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Introduction

America is a highly mobile society. Since the end of World War II, we have become more and more dependent upon automobile, bus, and truck transportation for our economy, our day-to-day lives, and for our recreation. All of these vehicles have one thing in common – they all run on rubber tires. Even with the extraordinary technological advances in the manufacture of tires, they still wear out and must be disposed of in some manner.

While there are many, many avenues available to consumers for the proper disposal of scrap tires, it is all too often that tires are discarded illegally. We have all seen them tossed beside our roads, in our alleys, in vacant lots, along lakes and streams and other places that are reasonably accessible but not always within plain view. Unfortunately, the presence of one scrap tire seems to induce other dumpers to cast off their unwanted tires at the same location. One scrap tire becomes two. Two become a dozen. And so on. It happens so frequently that our society has given the illegal dumping colloquial names. We refer to “midnight dumping” and other terms, and, sadly, most people know what we mean. If left unattended, these illegal dump sites continue to induce other illegal dumpers to add to the pile. It is then up to the property owners and the taxpayers to go to the expense of cleaning up the dump sites.

To be sure, scrap tires are not the only material or product that gets dumped illegally. However, the illegal dumping of scrap tires came into prominence in the mind of the public in the mid-1980’s, and it has stayed there ever since. In 1985, Minnesota became the first state to enact laws directed at the management of scrap tires. Over the next several years, nearly every state enacted laws and regulations to govern the disposal of scrap tires.

How Many Scrap Tires Are There?

Estimates vary as to how many scrap tires are generated each year. Reliable estimates by groups and organizations involved in the tire and waste management industries were that approximately 281 million scrap tires were generated in the year 2001. The estimated number of scrap tires that were in stock piles around the country in 2001 was estimated to be approximately 300 million. However, other estimates of the total number of scrap tires in various dumps and piles range as high as 3 billion.

Further on in this report, we will discuss the increasing types of economic uses for scrap tires. However, before that discussion is presented, it is important to realize that tire piles, whether they are legal or illegal, do provide at least two immediate and ongoing threats to the public health.

The first is that the piles provide a safe habitat for many different kinds of pests such as rodents and other vermin. Because tires are obviously manufactured to be impervious to water, it is easy for rainwater, dew and snow melt to accumulate into puddles. Ironically, the same materials and design that work so well to keep water out of tires also makes it very easy for water to accumulate *inside* the scrap tire. Such puddles are stagnant pools, and are almost the perfect breeding environment for mosquitoes. Plus, there are no predators inside a tire to eat the mosquito larvae. Many of the mosquito species that thrive in these tire piles are the vectors that carry and spread diseases deadly to man and animals. The only realistic control over these breeding grounds is the removal of the tires.

The second major public health threat is fire. Scrap tires are made of materials that are quite combustible. When a fire starts in a tire pile, it spreads rapidly because the fuel it needs to sustain itself is all but unlimited. Fires that are consuming tire piles are extraordinarily hard to extinguish, and they can burn for days. The smoke from the burning tires is a particularly dense black smoke that can permeate the environment for miles. The residue left from contact with the smoke is oily and is very hard to eradicate from the environment.

In these modern times, it is useful to keep in mind that tires almost never combust spontaneously. Tire pile fires are ignited by natural causes, such as lightning strikes, and by human intervention. Human causes may occur because of negligence or carelessness. And, they may occur because of intentional acts of arson. Whatever the cause, fires in tire piles are very serious and can pose a long term health risk to humans and damage to the environment.

There are no federal laws or regulations that specifically address or govern scrap tires. Regulation has been the responsibility of state and local governments. At least 48 states have some statutes or regulations that govern the disposal of scrap tires. As is common in America, there is not a uniform set of standards in place all across the country. Each state has features that are unique to its government and culture. However, there are common elements among most of the programs.

It should be noted, however, that the proper placing of scrap tires in landfills does not present an inherent environmental or health threat. Landfills are not the same as tire piles or dumps. Landfills are constructed and managed for the proper and safe disposal of a wide variety of solid wastes. Most are operated under strict regulatory standards. Scrap tires are a stable material, and they do not degrade after being placed in landfills. Nor do they have any toxic or hazardous substances that leach out of them to pollute groundwater.

