California Waste Tire Market Report: 2011

CalRecycle

California Department of Resources Recycling and Recovery

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Section 1
Introduction

Background

Under the California Tire Recycling Act of 1989 and subsequent amendments, the Department of Resources Recycling and Recovery (CalRecycle[1]) 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 2012 through April 2012. The report was prepared under CalRecycle contract by SAIC Energy, Environment & Infrastructure, LLC (formerly R.W. Beck, Inc.), with primary research assistance by D.K. Enterprises. Following this introduction, Section 2 provides a snapshot of diversion and markets for California waste tires, essentially a summary of key study findings. Section 3 describes market trends by category, with waste tire exports covered in more detail in Section 4. Section 5 analyzes the outlook for increased diversion, including opportunities and barriers, and stakeholder suggestions to CalRecycle.

Interpreting and Using Report Findings

Appendix A provides a detailed summary of the study methodology, sources of uncertainty, and adjustments in approach over time. Following are a few key points to consider 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 and information gathered from processors, baler/exporters, landfills, tire-derived fuel users, retreaders, CalRecycle's Waste Tire Manifest System and Disposal Reporting System, CalRecycle staff, and other stakeholders. 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.

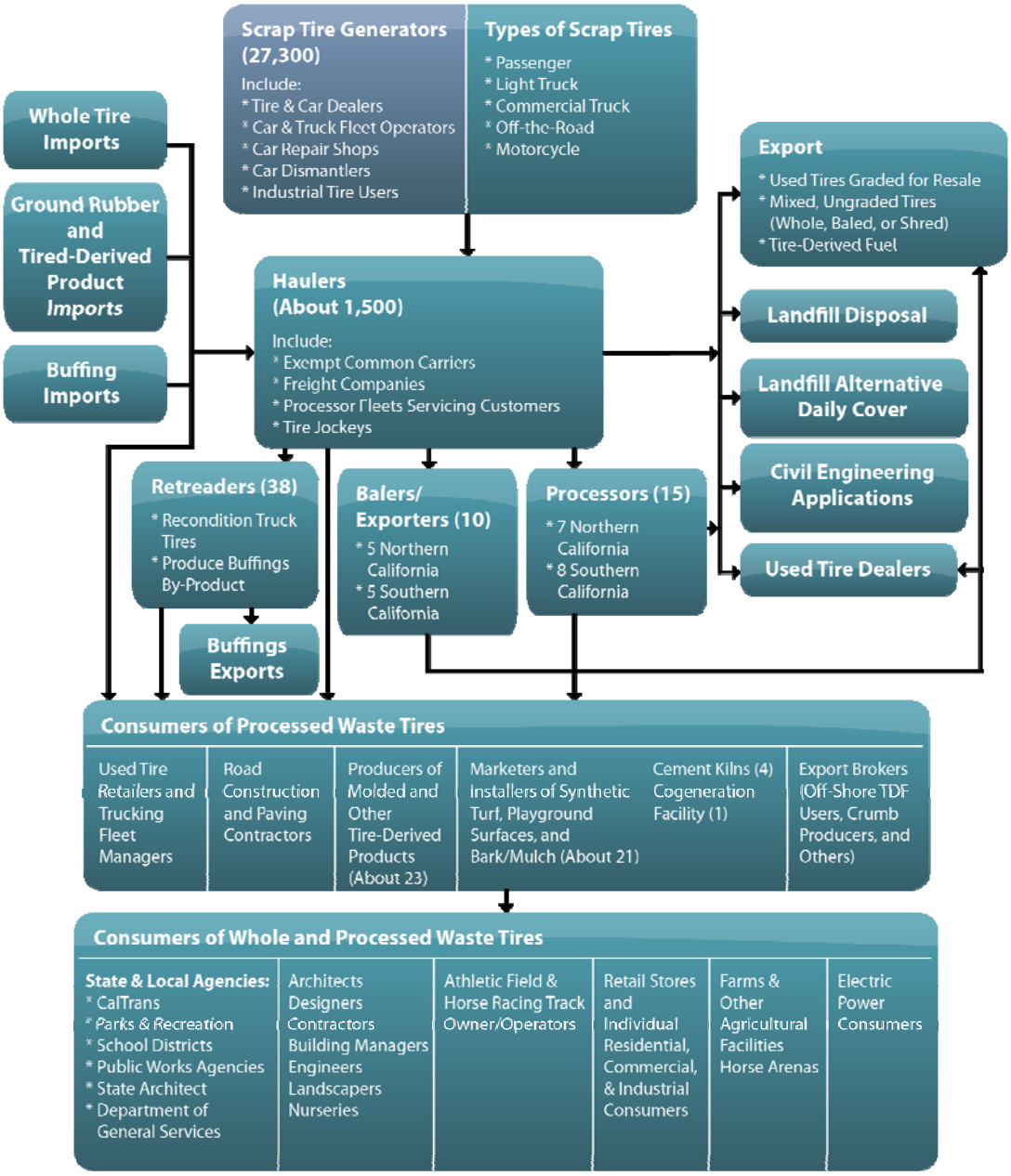
[1] The Department, known as CalRecycle, was formerly the California Integrated Waste Management Board. In this report "CalRecycle" is used to refer to the organization, both in relation to current and past activities.

