# 2004 Progress Report on Using Scrap Tires and Crumb Rubber in Texas Highway Construction Projects



Submitted Jointly by
The Texas Commission on Environmental Quality (TCEQ) and
The Texas Department of Transportation (TxDOT)
as required by House Bill 1, 78th Legislature
Article VI, TCEQ Rider 11, and
Article VII, TxDOT Rider 37

SFR-069/04
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# PREFACE

This report is being submitted as required by House Bill 1, Article VI, the Texas Commission on Environmental Quality Rider 11, and Article VII, the Texas Department of Transportation Rider 37, 78th Legislature:

**Agency Coordination.** The Texas Department of Transportation and 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 is the fifth annual Progress Report on Using Scrap Tires and Crumb Rubber in Highway Construction Projects. 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 years 2002 and 2003, both TCEQ and TxDOT oversaw developments that have already produced significant progress in the state's scrap tire situation. Major developments include the following:

- More Texas scrap tires were used beneficially than were generated in calendar 2002. Total use was 25 million scrap tire units (STUs) in 2002, which was 1 million more than were generated.
- The volume of scrap-tire material legally placed in landfills decreased 56 percent, from 2.3 million STUs in 2001 to one million STUs in 2002, largely due to increased demand from end users.
- The volume of scrap tire material stockpiled at previously registered scrap tire storage sites was reduced by approximately 6.3 million STUs.
- New facilities in Baytown and Stamford have increased the number of Texas scrap tires processed into crumb rubber.

**TCEQ Progress**

- In 2002, TCEQ awarded grants to two cement kilns to retrofit their facilities to use tire derived fuel (TDF). These grants are expected to result in consumption of an additional 2 to 4 million STUs annually.
- In March 2003, TCEQ awarded contracts for the cleanup of the two largest scrap tire stockpiles in the state, which will reduce the number of scrap tires stockpiled in Texas by approximately 45 million over the next several years.
- In 2003, TCEQ contracted for the removal of 250,000 STUs from an additional site in Houston.

**TxDOT Progress**

- Successful projects using crumb rubber or other scrap tire materials in several TxDOT districts, including asphalt-rubber paving and scrap tire bales, have garnered industry attention around the state and beyond.
- TxDOT maintained its consumption of crumb rubber in asphalt, crack sealer, and other paving products at 16,300 tons in FY03, spending $65 million.
- TxDOT increased its use of viable tire-rubber products, including anti-vegetation mats for use around sign posts and guard rail posts, delineator posts, and guard rail spacer blocks.

## Trends and Continuing Issues

Although TCEQ and TxDOT continue to reduce and prevent stockpiles and use products with tire rubber, two primary issues persist.

- Illegal scrap tire dumping is likely to continue in areas of the state that have few end users or disposal facilities.
- Demand for scrap-tire products is not strong enough to clean up existing illegal dumpsites.

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. Consequently, tire fires and the breeding of mosquitoes that can transmit West Nile virus will continue to be risks to the environment and human health.

## Conclusions

TCEQ and TxDOT made progress in 2002 and in 2003 ensuring that scrap-tire handlers comply with all applicable regulations and identifying additional scrap-tire markets and products. As the volume of crumb rubber and other scrap-tire rubber processed in the state increases, the potential for productive use grows.

Despite this progress, ongoing challenges that offer direction for future progress include:

- funding cleanup efforts
- developing new markets and end users

# OVERVIEW OF TEXAS SCRAP TIRE MANAGEMENT

Scrap tire management continues to present a worldwide challenge, with more than 272 million scrap tires generated in the United States in 2001. Of that number, approximately 218 million were used or disposed of, leaving the remainder to be added to the growing accumulation. At least 310 million may be stockpiled nationwide, according to the Rubber Manufacturers Association.[1]

## Texas Compared to Other States' Tire Management Systems

Although one of only seven states that phased out its state-mandated tire-collection fee, Texas still regulates the management and disposal of scrap tires. The state requires registration for tire collection, transport, processing, and storage. The state is also actively working to clean up all stockpiled tires in Texas.

Texas fits into each of the following scrap-tire management categories[2]:

- 41 states allow cut or shredded tires in landfills.
- 37 prohibit landfilling whole scrap tires.
- 36 require tire collectors, processors, or both to be registered or permitted.
- 36 have stockpile cleanup programs.
- 29 do not have dedicated scrap-tire funds.
- 31 do not have market development incentives.
- 15 states do not collect fees for scrap tire management, including those that discontinued the fee.

## Scrap Tire Availability in Texas

Based on industry estimates, Texans generate 24 million scrap tires each year—more than one tire for every person residing in the state. In addition, at the end of calendar year 2002, the equivalent of approximately 69.1 million scrap tires lay on the ground in Texas. (See Table 1, below.)

[1] State Legislation – Scrap Tire Disposal. Edited and updated by M. Blumenthal/J. Falardeau, September 2003. Rubber Manufacturers Association website.
[2] Ibid.