But, not all landfills accept scrap tires. Several states have banned all tires from landfills. Some states ban whole tires, but allow shredded tires. The regulatory standards vary by state. Landfills usually try to regulate the disposal of whole tires because they have a tendency to “float” to the top of the landfill over time, and can

damage liners and caps on the landfill. The Colorado Department of Public Health and Environment regulates landfill operations in Colorado, and information may be obtained from the Department's website at: www.cdphe.state.co.us/environ.asp#top.

The Colorado Program

Like most states, Colorado also has old tire dumps and piles. Some were created before there were effective laws to regulate them, and some were created illegally. Colorado does have a state program dedicated to the recycling of scrap tires, and it is administered by the Department of Local Affairs. The essential components of the program are that a nominal fee is levied upon retailers, and that the funds generated from the fee are then used to further recycling and reuse programs. This program has minimal state level oversight, and the Department of Local Affairs performs an administrative function rather than a regulatory one. The intended beneficiaries of the program are local governments and end users who convert or reuse the scrap tires.

As with all programs that are created by statute, there are frequent amendments and modifications to the program. For the most current information about both the program and the application process, please visit the Waste Tire Grant webpage sponsored by the Department of Local Affairs. For convenience, we have provided you with the following link to that webpage: www.dola.state.co.us/LGS/FA/wtf.htm.

From Solid Waste to Valuable Resource

The days when scrap tires were thought to be little more than scrap with few valuable or viable uses are long gone. Now, there is an extensive recycling effort underway to recover the materials in the tires and use it for new purposes. Little more than a decade ago, only about 10% to 11% of scrap tires were recycled. Now, over 70% of the scrap tires are either recycled or they are exported. The remaining tires are stockpiled or they are shredded and buried in single material landfills or are used as a landfill cover.

It is easy to see that the rubber in scrap tires can be a valuable commodity, but the steel wire that is inside the tire is also a very valuable commodity.

According to industry sources, the process used to recycle tires allows the recovery of almost all of the steel wire that is in the tire. By removing the steel wire, nearly 99% of a passenger tire can then be recycled. The steel that is recovered is a high-quality steel and is used to make new steel. Each year, somewhere between 60 million and 70 million tons of steel scrap are recycled in this country. Not all of the recycled steel originates in scrap tires. It comes from old appliances, automobiles, construction materials, and other products. Year after year, steel is consistently one of the most recycled materials in America. It is a testament to both the value of the recycled steel and the technology of recycling that all new steel is manufactured with a minimum of 25% recycled steel.

Retreading Recycled Scrap Tires

Retreading of scrap tires has become a major business. According to the Tire Retreading Information Bureau, over 24 million retreaded tires were sold in the United States and Canada in 2001. Total sales exceeded \$2 billion – a very big business indeed. Interestingly, the retread industry is itself a source of scrap rubber to be used for conversion into crumb rubber. A byproduct of the manufacturing process for retreaded tires is called “buffings,” and it has accounted for a significant percentage of the total pounds of material used for crumb rubber.

For more information, please visit the Bureau's website at www.retread.org/Facts/index.cfm/ID/226.htm.

Playground Safety and Health – A Rapidly Emerging Market

Colorado Recycles has been very interested and supportive of efforts to use recycled scrap tires for playground safety improvements. In 2001, the Board of Directors bestowed the President's Recycler of the Year Award on Governor Bill Owens and the Colorado Child Care Association. This is the most prestigious award that Colorado Recycles makes, and it is not given every year. It is only awarded when the program is especially noteworthy. The 2001 award was made because of the combined efforts of the Governor's staff, the Colorado Child Care Association, and the Colorado Department of Human Services in initiating a pilot program to use recycled crumb rubber to replace sand, dirt and other materials in the fall zones of playground equipment. The pilot was a resounding success, and many lessons were learned that have been useful to preschool operators, public and private school officials, and recreational specialists.

For more information concerning the Recycler of the Year Awards program sponsored by Colorado Recycles, please go to that page of our website through the menu bar.

America prides itself on making environments safe for our children. We all have played on playgrounds and playground equipment as children. We have taken our own children and grandchildren to playgrounds for their enjoyment and for our own pleasure in watching them have fun. But playgrounds can also be a place where injuries can occur. Most often these injuries result from falls, and falls from playground equipment can be serious.