- **Estimates are for Use of California-Generated Tires Not Total Market Size:** The 2011 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 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 Management Based on Documented Flows:** The report does not directly estimate waste tire generation. Rather, the total estimate of waste tires managed is estimated based on the sum of all documented flows, mainly to and from processors and other recipients of whole tires, derived from the sources listed above, with some limited adjustments for undocumented flows (tire reuse, un-manifested exports), and to avoid double counting. Tires that are stored as inventory or not managed in accordance with regulations are not necessarily captured by this methodology.
- **Tire Diversion Rate Not Adjusted for Residuals:** As with most state and national tire recycling market studies, in this report the tire diversion rate is based on whole passenger tire equivalents (PTEs) that go to different market segments. Adjustments for steel and fiber residuals that may occur as a result of producing ground rubber have not been made. While these residuals are often recycled, a comprehensive analysis of their disposition has not been performed.

Industry Overview

Figure 1 below illustrates California waste tire flows and identifies the number and types of firms involved in California waste tire management. The 15 "processors" indicated in the figure are the active facilities surveyed for this report that handle significant quantities of whole waste tires generated in California. There are also additional, permitted facilities such as cement kilns using whole tires and landfills that shred and dispose of tires. Additionally, nine baler/exporter facilities were identified which receive whole waste tires and bale or shred them for export.

Figure 1
2011 California Waste Tire Management Flow Chart[2]



[2] The number of California facilities operating in 2011 is estimated where possible (but not changes since then).

Section 2
Market Snapshot

This section presents key study findings on waste tire diversion, market and industry trends.

Estimated 2011 Waste Tire Diversion Rate

This section provides a snapshot of California waste tire markets as of December 2011, and discusses key trends. Detailed trends for market segments are covered in Section 3. The overall waste tire diversion rate increased significantly from 81.0 percent in 2010 to 87.8 percent in 2011. This increase was largely a result of the continued, unprecedented rapid growth in the export of waste tires to Pacific Rim nations, largely for use as tire-derived fuel (TDF), which is now the largest single end-use destination for California waste tires. In addition the domestic reuse markets for both truck tire retreads and used passenger tires grew significantly in 2011. Ground rubber markets increased slightly, while civil engineering applications declined significantly, as did use of tire-derived fuel.

Given sustained export increases and generally stable to growing domestic recycling markets, it appears likely that CalRecycle will achieve its 90 percent diversion goal in 2012. If waste tire export (but not used tire export), alternative daily cover, and TDF were excluded, the 2011 diversion rate would be only 44.4 percent. CalRecycle is currently focused on increasing diversion through ground rubber and civil engineering, and these segments are currently diverting only 21.6 percent and 1.4 percent, respectively. Historical waste tire diversion rates and the outlook for future increases is analyzed in detail in Section 5.

