips: well-structured "honeycomb" does not collapse on excavation
Stone aggregate: no structure; collapses on excavation

__*Appearance of Aggregate*__

Tire chips: intact, good separations, covered in a "fuzzy beige biofilm," wires oxidized and mostly gone.

Stone aggregate: fairly clean—no attached biofilm

__*Biomat Underneath The Aggregate*__

Tire chip trenches: well-formed biomat trench bottom—black
Stone aggregate trenches: well-formed biomat—dark

__*Macrobiology*__

Tire chip trenches: No protozoa; nematodes in abundance
Stone aggregate trenches: No protozoa or nematodes

South Carolina Septic Systems (6) —installed SC rules: Drain line directly on soil, then aggregate, covered geotextile fabric. Tire chip systems are widely used in Horry County, S.C**.** Sampled near Conway, S.C.—Mobile Home Park with both types of systems and soils—at least 8 years old. Results of sampling the biomats for protozoa and metazoa (higher forms)(as always, other factors involved—heavy rains days before our trip)

__*Excavation*__

Tire chips: well-structured "honeycomb" does not collapse on excavation. After 8 years drainfield was not collapsed—well structured

Stone aggregate: no structure ; collapses on excavation

__*Appearance of Aggregate*__

Tire chips: intact, not pitted, covered in a "fuzzy beige biofilm," wires oxidized, almost gone.

Stone aggregate: fairly clean—no attached biofilm

__*Biomat Underneath The Aggregate*__

Tire chip trenches: well-formed biomat trench bottom—thick (several mm) black sheet of biofilm; somewhat intact

Stone aggregate trenches: well-formed biomat—very thin (mm) dark beige/black

__*Macrobiology*__

Tire chip systems sampled

I. Systems with effluent in trenches—no protozoa or metazoa
II. Normal System—abundant forms
  a. Protozoa—3 types of ciliates
  b. Metazoa—oligochaetes (aquatic /segmented worms) (3 types at least – maybe some parts…)
  c. Metazoa—nematoda (roundworms) somewhat abundant
  d. Metazoa—insect larva (psychodidae—filter fly/ drain fly)

Stone aggregate systems

I. Normal trenches—no protozoa or metazoa or small protozoa later in cultures
II. System with effluent in trenches—no protozoa or metazoa

Appendix D
Tire Processing Equipment Specifications

American
PULVERIZER COMPANY

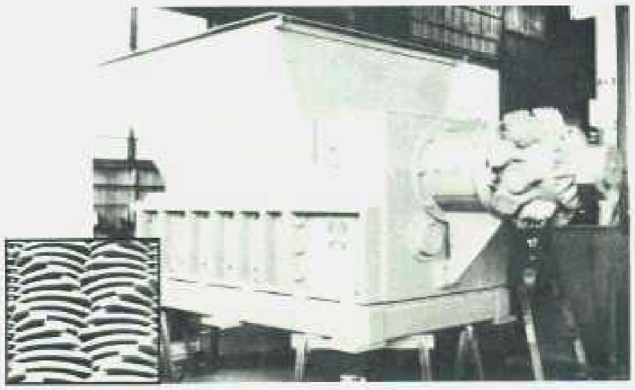
SHEAR-TYPE WASTE SHREDDERS

Mixed waste reduction with safety and economy.

American SHEAR-TYPE WASTE SHREDDERS
...new slow-speed efficiency in solid waste reduction.

American Pulverizer Company now offers the versatility of slow-speed reduction in waste shredders that cut waste handling costs from 50% to 75%. Their unique design reduces vibration, noise, dust, energy costs, maintenance, explosion liability, and even installation costs.

American Shear-Type Waste Shredders reflect nearly a century of experience in producing reduction equipment of unmatched dependability, minimum maintenance and long service life.



CUTTER DISKS counter-rotate to tear and shear waste materials; cutter width and tooth patterns can be varied as needed.