According to a report issued in 2001 by United States Product Safety Commission, every year approximately 200,000 children are injured in playground equipment accidents severely enough to need to be treated in hospital emergency rooms. Of these 200,000 injuries, about 148,000 involve public playground equipment and about 51,000 involve home playground equipment. Most of the injuries involve falls either into the fall zone below the equipment or on to other pieces of playground equipment. For a brief synopsis of this report, use the following link: www.cpsc.gov/CPSCPUB/PUBS/Playfct.pdf.

For many years, the Product Safety Commission has issued reports to help parents, recreational specialists and educators design and construct safe playgrounds. These reports are free to the public through the Commission's website. For your convenience, we have provided the following link to the index of the relevant reports: www.cpsc.gov/CPSCPUB/PUBS/playpubs.html.

Another very useful and informative site for playground safety is the National Program for Playground Safety, which is affiliated with the University of Northern Iowa. Among the very useful comparisons available through the Program is a guide called "Selecting Playground Surface Materials" which provides the most recently available information on a variety of surface materials. To access their website, please use the following link: www.uni.edu/playground/.

What is clear, however, is that many, if not most, of these injuries can be prevented or reduced in severity by the simple expedient of improving the cushioning properties of the material in the fall zones under playground equipment. Some older playgrounds use asphalt and concrete that have no shock absorbing properties of any kind. Similarly, natural grass and turf have very limited cushioning properties that also vary with environmental and climate conditions. When the ground is subject to below freezing temperatures, it can become as hard as concrete or asphalt.

A much better alternative can be found in loose-fill surfacing materials. There are a variety of these products that are readily available, and the Commission's reports provide a wealth of information about the features of almost all of them. Among the readily available materials, crumb rubber stands out as a safe surface. Surfaces that are covered with scrap tire derived material have some of the best shock absorbing features of any of the materials available.

Generally, there are two types of rubber surfacing materials that are frequently used for these fall zones. The two types are a loose-fill composite and a solid-mat type installation. In either case, all non-rubber component parts (such as the steel wire discussed in an earlier section) are carefully removed before the rubber is used for playground surfaces. Whereas the loose-fill rubber can be applied in much the same manner as other loose-fill products, mats are either a conventional size and dimension type or a pour-in-place type.

The conventional mats are manufactured as one large piece or as interlocking smaller pieces that can be configured as desired. The pour-in-place variety is blended with a binding agent, and then is poured under the equipment much like the process used to pour concrete.

Each type of material has its advantages, and the information provided by the Commission has a lot of useful points and tips to help the consumer make an informed decision. One of the issues that is becoming important is the accessibility to playground equipment by children with disabilities. In most cases, mats will prove a good option for accommodating children with mobility improving equipment such as wheelchairs, walkers or crutches.

Many federal, state and private agencies and laboratories have investigated the safety of materials made from scrap tires, and the reports were strongly positive for the material. Among the tests that have been reported, tire chips were tested for flammability in accordance with Federal standards. It was determined that the chips were not flammable.

Additionally, various reports and studies have found that the tire chips:

- *Are clean
- *Are not toxic
- *Do not retain or attract moisture
- *Do not create dust, dirt or mud
- *Do not attract rodents, vermin, cats or dogs. In some of the anecdotal information reported by preschool operators in Colorado, some of the fiber fill (not rubber) materials did attract cats that used the material as a litter box.
- *Maintained good solid performance in a variety of weather and climate conditions.

An unexpected nice feature of the surface material noted by parents and preschool owners is that the material does not abrade clothing (such as the knees on jeans), nor is it tracked inside to damage floors as is sand.

One of the more interesting reports was issued by the State of Maryland's Environmental Services Department. All parents and grandparents know that children ingest a wide variety of materials. The question raised was whether harm would result if a child swallowed a rubber chip. The tests showed that since the rubber was not digestible, it would simply pass through the child's digestive tract.

Recreational Field and Public Area Uses

The shock absorbent properties of scrap tire surface applications do not stop at the playground. Many schools and park and recreation departments are using scrap rubber as surface material for athletic fields, tracks, gymnasiums, rodeo arenas, soccer fields and other similar sites. Not only is safety and performance enhanced, the materials are very cost effective over the life of the site. The cost-effectiveness of the material will become even more important to schools as they face ever increasing budgetary constraints.