Diversion by Market Segment

Table 1 presents 2011 estimated uses for California-generated waste tires, with data from 2009 and 2010 for comparison.

Table 1
Estimated End-Uses for California Generated Waste Tires, 2009– 2011[3],[4]

Category	Sub-Category	2009		2010		2011		Percent change 10-11
		Million PTE	Percent of Total	Million PTE	Percent of Total	Million PTE	Percent of Total	
Export	Waste Tires	3.3	8.0%	6.4	15.5%	9.6	23.4%	50.3%
	Used Tires (Exported)	1.8	4.3%	1.8	4.3%	1.8	4.3%	-0.6%
	Subtotal	**5.1**	**12.3%**	**8.1**	**19.8%**	**11.3**	**27.7%**	**39.2%**
Reuse	Retread	4.4	10.7%	3.6	8.8%	4.1	10.0%	12.9%
	Used Tires (Domestic)	2.0	4.7%	2.0	4.9%	2.8	6.9%	39.5%

[3] Data for 2009 and 2010 are from the "California Scrap Tire Market Report: 2010." PTE stands for passenger tire equivalents, which is defined by the State of California to equal 20 pounds.

[4] Numbers may not sum to subtotals or totals exactly due to rounding.

Category	Sub-Category	2009		2010		2011		Percent change 10-11
		Million PTE	Percent of Total	Million PTE	Percent of Total	Million PTE	Percent of Total	
	Subtotal	**6.4**	**15.4%**	**6**	**13.7%**	**6.9**	**16.9%**	**22.4%**
Ground Rubber	RAC & Other Paving	4.6	11.3%	5.0	12.2%	4.9	11.9%	-3.3%
	Turf & Athletic Fields	1.3	3.3%	1.4	3.3%	1.7	4.2%	23.6%
	Pour-in-Place Playground	0.2	0.6%	0.1	0.4%	0.1	0.4%	1.2%
	Loose-Fill Play/ Bark/Mulch	1.3	3.1%	1.1	2.7%	1.1	2.6%	-3.9%
	Molded & Extruded	0.8	2.0%	0.7	1.7%	0.9	2.2%	27.5%
	Other	0.1	0.3%	0.2	0.4%	0.1	0.3%	-27.6%
	Subtotal	**8.5**	**20.5%**	**8.6**	**20.8%**	**8.8**	**21.6%**	**3.1%**
Civil Engineer-ing	Landfill Applications	1.4	3.4%	1.8	4.4%	0.6	1.4%	-67.0%
	Non-Landfill Applications	0.4	0.9%	<0.1	0.1%	0.0	0.0%	-100.0%
	Subtotal	**1.8**	**4.2%**	**1.8**	**4.4%**	**0.6**	**1.4%**	**-67.6%**
Alternative Daily Cover		**1.2**	**2.9%**	**0.8**	**1.9%**	**2.0**	**4.8%**	**147.1%**
Other Recycling[5]		**0.1**	**0.2%**	**<0.1**	**0.1%**	**0.1**	**0.2%**	**50.1%**
Tire-Derived Fuel		**7.0**	**17.0%**	**8.4**	**20.3%**	**6.2**	**15.2%**	**-26.0%**
Landfill Disposal		**11.3**	**27.4%**	**7.8**	**19.0%**	**5.0**	**12.2%**	**-36.3%**
Total Generated		**41.2**	**100.0%**	**41.1**	**100.0%**	**40.8**	**100.0%**	**-0.8%**
Total Diverted from Landfill		**29.9**	**72.6%**	**3**	**81.0%**	**35.8**	**87.8%**	**7.5%**
Imports		1.5	3.6%	1.0	2.5%	1.2	3.0%	18.4%

Key Market Trends

Figure 2 graphically shows trends by broad market category since 2002. It should be noted that beginning in 2007 category definitions were adjusted for a couple of categories and some changes were made to the data-gathering methodology as well. Appendix A describes these adjustments along with other methodological and data limitations in detail.

