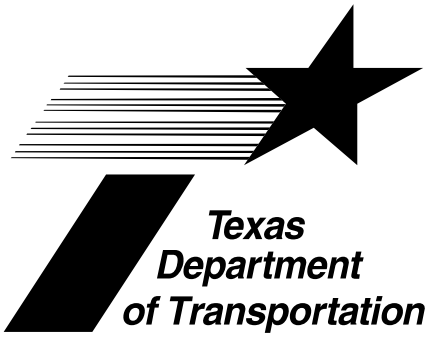
Progress Report on Using Scrap Tires and Crumb Rubber in Highway Construction Projects



Submitted Jointly by
the Texas Commission on Environmental Quality and the Texas Department of Transportation
As required by Senate Bill 1, 77th Legislative Session TCEQ-Rider 19 and TxDOT-Rider 44

SFR-069/03
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Contents

FIGURES

TABLES

PREFACE

This report is being submitted as required by Senate Bill 1, Article VI, Texas Natural Resource Conservation Commission (now the Texas Commission on Environmental Quality) Rider 19 and Texas Department of Transportation Rider 44, 77th Legislature:

> ***Agency Coordination.*** The Texas Department of Transportation and the Texas Natural Resource Conservation Commission [now the Texas Commission on Environmental Quality] shall coordinate their efforts on the acquisition and potential uses of crumb rubber and shredded tire pieces in the various phases of highway construction. The Texas Department of Transportation and the [Texas Commission on Environmental Quality] shall provide to the appropriate Legislative Committees a report on their progress by January 1 of each fiscal year.

EXECUTIVE SUMMARY

This report is the fourth annual *Progress Report on Using Scrap Tires and Crumb Rubber in Highway Construction Projects* submitted on January 1 of each year to Legislative Committees. This report represents the cooperative effort between the Texas Commission on Environmental Quality (TCEQ) and the Texas Department of Transportation (TxDOT) to assess the scrap tire situation in Texas and identify beneficial uses of tires, including highway construction.

During calendar 2001 and 2002, both the TCEQ and TxDOT took part in significant developments that brought progress in the state's scrap tire situation. Major developments include:

- For the first time in tire program history in Texas, the total volume of scrap tire material reported as consumed by end users or disposed of legally in landfills exceeded the number of scrap tires generated. In 2001, 25.5 million scrap tires were consumed or disposed of, whereas the tire industry estimates that approximately 24 million newly scrapped tires were generated.
- In spite of this overall increase in scrap tire consumption and disposal, the volume of material legally placed in landfills decreased 31 percent, from 3.4 million scrap tire units[1] (STUs) in 2000 to 2.3 million STUs in 2001. This decrease is largely due to an increase in demand from end users. Total demand rose from 18.8 million STUs in 2000 to 23.1 million STUs in 2001.
- The volume of scrap tire material stockpiled at previously registered scrap tire storage sites was reduced by approximately 500,000 STUs. This material went to authorized end users for recycling or to authorized landfills for disposal.
- The TCEQ has laid the groundwork for awarding contracts for the cleanup of the two largest stockpiles at previously registered facilities. If contracts for remediating these sites can be awarded, the total volume of stockpiles at previously registered facilities will begin to be reduced significantly. Completion of this contract work is likely to take several years.
- The TCEQ coordinated the full or partial cleanup of several scrap tire storage sites between 2000 and 2002—Southern Recycling (Houston; 1.6 million STUs), Gibson Recycling (Corpus Christi; 250,000 STUs), Scrap Tire Recycling

[1] A scrap tire unit (STU) equals 20 pounds of scrap tire material, regardless of whether the tires are whole or have been split, quartered, shredded, or processed into some other form. Given the volumes mentioned in this report, it might be useful to note that 10,000 tons of scrap tire material corresponds to 1 million STUs.

(Houston; 150,000 STUs removed; partial cleanup), and Quantum Tech, Inc., (Houston; 65,000 STUs removed; partial cleanup).

- The TCEQ has recalculated the amount of scrap tire material present in several existing stockpiles and has revised its data to more accurately reflect the actual volumes of these stockpiles.
- Two additional cement kilns have been retrofitted to use tire-derived fuel (TDF) and are working with the TCEQ to amend their air quality permits accordingly.
- TxDOT increased its consumption of crumb rubber in the form of crumb rubber-modified asphalt (CRMA) by 19 percent in fiscal 2002, to 16,295 tons versus 13,663 tons in fiscal 2001. This development demonstrated to private industry that there was a significant in-state demand for crumb rubber. However, much of this material came from out of state because Texas had no crumb rubber facilities.
- With the opening of a crumb rubber facility in Baytown in late 2002, it is now possible that a significant portion of the tires scrapped in Texas each year can become crumb rubber. Also, an asphalt plant—an important end user—opened in Big Spring.
- Several TxDOT districts carried out high-profile roadway construction or maintenance projects using CRMA or other scrap tire materials, with great success.
- One TxDOT district carried out a high-profile roadway maintenance project using scrap tire bales to stabilize the roadway slope. While the project involved a relatively small number of tires, this initial effort provided valuable experience in employing a technique that holds promise for a variety of uses. The project stirred considerable interest at a Rubber Manufacturers Association workshop in October 2002.

Although progress has been demonstrated, several obstacles remain, including insufficient funding and, in certain areas, the difficulty of reaching end users or disposal facilities. In addition, newly raised issues such as West Nile virus, along with continuing risks such as fires, heighten the urgency that progress be continued and increased.

When funds appropriated for cleanup of existing scrap tire stockpiles have been exhausted, very limited funding will be available for the maintenance or cleanup of the remaining stockpiles. If the remaining stockpiles are to be eliminated, additional state funding will be required.

Although increasing, the demand for scrap tires is not consistent throughout the state. Illegal scrap tire dumping is more likely to occur in areas that have few end users or disposal facilities. End uses or disposal options still need to be developed in pockets scattered across the state, where neither end users nor landfills are located reasonably close by.

Finally, recent discovery of the West Nile virus has increased concern regarding the control of mosquitoes statewide.

The TCEQ has also taken actions as necessary to ensure that scrap tire generators, transporters, processors, and end users comply with all applicable regulations. These actions include participation in numerous educational or outreach events, coordination with local governments, development of guidance materials, and initiation of investigations and enforcement procedures. An audit report produced in coordination with the Comptroller's Office[2] indicates that these efforts have resulted in improvements in the management of scrap tires.

The TCEQ and TxDOT continue in their joint efforts to develop additional scrap tire markets, working through conferences, meetings, and workshops both across Texas and beyond its borders.

[2] For the complete audit report, see *Tracking the Fate of Scrap Tires in Texas: An Audit Report* (TCEQ publication SFR-078/02).

OVERVIEW

Scrap tire management has been a worldwide challenge, with as many as 281 million used and scrap tires generated in the United States last year. Of that number, 218 million were used or disposed, leaving the remaining 63 million to add to the growing accumulation. Around the nation, states are taking a variety of approaches to deal with this problem:

- 48 states regulate the disposal of scrap tires in some manner;
- 35 regulate tire processors;
- 34 regulate transporters;
- 32 collect fees for scrap tire management;
- 8 have no landfill restrictions;
- 3 subsidize the collection or processing of scrap tires.

Some states provide market incentives for the purchase of products made from recycled scrap tires. Although Texas is one of six states that phased out a tire collection fee, the state still regulates the management and disposal of scrap tires. Texas requires registration for tire collection, transport, processing, and storage and has been actively working to clean up and dispose of all stockpiled tires in the state.

