
California Waste Tire Market Report: 2010



California Department of Resources Recycling and Recovery

June 2011

Contractor's Report
Produced Under Contract By:



STATE OF CALIFORNIA

Jerry Brown
Governor


John Laird
Secretary, California Natural Resources Agency

**DEPARTMENT OF RESOURCES RECYCLING AND
RECOVERY**

Mark Leary
Acting Director

Department of Resources Recycling and Recovery
Public Affairs Office
1001 I Street (MS 22-B)
P.O. Box 4025
Sacramento, CA 95812-4025
www.calrecycle.ca.gov/Publications/
1-800-RECYCLE (California only) or (916) 341-6300

Publication # DRRR-2011-017

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Prepared as part of contract number IWM07059 for \$5,100,000, including other services.

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Introduction

Background

Under the California Tire Recycling Act of 1989 and subsequent amendments, the Department of Resources Recycling and Recovery (CalRecycle¹) has adopted an overall tire management strategy focusing on two interrelated fronts: 1) Providing a strong and fair regulatory framework to protect public health and safety and the environment while not stifling waste tire flow and processing; and 2) Supporting expansion of the business and government market infrastructure for producing and using tire-derived products. CalRecycle's Five-Year Plan for the Waste Tire Recycling Management Program, which is required to be revised every two years, guides efforts to reach a 90 percent diversion goal by 2015. The latest version of the Five-Year Plan was adopted by CalRecycle in May 2011.

This report supports CalRecycle's efforts by providing information on the waste tire diversion rate, market trends, and supply/demand balance based on research conducted from January 2011 through April 2011. The report was prepared under CalRecycle contract by SAIC Energy, Environment & Infrastructure, LLC (formerly R.W. Beck, Inc.), with research assistance by D.K. Enterprises. Following this introduction, Section 2 provides a snapshot of markets for California waste tires with estimated waste tire uses for 2010, a look at key trends, with a discussion of the outlook for increased diversion. Section 3 then begins with a discussion of the current balance between supply and demand, and then describes trends under each market category in more detail. Section 4 provides conclusions.

Interpreting and Using Report Findings

Appendix A provides a detailed summary of the methodology, sources of uncertainty, and adjustments to report methodology over time. Following are a few key points to remember when interpreting and using data presented in this report:

- **Significant Uncertainty but Reasonable Trend Information:** As described in Appendix A there are several important sources of uncertainty associated with the estimated market flows. For most market segments, the estimates are thought to be accurate to about +/- 10 percent and can reasonably be used to evaluate trends over time.
- **Many Sources Combined and Cross-Checked:** The estimates are generally derived from primary data gathered from processors, landfills, tire-derived fuel users, retreaders, CalRecycle's Waste Tire Manifest System and Disposal Reporting System, and CalRecycle staff, as well as discussions with a range of tire-derived product producers and others with a stake in California waste tire management. Data from these sources is combined and analyzed to remove double-counting, and cross-checked to derive the most accurate estimates possible given the information available.
- **Estimates are for Use of California Generated Tires Not Total Market Size:** The 2010 estimates presented in the report indicate the approximate number of California waste tires flowing into each market segment. They do not "count" imported ground rubber or finished products; nor do they "count" rubber buffings derived from retread operations that subsequently

¹ The Department, known as CalRecycle, was formerly the California Integrated Waste Management Board. In this report "CalRecycle" is used to refer to the organization, both in relation to current and past activities.

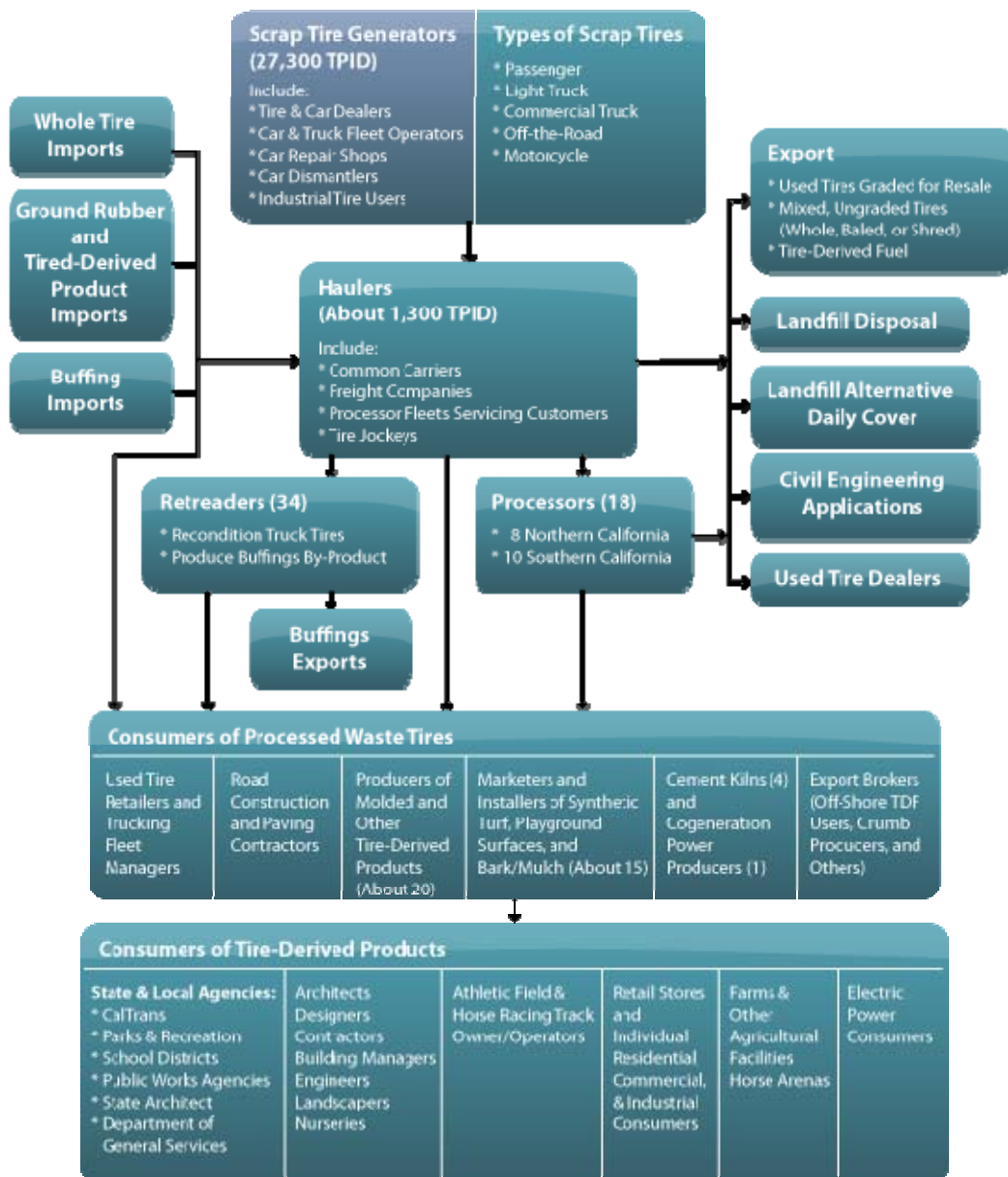
go into a variety of recycled rubber applications. Consequently, the estimates indicate the flow of California waste tires into different end-use market segments, not the size of the end-use markets themselves.

- **Waste Tire Generation Based on Documented Flows:** The total estimate of waste tire generation is based on the sum of all documented flows derived from the sources listed above, after adjusting for double counting. Generation estimates are not based on sales data or estimated time between purchase and tire discard.
- **Tire Diversion Rate Not Adjusted for Residuals:** As with many other state and national tire recycling market studies, in this report the tire diversion rate is not adjusted for steel and fiber residuals that occur as a result of producing ground rubber. While these materials are often recycled, to date the project team has not comprehensively gathered this data in order to simplify the survey process.

Industry Overview

Figure 1 below provides a flow chart identifying the number and types of firms involved in California waste tire management. Note that the 18 “processors” indicated in the figure refers to the active facilities surveyed for this report that handle the vast majority of tires generated in California. There are also additional, permitted facilities such as cement kilns using whole tires and landfills accepting whole tires.

**Figure 1
California Waste Tire Management Flow Chart²**



² Estimates of the number of California facilities are provided where they are available. TPID stands for tire program identification number, assigned to regulated entities under CalRecycle’s Waste Tire Manifest System.

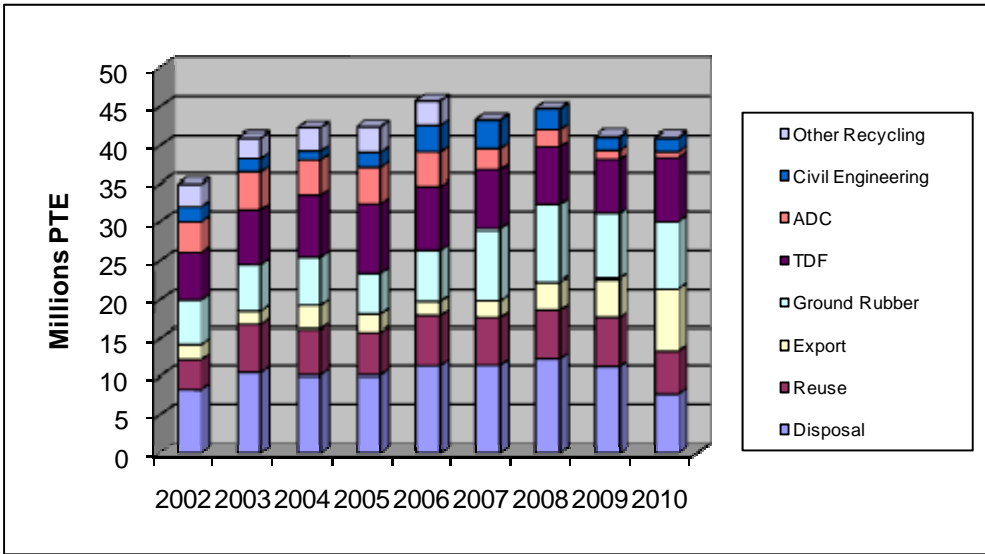
Market Snapshot

Current Diversion Rate and Key Trends

This section provides a snapshot of California waste tire markets as of December 2010, and discusses key trends. This year’s report showed a spike in the overall waste tire diversion rate from 72.6 percent in 2009 to 81.0 percent in 2011. However, nearly all of this net increase was a result of the continued, unprecedented rapid growth in the export of baled and processed waste tires to Pacific Rim nations, largely for use as tire-derived fuel (TDF). And as in previous years, domestic tire-derived fuel played a major role in the California waste tire market. If waste tire exports and domestic tire-derived fuel were excluded, the overall California waste tire diversion rate would be only 45.2 percent. More detailed trends for each market segment are covered in the next section.