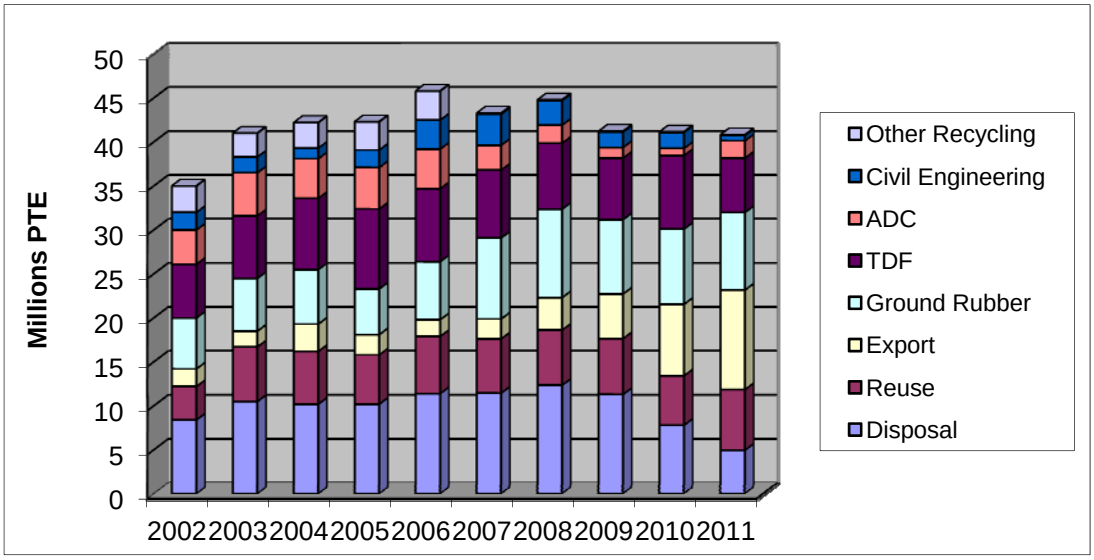
Following are some key trends in California's waste tire management industry and markets:

- **Waste Tire Generation Down.** The sluggish California economy and an unemployment rate of more than 11 percent in the state in 2011 resulted in a continuation of the 2009 and 2010 situation where reduced miles were being driven and consumers waited longer to replace tires, which translated into reduced waste tire generation rates. While this report does not

[5] "Other recycling" includes recycling not included in other categories such as the use of rings cut from truck tires used to weigh down agricultural film plastic and cut and stamped products such as dock bumpers.

measure generation directly, this was reflected in a slight decrease in the total number of waste tires managed as documented by SAIC.

Figure 2
Ten-Year Trend for California Waste Tire End-Uses[6]



- **Increased Competition for Waste Tires and Supply/Revenue Disruptions.** Strong demand for waste tires in Asia and other parts of the world, combined with favorable economics has lead several firms to rapidly set up baler/exporter operations that are competing aggressively for waste tire collection accounts with generators such as tire and auto dealers. This is shifting the established supply lines for processors (including crumb rubber producers) and cement kilns that rely on whole waste tires. It is also reducing the tip fee revenues processors have built their business models around, and could eliminate tip fees for cement kilns or even require them soon to pay for tires they previously received payment to accept. Many established processors complain that the new baler/exporters do not have waste tire facility permits and are noncompliant in other respects. In response, CalRecycle has stepped up compliance monitoring and enforcement and is considering a range of responses; furthermore, a bill has been introduced in the legislature (AB 1647, Gordon, Session 2011-12) that would streamline the administrative hurdles under which CalRecycle's permitting and enforcement program operates.[7]

[6] 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."

[7] The text of this bill is available at: http://www.leginfo.ca.gov/pub/11-12/bill/asm/ab_1601-1650/ab_1647_bill_20120502_amended_asm_v97.pdf.