AUTOMATIC REVERSING in jam-proof system handles difficult-to-shred waste; adjustable reversing cutoff control.

CHOICE OF DRIVES includes hydraulic or electric, plus optional portable or stationary systems.

RUGGED DESIGN for longer wear, with hardened gears, splined shafts, sealed bearings, and rib-reinforced housings.

BROAD APPLICATIONS include mixed waste, damp or hazardous materials, loose or baled paper products, foam rubber, bed springs, drums, cables, tires, pallets, batteries and more.

OPTIONS include: stainless steel or tool steel cutters; hydraulic feed rams.

PORTABLE OR STATIONARY models available; for standard or heavy duty operation.

SLOW SPEED keeps vibrations down, along with noise and dust; requires less horsepower than hammermills; minimizes foundation work to keep installation costs low.

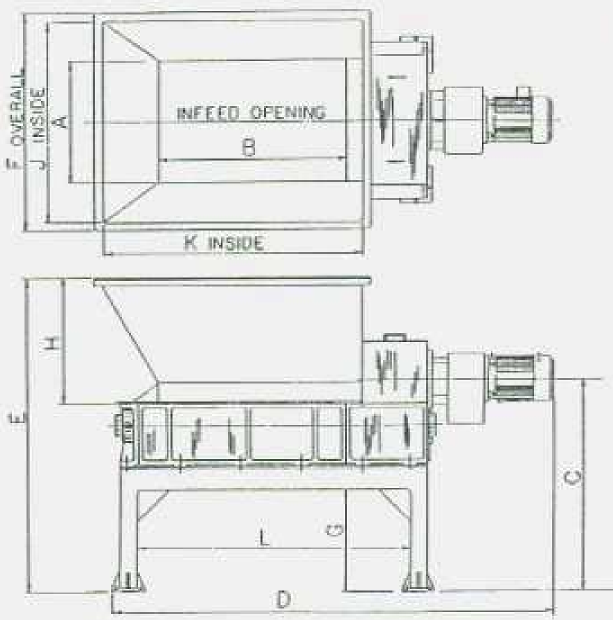
LOWER HANDLING COSTS maintained by achieving waste reduction rations of up to 5:1.

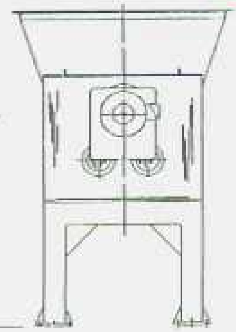
GENERAL SPECIFICATIONS

MODEL NO.	FEED OPENING		HORSEPOWER	APPROX. WT. (lbs.) (Shredder Head Only)
	LENGTH	WIDTH		
STANDARD DUTY				
TRS 28 x 17	28	17	20-25	3,900
TRS 36 x 25	36	25	10-40	5,200
TRS 51 x 25	51	25	20-60	9,000
HEAVY DUTY				
TRS 50 x 35	50	35	60-150	16,500
TRS 54 x 40	54	40	100-300	23,500
TRS 64 x 40	64	40	100-300	25,500
TRS 72 x 46	72	46	150-400	28,000
TRS 72 x 52	72	52	200-600	36,000
TRS 95 x 52	95	52	200-600	40,000
TRS 105 x 72	105	72	400-800	55,000

All dimensions in inches.

Length of feed opening will vary with size and quantity of material being shredded.