Figure 2 graphically shows trends by broad market category since 2002, and Table 1 (on the following page) presents estimated uses for California-generated waste tires in 2010 along with data from 2008 and 2009 for comparison. Compared with earlier CalRecycle reports, the statistics beginning in 2007 are based on adjusted categories and data-gathering methodology. Appendix A describes the methodology, data limitations and differences with prior CalRecycle studies in more detail.

Figure 2
Nine-Year Trend for California Waste Tire End-Uses³



The sluggish California economy and an unemployment rate of more than 12 percent in the state in 2010 resulted in a continuation of the 2009 situation where reduced miles being driven directly translated into reduced waste tire generation rates. Anecdotally, 2010 began with waste tire

³ Data for 2002 – 2006 are from CalRecycle’s annual “California Waste Tire Generation, Markets and Disposal” reports. Methodological differences complicate direct comparisons between 2002 and 2006 and later statistics. “Retread” and “reused tires” from previous reports are regrouped here as “reuse.” “Ground rubber” includes RAC and some other ground rubber uses that were previously grouped as “other recycling.”

generation rates continuing to decline; however, this trend turned around by the end of the year, and overall waste tire generation remained about flat compared to 2009.

**Table 1
Estimated End-Uses for California Generated Waste Tires, 2008– 2010⁴**

Category	Sub-Category	2008		2009		2010		Percent change 09-10
		Million PTE	Percent of Total	Million PTE	Percent of Total	Million PTE	Percent of Total	
Export	Waste Tires	2.2	4.9%	3.3	8.0%	6.4	15.5%	93.3%
	Used Tires (Exported)	1.5	3.4%	1.8	4.3%	1.8	4.3%	-0.2%
	Subtotal	3.7	8.2%	5.1	12.3%	8.1	19.8%	60.5%
Reuse	Retread	4.4	9.9%	4.4	10.7%	3.6	8.8%	-18.1%
	Used Tires (Domestic)	1.9	4.1%	2.0	4.7%	2.0	4.9%	3.6%
	Subtotal	6.3	14.0%	6.4	15.4%	5.5	13.7%	-11.4%
Ground Rubber	RAC & Other Paving	4.3	9.7%	4.6	11.3%	5.0	12.3%	8.4%
	Turf & Athletic Fields	2.4	5.5%	1.3	3.3%	1.4	3.3%	2.3%
	Pour-in-Place Playground	0.4	1.0%	0.2	0.6%	0.1	0.4%	-40.8%
	Loose-Fill Play/Bark/Mulch	1.1	2.6%	1.3	3.1%	1.1	2.7%	-14.3%
	Molded & Extruded	1.2	2.6%	0.8	2.0%	0.7	1.8%	-12.0%
	Other	0.5	1.2%	0.1	0.3%	0.2	0.4%	41.8%
	Subtotal	10.1	22.4%	8.5	20.5%	8.6	20.8%	1.1%
Civil Engineering	Landfill Applications	2.1	4.6%	1.4	3.4%	1.8	4.4%	28.3%
	Non-Landfill Applications	0.7	1.6%	0.4	0.9%	<0.1	0.1%	-90.1%
	Subtotal	2.8	6.2%	1.8	4.2%	1.8	4.4%	4.4%
Alternative Daily Cover		2.1	4.6%	1.2	2.9%	0.8	1.9%	-34.2%
Other Recycling		0.1	0.2%	0.1	0.2%	<0.1	0.1%	-31.3%
Tire-Derived Fuel		7.5	16.7%	7.0	17.0%	8.4	20.3%	19.7%
Landfill Disposal		12.3	27.6%	11.3	27.4%	7.8	19.0%	-31.0%
Total Generated		44.8	100.0%	41.2	100.0%	41.1	100.0%	-0.1%
Total Diverted from Landfill		32.4	72.4%	29.9	72.6%	33.2	81.0%	11.5%
Imports		0.5	1.1%	1.5	3.6%	1.0	2.5%	-31.3%

⁴ Data for 2008 and 2009 are from the “California Scrap Tire Market Report: 2009.” PTE stands for passenger tire equivalents, which is defined by the State of California to equal 20 pounds.

One of the most significant market trends in 2010 was the near doubling of waste tire exports. The majority of the increase in exports was due to demand for two-inch tire chips as tire-derived fuel in Japan. The increase in demand for tires as fuel was also reflected in California as well, as cement plants increased their demand compared to 2009. Rubberized asphalt concrete (RAC) continued to grow as a result of local government acceptance and growing familiarity with the material. Most other diversion segments, however, showed little change compared to 2009. The combination of flat waste tire generation—combined with significant increases in demand for tires as tire-derived fuel, both in California as well as by export markets—resulted in an all time high tire diversion rate of 81 percent. However, if domestic tire-derived fuel and exports of waste tires are excluded, the diversion rate would be 45.2 percent. Detailed market figures are shown above in Table 1.

The California waste tire management industry remained highly dynamic with several changes in processing facilities and clear shifts in certain markets. Following are some of the key trends currently shaping the market:

- **Infrastructure:** Competition for waste tires intensified in 2010 as ground rubber production facilities that started operations in late 2009 and early 2010 aggressively sought sources of supply for their new capacity, as several existing processors sought to expand market share (in part driven by strong export demand) and as a shortage of truck tires in Southern California intensified. However, demand for ground rubber generally did not increase (except for rubberized asphalt concrete) and production of ground rubber by new producers has yet to increase to the levels targeted and publicly announced in connection with CalRecycle loan awards. One of the new facilities experienced a plant fire in the fall of 2010, which when combined with the other market difficulties led to its bankruptcy. Currently, 18 processors handle the vast majority of tires generated in the state.
- **Exports:** Exports nearly doubled in 2010, driven largely by strong demand for tire-derived fuel in Japan and sustained demand in Asian countries, especially China. Anecdotally, waste tire exports are continuing to grow rapidly in 2011, buoyed by sustained strong demand and favorable pricing. There are reports of many export brokers aggressively seeking increased supplies of waste tires and/or processed tire-derived fuel for export.
- **Reuse:** Reuse, including retreading of truck tires and the culling of used tires for sale domestically, remains strong. Because of a change in the methodology used to estimate truck tire retreading, the retreading figures show an apparent decline; however, conversations with truck tire retreaders indicate that a drop in demand triggered by the weak economy has now turned around, and they point to continued strong demand and even expanded interest in their products compared to new tires because of the challenging economy.
- **Ground Rubber:** The overall demand for ground rubber produced from California waste tires was essentially flat compared to 2009. However, the number of tires used to produce ground rubber sold into rubberized asphalt concrete and other paving applications increased by 8 percent from 4.6 million passenger tire equivalents (PTEs) in 2009 to 5.0 million PTEs in 2010. Unfortunately, this growth was offset by declines in playground, mulch, and molded and molded/extruded market segments. Toward the end of the year, turf and athletic field markets began to recover and processors are optimistic that crumb rubber markets will improve in 2011. Anecdotally, there are reports of increased importation of crumb rubber from outside of California combined with aggressive sales tactics, resulting in a softening in crumb rubber pricing and concerns over potential future softening of sales (outside of CalRecycle grant-supported TDP sales which must use California rubber).

- **Civil Engineering:** The estimated use of tire-derived aggregate from California waste tires in civil engineering applications remained flat in 2010 compared to 2009. Estimated landfill civil engineering applications increased from 1.4 million PTEs to 1.8 million PTEs. Not all landfill operators use the most efficient engineering design for their tire-derived aggregate projects, so landfill use is primarily governed by the cost of conventional aggregate, and the availability of waste tires to produce tire-derived aggregate (several processors are co-located at landfills). One of those processors moved to a new location in late 2010 and as a result landfill tire-derived aggregate use may decline in 2011. Landfill tire-derived aggregate use reported here is based largely on surveys of landfills, and has not been verified by CalRecycle to be consistent with typical tire-derived aggregate landfill civil engineering application design.

The increase in landfill civil engineering use was offset by a decline in non-landfill civil engineering applications, which declined for the second straight year, as there was only a single project in 2010 to repair a road damaged by a landslide. The lack of scheduled non-landfill civil engineering projects in 2011 means that civil engineering overall is expected to decline in 2011. However, there are a pair of major rail projects scheduled for 2012, at which time civil engineering is expected to recover. In addition, CalRecycle is developing a tire-derived aggregate grant program for 2012, which may likely result in an increase in both landfill and non-landfill civil engineering use. Moreover, a single large project has the potential to trigger an abrupt rise in tire-derived aggregate use.