**Table 1. Statewide Totals of Scrap Tires, End of Calendar year 2002**

| Type of Site | No. of Sites | Quantity (STUs*) | Form of material | Details in: |
|---|---|---|---|---|
| Formerly Registered Facilities | 12 | 61.6 million | Mainly tire shreds; some tire pieces; few whole tires | Appendix A |
| Known Illegal Dumps | ~150 | 4.5 million | Mainly whole tires | Appendix B |
| Registered Facilities | 7 | 3 million | Varies | 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 equal 10,000 tons of scrap tire material.

This accumulation of shredded tires is primarily a carryover from the state's Waste Tire Recycling Program which operated from 1992 through 1997. A brief history of the scrap tire program can be found in last year's report (SFR-069/03), along with diagrams illustrating scrap tires' routes from discard to final disposal or usage.

## Scrap Tire Usage and Landfill Disposal in Texas

Developments in 2002-2003 have brought improvements that suggest even more significant progress to come. Based on 2002 reports, approximately 25 million STUs of scrap tire material were consumed by end users and 1 million legally placed in landfills. For the first time, the beneficial use of scrap tires in Texas exceeded the number of scrap tires generated. To meet this excess demand, end users drew some material from stockpiles at formerly registered scrap tire storage sites, reducing the volume of these stockpiles by approximately 6.3 million STUs. Several registered processors may also be reducing their inventories to meet this demand.

Demand for scrap tires is growing for energy, crumb rubber, land reclamation, and other applications. The volume of material reported as consumed in calendar year 2002, the most recent year for which end-use data is available, increased approximately 8 percent, from 23.1 million STUs in calendar year 2001 to 25 million STUs in calendar year 2002. This increased use of 1.9 million STUs helped reduce legal disposal by 56

percent, or 1.3 million STUs (from 2.3 million STUs in 2001 to one million STUs in 2002).

The end-use and disposal categories are explained below in order from largest to smallest. Table 2, below, presents each category's consumption of scrap tire material in the years 2000 to 2002 and their changes from 2001 to 2002.

**Table 2. Texas Scrap Tire Usage and Landfill Disposal, 2000 to 2002**

| Category | Consumption (Scrap Tire Units*) | | | Change from 2001 to 2002 |
|---|---|---|---|---|
| | 2000 | 2001 | 2002 | |
| **End Uses** | | | | |
| Tire-Derived Fuel | 9,022,566 | 11,179,401 | 11,632,968 | +4% |
| LRPUT** | 2,621,779 | 4,639,575 | 7,847,146 | +69% |
| Civil Engineering Projects | 4,990,474 | 5,019,091 | 3,810,200 | - 24% |
| On-Site Septic Systems | 756,019 | 672,146 | 504,426 | - 25% |
| Crumb Rubber Products | 2,232 | 7,485 | 340,573 | +4,450% |
| Other End Uses | 1,400,338 | 1,592,197 | 827,392 | - 50% |
| **End Uses Subtotal** | **18,793,408** | **23,109,895** | **24,962,705** | **8%** |
| | | | | |
| **Landfill Disposal** | **3,393,679** | **2,338,574** | **1,037,834** | **-56%** |
| | | | | |
| **TOTAL** | **22,187,087** | **25,448,469** | **26,000,539** | **+2%** |

* 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.
* LRPUT – Land Reclamation Project Using Tires

**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. Due to their intensive fuel requirements, cement kilns, electric utilities, and pulp and paper mills have been the main users of TDF. Use in Texas has increased steadily since 1995, growing 4 percent from 2001 to 2002. This use accounted for approximately 45 percent (11.6 million STUs) of the scrap tires consumed in 2002. Appendix D lists facilities that use Texas TDF.

TCEQ awarded grants during 2002 to retrofit two cement kilns to utilize TDF that have not previously used scrap tires as fuel. One cement plant has completed its retrofit and is currently using TDF while the other is working with TCEQ to amend its air quality permit to allow the use of TDF. 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 year 2002 consumption levels) by the end of calendar year 2004 due to potential increased demand from existing and new TDF users. Now that demand for scrap tire material 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.

**Land Reclamation Projects Using Tires (LRPUTs)**

The second largest use category for scrap tires in Texas is Land Reclamation Projects Using Tires (LRPUTS). Shredded scrap tires have routinely been used as fill material in civil engineering and reclamation projects for a number of years. 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.

There are currently five LRPUTs operating in the state. The number of scrap tires consumed by these projects increased significantly (69 percent) in 2002 due to an increase in the number of scrap tires accepted by a LRPUT in Houston. This category accounted for approximately 30 percent (7.8 million) of the scrap tires consumed in 2002. 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 and the closure of a LRPUT in Fort Worth. In locations where LRPUTs and TDF are competing end uses, TDF is typically the economically favorable option.

**Civil Engineering Projects in Landfills**

The third largest use category for scrap tires in Texas is civil engineering applications in landfills. The vast majority 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 landfill gas collection systems and for daily waste cover material in lieu of soil.

The consumption rate for this category decreased 24 percent from 2001 levels. In 2002, this use accounted for approximately 14.5 percent (3.8 million) of the scrap tires consumed. It is expected to decrease slightly in 2003.