DIRECT ELECTRIC DRIVEN SHEAR-TYPE WASTE SHREDDERS

STANDARD DUTY MODELS

APPLICATIONS

- Aluminum Cans
- Ceramics
- Glass
- Hazardous Waste
- Hospital Waste
- Hotel Waste
- Low-Capacity Pallets
- Metal Turnings
- Pharmaceuticals
- Plant Refuse
- Plastics
- Rags
- Security Shredding
- Wood Scrap

DIMENSIONS

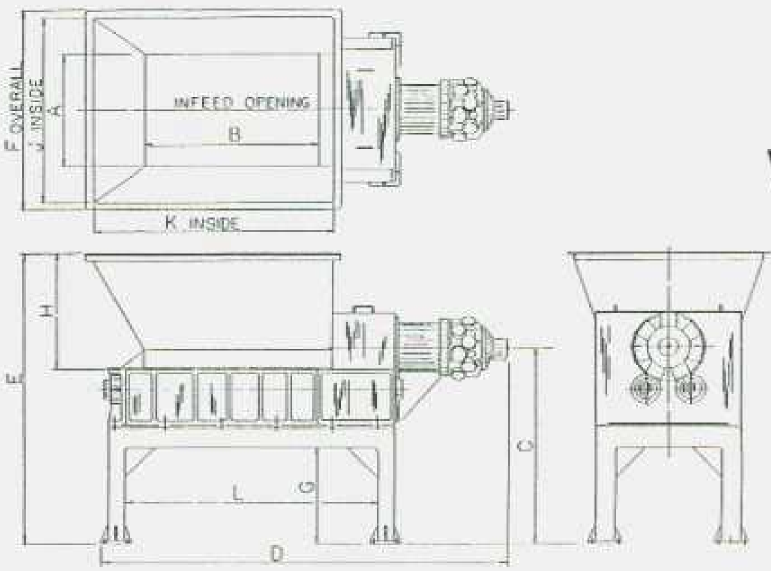
MODEL	A	B	C	D	E	F	G	H	J	K	L
28 x 17	17	28	48	78	66	40	30	24	36	48	46
36 x 25	25	36	53	94	78	58	32	36	54	64	54
51 x 25	25	51	53	110	78	58	32	36	54	80	72

All dimensions in inches.

CAPACITIES

MATERIAL	CUT	MODEL 28 x 17	MODEL 36 x 25	MODEL 51 x 25
Aluminum Cans	8-12 lb./cu³	550-1200#/hr	2000-4000#/hr	2500-5000#/hr
Steel Cans	20-25 lb./cu³	1000-2500#/hr	4000-8000#/hr	4500-9000#/hr
Paper Cardboard, Magazines, Books	1"-3"	500-1000#/hr	1000-2000#/hr	2000-3500#/hr
Wood Scrap	1"-3"	500#/hr	1500#/hr	2500#/hr

Capacities shown are nominal and can vary greatly depending on density, size, and position of infeed material as well as cut desired.



HYDRAULIC DRIVEN SHEAR-TYPE WASTE SHREDDERS

HEAVY DUTY MODELS

APPLICATIONS

ACSR Cable
Aluminum Sheet and Castings
Asphalt
Batteries
Cardboard
Carpets
Concrete Blocks
Demolition Lumber
Foam Rubber
Glass
Hardwood Scrap
Hazardous Waste
Heavy Pallets
Mattresses
Metal Turnings
Solid Waste
Steel Drums
Tires, Truck or Car
Tree Stumps, Brush
White Goods

DIMENSIONS

MODEL	A	B	C	D	E	F	G	H	J	K	L
50 x 35	33	50	74½	140	110	71	39¼	48	65	74½	81¾
54 x 40	40	52	77	145	116	76	39¼	48	70	97½	84
64 x 40	40	62	77	155	116	76	39¼	48	70	87½	94¾
72 x 46	46	70	80½	166	119½	82	39¼	48	76	95½	102¾
72 x 52	52	70	82	167	160	86	39¼	48	80	95	102
95 x 52	52	93	84	190	162	88	39¼	48	82	118½	125¾
105 x 72	72	103	86	195	168	108	39¼	48	102	128½	135¾