Based on industry estimates, Texans generate 24 million scrap tires each year—a little more than one tire for every person residing in the state. In addition, at the end of calendar 2001, the equivalent of approximately 74 million scrap tires lay on the ground in Texas (see Table 1).

Table 1. Statewide Totals of Scrap Tire Volumes, End of Calendar 2001

Category of site	No. of sites	Volume (STUs*)	Form of material	Details in:
Previously registered facilities	13	67.9 million	Mainly tire shreds; some cut tire pieces; relatively few whole tires.	Appendix A
Known illegal dumps	~150	4.5 million	Mainly whole tires	Appendix B
Registered facilities	14	1.7 million	Varies from facility to facility	Appendix C

*Scrap tire unit. 1 STU = 20 pounds of scrap tire material. This unit of measurement is used because scrap tire material can take many different forms. For large volumes, it is helpful to note that 1 million STUs equals 10,000 tons of scrap tire material.

This accumulation of shredded tires is a carryover from the state Waste Tire Recycling Program, which operated from 1992 through 1997. During that time, the state managed all used tires, charging a $2 recycling fee for every tire replaced on vehicles. The proceeds

were used to ensure that scrap tires were picked up from local businesses and transported to processors for shredding or recycling. The funds were also intended to clean up illegal sites and to help retrofit energy-recovery facilities and reimburse them for using tires as fuel. Because adequate end-use markets did not exist to accept the amount of shredded scrap tire material, millions of STUs of material accumulated in these stockpiles (Figure 1).

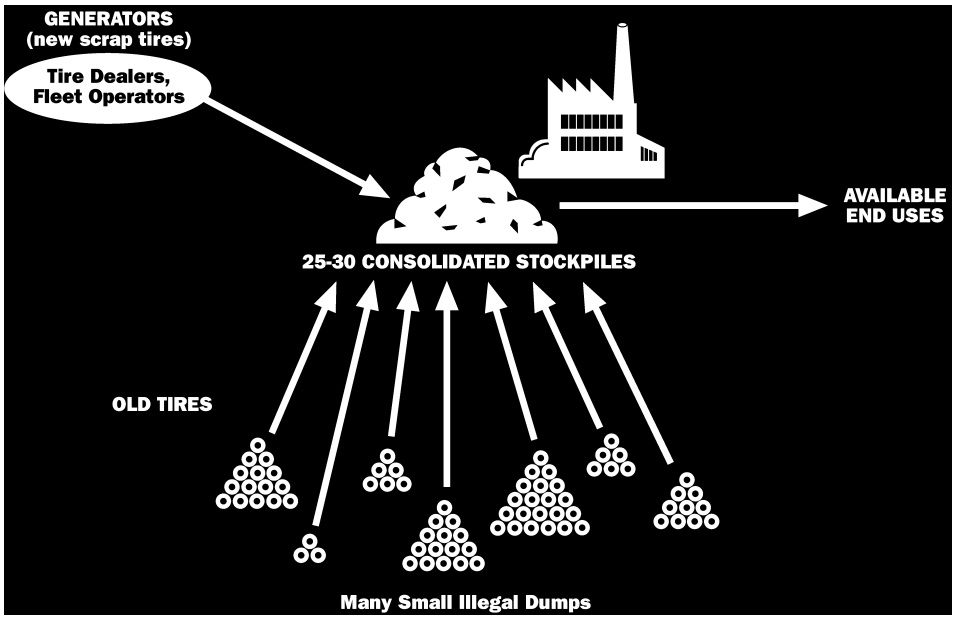


Figure 1. Consolidation of illegal scrap tire dumps into stockpiles of tire shreds under the former Waste Tire Program.

When the tire program sunsetted in 1997, the mandatory fee was dropped, allowing tire dealers to set their own fees. Supply and demand was left to a market-driven system. Since then, this market-driven system has developed into a scrap tire economy (Figure 2, facing page) that, from all indications, is efficiently handling newly scrapped tires. However, end uses or disposal options still need to be developed in pockets scattered across the state, where neither end users nor landfills are located reasonably close by.

Based on 2001 reports, 25.5 million STUs of scrap tire material was consumed by end users or legally placed in landfills—some 1.5 million STUs more than was generated. This was the first time that demand for scrap tires in Texas exceeded the number of scrap tires generated in the same year. To meet this excess demand, end users drew at least some material from stockpiles at previously

registered scrap tire storage sites, reducing the volume of these stockpiles by approximately 500,000 STUs. Registered processors may also be reducing their inventories to meet this demand.

Additionally, the TCEQ coordinated the removal of approximately 2 million STUs from several abandoned stockpiles to authorized end users. Nonetheless, a great deal of scrap tire material remains at the 13 previously registered facilities and approximately 150 illegal dumpsites identified throughout the state.

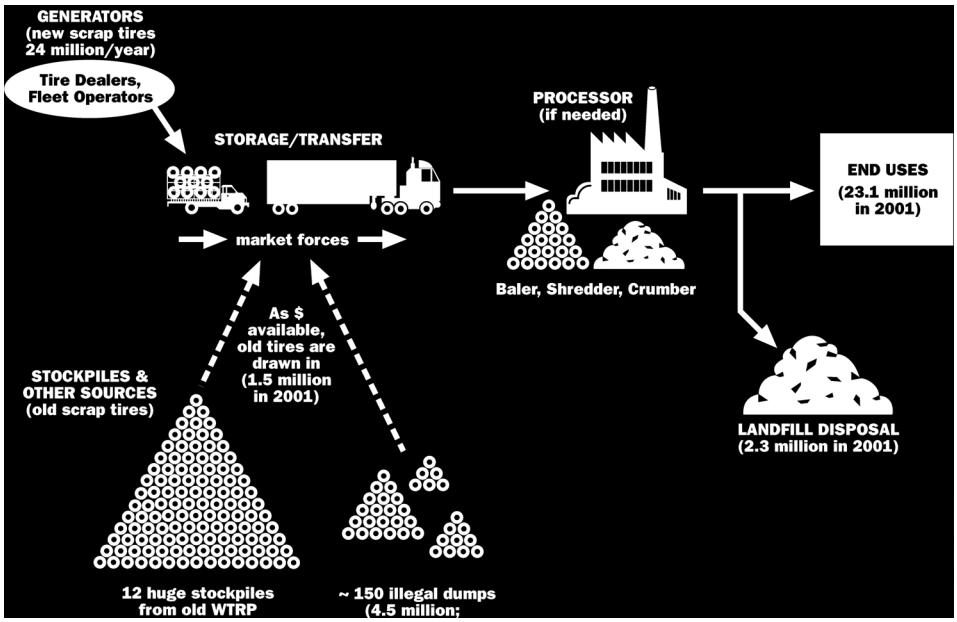


Figure 2. Market forces efficiently draw scrap tires to end uses under system in place since 1998.

Through workshops and other means, TxDOT has continued to promote the use of scrap tires and crumb rubber in roadway construction and maintenance projects. As a result, the use of crumb rubber climbed substantially in 2001, increasing to 7,485 STUs from 2,232 STUs. Additional gains are anticipated with the increased availability of quality crumb rubber, crumb rubber-modified asphalt (CRMA), and asphalt rubber from new processors in the state.