[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".

**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, TCEQ believes disposal facilities provide a necessary scrap tire management option in areas where few end users exist. This category accounted for approximately 4 percent (1 million) of the scrap tires consumed in calendar year 2002. The amount of scrap tire material consumed by this category is expected to remain constant or decrease slightly by the end of calendar year 2003 as scrap tire material is directed to recycling rather than disposal facilities.

**On-Site Septic Systems**
Tire shreds provide good filter material and can be used in place of gravel in drain fields of septic systems. This category accounted for approximately 2 percent (504,426) of the scrap tires consumed in Texas in 2002. Although having decreased 25 percent in 2002, the amount of scrap tire material consumed by this category is expected to remain constant or only slightly decrease by the end of 2003.

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

Consumption in this category accounted for only 1.5 percent (340,572) of the scrap tires that were consumed in Texas in 2002 but increased a phenomenal 4,450 percent.

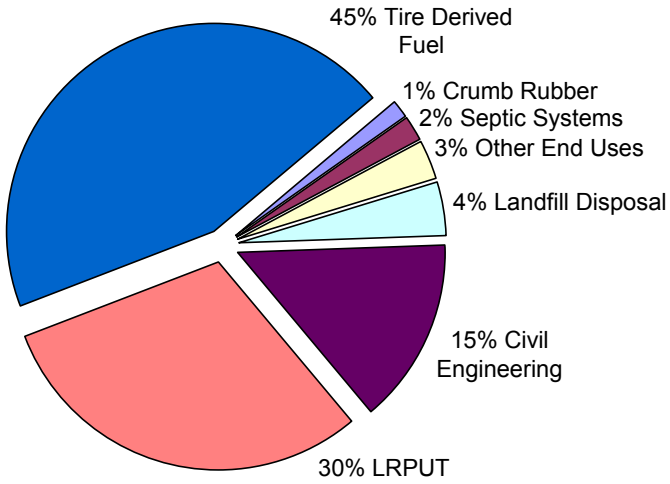
Crumb rubber production capacity increased significantly due to startup of crumb rubber facilities in Baytown and Stamford. With new processing capability and a growing level of use in roadway construction and maintenance, and for other applications, the amount of material consumed in this category is expected to continue to increase significantly by the end of 2003.

**Other End Uses**
Scrap whole tires and tire pieces are being put to a variety of other end uses. Texas manufacturers turn them into tires for agricultural trailers and tractors. Other companies make products for highway and road uses using tire sidewalls as weights for traffic-control barrels or bales to stabilize embankments. Other uses include artificial reefs and shooting berms at gun ranges.

This category accounted for approximately 3 percent (827,392) of the STUs consumed in calendar year 2002. Use in this category dropped by 50 percent last year but it is expected to remain constant through the end of calendar year 2003.

Figure 1 illustrates the 2002 percentage for each of the end-use categories and landfill disposal discussed above.

**Figure 1. 2002 Scrap Tire Usage & Landfill Disposal in Texas**



# TCEQ PROGRESS

**Compliance**
TCEQ has taken action 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. A 2002 audit report produced in coordination with the Comptroller's Office[4] documented the improvements in the management of scrap tires resulting from these efforts.

**Contracts for Cleaning Up Atlanta and Stamford Stockpiles**
The 77th Legislature appropriated TCEQ $7.5 million through Senate Bill 1, Article VI, Rider 35, "Waste Tire Disposal Grants," to address scrap-tire stockpiles. In turn, TCEQ awarded three-year contracts in March of 2003 for the cleanup of the two largest scrap-tire stockpiles in the State. TCEQ awarded contracts to Merrick Construction Company to remediate the Gibson Recycling, Inc. site in Atlanta, and to Silver Creek Materials, Inc. to remediate the ERRI/TCI site in Stamford.

As of the end of 2003, the Stamford site was approximately 70 percent complete and major progress was made at the Gibson site near Atlanta. By 2006, remediation of these two sites will reduce the total volume of scrap-tire material stockpiled in Texas by 65 percent, or nearly 45 million STUs.

**Clean Up of Other Non-Compliant Sites**
In 2002, the volume of scrap-tire material stockpiled at 12 formerly registered storage sites and approximately 150 illegal dumpsites was reduced by approximately 6.3 million STUs, or approximately 9 percent of the material in these stockpiles. This reduction was primarily due to removal by site owners to authorized end users. In addition, TCEQ contracted in 2003 for the removal of approximately 250,000 scrap tires from other abandoned sites, primarily a single abandoned stockpile.

**Reduction in Landfill Disposal**
The volume of scrap tire material being legally placed in landfills decreased 56 percent, from 2.3 million STUs in 2001 to one million STUs in 2002. The decrease is largely due to increased demand from end users.

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

**Cement Kiln Retrofits**
In 2002, TCEQ awarded grants to two cement kilns to retrofit them to burn scrap tires as fuel, which they had not used previously. These grants are expected to result in consumption of an additional 2 to 4 million STUs annually. As of the end of 2003, one cement plant had completed its retrofit and was using TDF while the other was working with TCEQ to amend its air quality permit to allow the use of TDF.