The porous design of crumb rubber allows water to flow unobstructed from the surface to drains, and the surface is more stable for footing. This combination makes the use very desirable for walking and jogging paths. Its long life span makes it a very cost effective alternative to mulch, bark, wood chips or sawdust.

When used as a soil additive in grass-surfaced areas, it has been learned that not only is drainage improved but that the material also retards the growth of weeds. Often, the grass is allowed to grow through the blended material, and the shock absorbency properties allow walking, running and playing on the surface without damaging the grass itself. A particularly nice feature is that wear spots are often mitigated or prevented. For pet owners, the reduction of mud is a huge consumer selling point.

A rapidly growing use of this type can be found in and around golf courses. The material provides a great surface for the aprons of greens and for golf cart paths. Some golf clubs have reported using recycled rubber mats in the high traffic areas around clubhouses, locker rooms, restaurants, patios and pro shops because the mats are resistant to damage from spiked golf shoes, and provide a non-slip surface for pedestrian traffic.

In 2001, the United States Open Tennis tournament was played for the first time on surfaces that had been bolstered with 50% recycled rubber. The USTA National Tennis Center officials reported that the players were very positive about the resiliency and cushioning effect that the new layers of rubber provided during the tournament. The players also reported better footing conditions and better ball control.

But it is just not tennis courts and soccer fields that are being improved by rubber filled surface applications. The Kansas City Chiefs and the Green Bay Packers have reconstructed certain of their practice fields. The artificial grass surface is reported to have same characteristics of natural grass, but can be used in both outdoors and indoor applications.

Recycled scrap tires that are manufactured to look like cobblestone have proved to be not only aesthetically pleasing to users, but they also restrict the use of the same areas by skateboarders and in-line skaters. The resilient nature and surface texture are not compatible with skate use. They have been installed in areas near seating, steps, ramps and planter boxes to thwart the skaters and the damage that they can inflict. Not only does the texture and surface consistency restrict the actual skating, skaters are discouraged from attempting jumps. But while restricting the skaters, the surface is very compatible with pedestrian use (even high heels), wheelchairs, strollers and shopping carts.

Scrap Tires for Fuel

In a preceding section, it was noted that one of the health hazard properties of scrap tires is their inherent combustibility. Whereas this property is particularly dangerous in tire dumps and tire piles, it is a valuable property when scrap tires are used for fuel. According to industry sources, nearly 115 million scrap tires were used as fuel in the United States in 2001. These tires are used in power plants, in cement kilns, in pulp and

paper mills, and in boilers in industries that need high sustainable heat. The demand for the use of scrap tires for fuel increases each year, and this use is currently the largest single use of scrap tires.

Each passenger tire has the equivalent of 7 gallons of oil, or 25 pounds of bituminous coal. A pound of tire material used for fuel generates 12,000 to 15,000 BTU's. A particularly attractive feature of scrap tires used as fuel is that they produce less ash than most types of coal, and less sulfur than bituminous coal. While some applications use whole tires or shredded tires as the only fuel source, most mix the scrap tires with other fuels such as coal. The scrap tires usually comprise about 10% of the total fuel mix when they are used as "co-fuel."

Flooring and Mats

A particularly innovative use of scrap tires is in the manufacturing of rubber mats and flooring. Similarly with the use of mats and crumb rubber for playgrounds, the shock absorbency properties have been shown to be very promising for use in stables and kennels. The mats help protect the animals legs, and they are easily cleaned.

Floor tiles made of recycled scrap tires are often used in fitness centers, weight training rooms or areas, exercise areas, locker rooms and ski areas. The tiles provide a slip resistant surface, even when wet, are easily cleaned and they provide an increased element of comfort and safety because of their shock absorbing qualities. And, users report that noise levels are diminished where the rubberized tiles, floor and mats are installed.

Rubberized Asphalt

One of the older markets and uses of crumb rubber is as an addition to asphalt used for paving, called rubber-modified asphalt. The crumb rubber can be used as part of the asphalt rubber binder, seal coat, cape seal spray or sealant for cracks and joints. It can even be used as an aggregate replacement. There have been various regulatory attempts over the years to further the use of rubber-modified asphalt, but they have met with mixed success and resistance. California, Arizona and Florida seem to be the states with the longest history and success in promoting the use of rubber-modified asphalt.