ACCOMPLISHMENTS

Several significant trends or developments during calendar 2002 should improve the scrap tire situation in Texas. These include:

- Continued development of end-use markets

- Addressing the largest scrap tire sites as well as numerous smaller sites, both registered and unauthorized
- Startup of new scrap tire processors in the state (see Appendix D for a list of registered processors)
- Retrofitting of additional cement kilns for TDF use
- Improved data and compliance with regulations concerning stockpiled scrap tires
- Greater use of scrap tire materials in roadway construction and maintenance projects
- Additional educational and outreach events

Developing End-Use Markets

Demand for scrap tires is growing for energy, civil engineering, land reclamation, and other applications. End-use markets have continued to develop and, for the first time in Texas tire program history, the volume of scrap tire material reported as consumed by end users or disposed of legally exceeded the number of scrap tires generated. The volume of material reported as consumed in calendar 2001, the most recent year for which end-use data is available, increased approximately 23 percent, from 18.8 million STUs in calendar 2000 to 23.1 million STUs in calendar 2001. This 4.4-million-STU increase helped reduce legal disposal by 31 percent, or 1.1 million STUs (from 3.4 million STUs in 2000 to 2.3 million STUs in 2001). This promising development bodes well for the reduction of existing stockpiles.

The end-use categories are explained below in order from largest to smallest. Figure 3 illustrates each category's contribution to consumption of scrap tire material in 2001. For total consumption by each end use each of the last three years, see Appendix E.

Tire-Derived Fuel (TDF)

The largest single use for scrap tires in Texas is tire-derived fuel. Whole and shredded scrap tires have been used as a fuel source by industries in the United States, Europe, and Asia for a number of years. Use in Texas has increased steadily since 1995, accounting for approximately 44 percent (11.2 million STUs) of the scrap tires consumed in 2001.

Scrap tires have properties that make them viable alternative fuel sources for certain industries. Due to their intensive fuel requirements, cement kilns, electric utilities, and pulp and paper mills have been the main users of TDF. While images of billowing

black smoke associated with the open burning of tires may come to mind, this is not at all the case when tires are burned in the properly controlled, high-temperature combustion environments typical of these industries.

The TCEQ has evaluated the scientific data on the use of TDF and concluded that tires can be safely burned as fuel, provided proper emission control devices are used. Having reached the same conclusion, a number of other state environmental programs and the Environmental Protection Agency (EPA) have approved the use of TDF as a fuel source. Support for this conclusion comes from the review of a number of national studies of air emissions from burning TDF. Independent of this review, the TCEQ has required smokestack testing for facilities seeking to burn TDF in Texas and has conducted air and soil monitoring in areas where TDF was in use. These efforts have helped to further establish the use of TDF as an acceptable alternative to fossil fuels. For summaries of these studies and recent information on facilities already using TDF, see Appendix F.

Nine facilities, most of them cement kilns, are presently equipped and permitted to use whole or shredded scrap tires as a partial fuel source. Additionally, a significant amount of TDF was sent out of state.

Two cement kilns that have not previously used scrap tires as fuel have retrofitted their kilns and are now conducting final trial burns and completing the permitting process. Each of these kilns is expected to use approximately 2 million whole tires per year as fuel.

The amount of TDF consumed by end users is projected to increase an additional 3 to 8 million STUs (from calendar 2001 consumption levels) by the end of calendar 2003 due to potential increased demand from existing and new TDF users. Now that demand for scrap tire materials is outpacing scrap tire generation, the expected increase in demand must compete with other end uses, lead to the removal of scrap tires from existing stockpiles, or both.

Civil Engineering Projects in Landfills

The second largest use category for scrap tires in Texas is civil engineering applications in landfills. The consumption rate for this category has remained constant for the past several years and accounted for approximately 20 percent (5 million) of the scrap tires consumed in 2001; it could decrease slightly in 2003.

The vast majority (approximately 99 percent) of scrap tires used in landfill civil engineering projects were shredded to a size specification and used as drainage media in landfill leachate collection systems. Scrap tire shreds or chips[3] were used in place of the gravel normally used in the leachate collection systems. Limited amounts of shredded or chipped scrap tire material were also used in lieu of soil for daily waste cover material.

Land Reclamation Projects Using Tires (LRPUTs)

In areas that have been strip-mined or mined for sand and gravel, a 50:50 mixture of tire pieces and soil can be used as fill material to reclaim the mined area. Shredded scrap tires have routinely been used as fill material in civil engineering and reclamation projects for a number of years. The TCEQ has evaluated the scientific data and has concluded that scrap tires can be safely used in engineering and reclamation projects.

Field studies indicate that tire shreds appear to have a negligible effect on groundwater quality and pose minimal risk of fire when certain design and placement standards are followed.

There are currently 6 LRPUTs operating in the state. The number of scrap tires consumed by these projects increased significantly in 2001 due to startup of a new LRPUT in Houston. This category accounted for approximately 18 percent (4.6 million) of the scrap tires consumed in 2001. The amount of scrap tire material consumed by this category is expected to decrease by the end of 2003 due to loss of volume to TDF users. In locations where

[3] When tires are shredded, the resulting pieces range widely in size. Tire chips are produced under conditions to control the size of the final pieces, which are typically either 2" by 2" or 3" by 3".

LRPUTs and TDF are competing end uses, TDF is typically the economically favorable option for the scrap tire processor.

Landfill Disposal

Scrap tires may be disposed of as waste in municipal solid waste landfills provided they are split, quartered, or shredded. Although disposal cannot be considered a true end use, the TCEQ believes disposal facilities provide a necessary scrap tire management option in areas where few end users exist. This category accounted for approximately 9 percent (2.3 million) of the scrap tires consumed in calendar 2001. The amount of scrap tire material consumed by this category is expected to remain constant or decrease slightly by the end of calendar 2003.

Drainfield Fill for Septic Systems

Tire shreds provide good filter material and can be used in place of gravel in drainfields of septic systems. This category accounted for approximately 2.5 percent (672,000) of the scrap tires generated in Texas in 2001. The amount of scrap tire material consumed by this category is expected to remain constant or slightly decrease by the end of 2003.

Crumb Rubber

Finely ground tire rubber can be used to modify asphalt, and to manufacture traffic control devices, rubberized lumber, soft playground surfaces, running tracks, synthetic sports turf, rubber mats, and other products.

Consumption in this category accounted for only 7,485 of the scrap tires that were generated in Texas in 2001. Because there were no Texas facilities producing crumb rubber from scrap tires in 2001, virtually 100 percent of the 1.6 million STUs of crumb rubber consumed by TxDOT was obtained from out-of-state sources.

However, a TDF plant in Baytown added a new crumb rubber unit that began operating in 2002 and is now capable of processing scrap tires at the rate of 5.5 million per year and increasing. Plant owner Recovery Technologies Group, Inc. (RTG), the largest crumb rubber producer in North America, supplies customers both inside and outside the state. RTG, which plans to open another facility in Dallas, expects the Baytown plant to produce 20,000 tons of crumb rubber in its first year, along with 40,000 to 50,000 tons of TDF. With new processing capability and a growing level of use in roadway construction and maintenance in the state, the

amount of material consumed in this category is expected to increase significantly by the end of 2003.

In addition, an end user for crumb rubber opened its doors in Big Spring in 2002. ALON USA will ally with Wright Asphalt Products Company to produce asphalt products incorporating crumb rubber for use in roadway maintenance projects, at ALON USA's refinery in Big Spring. Wright Asphalt created the first commercially successful paving-grade terminal-blended CRMA line of products in the country, including tire-rubber-modified asphalt cement (TRMAC) and liquefied tire rubber (LTR). Wright, which operates in eight states in the West and Midwest, will be responsible for marketing the products to contractors in West Texas and New Mexico.