- **Uncertain Infrastructure Future.** The export-induced market shifts are causing some concerns about how California's tire processing infrastructure may evolve in the future. A worst case scenario would be a significant decline in California's established processing and market infrastructure, followed by a rapid decrease in exports. This would impact the significant investments made by CalRecycle and private industry over the past two decades and also leave the state poorly equipped to maintain waste tire diversion levels similar to current ones. On the other hand, if export demand and economics continue to be strong, it is likely that baler/exporters will become established, fully compliant businesses that assume a lasting role in California's waste tire management infrastructure. While this will surely disrupt established processors, to the extent that current pricing continues it could result in reduced costs for waste tire management and a pillar, for better or worse, of a newly cast tire recycling marketplace.

- **Exports Up Sharply.** The continuing growth in waste tire exports was probably the most significant trend in 2011, with increases of 190 percent since 2009 (2010 export demand doubled over 2009 levels, and 2011 levels increased by 50 percent over 2010 export levels). This trend appears to be continuing in the first part of 2012, further exacerbating the tire supply disruptions described in the previous bullet. When used tire exports (4.5 percent) are combined with waste tire exports (23.4 percent), the export total in 2011 was nearly 28 percent. If the current export growth rate persists, more than one-third of California tires will be exported in 2012. Section 4 provides a detailed analysis of export trends and impacts.

- **Reuse Up.** Reuse, including truck tire retreading and culling of used tires for sale domestically, increased by 22 percent over 2010, with domestic used passenger vehicle tire reuse increasing by 39 percent and truck tire retreading increasing by 13 percent. Truck tire retreaders expect the trend to continue in 2012. Demand for retread services as well as domestic reuse of tires are strengthened as consumers view reuse and retread as valid means of saving costs in the challenging economic times.

- **Ground Rubber[8] Up Slightly.** Overall ground rubber market demand showed a modest 3 percent increase in 2011, although there were different factors at work in the different ground rubber market segments. Although Caltrans indicates that its use of rubberized asphalt concrete (RAC) increased significantly in 2011, California processors reported selling slightly less into that market segment. Two factors are believed to be at work, including: 1) Stressed municipal and county budgets resulted in the deferment of paving projects funded by local governments; and 2) The use of out-of-state ground rubber in Caltrans paving projects (see further discussion of Caltrans use in Section 3). Although 0.1 million PTE less ground rubber from California tires went into RAC in 2010 than in 2011, that loss was more than compensated for by increases in ground rubber going into turf and athletic fields, which increased by 27 percent from 1.4 million passenger tire equivalents (PTEs) in 2010 to 1.7 million PTEs in 2011. Despite this increase, according to California crumb producers, significant quantities of imported crumb rubber are being purchased for California turf projects. The molded and extruded product market increased by 27 percent, but still comprises a very small part of the overall crumb rubber market, at 0.9 million PTE in 2011

[8] In this report, the terms "ground rubber" and "crumb rubber" are used interchangeably. Some define ground rubber as coarse material generally of ¼ inch or greater in size, and some define crumb rubber as fine material generally of 4 mesh or smaller.

compared with 0.7 million PTE in 2010. The pour-in-place playground market also saw a slight increase in the use of crumb rubber (1 percent); however, this market is a relatively small portion of crumb rubber use and the vast majority of pour-in-place products use buffings from retreaders, which are not included in this report's market estimates. Market demand for other ground rubber applications, including loose-fill play/bark/mulch, and "other" applications, was flat, on average.