- **Alternative Daily Cover:** The use of waste tires as Alternative Daily Cover decreased for the fifth straight year as tires went to more value-added markets, and as construction and demolition debris and green waste met landfills' needs for cover materials.
- **Tire-Derived Fuel:** The estimated use of California waste tires as tire-derived fuel within California itself increased in 2010, reversing a five-year decline. This increase was surprising given that cement production remains depressed due to the continuing weak economy.
- **Disposal:** Landfill disposal declined by 31 percent, from 11.3 to 7.8 million PTEs. Because all other major market categories were essentially flat, this decline is directly attributable to increased demand for tire-derived fuel, both as overseas exports and in California.

Outlook for Increasing the Waste Tire Diversion Rate

CalRecycle has adopted a goal of increasing the diversion rate to 90 percent by 2015. As shown in Figure 3, California waste tire diversion steadily increased from about 31 percent in 1990 to about 75 percent in 2001, and hovered between 75 and 72.4 percent throughout the 2000s. For the first time, in 2010, the diversion rate broke through this barrier and reached an 81 percent diversion rate, while at the same time the smallest percentage of tires were landfilled since statistics have been kept. Although California tire markets may continue to grow and diversify, it will likely be challenging to meet the 90 percent goal without a heavy reliance on tire-derived fuel and export markets. In 2010, if domestic tire-derived fuel and exports of waste tires are excluded, the resulting diversion rate would be 45.2 percent. Also, the Waste Tire Program Evaluation Report prepared by CalRecycle in 2010 identified a number of legislative changes that could potentially assist in expanding diversion through ground rubber, outside of tire-derived fuel.

**Figure 3
Waste Tire Diversion and Disposal Trends**

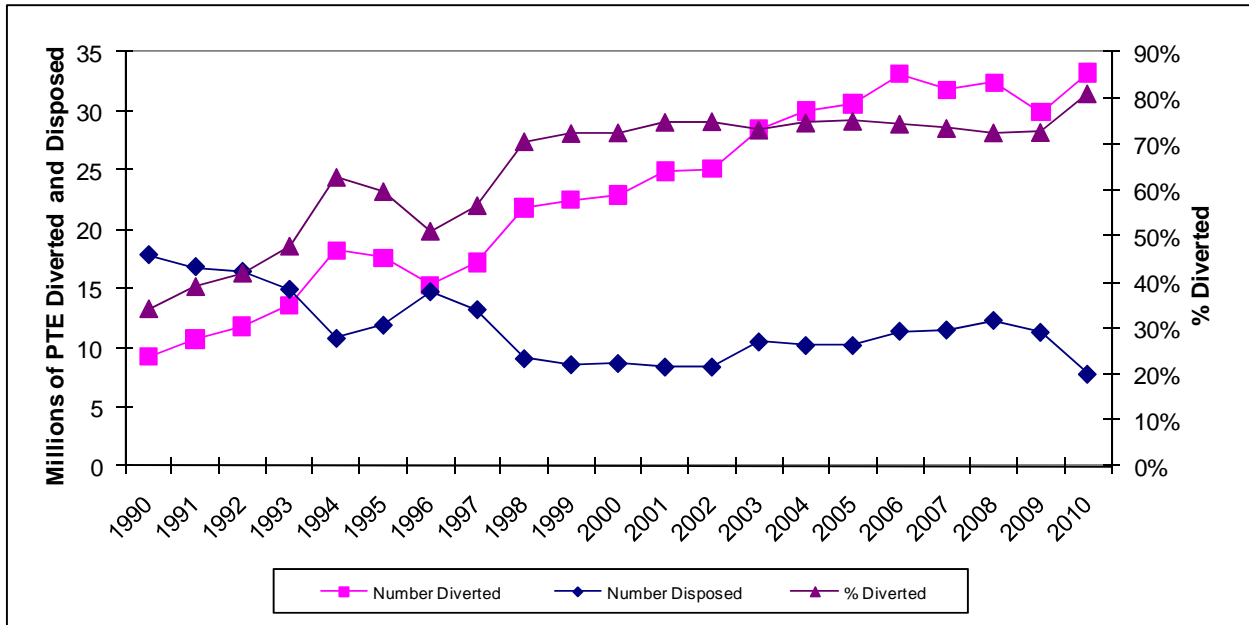


Table 2 summarizes expected short term diversion trends, indicating that there is a good chance that both waste tire diversion volumes and the diversion rate may increase in the next two years, assuming that key threats identified do not materialize.

Table 2
Short-Term (Two Year) Diversion Outlook, Drivers and Threats

Category	2010 Diversion		Two-Year Diversion Outlook	Drivers	Barriers/Threats
	Million PTE	Percent			
Reuse	5.5	13.7%	Flat	<ul style="list-style-type: none"> ▪ Favorable economics 	<ul style="list-style-type: none"> ▪ None in short term
Ground Rubber	8.6	20.8%	Increase, depending on local government budgets and overall economy	<ul style="list-style-type: none"> ▪ CalRecycle support ▪ Strong demand, especially for RAC ▪ Expanded ground rubber production capacity 	<ul style="list-style-type: none"> ▪ Recession-driven reduced demand and government budgets ▪ Health concerns may reduce turf demand ▪ Increasing imports and possible glut if demand remains low
Civil Engineering	1.8	4.4%	Decline in 2011, then growth in 2012	<ul style="list-style-type: none"> ▪ Expanding CalRecycle focus and support ▪ Favorable economics at certain landfills ▪ Growing experience for transportation uses 	<ul style="list-style-type: none"> ▪ Supply challenges ▪ Lack of awareness/experience ▪ Value of tires for TDF may make TDA unaffordable for civil engineering uses
ADC	0.8	1.9%	Flat or declining	<ul style="list-style-type: none"> ▪ Does not count as disposal per statute 	<ul style="list-style-type: none"> ▪ Other ADC materials are easier to use than tire shreds
Other Recycling	<0.1	0.1%	Flat	<ul style="list-style-type: none"> ▪ None in short term 	<ul style="list-style-type: none"> ▪ None in short term
TDF	8.4	20.3%	Increase	<ul style="list-style-type: none"> ▪ Favorable economics and production benefits at cement plants vs. other fuels ▪ Reduces emissions relative to coal or petroleum coke 	<ul style="list-style-type: none"> ▪ Shift of cement production to locations outside of California ▪ Expanded permitted capacity of 2.5 million PTE at one facility with stated desire to increase TDF use if economy improves
Export	8.1	19.8%	Increase	<ul style="list-style-type: none"> ▪ Strong and growing demand by Asian countries for TDF ▪ Favorable economics to processors 	<ul style="list-style-type: none"> ▪ Unpredictable demand dependent on fuel prices and currency exchange rates ▪ Complex regulations & language challenges
Total Diversion	33.2	81.0%	Modest diversion increase	<ul style="list-style-type: none"> ▪ Ground rubber, export and TDF are likely to increase 	<ul style="list-style-type: none"> ▪ Fundamentals currently supporting TDF and exports may change with a sudden drop in demand

Market Trends by Category

This section describes in more detail the current balance between supply and demand in the California waste tire market, and key market trends affecting each market segment.

Overall Supply and Demand Balance

As in any commodity market, the balance between the supply of waste tires and processed tire feedstock, and demand for these materials is constantly shifting in response to market trends, changes in processor and TDP producer capacity, and government support/regulation.

Following is a brief update on supply infrastructure trends, concluding in a synopsis of the current balance between supply and demand for different market segments, and implications for potential expansion projects.

Processing Expansions, Contractions and Partnerships

More than 27,000 registered California facilities, such as tire dealers and auto repair shops, generate waste tires. California has a large, dynamic infrastructure for collecting and processing waste tires, including about 1,300 registered haulers and 30 facilities with an active major or minor waste tire facility permit. The vast majority of tires generated flow to one or more of 18 processor facilities analyzed in this report, with the remainder hauled directly to disposal or end-uses such as reuse or cement kilns burning tire-derived fuel, which were also surveyed. Although whole tires and processed product are sometimes shipped between Northern and Southern California, to a large degree most operators are only active in one region or the other, with relatively little flow of tires between the two distinct regions, and with each region having somewhat different market dynamics.

California waste tire processing continues to experience a very dynamic period involving processor expansions, contractions and partnerships. This activity is fueled largely by the market trends described throughout this report.

In 2010, one Southern California processor ceased operations and another new Southern California processor began operations. Processors in both regions who had placed new equipment into service in 2009 and 2010 to produce crumb rubber began to ramp up production. The concern discussed in this report last year over the potential for overproduction of crumb rubber compared to demand did not materialize, although equipment is not yet being utilized to capacity, and pricing for crumb rubber did decline during 2010. Furthermore, one Northern California crumb producer and one Southern California crumb producer have received CalRecycle loans that will expand their production capacity. According to public CalRecycle loan approval documents, Tri-C Manufacturing was awarded a \$640,000 loan to purchase equipment that will allow them to increase crumb production capacity from 2.6 million PTE/year to 3.0 million PTE/year, including the use of fork lift tires and off-the-road tires, and production of rubber bark for landscaping applications. ReRubber, which uses mainly truck tires, was awarded a loan of \$1.35 million to install a second production line, increasing the firm's capacity from 1.1 million PTE/year to 2.2 million PTE/year, and allowing production of up to 120 mesh crumb.

Interest in partnerships by and between processors and tire-derived product producers continued, in some cases with the goal of helping both parties secure their niche as tire-derived product markets mature. These relationships are especially becoming more important for the growth of ground rubber processing businesses, as national brands become dominant in synthetic turf and playground applications, and large California rubberized asphalt concrete producers develop

preferred supplier relationships. A concrete example of the maturation of the tire-derived product industry was the launch of the [California Rubber Recycling Network](#) in 2010. This new network of tire-derived product producers and processors was formed with the goal to advance tire-derived products into the marketplace.