Other End Uses

Scrap tire material can be put to a variety of other end uses—agricultural applications (agricultural vehicle wheels and silage cover weights), highway and road products and uses (tire rings, culverts, and traffic weights), and other miscellaneous uses (tire bales, shooting berms, and artificial reefs). For example, TxDOT used 36,000 whole scrap tires in compressed bales to stabilize a slope failure in its Fort Worth District. This project is described in detail on page 12.

This category accounted for approximately 6.5 percent (1.6 million) of the STUs consumed in calendar 2001. The amount of scrap tire material consumed by this category is expected to remain constant through the end of calendar 2003.

The TCEQ's Progress on Scrap Tire Stockpiles, Data, and Compliance

The TCEQ was awarded $7.5 million through Senate Bill 1, Article VI, Rider 35, 77th Texas Legislature,"Waste Tire Disposal Grants," to address stockpiles. The TCEQ has been working to award contracts to remediate some of the largest stockpiles. If these contracts can be awarded, the volume of stockpiled tires in Texas could be reduced significantly over the next several years.

In addition, data on stockpiled material have been improved. The TCEQ reviewed information for all previously registered scrap tire sites and, where necessary, revised stockpile data to more

accurately reflect the actual stockpile volumes. These revisions were based on field measurements or new data received. Appendix A to this report shows the revised volume for each affected site. The volume of scrap tire material stockpiled at previously registered scrap tire storage sites was reduced by approximately 500,000 STUs, or approximately 1 percent of the material in these stockpiles. In the last year, the TCEQ coordinated the removal of approximately 2.0 million scrap tires from other abandoned sites.

The TCEQ has also taken actions as necessary to ensure that scrap tire generators, transporters, processors, and end users comply with all applicable regulations. These TCEQ actions include participation in numerous educational or outreach events, coordination with local governments, development of guidance materials, and initiation of investigations and enforcement procedures.

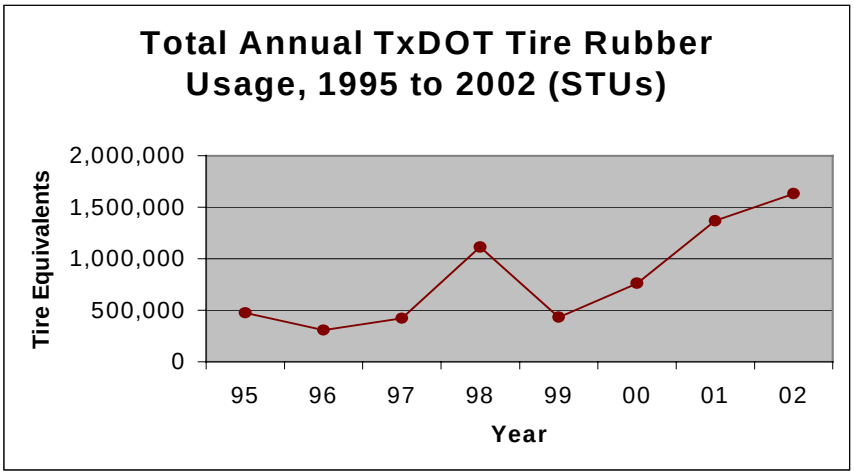
Recent TxDOT Scrap Tire Usage in Roadway Construction and Maintenance

Over the past fiscal year[4], TxDOT has significantly increased its consumption of scrap tires in several forms, primarily using crumb rubber-modified asphalt in roadway construction and maintenance projects. In fiscal 2002, TxDOT used 16,295 tons of crumb rubber (1.6 million STUs) versus 13,663 tons (1.4 million STUs) in fiscal 2001. (See Figure 3 below.)

Several projects, including preventive maintenance projects in El Paso and San Antonio, have been completed recently with excellent results. These projects contributed to an increase of 20 percent in TxDOT's use of crumb rubber and whole scrap tires in fiscal 2002.

Although essentially 100 percent of the crumb rubber used in TxDOT projects in the past was obtained from outside the state, future projects will likely draw on the supply of crumb rubber that will now be processed within the state through in-state crumb rubber producers.

Figure 3. Total Annual Scrap Tire Usage by TxDOT from 1995 to 2002



[4] TxDOT collects data on a fiscal year basis (September through August), whereas reports received by the TCEQ cover the calendar year.

El Paso District: CRMA and Maintenance Longevity

During 2001 and 2002, the El Paso District carried out a progression of projects using a variety of crumb rubber-modified asphalt (CRMA), ultimately setting a record for total scrap tire equivalents used by a TxDOT district. Beginning in 2001, El Paso District staff identified a number of roads to be treated with a seal coat followed by a porous friction course (PFC), and in 2002 a seal coat was applied districtwide. Together, these projects have provided the district a comprehensive and effective preventive maintenance approach. The district anticipates that the project will extend the pavement durability two to five years beyond the normally expected seven-year maintenance lifespan. Over the course of this treatment, the El Paso District recycled an estimated 805,000 discarded tires and extended the life of more than 700 miles of roadway. This total set a record for the most tons of scrap tire equivalents used in a hot asphalt rubber seal coat project. (See Appendix G.)

San Antonio District: Crumb Rubber in Pavement

A recent San Antonio project using crumb rubber has produced very positive results. A stretch of continuous reinforced concrete pavement (CRCP) on Interstate 35 north of San Antonio was highly distressed and cracked, resulting in a rough, noisy ride. These conditions, untreated, would have sped up the aging of the pavement and weakened its structural integrity. To address these problems and to provide a smooth and safe road for the public, the district decided on construction of a permeable friction course (PFC) layer on top of the existing CRCP. PFC consists of an open-graded asphalt concrete containing a large portion of one-sized aggregate, resulting in a large void content that permits water to drain laterally out to the shoulder.

In addition to improving skid resistance and preventing hydroplaning, PFC improves visibility of pavement marking compared to CRCP and reduces tire splash and spray. The subsequent noise reduction and improvement in ride quality resulting from the use of asphalt rubber have won over some former skeptics.

According to preliminary evaluation data, measurable improvements were found in noise reduction, ride smoothness, and other factors. Noise measurements after PFC application showed an average reduction of 11.6 decibels on the southbound lane and 17.1 decibels on the northbound lane. Increased ride smoothness was demonstrated by a reduction in the International Roughness Index (IRI) from 201 to 79 southbound and from 203 to 80 northbound.

Fort Worth District: Tire Bales in Embankments

TxDOT continues to experiment with, document, and evaluate innovative ways of using scrap tires in highway construction and maintenance applications. The Fort Worth District investigated the use of baled scrap tires during fiscal 2002 as a repair method for slope failures resulting from higher than normal rainfall in the area.

The twofold goal was to: (a) provide an alternative to the use of the I-beam/metal beam guard fence repair method, and (b) find another useful way to recycle scrap tires. A slope failure site was identified on Interstate 30 east of Fort Worth. The project was carried out in several phases between February 2002 and August 2002, using a total of 360 tire bales containing on average 100 scrap tires per bale, for a total of approximately 36,000 scrap tires. The bales weighed approximately 2,000 pounds each and were either vertically or horizontally compressed and bound into shape with steel straps. Once the failed slope was excavated, the bales were laid in layers, with soil graded over each layer after placement. (See Appendix H for pictures and additional details.)