**Development of End-Use Markets**
Since early 2003, TCEQ and the Region 6 (Dallas) Office of the Environmental Protection Agency have explored Texas-Mexico border waste tire issues. These grant-funded activities included two workshops and a roundtable where representatives of both the public and private sectors shared experiences and explored regional binational scrap tire dynamics. Included in these efforts to identify opportunities to encourage waste tire recycling were local, state and federal government representatives from both the U.S. and Mexico, the private sector (including waste tire transporters, used tire dealers, tire recyclers and end users), trade organizations such as the Rubber Manufacturers Association, the North American Development Bank, and the Border Environment Cooperation Commission.

# TxDOT Progress

**"TxDOT adheres to values that have created an entire industry out of resource conservation. Because so many of the materials and products we use also come from recycled sources, this department has myriad opportunities to support a sustainable society. Indeed, it's good business to be good stewards of the environment."**
- Michael Behrens, Executive Director, Texas Department of Transportation, in *Transportation News*, September 2003

TxDOT continues to identify and develop viable uses for scrap tires and crumb rubber in roadway construction and maintenance projects. Each use must meet the department's stringent engineering, environmental, and financial standards. Fortunately, many paving and rubber-content products meet TxDOT's needs and compete evenly with traditional products, some even performing better.

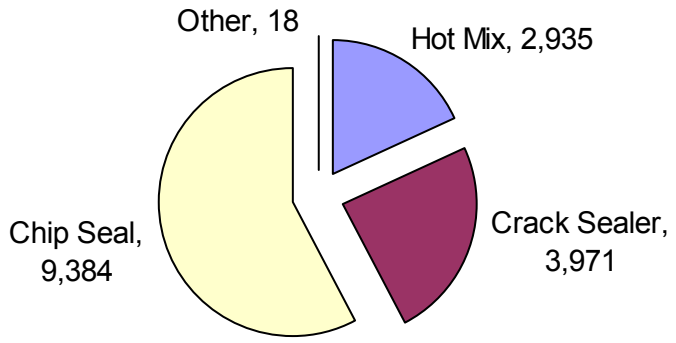
TxDOT's use of these products helps assure the department that non-disposal options exist for the 600,000 STUs TxDOT districts generate each year through vehicle maintenance and roadway cleanup. Otherwise, TxDOT could be paying even more than the nearly $300,000 it paid the state's tire processing contractor in FY03.

In FY03, TxDOT spent $65 million on paving and crack sealer—nearly $5 million more than in FY02, although the actual number of STUs grew only slightly to 1.63 million, or about 16,300 tons of crumb rubber.

Additional gains are anticipated with the increased availability of quality crumb rubber and asphalt rubber in the state.

TxDOT uses recycled tire rubber in paving seal coats, which can be the finished surface or a water-proof underseal, and in hot mix asphaltic concrete (HMAC), including the Permeable Friction Course (PFC) pavement. TxDOT also seals cracks in pavement with an asphalt-rubber product that contains 22 percent tire rubber. Figure 2 presents the total tons of tire rubber in the products TxDOT used in FY03.

**Figure 2. Tons of Tire Rubber in Products Used by TxDOT, FY03**




Some of the successful TxDOT projects introduced in the previous report have garnered industry attention outside the state, including the San Antonio District's application of PFC and the Fort Worth District's repair of an embankment using scrap-tire bales. Also, the El Paso District's extensive hot asphalt-rubber surface treatment (chip seal) project in 2001 has been cited as the "largest chip seal project in the world."[5]

[5] RPA News, Rubber Pavements Association newsletter, Vol. 6, No. 3, Fall 2002, p. 5.

**Permeable Friction Course (PFC)**
The Rubber Pavement Association recognized the San Antonio District's overlay of Asphalt-Rubber Permeable Friction Course (PFC) on a stretch of old concrete pavement for its improved drainage and resulting increased visibility during rainy conditions, in addition to its improved surface and dramatic noise reduction.[6] In addition, TxDOT's Construction Division issued a Technical Advisory on "Use of PFC to Improve the Performance of Continuously Reinforced Concrete Pavement (CRCP)," which is included as Appendix E.

PFC increases roadway comfort and safety for the traveling motorists while providing TxDOT with a durable, affordable, and environmentally sensitive pavement. The photograph in Appendix F illustrates well the following benefits of PFC:

- Reduces splash and spray
- Increases visibility
- Improves ride quality
- Reduces noise
- Contains recycled scrap-tire rubber

**Embankment Repair with Tire Bales**
The Fort Worth District's embankment repair on IH 30 using scrap-tire bales, discussed in the previous report, continues to hold up well, according to subsequent geological evaluation. The Fort Worth District is planning a second embankment repair using scrap-tire bales. The geological evaluation of the original experimental project recommended tire bales for similar situations based on finding favorable stability, an increased factor of safety, and cost effectiveness from the improved long-term stability.[7]

**Tire-Rubber Molded Products**
While not using enormous quantities of STU equivalents, the use of new products containing scrap-tire rubber represent growing opportunities. Photographs of these products are included in Appendix G.