Availability of, and Increased Competition for, Waste Tires

Overall waste tire generation (based on documented flows in this study) was estimated to be about the same as 2009 and down from the quantities generated in the mid-2000s. This trend is apparently turning around, and waste tire generation may increase markedly in 2011 and beyond. According to Rubber Manufacturers Association (RMA) statistics, new tire shipments were forecast to increase nationally by 9 percent in 2010 compared to 2009. About half the increase was attributed to new vehicle sales and the other half to tire replacements for existing vehicles. Economic uncertainties will keep growth at about 2 percent in 2011, according to RMA. Unfortunately, these national statistics do not directly apply to California and the state's stubbornly high unemployment rate of over 12 percent illustrates that the slowly recovering national economy didn't quite make it to California in 2010. As Californians get back to work in 2011 and 2012, the supply of waste tires can be expected to grow.

Due to increased demand for tire-derived fuel, especially for export markets, no increase in tires generated, and new crumb rubber processing capacity, overall demand for waste tires by processors intensified in 2010. In both Northern and Southern California, there are anecdotal reports of aggressive competition for collection accounts, which is driving down collection fees and therefore processor revenue. In Southern California, truck tires in particular are currently in very short supply as tire processors who are trying to produce crumb rubber are competing against processors who are trying to source waste truck tires to produce buffings for pour-in-place playgrounds and other tire-derived product applications. The economic recession, however, appears to have helped truck tire retreaders who saw increased demand for retread versus new tires.

Other Supply Trends

Additional trends/factors related to waste tire and rubber feedstock supply include:

- **Competition from out-of-state suppliers:** Anecdotally, sales to California customers of ground rubber and TDPs from out-of-state producers have increased, and may in some cases contribute to relatively flat California crumb sales. Increasingly, not only is ground rubber as raw material being imported, but TDPs are being imported too, from as far away as China. A recurring concern of stakeholders is that CalRecycle continue to provide due diligence to ensure that grant funds used for TDP products are supporting the development of California waste tire processing and TDP manufacturing infrastructure and not supporting producers from states and provinces that subsidize ground rubber at a competitive advantage. In response, CalRecycle's TDP grant program and Tire-Derived Product Business Assistance Program are both stepping up documentation requirements to verify California rubber use. However, it is important to note that increasingly national firms are dominating certain tire-derived product categories, such as synthetic turf and playgrounds. These national firms want to minimize their number of suppliers and prefer to not maintain records of the origin of tires used in their products. One large North American processor and crumb producer continues to expand production via acquisitions, potentially contributing to a possible imbalance between crumb rubber supply and demand in 2011 and beyond.

- **Scarcity of fine rubber powders:** Suppliers in California are generally not able to supply fine rubber powders (80 mesh) that meet TDP manufacturers' quality specifications and such fine rubber powders are imported into the state. The added cost to import these materials is believed to have an impact on further development of certain TDP products.
- **Scarcity of truck tires:** The relatively high natural rubber content of truck tires make them desirable for use in rubberized asphalt concrete, and Caltrans' specifications requires certain minimum concentrations of natural rubber in the asphalt mixes. As rubberized asphalt concrete paving continues to grow, the demand for crumb rubber truck tires will continue to grow as well. Truck tires are becoming valuable and scarce in California and there is intense competition for old truck tires from retreaders, processors who buff the tread from waste truck tires for tire-derived product producers (e.g., pour-in-place playgrounds and molded products), and crumb suppliers for rubberized asphalt concrete projects.
- **Storage of tire-derived aggregate:** Transportation projects that use tire-derived aggregate require large quantities of tire-derived aggregate over a short period of time. It can be difficult for processors to supply such projects without disrupting their regular daily market shipments, unless tire-derived aggregate can be safely and legally stockpiled.
- **Export removal of tire "supply:"** Up till now growing export markets (largely tire-derived fuel) have not adversely impacted the supply of waste tires for ground rubber, reuse, and civil engineering applications, largely because of flat demand for those market segments in the last couple of years. However, it is anticipated that trends suggesting a recovery of those markets in late 2011 and 2012 may result in a tightness of supply in certain regions due to waste tires being locked up in export market supply contracts.

Mixed Demand Trends

As summarized above and described in detail below, overall demand in 2010 for ground rubber was flat as increases in demand for rubberized asphalt concrete were offset by declines in loosefill playground, bark/mulch, and molded and extruded products. Anecdotally, this trend is continuing in 2011. Some suggest that turf may be beginning to rebound in 2011, although there is apparently wide spread sentiment that this market segment, which has grown substantially in the past several years, could potentially decline if the industry shifts to other infill materials. (The Los Angeles Unified School District, for example, has announced that it is no longer purchasing recycled tire rubber as infill in synthetic turf projects.) Demand for tire-derived fuel increased in 2010 for both domestic and export markets and this trend is continuing in 2011. Overall demand for civil engineering uses was flat and is expected to decline in 2011. Similarly, demand for ADC declined and is not expected to recover in 2011. Overall, the increases in California tire-derived fuel demand and rubberized asphalt concrete are unexpectedly positive, given the magnitude of the economic downturn and its effects on lower than historical production by the cement industry (which consumes tire-derived fuel) and less Caltrans paving projects (reduced state purchasing of rubberized asphalt concrete). With expected modest growth of certain ground rubber markets in 2011, expected strong tire-derived fuel export growth, and tightness in waste tire supply, 2011 offers promise for further growth in the state's waste tire diversion rate.

Implications of Supply/Demand Balance for Future Market Expansion Projects

Following are some implications of the above analysis for future market expansion projects:

- Projects to expand ground rubber production capacity should proceed with caution – one new ground rubber producer went bankrupt in 2010 and other new producers need time to develop

supply and market relationships. The issue of supply and demand balance is particularly important for ground rubber, which requires a greater processor investment than other rubber feedstock operations and therefore puts facilities at greater risk during downturns. And, it is particularly important for operations relying on truck tires as raw material. Despite these concerns, there is a need for more fine powder supply in the state (80 mesh crumb).

- Terminal blend asphalt is a new market option for fine crumb rubber that is distinct from the current rubberized asphalt concrete applications for tire crumb.
- Tire-Derived Aggregate Needs Expansion in both Demand and Supply—Unlike ground rubber, the tire-derived aggregate market is in its early stages and is in need of expansion for both demand and supply. Because non-landfill transportation projects are occasional in nature (only one occurred in 2010) and demand very large quantities of tire-derived aggregate all at once, few processors are willing to commit to serving this market sector. There is a need to build up a more consistent level of market demand and investigate ways that tire-derived aggregate may be able to be accumulated over time in compliance with regulations.

Market Segment Updates

Reuse

Reuse, including retreading and sale of partially worn used tires, is strong and stable, with about 5.5 million PTE being reused in 2010. Because of a change in methodology regarding how truck tire retreading was estimated (see below), retreading appeared to decline from 2009 to 2010. However, retreaders and sellers of used tires reported more interest, not less interest in tire reuse. When the economy recovers, there is the potential for demand of used tires to fall if purchasers return to purchasing new instead of used/retreaded tires.

RETREAD TIRES

The CalRecycle estimate of California retread levels has been held flat since 2003 at 4.4 million PTEs. However, this was due to challenges in the measurement of retread volumes. For the 2010 market analysis report, a new approach was utilized that included a combination of expanded surveys and detailed analysis of manifest data to estimate retread volumes and identify broad trends. The outcome of the surveys and analysis was an estimate of 3.6 million PTEs of truck tire retreading for 2010.

California is home to more than 30 retread companies that remanufacture used truck tire casings into retread tires for reuse. Some tires also leave the state to be retreaded elsewhere. Although retreaders receive some casings from haulers and processors, retreaders most often provide services directly to their customers, mainly trucking companies and other trucking fleet managers.

Truck tire retreading is highly economical and considered mainstream by many trucking companies and other fleet managers. Anecdotally, some retreaders opined that retread volumes may have grown in part to cost-saving measures implemented in response to the recent economic downturn. Others suggest the down economy may have resulted in a decline in retreading since the downturn is also responsible for reduced trucking miles driven, moderating any overall increase in retread demand. There is also a shift occurring in the industry, with small retreaders losing market share to large retreaders, which makes it more difficult to clearly identify trends. Overall, truck tire retreading appears to be relatively stable.

The main barriers to increased retreading are market saturation and the concern of some fleet managers regarding relative safety and performance compared to new truck tires. However, industry representatives argue that retreads perform as well as new truck tires. However, truck tire retreaders are hopeful that truck fleets that decided to give retreaded tires a try during the recession may decide to continue with retreaded truck tires into the future, leading to higher reuse levels.

USED TIRES

Shipments of used tires to dealers within California were estimated at 2.0 million PTEs in 2010, the same as the 2009 level. Additionally, as discussed under “Imports and Exports” later in this section, in 2009 an estimated 1.8 million PTEs of used tires were exported from California. It should be noted that the amount of used tires that are used domestically versus exported from California to places such as Mexico may be overstated as used tires that seemingly appear to be for domestic use may be subsequently exported south of the border.

Used tires are partially worn tires suitable for continued use as vehicle tires that have been culled and graded by haulers or processors for resale. Most processors view used tires as an attractive market because of the relatively low cost to prepare them and the relatively consistent price and demand for them. A large network of dealers purchase used tires for wholesale distribution to tire outlets, for direct resale to consumers, and/or for export. As with retreads, some processors report that the economic downturn is resulting in increased demand for used tires both domestically and internationally. The main constraint to increasing used tire shipments is the limited number of waste tires that are suitable for reuse.