Once all of the tire bales were in place, the bales were completely covered with soil and the surface built up and shaped to match the surrounding slope. The slope was then spread with compost and seed to stimulate vegetation growth in order to minimize future surface slope erosion. In spite of the nearly 50 inches of rain that fell after the initial tire bale placement, preliminary analysis revealed that the use of tire bales instead of the original soil slope had improved the factor of safety as much as threefold.

While this particular kind of application uses relatively few scrap tires, the project is important in demonstrating the capacity to find useful new ways to deal with scrap tire accumulations, as well as

offering effective solutions to difficult roadway engineering problems. Results are being documented and the experience is being used to formulate engineering specifications to facilitate similar projects in the future. At a scrap tire workshop sponsored by the Rubber Manufacturers Association, the Fort Worth tire bale project proved to be a topic of considerable interest.

Continuing Efforts in Market Development

TxDOT continues its joint efforts with TCEQ and with industry partners to develop additional scrap tire markets, and to promote crumb rubber uses to highway construction personnel through multiple means, including participation in conferences, meetings, and workshops both across Texas and beyond its borders. Working with the Rubber Pavement Association, TxDOT has been involved in carrying out a series of workshops on asphalt rubber pavement, including sessions in Amarillo, Atlanta, Corpus Christi, Dallas and Houston. The TCEQ will lead, and TxDOT may participate in, workshops along the international border with Mexico to address problems and present opportunities specific to that area. In addition, discussions are under way regarding possible Federal Highway Administration funding for other projects, including educational materials documenting successes using scrap tires and CRMA.

CONTINUING ISSUES

Although developments during 2001–2002 have improved the scrap tire situation in Texas, challenges and obstacles remain. Insufficient funding and, in some areas, a lack of infrastructure continue to pose major challenges. In addition, newly raised issues such as West Nile virus heighten the urgency to reduce stockpile volumes.

When funds from Senate Bill 1, Article VI, Rider 35, 77th Texas Legislature, for cleanup of existing scrap tire stockpiles have been exhausted, very limited funding will be available for the maintenance or cleanup of the remaining stockpiles. Additional

funding will be necessary if the state is to eliminate the remaining stockpiles. Funding is also an issue affecting decisions on using crumb rubber in roadway construction.

Although annual end user demand for scrap tires now exceeds the annual scrap tire generation rate, demand for scrap tires is not consistent throughout all areas of the state. Areas with no conveniently located landfills or end users tend to have a higher incidence of illegal scrap tire dumping. Additional end user development is needed in some regions so that practical end use or disposal options are available statewide.

Spread of the West Nile virus has increased concern regarding the control of mosquitoes statewide.

Numerous factors go into decisions about materials used in roadway construction and maintenance, including weather, traffic, timetables for other construction and maintenance in the area, and funding, among others. Funding issues pose an ongoing challenge to TxDOT and its district engineers since TxDOT currently receives approximately 36 percent of the funds needed to perform the required construction and maintenance of state transportation systems.

The use of crumb rubber-modified asphalt in roadway projects often can cost more initially than the use of more traditional materials. Long-term costs may be lower due to durability and reduced maintenance costs. However, with funding at a premium, a decision to select a more expensive alternative for one project may mean that other projects face delays for lack of funding. So the cost of choosing to use a particular product will always be a critical factor.

Nevertheless, some TxDOT districts are beginning to evaluate crumb rubber applications from the perspective of life cycle cost analysis, which takes into account long-term maintenance cost factors to counterbalance higher initial costs.

If the cost of projects can be figured over a longer period, the reduced maintenance costs that have been found with CRMA surfaces can be factored in, and the cost of such projects falls more in line with, or may even improve on, other more traditional methods.

Using a highway life cycle cost approach may offer promise as it provides a means of assuring value for the taxpayer dollars spent on highway construction and maintenance. TxDOT's El Paso

District estimated that its use of a preventive maintenance procedure involving crumb rubber would cost an average of $78.15 less per lane mile than the traditional asphalt seal coat. This estimate was based in part on life cycle cost analysis. The calculation took into account reduced maintenance needs due to the longer life span of 9 to 12 years for crumb rubber seal coat compared to approximately 7 years for the regular seal coat.

A new version of the TxDOT construction specifications will incorporate the option of using a crumb rubber-based PFC as a routine rather than special option. While the new wording allows an either-or approach, it still accords the recycled material the status of a standard rather than special material.

CONCLUSIONS

While significant challenges remain, progress in addressing scrap tires continued during fiscal 2001 and 2002. Developments during the past calendar year promise further improvement during the upcoming year.

Ongoing challenges provide action steps for future progress:

- The need for funding of cleanup efforts will continue to be a very high priority.
- Remaining challenges include a need for funding for the cleanup of existing scrap tire sites, the need for increasing the availability of end users and disposal facilities in certain areas, and managing the risks of fires in tire stockpiles and West Nile virus.

Positive developments include:

- Scrap tire consumption is increasing and has overtaken the number of scrap tires generated for the first time in TCEQ Tire Program history.
- The TCEQ has laid the groundwork for awarding contracts for the cleanup of the two largest stockpiles at previously registered facilities. If contracts for remediating these sites can be awarded, the total volume of stockpiles at previously registered facilities will begin to be reduced significantly. Completion of this contract work is likely to take several years.
- The volume of scrap tire material stockpiled at previously registered scrap tire storage sites was reduced by approximately 500,000 STUs by removal to authorized end users for recycling or to authorized landfills for disposal.
- The TCEQ coordinated the full or partial cleanup of several scrap tire storage sites between 2000 and 2002, representing a total of some 2 million scrap tires.
- Production infrastructure is improving, most notably with the addition of the RTG crumb rubber unit in Baytown, the Big Spring asphalt plant, and the retrofitting of additional cement kilns for TDF.
- TxDOT increased its use of scrap tires significantly.
- TxDOT has drafted a new version of the construction specifications manual that will incorporate the option of using a crumb rubber-based PFC as a routine rather than special option.

Appendix A: Stockpile Volumes at Previously Registered Facilities, End of Calendar 2001

Facility Name	City	County	TCEQ Reference Number	Stockpile Volume (in Scrap Tire Units*)	
				2000	2001
ERRI/TCI**	Stamford	Haskell	44114 44150	14,500,000	14,500,000
Nathaniel Energy Corporation***	Hutchins	Tarrant	44115	1,468,138	1,468,138
Touche International**	Whitesboro	Grayson	–	300,000	300,000
Gibson Recycling, Inc.	Atlanta	Cass	44072	29,823,360	29,823,360
Tres Pesetas, Inc.	El Paso	El Paso	79030	0	5,360
Safe Tire Disposal Corp.	Penwell	Ector	44103	5,023,711	4,984,464
Gibson Recycling, Inc.	Beaumont	Jefferson	79508	2,048,100	2,048,100
Safe Tire Disposal Corp.	Cleveland	Liberty	44109	4,988,284	4,551,892
Scrap Tire Recycling, Inc.**	Pasadena	Harris	44096	1,950,000	1,800,000
Quantum Tech, Inc.**	Houston	Harris	44105	124,800	60,000
American Tire Recycling**	San Antonio	Bexar	79019	850,000	850,000
Safe Tire Disposal Corp.	San Antonio	Bexar	44107	6,368,737	6,507,576
World Tire Recycling**	Brownsville	Cameron	44147	1,000,000	1,000,000
Total				**68,445,130**	**67,898,890**
Change, 2000 to 2001					**– 1%**

* One scrap tire unit equals 20 pounds of scrap tire material. 1 million STUs equals 10,000 tons of scrap tire material.