A number of states and localities have been conducting noise studies along highways that are paved with rubber-modified asphalt. Early reports are that the rubber-modified asphalt surfaces are significantly quieter than those paved with conventional materials. A particularly useful source of information is the Rubberized Asphalt Concrete Technology Center (RACTC), which is a cooperative effort of the County of Los Angeles, the County of Sacramento and the California Integrated Waste Management Board. There is a great deal of important and useful information available through the RACTC's website at www.rubberizedasphalt.org.

As technology and installation techniques have improved over the years, California, Illinois, Kentucky, Michigan, Texas, Ohio, Virginia, and Wisconsin have become interested in what has become known as the "perpetual pavement concept". This concept is predicated on using rubber-modified asphalt to extend the life span of major highways, and to reduce the amount of traffic restricting maintenance. There are reports that the rubber-modified asphalt has less of a tendency to rut, which reduces water, snow and ice accumulation that both poses a danger to motorists and also allows freezing and thawing to degrade the asphalt surface.

There are other highway uses for scrap tire rubber. Wyoming has begun to use a type of post that is made of recycled tires with a special hinge that allows the post to be knocked over but return to its original configuration. The Wyoming highway department placed these posts along I-25 in the Cheyenne area and at the port of entry between Wyoming and Colorado. Used mostly to direct and channel traffic, the department reported great success. Whereas the previous steel and fiberglass posts were impacted daily by oversize loads

and were broken and had to be replaced, the rubber posts bent and then returned to shape. The success generated by these posts led Wyoming to install them in other difficult highway locations. One of the advantages reported was that they proved to be much safer for motorists because they did not break off and become piercing or puncturing hazards.

Another interesting use that is coming into prominence is the safety-stripped speed bump. Parking lots have long used asphalt speed bumps to slow down motorists driving through areas where pedestrians or other vehicles could be hit. These rubber speed bumps are manufactured with built-in reflectors, which improve visibility and safety in the dark and inclement weather. They appear to have a multi-year useful life span, and do not channel or deteriorate as do asphalt speed bumps.

Leach Fields

In 2000, the Twin Landfill Corporation received a special recognition award from Colorado Recycles for perfecting a use of scrap tires as a leach field in a new landfill. The leach field is used to protect the groundwater from incursions of hazardous substances that could pollute the aquifers. Traditional construction used sand or gravel to form the filtration layer. Water in landfills is often very caustic, and works its way through the filter system at the base of the landfill and is then pumped out, treated and released. The tire chips are an improvement over sand and gravel because the rubber is more porous and allows the water a more efficient route to the pump. Also, tire chip layers have fewer maintenance requirements because, unlike sand, the rubber does not migrate and clog the landfill filters and pumps.

The project that got the attention of the Colorado Recycles board of directors was the Twin Landfill project in Fremont County at the Phantom Landfill. The improved filtration offered by the shredded tires is already having a profound impact on protecting the ground water that ultimately flows into the Arkansas River.

Also during the year 2000, it was reported that almost 90% of the septic systems installed in the southeastern portion of the United States were using scrap tire rubber as leach pads. The use of the tire chips proved to be more economical than using rock, was easier to install, and had better water absorbency.

The same properties that make the shredded tires a good application for leach fields, also make them very attractive for use in other drainage applications such as French drains and foundation drainage needs.

Roofing Shingles

A relatively new application for scrap tires is in the manufacture of roofing shingles. These shingles are being billed as "hail-proof" and are manufactured to have a natural slate look to them. Early reports are that these shingles are more resilient and have more insulation properties than traditional asphalt shingles.

Developing Uses

The foregoing discussion is an indication of the many valuable economic uses for recycled scrap tires. But, there are new and exciting uses announced almost every month. One that has been researched here in Colorado is the use of tire bales as noise barrier walls along major highways. The research has been conducted by the Colorado School of Mines. Other applications for tire bales include construction of buildings.

Many states are experimenting with shredded tires as mulch along highway revegetation applications and as light-weight fill for highway and interchange construction.

Not only are the recycled scrap tires being viewed as light-weight fill materials, they are also being tested for track bedding in light rail applications.

And, in yet another new test, California is testing the light-weight fill uses of the scrap tires in rehabilitating its extensive, but aging, levee system.

The uses of scrap tires in economically viable applications are wide and varied. Colorado Recycles expects to see an increasing use of these products in Colorado where our climate and commitment to protecting our environment is a fundamental part of our culture.