- **Civil Engineering Down.** The use of tire-derived aggregate (TDA) from California waste tires in civil engineering applications declined significantly in 2011. Estimated landfill civil engineering applications decreased from 1.8 million PTEs in 2010 to 0.6 million PTEs in 2011. Some landfills indicated that their cell construction, closure, and landfill gas collection system installation schedule slowed due to reduced landfill activity from the depressed economy. More significantly, one processor that had previously been co-located with a landfill moved to a different location. After this move occurred, low-cost on-site TDA was no longer available to that landfill and its use of TDA was curtailed. CalRecycle awarded a TDA grant to a landfill in January 2012 (for multiple projects) that is expected to support TDA use in civil engineering applications in coming months. Landfill tire-derived aggregate use reported in this report 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 use of tire-derived aggregate in transportation-related applications decreased from less than 0.1 million PTEs in 2010 to no use in 2011. Like landfill uses, transportation-related TDA use depends on the timing of road and rail construction projects and there were no projects slated to use the material in 2011. Weak budgets and the exhaustion of stimulus funding contributed to the decline. At least two projects expected to use about 1.5 million PTE are planned for late 2012 and 2013.

- **Alternative Daily Cover Up Sharply.** The use of shredded waste tires as alternative daily cover for municipal solid waste at landfills increased from 0.8 million PTE in 2010 to 2.0 million PTE in 2011. This follows five straight years of decline in use as alternative daily cover (ADC). There are only three landfills that use significant quantities of shredded tires for ADC, so a change in practice at one or two landfills can result in a significant overall change to this category, which was the case for 2011.

- **Tire-Derived Fuel Down.** The estimated use of California waste tires as tire-derived fuel within California declined in 2011. This decline is a result of a co-generation facility slowing activity (and eventually closing in early 2012) and reduced cement production at one of the four cement kilns that accept TDF as a fuel source. Three cement kilns reported increased usage in 2011 and all indicated that they expect use to continue to expand in 2012 as demand for cement is expected to increase.

- **Disposal Down to a Record Low.** Landfill disposal declined by 36 percent, from 7.8 to 5.0 million PTEs. The decline in disposal appears to be largely due to the increase in exports, as well as the increase in demand for reuse.

Section 3
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.

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 tire-derived product (TDP) producer capacity, and government support/regulation. Following is a brief update on supply-side infrastructure changes (including tire processing facilities, collectors, and baling facilities), concluding in a synopsis of the implications of these considerations for market development efforts.

Processing and Product Production Expansions and Contractions

California has a large, dynamic infrastructure for collecting and processing waste tires, including about 1,500 registered haulers and exempt common carriers, seven facilities with a major waste tire facility permit and 28 facilities with a minor waste tire facility permit. The vast majority of tires generated flow to one or more of 15 processors or ten known baler/exporter facilities analyzed in this report, with the remainder hauled directly to disposal or end uses such as reuse or cement kilns consuming whole tires, 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 whole tires between the two distinct regions, with the exception of used tires, and with each region having somewhat different market dynamics.

In 2011, one Southern California crumb producer that had started production in late 2010 ceased operations. However, generally after several years of expansions and contractions, California's crumb rubber production capacity has been relatively stable since early 2011. This is in spite of the increased competition for tires outlined elsewhere in this report. Due to a lack of demand for tire loan funds (three crumb producers received loans in the previous year), in April 2012 CalRecycle reallocated $4 million that had been allocated to the tire loan fund for processor and manufacturer capital investments, to grant programs. The main change in processing infrastructure is the establishment of at least ten baler/exporter facilities (some of these handled relatively small tonnages in 2011 (with even more such facilities starting operations in 2012), while others saw large and increasing volumes). With low start-up investments and relatively simple business models, these facilities are handling an increasing number of tires (especially in Northern California) and diverting them in some cases from established processors that have relatively large investments in plant and equipment.

Interest in partnerships/vertical integration 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 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 paving companies develop preferred supplier relationships. The California Rubber Recycling Network

was launched in 2011 with CalRecycle support, as a partnership among tire-derived product producers and processors, with the goal of advancing tire-derived products into the marketplace. Although the network saw momentum slow in late 2011, some industry players continue to express support for cooperative efforts and the vision for this effort is still alive.

Several supply issues continue to play a role in inhibiting the expansion of crumb rubber processing in California.