** The TCEQ estimated the number of STUs in these stockpiles. All other values were obtained from annual reports.

*** Data for Nathaniel Energy Corporation for 2000 were estimated based on 2001 report.

Appendix B: Known Illegal Tire Dumps in Texas

If you are interested in cleaning up one of these known tire dumps or if you can update the information on any dump listed in this table, call the TCEQ Tire Program at 512/239-2515.

County	Site Name	TCEQ Identification Number	Estimated No. of Tires
Amarillo area (TCEQ Region 1)			
Gray	Larry Fulton	70155P	20,000
	James I. Shaw	70517P	6,000
Potter	Franklin Gilley	70510P	2,000
	Robert Parker	70514P	1,500
	I-40 Trading Center	70724P	600
	Sell Farm Supply	70784P	3,500
Lubbock area (TCEQ Region 2)			
Lubbock	North Quacker Wrecking	70341P	15,000
Abilene–Wichita Falls area (TCEQ Region 3)			
Archer	Bennett Williams Stone	70757P	2,000
Brown	Jet Hays	70181P	1,000
	Doyle Smith Tire Site	70915P	2,825
Callahan	Buddy Lackey	70263P	1,200
Clay	Charles Ridinger	70070P	1,000
Dallas–Fort Worth area (TCEQ Region 4)			
Cooke	Lisa Bellows	70940P	2,000
Dallas	Calabrin Properties	70032P	400
	Dallas County - Post Oak	70623P	22,000
	Dallas Baptist University	70858P	1,500
	Steve and John Roten	70867P	1,700
	City of Dallas (Locust Drive)	70873P	1,000
	Kirnwood Drive	70917P	750

Appendix B: Known Illegal Tire Dumps in Texas (continued)

County	Site Name	TCEQ Identification Number	Estimated No. of Tires
Denton	DFW Adventure Park	70941P	515
Ellis	A. J. Scott	70868P	650
Erath	Jack Berry	70447P	4,000
Hood	Judy Knudsen/Equibrand	70944P	1,000
Kaufman	Wayne Gilcrease	70895P	4,000
	Tarrant County Water District	70895P	4,000
	Virrel P. Robertson	70934P	6,000
Navarro	Arvin Lee Blaylock	70693P	600
Palo Pinto	Donna/ Marjorie/ Clifford	70723P	650
	Floy Graham	70846P	2,500
	Guy Montgomery	70854P	2,500
	Erwin Scutz	70876P	500
Parker	J. B. White	70559P	3,000
	Ervin Crane	70628P	3,000
	Dorothy Holland	70819P	--
	David and Joan Garner	70845P	3,000
	Grace Cartwright	70852P	4,000
	Clouse/Aorrow	70888P	2,500
	Gloria Drive	70945P	5,000
	Highland Ranch	70946P	50,000
	Belle Rich/Little Silver Creek	70947P	2,000
	Franklin Gilley	70510P	2,000
Somervell	Scottie Tudor	70419P	12,800
Tarrant	James Knapp, Jr.	70014P	600
	Sam E. Bishop	70016P	20,000
	Riverside Land	70367P	500
	Wet-N-Wild	70887P	1,500
	Olivia Mckenzie	70889P	1,000

County	Site Name	TCEQ Identification Number	Estimated No. of Tires
Wise	Joe and Renee Thrasher	70735P	2,300
	James Holder	70787P	9,000
	David McClendon	70820P	3,500
	Zelma Smith	70823P	2,500
	Billy and Lori Hwell	70824P	1,000
	Pike	--	2,000,000
Tyler-Longview area (TCEQ Region 5)			
Anderson	Shirley Irvin/Auria Wooldridge	70764P	1,500
	Gene Gilley	70769P	800
El Paso area (TCEQ Region 6)			
El Paso	PSB Site	70859P	2,500
Midland-Odessa area (TCEQ Region 7)			
Andrews	Hill	70771P	3,000
Dawson	Walton	70722P	2,000
Ector	Jones and Cupp Dirt	70567P	1,000
	Beason	70794P	600
Howard	Lloyd Property	70783P	1,300
Midland	Robert D. Hilliam	70828P	653
Ward	John Forrister	70782P	1,000
San Angelo area (TCEQ Region 8)			
Crockett	J.B. Miller Ranch	70379P	12,000
Sutton	Hooper Trucking	70352P	1,000
Tom Green	Nauman Acres	70312P	600
Waco area (TCEQ Region 9)			
Bell	Calvin Kraemer	70253P	5000
	Belton Lake Recreational Area	70808P	6,000
	Mickey and Jewel Herzog	70829P	600
Bosque	William T. Clarke	70918P	2,000
	Linda Roberts Site	70931P	2,000

Appendix B: Known Illegal Tire Dumps in Texas (continued)

County	Site Name	TCEQ Identification Number	Estimated No. of Tires
Coryell	F.L. Brown	70683P	1,300
Grimes	Donald Klodzinski	70809P	5,000
Hill	L.C. & Mary Johnson	70806P	5,000
Madison	P.M. Standley	70936P	3,000
McLennan	John Holder	70772P	300
	Frank Muhl	70901P	1,000
Robertson	Kevin Hurst	70807P	2,000
	Daniel Joseph Konieczka	70921P	4,000
Beaumont–Port Arthur area (TCEQ Region 10)			
Jasper	Temple Inland Sanders	70458P	2,000
	Kirbyville Unit #2	70625P	10,000
Jefferson	Everett McPike	70088P	50,000
	Port Acres	70459P	1,500
Newton	Bleakwood	70399P	1,000
Austin area (TCEQ Region 11)			
Bastrop	Jones & Son	70067P	2,500
Blanco	Reeves	70407P	10,000
Caldwell	Holdstrom	70739P	5,000
Fayette	Petrash Lot	70738P	1,100
Hays	Dahlstrom Lower Yard	70810P	700
	Rosa Lena Collins Property	70884P	6,000
	Phillip Koch Property	70894P	800
Travis	Walnut Hollow Business Park	70157P	2,500
	Bertucci Lot	70500P	1,500
	Lance Crabtree	70503P	2,000
	Crider Lot	70547P	3,000
	Cameron Road Tire Dump	70682P	10,000
	Garrett Ranch	70697P	2,000
	Butler Warehouse	70721P	7,000

County	Site Name	TCEQ Identification Number	Estimated No. of Tires
Travis (cont.)	Steve Mendoza Property	70850P	2,000
	City of Austin Police Department	70880P	2,000
	Creighton Property	70905P	2,000
	Walnut Creek WWTP Outfall	70927P	3,000
	Shriner/Ben Hur Shooting Range	70933P	1,300
	Ann Lopez Property	70948P	800
Houston-Galveston area (TCEQ Region 12)			
Austin	E.L. Newton /All Tread Tire	70101P	100,000
	Haley Site	70811P	5,000
Brazoria	Ehman	70861P	2,000
Chambers	Mason	70310P	2,500
Colorado	Deborah Kay	70464P	2,000
	Parr Site	70904P	2,000
	Prause	70937P	2,500
Fort Bend	Felton McCook	70100P	700
	Roy Wendell Harper	70375P	2,000
	Boss Gaston	70570P	2,000
	Klaus Maier	70930P	1,200
Harris	Joe Tinkle Estate	70023P	900
	David T. Bacot	70106P	30,000
	Western Equities	70246P	36,000
	Market Street	70374P	1,200
	Conklin	70376P	2,000
	Jackson Lee	70463P	600
	Airtex	70530P	1,700
	Strawn Street	70576P	2,000
	Swanner	70652P	600
	Howton Two	70654P	600
	Bender Road	70669P	8,000