**Anti-vegetation mats.** Installed around sign posts and guardrail posts, anti-vegetation mats provide multiple benefits. Besides using recycled tire rubber, they reduce herbicide use and string trimming, which also cuts down on air emissions from power trimmers. Recent installations in the TxDOT Lufkin, Bryan, and Corpus Christi Districts helped the department obtain federal funding for these and other districts to install and evaluate additional mats of various designs.

[6] RPA News, Rubber Pavements Association newsletter, Vol. 7, No. 1, Summer 2003, p. 3.
[7] Geotechnical Investigation and Analyses: Slope Failure Repair Utilizing Baled Tire Fill, Interstate Highway 30 West of Oakland Blvd., Report to Ft. Worth District, Texas Department of Transportation, TEAM Consultants, Inc., March 2003.

**Delineator posts.** Recycled delineator posts with 25 percent recycled tire rubber and 60 percent recycled high density polyethylene, were developed in partnership between the Pharr District, TxDOT's Traffic Division, and CaminoVerde, a Brownwood-based manufacturer. This delineator post performs as well as, or better, than the designs it replaces, installs more easily, and costs about the same. Consequently, TxDOT purchases of this post helped develop a market for scrap tires while saving the department labor and product costs. In FY03, TxDOT spent $272,000 on 11,300 delineator posts and their installation systems.

**Guardrail spacer blocks.** TxDOT and its contractors can choose from several manufacturers' spacer block designs that have crumb rubber content and have passed crash test requirements.

TxDOT's use of tires and rubber in molded products, paving, and other transportation-related products continues to grow in all areas.

# TRENDS AND CONTINUING ISSUES

Several significant developments during 2002 and 2003 should improve the scrap tire situation in Texas:

- beginning the cleanup of the two largest scrap-tire sites and one smaller site
- new scrap-tire processors in the state
- retrofitting of additional cement kilns for TDF use
- greater use of scrap-tire materials in roadway construction and maintenance
- continued development of other transportation-related products
- educational and outreach events

Although TCEQ and TxDOT continue to reduce and prevent stockpiles and use products with tire rubber, two primary issues persist.

- Illegal scrap tire dumping is likely to continue in areas of the state that have few end users or disposal facilities.
- Demand for scrap-tire products is not strong enough to clean up existing illegal dumpsites.

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. Consequently, tire fires and the breeding of mosquitoes that can transmit West Nile virus will continue to be risks to environmental and human health.

# CONCLUSIONS

While significant challenges remain, TCEQ and TxDOT made progress addressing scrap tires during 2002 and 2003. TCEQ continues to ensure that scrap-tire handlers comply with all applicable regulations and, in conjunction with TxDOT, to develop additional scrap-tire markets and products. As the volume of crumb rubber and other scrap-tire rubber material processed in the state increases, the potential for productive use grows.

Despite this progress, ongoing challenges that offer direction for future progress include:

- funding clean-up efforts
- developing new markets and end users

# APPENDIX A. STOCKPILE VOLUMES AT FORMERLY REGISTERED FACILITIES, END OF CALENDAR YEAR 2002

| Facility Name | City | County | TCEQ Reference Number | Stockpile Volume (in Scrap Tire Units*) | |
|---|---|---|---|---|---|
| | | | | 2001 | 2002 |
| ERRI/TCI** | Stamford | Haskell | 44114<br>44150 | 14,500,000 | 14,500,000 |
| Nathaniel Energy Corporation | Hutchins | Tarrant | 44115 | 1,468,138 | 0 |
| 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 | 5360 | 0 |
| Safe Tire Disposal Corp. | Penwell | Ector | 44103 | 4,984,464 | 4,977,934 |
| Gibson Recycling, Inc. | Beaumont | Jefferson | 79508 | 2,048,100 | 2,048,100 |
| Safe Tire Disposal Corp. | Cleveland | Liberty | 44109 | 4,551,892 | 1,765,961 |
| Scrap Tire Recycling, Inc.** | Pasadena | Harris | 44096 | 1,800,000 | 1,800,000 |
| Quantum Tech, Inc.** | Houston | Harris | 44105 | 60,000 | 60,000 |
| American Tire Recycling** | San Antonio | Bexar | 79019 | 850,000 | 850,000 |
| Safe Tire Disposal Corp. | San Antonio | Bexar | 44107 | 6,507,576 | 4,472,724 |
| World Tire Recycling** | Brownsville | Cameron | 44147 | 1,000,000 | 1,000,000 |
| **Total** | | | | **67,898,890** | **61,598,079** |
| **Change, 2000 to 2001** | | | | | **– 9%** |

* One scrap tire unit equals 20 pounds of scrap tire material. 1 million STUs equals 10,000 tons of scrap tire material.
** TCEQ estimated the number of STUs in these stockpiles. All other values were obtained from annual reports.