Ground Rubber

California is home to seven producers of ground rubber, two of which started operations at the end of 2009 or the beginning of 2010. Additionally, two facilities are currently producing buffings from waste truck tires, which are used in many of the same market categories as ground rubber. These ground rubber producers and waste truck tire recyclers used approximately 8.6 million PTEs in 2010 to produce nearly 120 million pounds of ground rubber, a 1 percent increase over the estimated amount produced in 2009. This includes coarse ground rubber of ¼ to ¾ inch (generally used for loose-fill playground, mulch, and horse arenas), finer ground rubber of 4 to 30 mesh (used in rubberized asphalt concrete, synthetic turf infill, and molded products) and buffings produced from truck tires by processors (used mainly in pour-in-place playground surfacing). Table 3 provides a summary of California ground rubber production by market segment for 2009 and 2010.

**Table 3
Estimated Ground Rubber Shipments by Market Category**

Category	2009		2010	
	Million Pounds ¹	Percent of Total	Million Pounds ²	Percent of Total
RAC & Other Paving	60.3	54%	70.4	59%
Turf & Athletic Fields	17.4	16%	19.2	16%
Pour-in-Place Playground	3.2	4%	2.0	2%
Loose-Fill/Bark/Mulch	16.8	15%	15.5	13%
Molded & Extruded	10.6	10%	10.1	8%
Other	1.7	1%	2.5	2%
Total	110.0	100%	119.7	100%

1 Production volumes for 2009 assume an average yield of 65 percent ground rubber per ton whole tires. Individual company yields vary based on the mix of tires and processing technologies used.

2 Production volumes for 2010 assume an average yield of 70 percent ground rubber per ton of whole tires. Several processors reported improvements to their production processes that have resulted in higher crumb rubber yields.

As the table shows, increases in rubberized asphalt concrete primarily, supplemented by a modest increase in artificial turf, offset losses in the playground, loosefill/bark/mulch, and molded and extruded categories. The economy has had a particularly negative impact on state and local government purchasing, which accounts for a majority of the playgrounds and athletic field purchases. Local government budgets will likely remain challenged for several more years because of this and the time lag associated with real property sales/valuations and its impact on local government property tax revenues.

Factors driving demand for all ground rubber products include: state rubberized asphalt concrete use mandates, CalRecycle grant programs and other financial/technical/promotional support efforts; and growing interest in green building and sustainability. Some common constraints include: recession-driven declines in demand, especially in the construction industry; declining government budgets; and, perceived environmental and health concerns.

Following is a brief description of each ground rubber sub-market.

RUBBERIZED ASPHALT CONCRETE AND OTHER PAVING

California ground rubber producers supplying rubberized asphalt concrete projects uniformly report that the market has not only maintained its strength, but appears to be growing. In 2010 about 70 million pounds of ground rubber, derived from approximately 5 million PTEs of waste tires, were used in rubberized asphalt concrete, chip seal, and other paving applications. In these paving applications, processors sell ground rubber to a small number of asphalt paving firms that have invested in the equipment required to produce rubberized asphalt concrete. These processors are often subcontractors on paving contracts from Caltrans or local government. While in the past there were only a limited number of blenders and paving companies had the equipment to produce rubberized asphalt concrete, more companies have the capability now and the increased competition has made the price more favorable and reasonable.

The largest individual rubberized asphalt concrete consumer in California is Caltrans, which is required by statute to increase the percentage of all flexible pavements that use rubberized asphalt

concrete to 25 percent by 2010 and 35 percent by 2013. In 2009, Caltrans used 3.6 million PTE in rubberized asphalt concrete projects, for a record high use rate of 32.9 percent of all flexible pavements. Caltrans estimated that its use in 2010 would be 2.5 million PTE with less rubberized asphalt concrete usage (in terms of PTEs of tires) forecasted while still maintaining the use of rubberized asphalt concrete in a large percentage of flexible paving projects. Caltrans depends on the State Highway Operation and Protection Program (SHOPP) for pavement projects. With the current state of the economy, Caltrans anticipates a significant reduction in funding for the construction of highway maintenance and SHOPP projects in the coming years that may result in a reduction in waste tire usage. The extent to which these cutbacks occur may adversely impact California crumb rubber producers. It should be noted that Caltrans does not specify that crumb rubber must come from California producers – only from U.S. sources – so declines in rubberized asphalt concrete paving may not be solely borne by producers located in the state.

Rubberized asphalt concrete is also used by local governments, sometimes with financial grant support and technical assistance provided by the CalRecycle. In these cases, the source of tire rubber must come from California tires in order to qualify for support. While Caltrans usage declined in 2010 (compared to other recent years), local government projects using rubberized asphalt concrete increased in 2010, outweighing the Caltrans decline. This is due to increasing demand by county and local governments who are becoming more familiar with the benefits of rubberized asphalt concrete due to market development efforts by CalRecycle, and more affordable project prices due to increased competition as discussed above. It is hoped that this broad based demand will continue to grow, particularly with new applications (chip seal and terminal blend) that are receiving market development assistance from CalRecycle, such as including terminal blend paving projects in municipal grants in 2011. The threat is that local government financial difficulties will result in delayed paving projects.

Suppliers of crumb rubber to the paving industry have confirmed that the demand for terminal blend is increasing. Terminal blend occurs when fine rubber crumb is dissolved into asphalt at the asphalt production terminal, eliminating the need to blend and mix crumb rubber in the field. Terminal blend differs from the traditional field blending for rubberized asphalt concrete in that it uses a finer crumb of rubber of approximately 50 mesh (compared to the field blend rubber primarily in the 10-30 mesh size range). With field blending the rubber particles are not dissolved, but instead undergo a limited reaction/interaction with the asphalt before being mixed with aggregate and laid down as pavement. The number of asphalt suppliers of terminal blend is very limited and it is not yet well known the extent to which terminal blend may contribute to increases in market demand, although it has the potential to expand the use of rubber in other asphalt products that are not paving applications (such as asphalt coatings, sealants, and asphalt shingle production). The number of California processors that can produce the fine mesh rubber for terminal blend is limited.

SYNTHETIC TURF AND ATHLETIC FIELDS

Ground rubber in the 10-20 mesh range is used as infill between the blades of grass in synthetic turf athletic fields and in a variety of running tracks, horse racing tracks, and other applications. The statewide use of ground rubber in synthetic turf and athletic fields in 2010 is estimated at 19.2 million pounds, equivalent to 1.4 million PTEs, marking a modest increase over 2009 levels. This increase follows a decline that occurred in 2008, but the trend otherwise had been increasing every year for the last several years. Because most installations come from municipal recreational facilities and school systems, the market segment is susceptible to reduced funding when

governmental budgets fall short. Projects are also susceptible to concerns over potential health impacts, especially where field use is intended for children.

For example, a limiting factor for artificial turf market growth is the concern that artificial turf may pose certain health and safety risks. Several scientific studies and literature reviews have addressed these concerns, and CalRecycle, through the Office of Environmental Health Hazard Assessment (OEHHA) also funded a study—released in October 2010—on the safety of tire crumb as infill in artificial turf fields. Other than a higher incidence of skin abrasions, the study confirmed the safety of using tire rubber for the field infill. Firms that are marketing artificial turf fields in California are optimistic that the OEHHA study will help to restore market growth in the state.

Despite these assurances, however, certain school districts (e.g., L.A. Unified School District) have chosen to not use tire crumb for infill. In 2008 the California Attorney General, joined by the Los Angeles City Attorney and the Solano County District Attorney, sued three artificial turf companies (Field Turf USA, AstroTurf, LLC and Beaulieu, LLC) for violating California Proposition 65, the Safe Drinking Water and Toxic Enforcement Act of 1986. The lawsuit was settled in 2010 after the companies agreed to reformulate their products to reduce lead levels to negligible amounts. Unfortunately, some reports could cause one to associate the presence of lead with the rubber from tires, but that was not the basis of the lawsuit. The lawsuit was instituted because lead was included in the grass turf as colorants/stabilizing agents, not because the tire crumb infill was asserted to have any lead.

Artificial turf is a very narrow market that is dominated nationally by one large firm. That firm has relationships with a large number of companies to market and install fields, with several California-based firms and out-of-state firms installing product in California. Supplier relationships, therefore, in combination with whether the field installation is being performed with assistance from a CalRecycle tire-derived product grant (which requires California crumb rubber), strongly influence whether California crumb rubber processors supply the crumb rubber for field installations or whether crumb comes from out-of-state.

LOOSE-FILL PLAYGROUND SURFACING, BARK AND MULCH

Although loose-fill playground surfacing and landscape bark/mulch are different market segments, they are combined in this report because most of the material produced for the two segments is of one specification and it is difficult for some producers to separate sales for the two different segments. In 2010, about 15.5 million pounds of ground rubber derived from approximately 1.1 million PTEs were used in loose-fill playground surfacing applications or sold as bark or mulch for landscaping and other applications in California, a 14 percent decline from the estimated levels in 2009. This material is generally of ¼- to ¾-inch size and is colorized and used to replace wood bark and other playground surfacing materials or in a variety of landscaping applications.

Loose-Fill Playground Surfacing

Loose-fill playground surfaces are marketed and installed in California by several firms based both in-state and out-of-state. Customers are largely local school districts and parks but also include other government agencies and architects, contractors, and designers responsible for new and renovated building construction projects.

According to stakeholders, this market segment may be more dependent upon CalRecycle grant funding than other segments, as municipalities and school districts, most of which have budget

constraints, comprise a large portion of this market. However, because grant funding only covers a portion of the project cost, it is not uncommon for municipalities and school districts to cancel or put projects on hold due to funding shortfalls. In order to qualify for grant funding, the rubber must come from California waste tires.

Key sales drivers include enhanced fall safety, longer life, and lower maintenance costs as compared to wood bark and many other alternative surfacing products. Satisfactory standardized safety test results are required by many customers, and many producers have received certification through the [International Playground Equipment Manufacturers Association](#) (IPEMA). Another driver is the potential for credit in green building programs such as the Leadership in Energy and Environmental Design (LEED) program administered through the [U.S. Green Building Council](#).