Appendix B: Known Illegal Tire Dumps in Texas (continued)

County	Site Name	TCEQ Identification Number	Estimated No. of Tires
Harris (cont.)	Verbosky	70673P	30,000
	Bisbee Street	70684P	600
	Schaff Place	70685P	600
	Greens Bayou	70686P	700
	N. Houston Rosslyn	70740P	1,000
	Industrial Road	70742P	2,000
	Falco	70743P	1,000
	American Pipe Inspection	70792P	1,500
	Feed Processors, Inc.	70926P	3,000
Liberty	Melvin Lowe	70097P	5,000
	South Liberty Oil Field	70172P	3,000
	Floyd Lowe	70830P	3,000
Montgomery	Briscoe L. Cook	70039P	500
	Harran	70645P	600
	David Sammons	70831P	1,000
	Bobby Yancy	70885P	1,000,000
Walker	Robinson	70774P	800
	Nettles	70775P	2,000
	Baker	70776P	800
Waller	Nicleberry Tire Recycling	--	10,000
San Antonio area (TCEQ Region 13)			
Atascosa	D.E. Hoyes	70907P	2,900
Bexar	Laurence Irvine	70048P	500,000
	Ballas and Lucci	70115P	3,000
	Redland Stone Products	70229P	--
	Roth	70851P	2,000
	S.A.W.S. – Bill Miller Tract	70892P	1,500
	E. Haverlah	70909P	2,800
	Jay Warriner	70922P	1,000

County	Site Name	TCEQ Identification Number	Estimated No. of Tires
Bexar (cont.)	B.L. Lifshutz, Trustee	70924P	5,000
	Habitat for Humanity	70935P	3,000
Gillespie	Eckhardt Ranch	70862P	2,000
Karnes	Krawietz	70816P	1,500
Wilson	Pundt Property	70912P	4,500
Corpus Christi area (TCEQ Region 14)			
Bee	Castilla's Garage	70382P	1,500
Jackson	Bobby Davenport	70779P	4,000
Refugio	Laura Custer c/o Joe Custer	70677P	5,000
San Patricio	Abraham Perez	70752P	2,450
Brownsville area (TCEQ Region 15)			
Cameron	David Jones	70313P	2,500
	Texmex Mercantile	70932P	50,000
Hidalgo	Javier Ulloa	70215P	8,000
Laredo area (TCEQ Region 16)			
Duval	Duval County Landfill	70393P	11,000
Webb	Juan M. Leven	70153P	21,000
	Barbosa	70493P	20,000
Total			**4,377,193**

Appendix C: Inventories at Registered Facilities, End of Calendar 2001

Facility Name	City	County	Reference Number	Inventory*, End of 2001
Thoshanowasti	Amarillo	Randall	79544	21,577
Lubbock Waste Tire Recycling	Lubbock	Lubbock	79540	92,321
Holnam Texas LP, Corp.	Midlothian	Ellis	66900	21,205
North Texas Cement Company	Midlothian	Ellis	76905	75,112
Safe Tire Disposal Corp	Midlothian	Ellis	79504	897,578
Acme Tyre Company	Atlanta	Cass	79539	32,400
Texas Lehigh Cement	Buda	Hays	76904	505
Dearth Brothers, Inc.	Houston	Harris	79555	3,200
Donohue Industries Incorporated	Houston	Harris	76903	170,550
J&J Used Tires	Houston	Harris	--	600
La Porte Tire Center	La Porte	Harris	6025572	456
RTG of Texas, Inc	Baytown	Harris	6044095	52,268
J & M Truck Tire Shop, Inc.	San Antonio	Bexar	79543	309,156
Texas Industries, Inc.	New Braunfels	Comal	76902	50,801
Total				**1,727,729**

* In scrap tire units (STUs). One STU equals 20 pounds of scrap tire material.

Appendix D: Registered Scrap Tire Processors

To find the address or physical location of any one of these facilities, go to the TCEQ Web site, look in the "Waste" Subject Index for "Tire Registrations," and then look on that page for the link to "Scrap Tire Registration Database Query."

City	Name of Facility	Facility ID
Alvarado	Thank You Tire Co	6013303
Amarillo	Thoshanowasti	79544
Amarillo	Tascosa Tire & Recycling	6027067
Atlanta	Acme Tyre Company	79539
Austin	A & G Tires & Wheels	6200090
Austin	Recycled Rubber Mats	79550
Balch Springs	RTCS LLC	6076401
Baytown	Waste Recovery Inc	79503
Cleveland	Safe Tire Disposal Corp	79507
Corpus Christi	Island Industries	79545
Dayton	Aarons Tire Repair & Service	6015724
El Paso	Tres Pesetas Inc	79030
Fort Worth	Texas Department of Transportation	6200081
Houston	American Tire Disposal Co	6026988
Houston	CATSCO of Texas Inc	6027088
Houston	Dearth Brothers Inc	79555
Huntington	Huntington Tire Company	6200121
Hutchins	Nathaniel Energy of Texas	6044115
Lubbock	Lubbock Waste Tire Recycling	79540
Marble Falls	DWI Hobby Shop	79548
Midlothian	Safe Tire Disposal Corp	79504
Mineral Wells	Real Deal Recycling	79546
New Ulm	J & J Tire Salvage	6026754
Paris	C & S Environmental Tire Salvage	6026701
Penwell	Safe Tire Disposal Corp	79505
Port Arthur	Alamo Service Station	6200102
San Antonio	Cameron Land & Cattle Company	79547
San Antonio	Safe Tire Disposal Corp	79506

City	Name of Facility	Facility ID
San Antonio	H & H Tire Shop	6026600
San Antonio	J & M Truck Tire Shop Inc	79543
Stephenville	Erath Recycling	6012926

Appendix E: Summary of End Uses of Scrap Tires, Calendar 2001

End Use Category	Consumption (Scrap Tire Units*)			Change from 2000
	1999	2000	2001	
Recycling End Uses				
Tire-Derived Fuel	9,239,374	9,022,566	11,179,401	+24%
Civil Engineering Projects in Landfills	4,969,924	4,990,474	5,019,091	+.5%
Land Reclamation Projects Using Tires	837,786	2,621,779	4,639,575	+77%
On-Site Septic Facilities	1,177,954	756,019	672,146	-11%
Crumb Rubber	1,047,618	2,232	7,485	+235%
Other	1,617,917	1,400,338	1,592,197	+14%
SUBTOTAL	18,890,573	18,793,408	23,109,895	+22%
Landfill Disposal	**1,445,970**	**3,393,679**	**2,338,574**	**-31%**
TOTAL	**20,336,543**	**22,187,087**	**25,448,469**	**+15%**

*Each 20 pounds of scrap tire material equals onescrap tire unit (STU).

Appendix F: Experience with Tire-Derived Fuel

The TCEQ has drawn from the experiences of other states and the EPA and has conducted its own specific studies in Texas to determine whether TDF can be burned in a manner that is fully protective of public health. The results of these investigations and the experience of facilities already using this fuel indicate that TDF presents a real alternative to other fuel choices.