# APPENDIX B. KNOWN ILLEGAL TIRE DUMPS IN TEXAS

Anyone who is interested in cleaning up one of these known tire dumps or who can update the information on any dump listed in this table, is invited to call 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 |
| | Dallas ISD/ Alvin Graff | 70939P | 13,000 |
| 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 |

| County | Site Name | TCEQ Identification Number | Estimated No. of Tires |
|---|---|---|---|
| | Riverside Land | 70367P | 500 |
| | Wet-N-Wild | 70887P | 1,500 |
| ***Dallas–Fort Worth area, continued*** | | | |
| | Olivia Mckenzie | 70889P | 1,000 |
| 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 |
| 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 |

| County | Site Name | TCEQ Identification Number | Estimated No. of Tires |
|---|---|---|---|
| | Crider Lot | 70547P | 3,000 |
| | Cameron Road Tire Dump | 70682P | 10,000 |
| | Garrett Ranch | 70697P | 2,000 |
| | Butler Warehouse | 70721P | 7,000 |
| ***Austin area, continued*** | | | |
| | 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 |
| | 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 |

| County | Site Name | TCEQ Identification Number | Estimated No. of Tires |
|---|---|---|---|
| | Redland Stone Products | 70229P | -- |
| | Roth | 70851P | 2,000 |
| | S.A.W.S. - Bill Milelr Tract | 70892P | 1,500 |
| | E. Haverlah | 70909P | 2,800 |
| | Jay Warriner | 70922P | 1,000 |
| | B.L. Lifshutz, Trustee | 70924P | 5,000 |
| | Habitat for Humanity | 70935P | 3,000 |
| Gillespie | Eckhardt Ranch | 70862P | 2,000 |
| ***San Antonio area, continued*** | | | |
| 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 YEAR 2002

| Facility Name | City | County | Reference Number | Inventory*, End of 2002 |
|---|---|---|---|---|
| Tres Pesetas | Lubbock | Lubbock | 79540 | 93,110 |
| Holnam Texas LP, Corp. | Midlothian | Ellis | 66900 | 1,204 |
| Safe Tire Disposal Corp | Midlothian | Ellis | 79504 | 1,126,891 |
| Acme Tyre Company | Atlanta | Cass | 79539 | 32,400 |
| Texas Lehigh Cement | Buda | Hays | 76904 | 96 |
| J & M Truck Tire Shop, Inc. | San Antonio | Bexar | 79543 | 302,510 |
| Texas Industries, Inc. | New Braunfels | Comal | 76902 | 11,270 |
| Nathaniel Energy Corp | Hutchins | Tarrant | 44115 | 1,468,138 |
| **Total** | | | | **3,035,619** |

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

# APPENDIX D. FACILITIES THAT USE TEXAS TIRE DERIVED FUEL, CALENDAR YEAR 2002

The following table presents each facility's consumption of Texas TDF in 2002.

| Facility | Product; Location | Authorized to Burn (STUs) | Quantity Burned (STUs) | | |
|---|---|---|---|---|---|
| | | | in 2000 | in 2001 | in 2002 |
| **TDF Used in Texas** | | | | | |
| Abitibi Consolidated | Paper/Pulp; Houston | -- | | 1,221,552 | 0 |
| *Capital Cement | Cement; San Antonio | 2,150,000 | 950,000 | 1,123,795 | 696,069 |
| *Cemex | Cement; New Braunfels | -- | 0 | 0 | 418,080 |
| *Cemex | Cement; Odessa | – | 0 | 131,962 | 293,783 |
| Donohue | Paper/Pulp; Houston | 2,055,000 | 1,596,373 | 1,571,200 | 0 |
| Georgia Pacific | Paper/Pulp | -- | 0 | 19,627 | 0 |
| Holcim | Cement; Midlothian | 10,565,000 | 75,800 | 167,034 | 1,638,038 |
| *North Texas Cement | Cement; Midlothian | 8,415,000 | 3,748,561 | 3,826,785 | 3,746,509 |
| *Texas Lehigh Cement | Cement; Buda | 3,180,000 | 8,080 | 12,294 | 46,740 |
| *Texas Industries | Cement; New Braunfels | 3,365,000 | 580,000 | 752,770 | 587,604 |
| **Texas TDF Sent Out of State** | | | | | |
| International Paper | Paper & Pulp; Louisiana | -- | -- | -- | 2,121,427 |
| Other Texas TDF Sent Out of State | | | 2,072,245 | 1,547,945 | -- |
| **Total Texas TDF** | | | | **10,374,964** | **11,140,810** |

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

# APPENDIX E. USE OF PERMEABLE FRICTION COURSE (PFC) TO IMPROVE THE PERFORMANCE OF CONTINUOUSLY REINFORCED CONCRETE PAVEMENT (CRCP)

Technical Advisory from TxDOT Construction Division from the Internet at:

ftp://ftp.dot.state.tx.us/pub/txdot-info/cmd/tech/ta020603.pdf

Texas Department of Transportation

C&M T

Technical Advisory

# USE OF PFC TO IMPROVE THE PERFORMANCE OF CRCP

## Introduction

Results of a recently completed project in the San Antonio district show that an overlay with Permeable Friction Course (PFC) can dramatically improve the performance of a Continuously Reinforced Concrete Pavement (CRCP). This project is the first of its kind in Texas. However, this practice has gained widespread acceptance in Arizona. As a result of their previous successes, the Arizona Department of Transportation (ADOT) recently launched a campaign to use PFC to overlay most, if not all, existing CRCP in the greater Phoenix area.