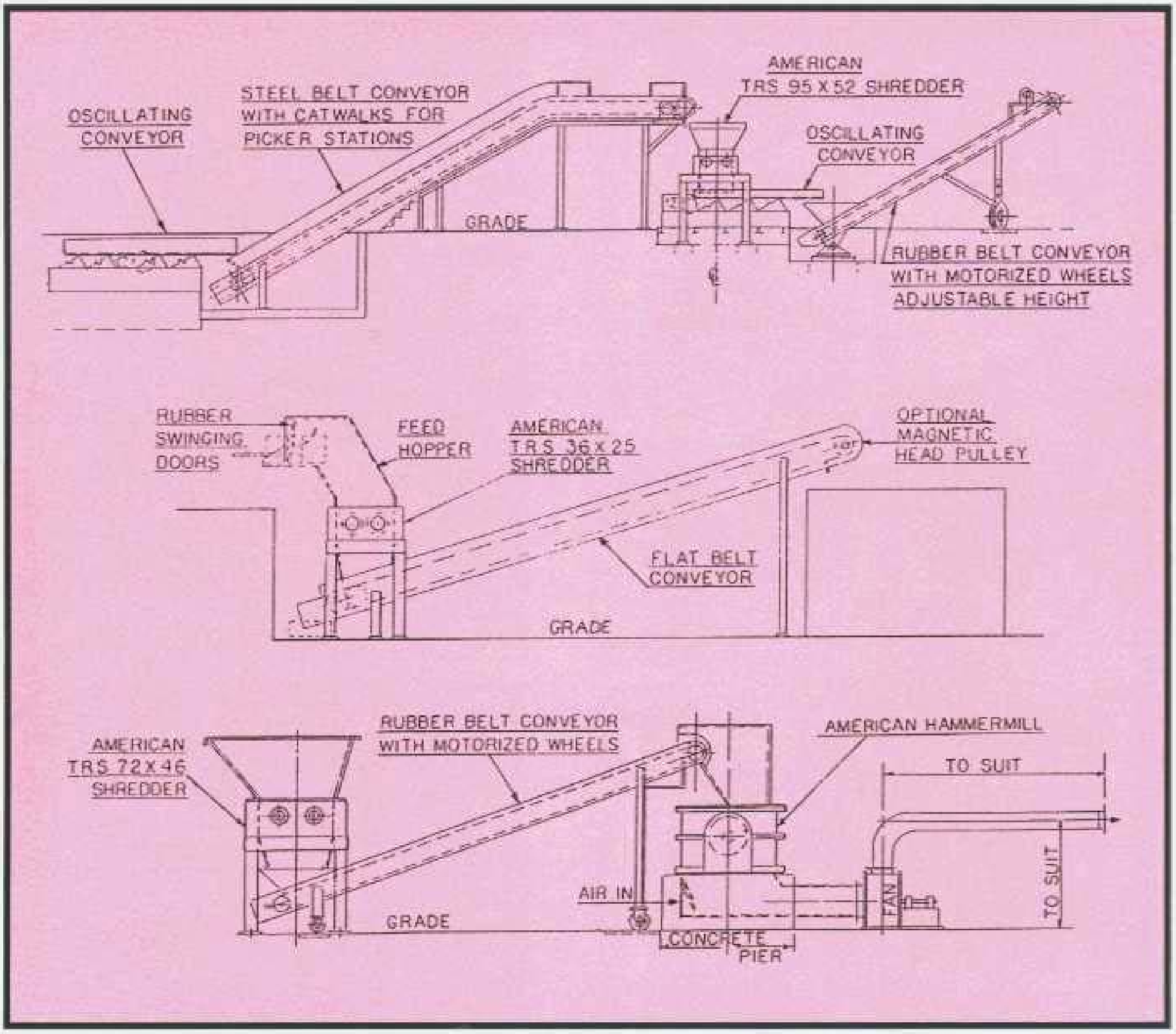
All dimensions in inches.