Summaries of Relevant Studies

1991 EPA Review of TDF

The EPA conducted a review of U.S. facilities that were burning TDF. This analysis concluded that TDF could be burned in an environmentally sound manner, with overall emissions consistent with the burning of fossil fuels such as coal. In fact, of all electric utilities surveyed, the Oxford Energy facility in California reported the lowest overall emissions despite burning 100 percent TDF. The EPA recognized that appropriate emission control devices are important when burning TDF, and these devices are commonly required by the TCEQ in granting air permits to burn TDF.

1994/1997 EPA Pilot Studies

The EPA performed several pilot studies in which tires were burned in a test incinerator, absent any emission control devices. The studies found that, with the exception of zinc (which is a component of tires), emissions were not increased when tires were substituted for coal as fuel. Air emission control devices would have likely minimized any zinc emissions. Further, emissions of several important constituents (for example, mercury) were significantly decreased when using TDF.

TCEQ Smokestack Testing

As part of the permitting process, the TCEQ required smokestack testing on several cement kilns that were proposing to supplement their fuel with TDF. Emissions when burning TDF were consistent with emissions from coal and were below levels of concern from a health standpoint.

TCEQ Ambient Air Testing

In 1996, to address local community concerns, TCEQ conducted extensive ambient air monitoring downwind of a cement kiln that was seeking a permit to supplement its fuel with TDF. All

constituents were either not detected or were measured well below levels of health concern.

TCEQ Soil Testing

Although steps are taken to fully characterize facility emissions during air monitoring, questions are sometimes raised about limitations such as knowledge of emissions during atypical conditions. The TCEQ has used soil sampling studies from Midlothian (home to several cement kilns, including one that burns TDF) to help address these types of concerns. Once emitted, many constituents of concern (for example, metals and dioxins) would be expected to deposit to local soils. Measured levels of these constituents in soils can be reflective of impacts from typical and atypical facility emissions. In Midlothian, the measured soil concentrations of all constituents of concern were generally consistent with background concentrations and were below levels of health concern.

Facilities in Texas That Use TDF

The following table list facilities in Texas that have experience with using TDF and their total consumption of TDF in 2001.

Table F-1. Use and Export of Tire-Derived Fuel in Texas, Calendar 2001

Facility	Product; Location	Authorized to Burn (STUs):	Quantity Burned (STUs)		
			in 1999	in 2000	in 2001
Abitibi Consolidated	Paper/Pulp; Houston				1,221,552
*Capital Cement	Cement; San Antonio	2,150,000	1,006,250	950,000	1,123,795
Cemex Plant	Cement; Odessa	–	0	0	131,962
Donohue	Paper/Pulp; Houston	2,055,000	1,354,797	1,596,373	1,571,200
Georgia Pacific	Paper/Pulp;		0	0	19,627
Holnam	Cement; Midlothian	10,565,000	112,025	75,800	167,034
*North Texas Cement	Cement; Midlothian	8,415,000	3,741,149	3,748,561	3,826,785
*Texas Lehigh Cement Co.	Cement; Buda	3,180,000	7,388	8,080	12,294
Texas Industries	Cement; New Braunfels	3,365,000	657,100	580,000	752,770
Sent out of State			–	2,072,245	1,547,945
Total					10,374,964

* These users burn whole tires. All others burn tire shreds.

Appendix G. TxDOT El Paso District News Release

MEDIA ADVISORY

November 14, 2002

TxDOT does part for Recycling Day

The El Paso District of the Texas Department of Transportation (TxDOT) has just completed a Crumb Rubber Seal Project that has set a record. The 2002 El Paso District seal coat project set a world record for the most tons of tires used on a hot asphalt rubber seal coat project. Together with the 2001 District seal coat, the 2001 Porous Friction Course (PFC) and the 2002 District wide seal coat, the El Paso District did a cost effective preventative maintenance procedure.

They were also successful in recycling over 805,000 discarded tires. Over 700 miles have been seal coated with hot asphalt rubber and plant mix seal, all using recycled tires as part of the process.

The crumb rubber seal process had its beginning in Arizona. The El Paso and Bryan Districts were the first to use this process in Texas in 1976. Since then, over 20 districts in Texas have used this method. Other states, California and Florida, to mention a few, have also used this product. Outside of the United States, countries from South Africa to Germany have also used this process.

Currently, there are two methods used to produce crumb rubber. One method is to grind the tires and the other is to freeze them. Both methods are used to remove the contaminants including fabric, metal, and other non-rubber substances.

The crumb rubber seal coat method has many benefits over the traditional asphalt or emulsified seal coats:

- Tire companies add UV protection to tires to prevent the tires from sun damage. Grinding these tires and adding to the asphalt gives the hot asphalt rubber membrane UV protection. It adds to the life of the roadway seal.

- Rubber added to the asphalt increases the elasticity of the hot asphalt membrane giving it more resilience to the roadway movement.

- The life span of a regular seal coat is approximately 7 years, while the life span of the crumb rubber seal coat is from 9 to 12 years plus.

- It is estimated that it costs an average of $78.15 less per lane mile for a hot asphalt rubber seal coat than the traditional asphalt seal coat. The longer the road stays together, without the need of maintenance, the less money is spent, thus saving the taxpayer money.

We have seen the many benefits of a crumb rubber seal coat, but the greatest benefit is that of recycling of old used tires. This process successfully re-enforces TxDOT's efforts in the recycling arena.

For more information, contact Frank de Santos, Public Information Office at (915) 790-4339.

Appendix H. Tire Bale Slope Failure Repair Summary

November, 2002

TxDOT's Fort Worth District embarked upon a recycling mission last year to find a way to use baled scrap tires. Taking up the Texas Legislature's mandate to increase the use of scrap vehicle tires in highway applications, the District's Construction and Maintenance Recycling Coordinator, Richard Williammee, P.E., investigated using tire bales as a possible repair method for slope failures resulting from higher than normal rainfall in the area. Tire bales had previously been used in other states as a roadbed foundation and to prevent channel erosion.

A slope failure site was identified on Interstate 30 east of Fort Worth. Although no additional project funds had been budgeted for baling tires, donations of tire bales and baling services were secured, along with a free demonstration of vertical tire baling equipment by a vendor from Minnesota. The Texas Transportation Commission approved the donations, and the Texas Commission on Environmental Quality (TCEQ) granted permits for using TxDOT's Arlington Maintenance yard as a temporary baling and storage site for the tire bale project.

The project was carried out in several phases between February 2002 and August 2002. A total of 360 tire bales were used, containing on average 100 scrap tires per bale, for a total of approximately 36,000 scrap tires. Once each row of the 2000-pound tire bales were in place, the slope was completely covered with soil, and reshaped in the final stage. A company was hired to supply and spread compost and seed, in order to stimulate vegetation growth to minimize future surface slope erosion.

As of mid-October 2002, the Ft. Worth area had received almost 50 inches of rain since placement of the first tire bales in mid-February. A site visit at that time revealed some small cracks developing along the top ridge of the slope, and a geotechnical engineer under contract to the Fort Worth office was hired to perform a preliminary slope stability analysis of the final product. Initial analysis revealed that the use of tire bales instead of the original soil slope had improved the Factor of Safety by 2-3 times.

Evaluation of the project as it was carried out already identified a number of engineering steps that can maximize success in using tire bales for future slope failure repairs. Additional sampling and testing will be conducted at the project site to determine tire bale properties to use in the final slope analysis calculations.

Scrap tire bales placed at toe of slope.

Scrap tire bales can be placed using readily available equipment.