Results from the Texas Department of Transportation's (TxDOT)'s project in San Antonio show that an overlay of only 1.5 inches of PFC:

- improved the ride quality of the existing CRCP by approximately 61%
- improved the skid resistance by over 200%
- reduced the noise levels by an average of 14 decibels (dB).

A noise reduction of 3 to 6 dB is normally considered to be very good. The noise reduction of 14 dB experienced on the San Antonio project is not only considered outstanding but is very possibly the largest noise reduction ever recorded on a TxDOT project.

PFC overlays on CRCP appear to merit serious consideration, given that Texas has a large amount of existing CRCP that currently ranks poorly in terms of ride quality and noise.

## Background

The project is located on IH 35 between mile marker 166 (near Walzem Road) and 168 (near Weidner Road). The New Braunfels Area Engineer (Greg Malatek, P.E.) and his assistant (Michelle Kopp, P.E.) were the engineers in charge of the project. The project was let in May of 2002, awarded to Dean Word Company, Ltd, and completed in the fall of 2002.

The existing CRCP was constructed in the early 1980s. The existing CRCP was generally sound, with only minor distresses. Safety concerns were the primary reasons for placing a hot mix overlay on the CRCP because skid resistance of the existing CRCP was low and the roadway had a history of numerous wet weather accidents. In addition to the safety concerns, the existing CRCP was also extremely rough and, therefore, extremely loud. Complaints were common. In some ways it represented a "worst- case-scenario" of pavement performance. It was not **comfortable,** but it was **durable**. In other words, it was "a problem that wouldn't go away."

The Area Engineer chose an asphalt rubber (AR) version of PFC for the overlay. AR (which contains approximately 18% crumb rubber) was chosen as the binder due to its excellent adhesive characteristics and history of successful performance on CRCP overlays in Arizona. PaveTex Engineering designed the PFC mixture and Cox Paving provided the AR binder. The mix was designed to have 8.3% binder and a total of more than 18% air voids.

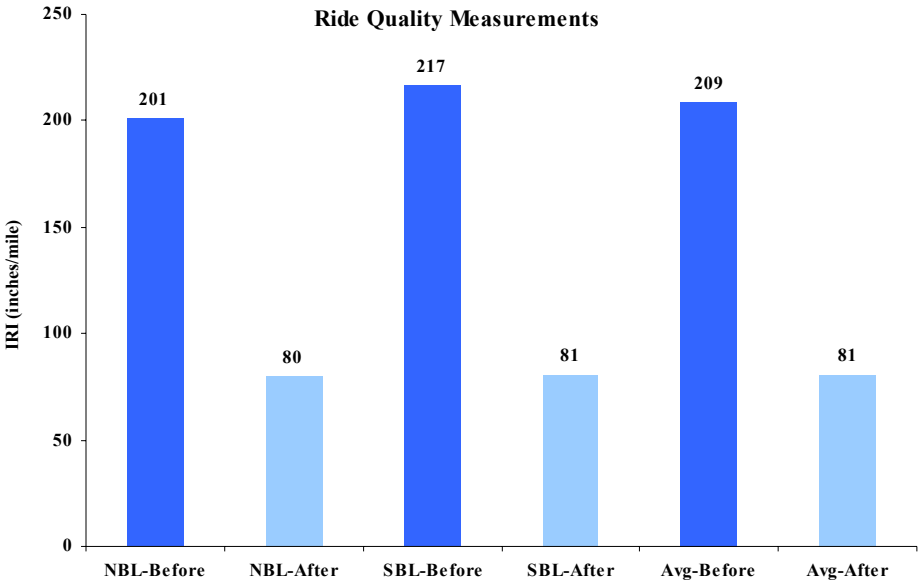
To date, TxDOT has approximately 20 overlays with PFC. PFC mixtures are used extensively throughout the southern region of the United States. The most common mixture of PFC utilizes fibers and polymer modified asphalt. PFC with AR is the second most common. PFC is the surface mix of choice in Florida, Georgia, Alabama, South Carolina, and Arizona. It is gaining popularity in Texas, New Mexico and other states due to its benefits:

- reduced hydroplaning
- improved skid resistance
- reduced splash and spray
- improved visibility of pavement markings
- reduced traffic noise
- improved ride quality

# RESULTS

Before and after ride quality results are presented in Table 1. Ride quality was measured using the International Roughness Index (IRI) with a high-speed inertial profiler. On average, the roughness was reduced by 128 inches per mile with the PFC overlay. This represents approximately a 61% improvement in ride quality. Research has shown that improving the ride quality of CRCP pavements can significantly extend its performance life by reducing the dynamic loading associated with roughness.