Another constraint is the relatively high up-front cost of rubber playground materials compared to wood, although this is moderated by claims of longer life and reduced maintenance, in addition to added safety. Finally, media coverage of perceived environmental health and safety concerns related to artificial turf products (discussed above) sometimes arise with rubber bark, mulch, and loose-fill playground surfacing as well, indicating this issue could potentially constrain sales in coming years.

Bark/Mulch

Bark/mulch is the same material as that used in loose-fill playground surfacing, but it is sold to landscapers, designers, architects, building managers, and others for a wide variety of landscaping and mulch applications. It can also be made from truck tire buffings. Rubber bark is one of the very few tire-derived products to be sold directly to consumers in national “big box” retail outlets such as Walmart and Lowe’s, and this has contributed to significant national market growth in recent years, especially on the East Coast. It is more expensive than natural mulches, and imported material is making inroads into California. Rubber bark/mulch offers benefits of lower maintenance costs and convenient performance characteristics such as long life, lack of deterioration, and choice of colors.

Mulch sales by California processors plummeted in 2010. Initial interest and sales of the product by big box retailers have cooled and there was reduced demand from municipal parks and recreation divisions in 2010, too. The declines appear to be related to cost in the context of tight budgets. Many in the industry feel that the bark/mulch market segment has substantial room for growth in coming years.

Pour-in-Place/Other Playground Surfacing

In 2010, about 2.0 million pounds of buffings, derived from about 170,000 waste truck tires (and lesser amounts of ground rubber), were used in pour-in-place playground surfacing applications, a decrease over the estimated amount in 2009. This amount is in addition to buffings produced as a by-product of retreading that were sold to multiple markets, including pour-in-place playground surfacing. In this application, buffings are combined with a urethane binder and generally a virgin ethylene propylene dimonomer (EPDM) rubber surface layer to produce a bound surface.

Many of the loose-fill playground surfacing installers also install pour-in-place surfacing products. One market indicator is the shift in the supply-and-demand balance for buffings over the past year and a half. Buffings were in short supply in 2008 with material commonly shipped across country to meet demand, but some firms currently report high inventories with pricing much lower than in recent years.

Pour-in-place markets benefit from the general tire-derived product benefits described above, although they do not qualify for CalRecycle grants unless they are made with buffings derived from California waste tires (buffings from truck tire retreading operations do not need market development grants). Pour-in-place surfacing generally satisfies ADA requirements for wheelchair accessibility, and given its bound state, is less vulnerable to concerns over fire and other health and safety factors. Partly for this reason, it has been suggested by stakeholders that the overall market for pour-in-place playground surfacing may exceed loose-fill playground surfacing over the long term, especially as new ADA test methods come into play. Its primary disadvantage is cost, and this may limit the recovery of this market segment over the short term due to municipal budget cutbacks.

MOLDED AND EXTRUDED PRODUCTS

In 2010, about 10.1 million pounds of ground rubber, derived from about 700,000 PTEs, were used to produce molded and extruded products, a 12 percent decrease in the estimated volume since 2009. In this application, ground rubber generally in the 10- to 30-mesh range is combined with urethane and other materials, including recycled plastics in some applications. A wide range of products are produced in California, including flooring, mats, wheelchair transition ramps, drainage channels, erosion control devices, traffic control devices, wheel stops, and others. Until purchasing by the industrial sector recovers, this market sector is expected to remain depressed.

The production of more premium molded and extruded products in California is limited by lack of production capacity in California to produce fine rubber powders, where particle sizes of at least 80-mesh and often 200- to 300-mesh is required. Nationwide several new producers of “very fine” ground rubber have emerged, though none to date in the West. Product applications include industrial machine parts such as gaskets, hoses, and insulation; reflective paints; and potentially use in the production of new tires.

Opportunities for expansion of this market category are largely in the feedstock conversion and new product development category, and may likely involve incremental increases of relatively high-value products that command a higher price in the marketplace. Generally, depending on the product, technology and other factors, manufacturers may benefit from one of three potential drivers:

- Potentially reduced raw material costs by substituting ground rubber for higher-priced oil, plastic, or other raw materials;
- Enhanced product performance due to the beneficial qualities of rubber in some product applications; and/or
- Enhanced marketing opportunities leveraging green marketing opportunities, for example in the green building arena.

Constraints to expanding this market involve, among others, institutional resistance to replacing established and proven raw materials, concern over customer reactions, the need for extensive product testing and performance documentation, and the need to develop new product recipes and processes. Despite its promise, feedstock conversion is notoriously challenging and slow to show results. Several feedstock conversion firms have received support through CalRecycle’s TBAP program and have marked progress towards expanding crumb demand in their products; however, the full potential promise of this work has not yet been seen. Feedstock conversion remains a priority for TBAP in the upcoming application cycle.

OTHER GROUND RUBBER APPLICATIONS

In 2010 about 2.5 million pounds of ground rubber was derived from about 175,000 PTEs and used to make a variety of products including horse arena material, products used in ballistics applications, and buffings from truck tires used in products other than pour-in-place surfacing. Comparison with previous years is difficult for two reasons. Because this is a relative small category that includes sale of raw materials, it is difficult to draw clear trends from year-to-year changes in this category.

Civil Engineering

Civil engineering applications used about 1.8 million PTEs in California during 2010, a 7 percent increase from the estimated volume in 2009. In California, civil engineering applications are segmented into two primary applications: use at landfills, which dominates the category; and other applications, which are primarily road/transportation projects.

Tires are used in civil engineering applications in the form of tire-derived aggregate, which competes with rock aggregate and/or a range of aggregate or lightweight fill materials. Generally, potential tire-derived aggregate benefits include:

- **Low Density**—It is lighter than soil and most aggregate materials, providing performance advantages in some situations and resulting in less tonnage required compared to heavier materials, and in some applications can result in the need for fewer project inputs (such as steel and concrete) due to its lighter weight, resulting in reduced costs for the project;
- **Desirable Performance Characteristics**—It has desirable performance characteristics. For example, it is relatively durable, compressible, a good insulator, and has good hydraulic conductivity; and
- **Price**—In many circumstances it is less costly to use than traditional lightweight fill and aggregate materials. Tire-derived aggregate in many instances does provide the lowest-cost solution to conventional aggregate needs, although, as with all construction materials, its use should be evaluated on a case-by-case basis. Its light weight and corresponding low density offers advantages that do provide relative cost benefits in some cases, especially in applications where lightweight fill is called for, or where vibration dampening is required, such as on light rail line construction.

Obstacles to the increased use of tire-derived aggregate have been identified in the following areas:

- **Storage and Supply**—Most large-scale construction projects require large quantities of tire-derived aggregate to be available at a particular location at a particular time. State and local storage regulations limit the amount of waste tire material that can be stored at a given site and strictly regulate how it can be stored to reduce fire risk and other threats. Tire-derived aggregate is considered by the state to be product and not a waste tire, Therefore CalRecycle will need to provide clear guidance on how the aggregate can be stored and transported.
- **Institutional**—Since it is not widely used in California, some decision makers and engineers may be reluctant to use tire-derived aggregate.
- **Suppliers** – Due to the large quantity of tire-derived aggregate that may be needed on a particular project, the existing suppliers may not be able to provide the needed material.

Therefore, more tire-derived aggregate suppliers are needed to assure an adequate supply is available for future projects. A few processors have stated they are interested in being a large-scale supplier. Some others, however, have voiced reluctance because of skepticism that a stable, large market will emerge and that the price will merit their investment in equipment and the opportunity cost of not sending material to current market outlets. The infrequent nature of projects is also a barrier to suppliers.

Notwithstanding these constraints, CalRecycle is making a significant investment in tire-derived aggregate through technical and financial assistance and promotion to local government and state agencies like Caltrans. While use in the short-term is not expected to increase substantially, the market could grow in the long term to be a major use of California waste tires. Although not available in 2010, a Tire-Derived Aggregate Grant Program may be available in 2011 to provide an incentive to introduce the product to local governments, public entities and private businesses for use in projects such as landslide repair, gravel replacement (in landfills), under rail lines, behind retaining walls, etc.

LANDFILL CIVIL ENGINEERING APPLICATIONS

In 2010 an estimated 1.8 million PTEs were used as tire-derived aggregate in civil engineering applications at landfills, a 31 percent increase from the amount reported in 2009. However, these landfill civil engineering use estimates should not necessarily be interpreted as showing progress in increasing usage at landfills. Rather, these estimates are based primarily upon surveys of landfill operators, and have not been verified by CalRecycle to be consistent with typical “tire-derived aggregate landfill civil engineering” application design. The vast majority of the total comes from two landfills that have tire processors that are co-located with them. At these landfills, shredded tire material is readily available in large quantities and the landfills have a tendency to use tire-derived aggregate liberally, unlike landfills that do not have an on-site processor, which use tire-derived aggregate only in the quantities required based on an efficient engineering design. Only a couple of landfills without an on-site processor were known to use tire-derived aggregate for landfill gas projects in 2010.

The available information suggests that the use of tire-derived aggregate by landfills remains very limited to only a few facilities. CalRecycle has identified these landfill applications as a priority and plans to increase financial, educational, and technical assistance to expand tire-derived aggregate use in this application. Because one of the processors that were co-located with a landfill in 2010 moved off-site in early 2011, it is likely that the total quantity of tire-derived aggregate reported used by landfills will decline in 2011.