CAPACITIES

MATERIAL	CUT	MODEL NUMBER						
		50 x 35	54 x 40	64 x 40	72 x 46	72 x 52	95 x 52	105 x 72
Tires	2"x6"	400-700/hr.	400-700/hr.	800/hr.	600-1100/hr.	800-1500/hr.	900-1700/hr.	Up to 2500/hr.
Pallets	2"x6"	3-4/min.	3-5/min.	4-6/min.	7-8/min.	10-10/min.	13-15/min.	Up to 25/min.
Demolition Lumber	2"x6"	45 yds./hr.	50 yds./hr.	60 yds./hr.	75-80 yds./hr.	90-95 yds./hr.	100 yds./hr.	Up to 145 yds./hr.
Solid Waste	2"x6"	4-5 TPH	5-7 TPH	8-10 TPH	12-14 TPH	15-25 TPH	30-40 TPH	Up to 50-65 TPH
Truck Tires	2"x6"	Not Recommended	25-75/hr.	25-100/hr.	40-125/hr.	100-200/hr.	100-250/hr.	Up to 300/hr.
Aluminum Cast & Extrusions	4"x8"	1 TPH	1½-2 TPH	2-4 TPH	3-5 TPH	5-6 TPH	6-8 TPH	10-14 TPH

Capacities shown are nominal and can vary greatly depending on density, size, and position of infeed material as well as cut desired.

COMPLETE SHREDDING SYSTEMS



American PULVERIZER COMPANY – YOUR SINGLE SOURCE

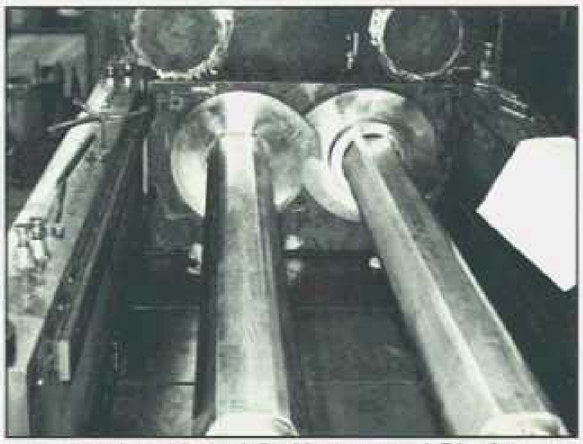
American Pulverizer Company will design and assemble a complete shredding system to meet your specific requirements. In addition to a complete line of waste shredders, American provides conveyors, trommels, magnetic separators, and pneumatic conveying to secondary shredding equipment.

Its Hustler Conveyor Division manufactures a complete line of rubber and steel belt conveyors as well as heavy-duty oscillating models.

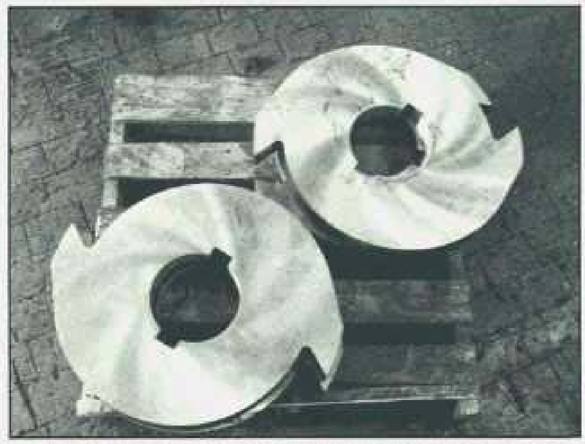
Each component is carefully selected to provide an efficient, coordinated system to provide you with the most dependable, cost-effective solution to your waste reduction requirements.

For more details, call or write.