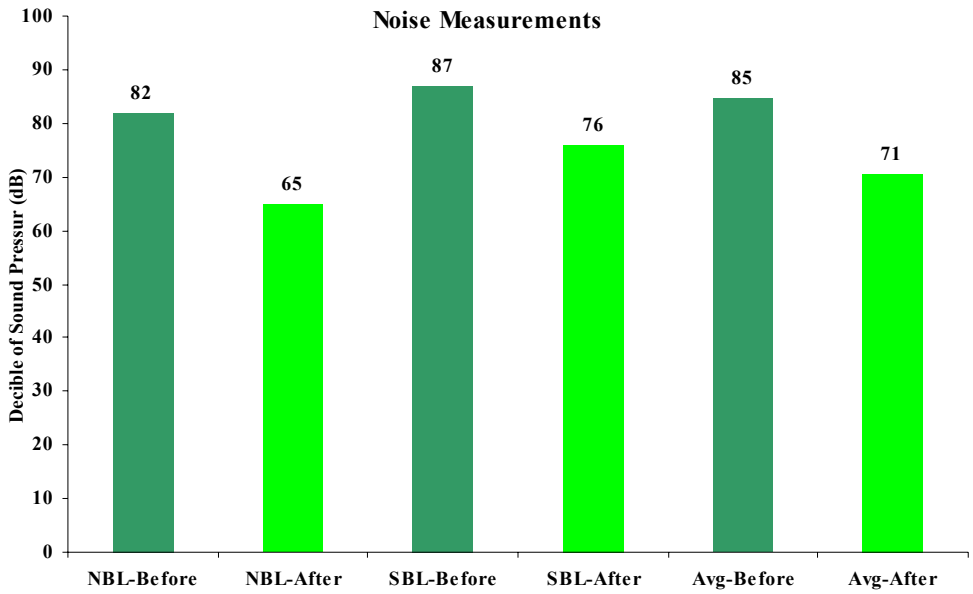
**Table 1. Average Ride Quality Measurements**




The before and after sound pressure (noise) measurements are presented in Table 2. The measurements were taken along the edge of the pavement using handheld noise meters. The results in Table 2 are the average readings taken at several locations along the project. The locations were documented so that the before and after readings could be taken at the exact same locations. On average, the noise was reduced from 85 to 71 dB. The reduction of 14 dB is significant because sound pressure is measured on a logarithmic scale. In laymen's terms, the noise was reduced by more than half. Noise reduction of this magnitude can be considered even more significant when compared to what is normally achieved by constructing noise walls along the highway. Such construction is relatively time consuming and expensive. Costs typically run over 1 million dollars per linear mile.

After the PFC overlay on this project, numerous compliments were received related to noise reduction from local business owners and residents. Numerous positive comments were even received on a radio "call-in" talk show.

**Table 2. Average Sound Pressure (Noise)**




# CONCLUSIONS

Early results from TxDOT's first PFC overlay on CRCP are extremely positive. If this project has the long-term success experienced in Arizona, this paving strategy should dramatically improve the performance of CRCP pavements in Texas. This combination strategy has the potential to optimize the durable properties normally associated with CRCP and add the safety and comfort properties associated with hot mix asphalt pavements. PFC and CRCP may be a winning combination to address TxDOT's vision to provide pavements that are **comfortable**, **safe,** and **durable**.

If you would like more information, contact Dale A. Rand (512.506.5836) or Amitis Meshkani (512.506.5847) at the Flexible Pavements Branch of the Construction Division.

**SPECIAL THANKS TO TXDOT EMPLOYEES IN THE NEW BRAUNFELS AREA OFFICE, SAN ANTONIO DISTRICT PAVEMENT MANAGEMENT STAFF, THE ASPHALT INSTITUTE, PAVETEX ENGINEERING, COX PAVING, AND DEAN WORD COMPANY.**

# APPENDIX F. ASPHALT RUBBER PERMEABLE FRICTION COURSE, IH 35, SAN ANTONIO DISTRICT


**Which surface do you want to drive on?**

On the left, Asphalt-Rubber Permeable Friction Course
On the right, old concrete pavement

This photo was taken on Interstate Highway 35 in San Antonio, Texas. It is a picture worth a thousand words on highway safety. It clearly depicts the difference in pavement surfaces in a light rain. The Asphalt-Rubber surface has no standing water or visible "spray" while the concrete surface is wet and visibility is limited due to the heavy spray caused by the vehicles. According to The Road Information Program (TRIP) motor vehicle crashes cost U.S. citizens $230 billion per year, or $819 for each resident, for medical costs, lost productivity, travel delay, workplace cost, insurance costs and legal costs. Isn't it time we consider safer driving surfaces?[8]

[8] RPA News, Rubber Pavements Association newsletter, Vol. 7, No. 1, Summer 2003, p. 3.

# APPENDIX G. SCRAP TIRE RUBBER PRODUCTS USED BY TXDOT

Tire-Rubber Anti-vegetation Mats – TxDOT Lufkin District

Tire-Rubber Delineator Posts – TxDOT Pharr District


Tire-Rubber Guard Rail Spacer Blocks – TxDOT Brownwood District

TxDOT has approved for use three brands of blocks with tire-rubber content.