The range of tire-derived aggregate uses at landfills includes use in landfill gas and leachate collection and redistribution layers, gas collection layers and in landfill road construction, generally replacing rock aggregate materials. The specification of tire-derived aggregate used in these applications varies, and sometimes a rough shred with a forgiving specification can be used. Landfill tire-derived aggregate is a low- or no-value adding market—processors delivering tire-derived aggregate to landfills may receive a small amount of revenue (e.g., \$2-\$5 per ton), may still need to pay a discounted tip fee, or may be permitted to drop materials free of charge.

Landfills can benefit from tire-derived aggregate use by reducing their costs for aggregate and by taking advantage of the availability of waste tires and the need for beneficial use opportunities. In some cases, landfill engineers lacking experience with tire-derived aggregate may be reluctant to use it, and there may be some situations when it is not appropriate or is prohibitively expensive

due to long haul distances from processors. However, generally, if a landfill is located near a processor there are few constraints to this use.

NON-LANDFILL CIVIL ENGINEERING APPLICATIONS

In 2010 about 35,000 PTEs were used in non-landfill civil engineering applications in California, all at a single road landslide repair project in Santa Barbara County. This is a significant decline from about 700,000 PTEs used in several projects in 2008 and 350,000 PTEs used in 2009. This decline is not believed to be a trend, but indicative of the facts that projects are large but of different magnitudes and are infrequent. As with landfill civil engineering, non-landfill applications may involve a small number of relatively large projects. Especially as CalRecycle continues its efforts to boost Caltrans' and others' use of tire-derived aggregate, abrupt increases or decreases in use are likely to occur.

Non-landfill applications include the use of tire-derived aggregate in landslide stabilization projects by Caltrans and local governments and use of tire-derived aggregate as vibration dampening for light rail trains. While other non-landfill civil engineering uses, such as in septic leach fields, are used in other states, there have been few tests in California and these applications are approved for use in California at this time. In contrast to landfill tire-derived aggregate applications, tire-derived aggregate used in non-landfill applications, depending on a range of factors, may provide modest positive revenue to processors.

In California, non-landfill civil engineering applications have been mainly limited to date to state-sponsored projects conducted by Caltrans contractors and a handful of local government projects, all conducted with considerable financial and/or technical support provided by CalRecycle. CalRecycle is currently developing plans for a new grant program targeting tire-derived aggregate applications.

Alternative Daily Cover

Alternative Daily Cover: Use of tires for alternative daily cover continued its decline as a combination of expanding export, ground rubber, and civil engineering uses drew tires away from alternative daily cover in Northern California. This trend is expected to continue.

In 2010, approximately 0.8 million PTEs were shredded and used as alternative daily cover in landfills, a 33 percent decline from the amount reported in 2009, continuing a decline that has been evident for several years. Tire shreds are used as alternative daily cover to replace dirt and other materials such as green waste or wood waste, and can provide landfills with a cost advantage if they would be required to purchase other materials for use as cover; however, materials such as green waste are readily available in most cases. Processors typically must pay a tip fee or, at best, may have zero cost for delivering tire shreds to landfills for use as alternative daily cover.

Only four landfills reported using tire shreds at a significant level as alternative daily cover in 2009, with the vast majority of tonnage occurring in Northern California. As diversion of tires to more value-added uses continues to increase, use of tires as alternative daily cover is expected to continue to decrease.

Other Recycling Uses

In 2010 fewer than 100,000 PTEs were used in a variety of applications classified in this report as "other recycling." Products in this category include rings cut from truck tires used to weigh down

agricultural film plastic and cut and stamped products such as dock bumpers. This category is likely to remain a small but stable use of California tires in future years.

Tire-Derived Fuel

Tire-Derived Fuel: While tire-derived fuel use has steadily declined over the past five years, this trend was reversed in 2010, despite the fact that the cement industry remains depressed as it is strongly dependent on construction industry activity. Favorable pricing for tire-derived fuel compared to the price of coal in 2010 contributed to the up-tick in demand.

In California, waste tires are used as tire-derived fuel in two types of facilities: cement kilns, whose primary fuel is coal or petroleum coke, and co-generation facilities that produce steam and electric power, primarily using coal as fuel. In 2010, about 8.4 million PTEs went to tire-derived fuel uses, a 20 percent increase from 2009.

Last year began with a threat to the ongoing use of waste tires for fuel after the U.S. EPA released a draft rule in April that had the potential to redefine the regulatory status of tire-derived fuel and result in an economic disincentive to its use. In its original draft of the rule, U.S. EPA was considering classifying tire-derived fuel as “waste” and not “fuel” if it had not been processed to remove the wiring in the tire. The impact of this change would have required certain users of tire-derived fuel to switch from using whole tires to more costly processed chips, or else use more costly air pollution control equipment than otherwise would be required. After receiving comments from numerous states, the cement industry, and the tire industry, U.S. EPA elected to publish in 2011 its final rule that tire-derived fuel, including whole tires, can be considered a fuel (not waste) as long as tires are managed through a state-regulated system like that in California. This favorable ruling means that tire-derived fuel will remain a cost-effective option for the diversion of waste tires from landfills in California.

In 2010 there were four California cement plants and one cogeneration plant using tire-derived fuel. Three of the cement plants use whole tires, which they may receive with no revenue or at no cost, or for a small tip fee. The fourth California cement plant and the cogeneration plant use processed waste tires for which they must pay. In addition to the four cement plants using tire-derived fuel, a fifth cement plant that used tire-derived fuel in previous years remained shut down for all of 2010 due to the reduced market demand for cement resulting from the poor economy. As the economy recovers, it is likely that the demand for tire-derived fuel will increase as cement plant production time increases.

Tire-derived fuel and whole waste tires can be an attractive supplemental fuel for plants that burn solid fuels such as coal or coke, depending on their proximity and access to suppliers and their production equipment, as well as their technology. Tire-derived fuel has a higher energy value than coal and is less expensive. Also, tire-derived fuel can improve air emissions relative to petroleum coke or coal. One plant stated that using tire-derived fuel allowed them to use more high-sulfur petroleum coke (which is less expensive than low-sulfur coke) because tire-derived fuel is low in sulfur.

The number of co-generation plants that use tire-derived fuel has declined over the last several years to only one remaining plant as several co-generation plants have converted from combusting coal/ tire-derived fuel to combusting biomass. These conversions have occurred because biomass is considered to be a renewable fuel and higher utilization of biomass is rewarded in order for California to meet its renewable portfolio standard. The remaining plant intends to continue using tire-derived fuel as a supplement to coal. Also, AB 32, the California

Global Warming Solutions Act, requires facilities generating more than 25,000 MTCO₂E to submit emissions reports to the state, and tire-derived fuel facilities may fall into this category.

Disposal

In 2010 about 7.8 million PTEs were disposed in landfills, a 31 percent decrease from 2009. This estimate is based on analysis of 15 landfills identified as accepting tires through surveys, CalRecycle's Disposal Reporting System, and the Waste Tire Manifest System (WTMS). The primary factors leading to a reduction in waste tire disposal are low overall waste tire generation rates, increased demand for tire-derived fuel, and increased demand by export markets, especially for tire-derived fuel.

For the first time in 2010, landfills were not the largest "market" for California tires, as flows to tires to ground rubber applications and tire-derived fuel each surpassed landfill disposal. Approximately 25 percent of landfilled tires were sent to landfills in Northern California, with the remaining 75 percent of landfilled tires going to Southern California landfills. The Azusa landfill, a tire monofill in Southern California, is the largest landfill destination for California tires. It receives 63 percent of the California tires that are landfilled. Factors that tend to drive the landfill disposal of waste tires include: favorable economics due to proximity, or in some cases, preferred tipping rates; insufficient demand for tire shreds at an acceptable price; lack of processing capability to produce higher value diversion products; and the inertia resulting from established relationships and business practices.

Imports and Exports

To varying degrees, used tires, processed waste tires (e.g., bales or shreds), ground rubber and buffings are all imported to and exported from California. Trends in each of these areas are described below.

USED TIRE IMPORTS AND EXPORTS

Used tires that have been culled and graded depending on their type and quality (as opposed to waste tires) have long been a staple export from California and other U.S. states. Though most California used tires are shipped to Mexico, they also are shipped to many different parts of the world including other Latin American countries, India, and Asia. No estimate of the number of used tires imported into California is available, although relatively small quantities are likely shipped from neighboring states.

In 2010 used tire exports from California were estimated to be 1.8 million PTEs, or the same quantity as in 2009. However, this estimate understates actual used tire exports because it is based only on shipments that were reported as directly exported. An unknown percentage of the used tire (domestic) category that was described above under reuse were likely sold to distributors who in turn exported a portion of the used tires they handle. Also, additional quantities of used tires were likely exported to Mexico through informal means that were not tracked or reported by generators and/or haulers.

The main drivers and constraints for used tire exports are the same as for used tires (domestic) described above under reuse. In short, exporting used tires is highly economical because of the low cost to cull and grade them, combined with their relatively high value (about \$6-\$8 each, wholesale). Because a high percentage of consumers in Baja Mexico opt to purchase used tires rather than new tires, there is a strong demand for them across the border. One export-specific constraint to used tires over the long-term is interest by some in certain developing countries to

curtail used tire imports in an effort to safeguard their domestic tire industries or over other concerns.

WASTE TIRE IMPORTS AND EXPORTS

Until 2007, export of waste tires (as opposed to used tires, described above) from California had been limited and sporadic, mainly involving small amounts shipped to neighboring processing facilities across the state border into Oregon, Nevada, Arizona, and into Mexico. However, in 2007 bulk export of waste tires to Asia, and in particular to China, began increasing. This trend has continued since that time with an estimated 6.4 million PTEs exported, primarily to Asian countries, in 2010. The largest market for waste tire exports in 2010 was believed to be Japan, where 2-inch(-) tire-derived fuel counts as renewable energy (the same is not the case in California).