American SHEAR-TYPE WASTE SHREDDERS

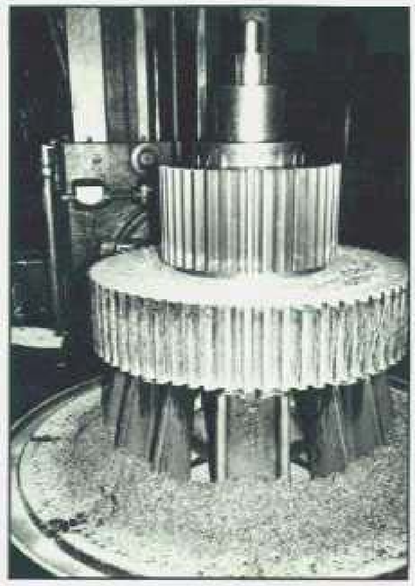


Double-Keyed Or Hexagonal Shafts
Available On All Models



Multi-Hook Design With Two Keyways

Infeed & Take Away Systems



Splined Cluster Gears

Call or write today for quote or sample run.

American PULVERIZER COMPANY
5540 West Park Avenue • St. Louis, MO 63110
314-781-6100
FAX: 314-781-9209

EncoreSystems

OF MINNESOTA
Brett Nesdahl - Terry Drews
1813 S. 25th Street
Moorhead, MN 56560
Phone: 218-284-3901
Toll Free: 1-888-548-6710

The EP100P Baler - Introducing for 2006, the new ENCORE PACKER model EP100P portable waste tire baler.

The baler and three persons are capable of making from four to six bales an hour on a steady basis. The completed bales are easily handled with a fork-lift, front-end loader or logger's clam.

The EP100P portable waste tire packer is a vertical down stroke portable baler which compresses approximately 100 whole passenger, light and commercial truck tires into a bale measuring 30" X 50" X 60". The weight of the completed bale is approximately one ton. The baler and three persons are capable of making from four to six bales an hour on a steady basis. The baler is also capable of baling other recyclables such as cardboard, aluminum, etc. With proper training, it is possible to incorporate two whole commercial truck tires or tractor tires in each passenger bale. This eliminates the need for a costly tire cutter. The completed bales are easily handled with a fork-lift, front-end loader or logger's clam.

2006 Detailed Specifications

Weight	
Unit weight	11,800 pounds
Dimensions	
In Transit	8'6" High, 24' Long, and 6'11" Wide
Operational	13'6" High, 30' Long and 6'11" Wide
Engine	
Engine Model	Kubota V2203M-FG
Engine Type	Vertical, 4-cycle liquid-cooled diesel
Number of Cylinders	4
SAE Gross Inter. HP	49 HP/2800 RPM
SAE Net Inter. HP	46 HP/2800 RPM
SAE Net Contin. HP	40 HP/2800 RPM

Fuel type	Diesel fuel No. 2-D (ASTM D975)
Fuel tank capacity	30 gallons
Operating Specs	
Cycle Time	Under 30 seconds
Average production	400 tires per hour
Controls	Manual Hydraulic
Operation	Bale Ejection System
Production	4 to 6 bales per hour (2-3 person crew)
Hydraulic System	
Controls	Manual hydraulic
Tank capacity	50 gallons
Safety Specs	
In use	Emergency cylinder stop when handle released
In use	Power beyond hydraulic controls for safety
In transport	Breakaway system on trailer
In use	Murphy safety shut-off switch
In use	Rear Stabilizers
Trailer Specs	
Hitch System	Gooseneck, others available.
Gauges	Tachometer, hour meter and sight gauges
Axles	Tandem, rubber torsion insert, 7,000 lbs.
Baler Specs	
Chamber Dimensions	30" x 60"
Rams	Twin 6" rams
Materials	Heavy-duty 3/8" plate steel door
Retainer Dogs	Ten per door
Warranty	
Kubota Engine	3 year/3,000 hour warranty in USA
Baler	1 year warranty, 5 year structural
Options	
Color	Standard green and yellow, custom colors by special request
Hitch System	Gooseneck standard, others available
Model Type	Stationary or mobile
Power	Diesel or electric
Axles/brakes	Air over hydraulic axles and brake systems on request for overseas applications

Appendix E

Tire Processing/Recycling RFP (Lancaster County)

Not in on-line version of Report