Processors export waste tires in containers, either baled or as shreds. Exports are driven mainly by favorable economics, with export firms often handling most logistical details including providing and picking up trucks at processors' facilities. 2-inch(-) tire-derived fuel has become a valuable commodity and processors have reported receiving a healthy positive value for the material.

Exporting does have some risks. For example, export markets have a tendency to be unpredictable. Some processors have confirmed that demand can suddenly increase or decrease significantly, and that sales terms can sometimes change abruptly. The economics of exporting could potentially be altered if a shortage of containers or shipping space developed, since the low shipping costs are highly dependent on these favorable conditions. And, regulations governing the import of other waste materials such as electronics waste in some countries, including China, have sometimes been abruptly changed, sometimes in a manner that makes it difficult for foreigners to confirm current regulations and requirements.

Waste tire export is controversial, and while some processors and others have called for CalRecycle to take action to reduce or stop exports, CalRecycle does not have any authority over export regulations and is limited to its role in regulating the shipment and management of waste tires in California. Under the International Basel Convention, each country individually determines if waste tires are defined as hazardous waste, and imports of tires into those countries would therefore not be allowed under the Basel Convention. The growing positive value of tire-derived fuel and shipment to industrialized countries such as Japan illustrate that waste tire material is increasingly being viewed as a resource and not a waste.

While difficult to predict in detail, demand for waste tires in the export market is likely to continue to increase, though the pace of increase may moderate in comparison to the past three years of rapid growth. To date, it appears that increasing exports have not steered waste tires away from high-value markets such as reuse and ground rubber, but it may provide an economic challenge to civil engineering uses for processed tires. Furthermore, individual processors have confirmed that tire-derived fuel export markets have directly resulted in the diversion of California tires that otherwise would have been landfill bound.

In addition to exports to other countries, some California waste tires were also exported to and imported from other states. Based on processor estimates, waste tire imports into California in 2010 totaled about 1 million PTEs, and exports of California tires to other states (where they were landfilled or retreaded) was estimated at approximately 0.3 million PTEs. Adjustments for the net imports of tires into California and exports of California tires to neighboring states were made in

the statistics provided in Table 1 so that the estimates only reflect the net market disposition of California-generated tires.

In addition to whole and shredded tire imports and exports, ground rubber, crumb rubber, and buffings from retread operations are also imported and exported from and to California. While imported ground rubber competes with in-state production, and sometimes benefits from subsidies (e.g., in British Columbia, Alberta, and Utah), to date there have not been widespread complaints that these producers are out-competing California producers. Moreover, some have observed that while California does not provide a direct per-ton subsidy, the state does support certain segments through a variety of means including grants to local agencies purchasing tire-derived products and rubberized asphalt concrete, use of rubberized asphalt concrete by the state (Caltrans), and technical assistance and loans to producers and processors. It was beyond the scope of this project to estimate the balance of imports and exports of raw materials and tire-derived products, and such figures are not provided in this report.

Conclusions

Given the magnitude of the recent recession and continuing weakness in the economy, the California waste tire industry entered 2010 in a relatively strong position, with diversified markets, a robust and expanding processing infrastructure, and sufficient state resources for market development programs. Increases in certain segments including rubberized asphalt concrete, tire-derived fuel, and exports when combined with low waste tire generation rates, resulted in the highest tire diversion rate that California has ever experienced. This trend bodes well for future diversion.

Although civil engineering is expected to decline in 2011, there are two rail projects scheduled for 2012 that are expected to consume more than 1 million PTEs. Civil engineering use of tire-derived aggregate may be poised for growth in the future given that several applications are now viewed as “proven,” and potential users are increasingly aware of the benefits. An obstacle to this market segment may be the increasing value of tire-derived fuel for export markets, which provides a somewhat more predictable and ongoing demand than the occasional and difficult to supply civil engineering projects. The addition of tire-derived aggregate grant program for both landfill and non-landfill applications similar to the one CalRecycle implements for the use of rubberized asphalt concrete in highway projects, may also result in an increase in the use of tire-derived aggregate in 2012.

CalRecycle continues to work to remove market barriers and assist in the development of tire markets and commercialization of tire-derived products. The main elements involve expanding outreach and education, increasing coordination across programs and targeting top priority market segments, identified as rubberized asphalt concrete, bark/mulch, molded products, and civil engineering applications. Despite the lingering slow economy, and vagaries associated with certain markets, such as tire-derived fuel and export markets, California seems well poised to continue the progress in diverting tires from landfill disposal.

Appendix A

Methodology and Data Limitations

This appendix briefly summarizes the methodology used for this report, the level of accuracy and sources of uncertainty, and differences with previous CalRecycle reports.

The market flow estimates presented in Tables 1 and 2 are thought to be accurate to within about +/- 10 percent, which may be an upper bound on the potential accuracy of waste tire flow studies generally. An exception to this general statement is retreads, for which a static estimate of 4.4 million PTEs has been used for the past several years due to challenges in firming up the estimate. For the first time this year a new methodology was utilized that included surveys of retreaders and extensive analysis of tire manifest data. Because a good baseline of survey data for retreaders from prior years has not been established, the new retread estimate of 3.6 million PTEs can be considered of greater accuracy in this first attempt at the new methodology, although it can be expected to improve over time.

The estimates cited in this report are based on surveys, interviews, analysis of data in CalRecycle's Waste Tire Manifest System (WTMS) and review of written information. Because these sources are generally incomplete and conflicting, the study team evaluated them for accuracy, double counting issues and overall consistency and selected the best available estimate for the facilities and market categories analyzed.

Data limitations include:

- **Conversion Factors**—Firms and CalRecycle typically use a standard conversion factor of 20 pounds per tire, even though waste tire weights vary significantly. According to the Rubber Manufacturers Association, based on national average statistics: passenger tires weigh 22.5 pounds; commercial/truck tires weigh 110 pounds; and mixed loads of passenger and light truck tires average 32.8 pounds per tire; and medium truck tires and off-the-road tires may weigh hundreds or even thousands of pounds. WTMS data in particular is subject to large errors as data may be entered in tons, pounds, number of tires or cubic yards and conversion factors may not accurately represent the true amounts, especially when there are mixed loads of passenger and non-passenger tires. If a truck tire weighing 110 pounds is manifested by number count, WTMS does not distinguish between that tire and a 22 pound passenger tire as both are counted as one PTE.
- **Data Entry**—As one example, CalRecycle estimates that approximately 25 percent of comprehensive trip log (CTL) reports have errors.
- **Un-Manifested Flows and Off-the-Books Transactions**—Some tire flows are not manifested, either due to CalRecycle-approved exemptions or through failure to submit required CTLs. Some flows, especially of used tires, are sometimes treated as off-the-books transactions and are not reported in surveys or tracked by generators, haulers and/or processors.
- **Discrepancies between Inputs and Outputs** – Manifest data provides data on inputs to facilities, while surveys provide data on outputs. Output data is often based on shipping data or facility estimates that do not reflect stored inventories and that may occur in a different study year than when the waste tire inputs to make them were received. Due to softening

demand, inventories were reported to generally be much greater than usual at the end of 2009 as firms sought to move materials into a market place weakened by the severe recession.

- **Data Gaps**—The project team had to confront a number of data gaps in developing this report, including the failure of certain companies to report data. Generally, in those cases, a review of past survey data and examination of manifest records was conducted to develop estimates for the companies and the markets they sell into.
- **Interpretation of Market Segment Definitions and Requested Data**—While every attempt is made to clearly explain data requested through surveys, it is possible that in some instances respondents are interpreting categories or units differently. Some recyclers also convert rubber buffings from tire retreaders into products, which has also been counted as recycled at the retreader stage, or they may recycle rubber from non-tire sources.
- **Waste Tire Generation vs. Documented Flow**—It should be noted that this report does not attempt to explicitly estimate waste tire generation. Rather, the total generation figure presented in Table 2 represents the total documented flow of waste tires, which is thought to represent a very high percentage of actual generation in the study years.
- **Tire Diversion Rate Not Adjusted for Residuals**—As with many other state and national tire recycling market studies, in this report the tire diversion rate is not adjusted for steel and fiber residuals that occur as a result of producing ground rubber. While these materials are often recycled, and data is requested, to date the project team has chosen not to focus on the accuracy of this data in order to simplify the survey process.

The methodology used for this report and those prepared for 2007-2009 is generally similar to that used for the previous “California Waste Tire Generation, Markets and Disposal” reports prepared by CalRecycle staff through 2006. However, there are some key differences that complicate direct comparisons with these earlier market reports, including:

- **Market Category Adjustments**—These include separating exports into waste tires and used tires, adding more detailed ground rubber categories and consequently reducing the types of uses included in the “other” category.
- **Different Survey Approach**— Different surveys were used for processors, tire-derived product producers, tire-derived fuel consumers, and retreaders and the amount of data and information gathered through interviews was increased.
- **Different Analysis Approach**—A new spreadsheet was developed to organize and compare data from different sources, especially to facilitate eliminating double counting and import/export other issues.
- **Number of landfills analyzed**—WTMS data for over 25 landfills was analyzed and attempts were made to survey a majority of those facilities. Ultimately, data from eighteen landfills were included in this report, including some that may not have been included in previous CalRecycle reports.

Finally, this analysis of 2010 waste tire flows reflects additional adjustments compared to the 2009 analysis, including:

- **Combined Cement and Co-generation**—These two previously separate tire-derived fuel categories were combined for this report, both in reporting 2010 flows as well as presenting 2009 data for comparison.

- **Retreads**—An in-depth survey and analysis of tire retreading was conducted for this report, unlike the prior methodology of depending on industry insiders to provide retreading estimates. Prior reports have kept retreading estimates constant at 4.4 million PTEs, but with reduced freight miles driven, and the desire for a more rigorous methodology, this new approach was undertaken this year.