- **Scarcity of truck tires and casings:** The relatively high natural rubber content of truck tires makes them desirable for use in rubberized asphalt concrete, and Caltrans' specifications require certain minimum concentrations of natural rubber in the asphalt mixes. As the use of rubberized asphalt concrete paving grows, which is the largest current market segment for ground rubber by far, the demand for crumb rubber truck tires will continue to grow as well. However the quantities of truck tires generated are relatively stable. Truck tires and casings are becoming valuable and scarce in California and there is intense competition for old truck tires among retreaders, processors who buff the tread from waste truck tires for tire-derived product producers (e.g., pour-in-place playgrounds and molded products), crumb suppliers for rubberized asphalt concrete projects, and losses of the tires to export when baling facilities are not familiar with the domestic market demand for the tires. Anecdotally, demand for reuse of truck tires is also strong in Mexico and South/Central America where truck tires and casings can be repaired more cost-effectively than they can in the U.S. Thus scarcity of truck tire supply may serve as a limiting factor to further significant expansion of RAC from California tires.

- **Lack of supply and standards for fine rubber powders and rubber-plastic compounds:** California has one crumb rubber producer focused on production of fine crumb rubber, and several firms are working with crumb producers and compounders to develop raw material formulae for use in producing a growing variety of molded and extruded products. However, to date, formulae must be developed on a case-by-case basis through experimentation. Several CalRecycle TBAP-funded projects are addressing this barrier.

- **Competition with low-priced crumb rubber imports.** There is currently an oversupply of crumb rubber in North America compared to demand, with a few large suppliers offering very attractive pricing across wide regions. Moreover, some out-of-state suppliers receive incentive payments that further provide them a competitive advantage, according to California crumb producers.

- **Competition for California Tires.** As described below, tire supplies are tight and tip fee revenue is down, putting further cash flow and supply pressure on some California crumb producers.

Waste Tire Supply Down and Competition Up

Overall waste tire generation (based on documented flows in this study) was estimated to be slightly lower than the quantity of tires managed in 2010. This is likely due to the continued effects of the economic decline and rising fuel prices. According to Rubber Manufacturers Association (RMA) statistics, national 2011 new tire shipments by domestic manufacturers decreased slightly by 0.2 percent. The RMA attributes to the decline to increased gas prices (which lead to reduced road travel) and several global natural disasters which affected vehicle manufacturing and shipments of new cars. RMA is forecasting an increase nationally for 2012 of

2 percent over 2011 quantities. These national statistics, however, cannot be directly applied to California. To the extent that the California economy improves in 2012 and beyond, the supply of waste tires can be expected to grow. The expansion of reuse in 2011 further reduced the availability of waste tires for other uses.

Competition for waste tire supplies further intensified in 2011. This was due mainly to aggressive competition for waste tire collection accounts by burgeoning baler/exporters, at a time of reduced supply and sustained demand by established processors, including crumb rubber producers. This is especially a factor in Northern California, and especially near ports, where several baler/exporters are effectively competing with processors. In Southern California, a relatively large portion of export activity is occurring through established processors who are mostly diverting tires that previously would have been landfilled. Section 4 discusses this trend in more detail.

North American Crumb Rubber Oversupply and Competition with Incentivized Producers

As in previous years, California crumb producers complained of competition with low-priced out-of-state suppliers of crumb rubber and TDPs. These California producers cite the relatively high operating cost in the state, as well as incentive payment systems (subsidies) in several other states and Canadian provinces as providing some suppliers with an unfair competitive advantage. (CalRecycle is set to publish a report on incentive payment systems in June 2012, and held a workshop on the topic in April 2012.) The crumb rubber oversupply issue is not only applicable to California – the situation is apparent across North America and beyond, with some suppliers offering low-priced crumb rubber for sale, delivered to most any location in North America. Moreover, several crumb rubber facilities have, or are planned to start up in the coming year, including a very large facility planned in Texas. At a time of slow market growth for TDPs from crumb, crumb prices may remain low for some time to come.

Implications of Supply/Demand Balance for Future Market Expansion Efforts

Following are two implications of the above analysis for future market expansion efforts.

First, projects to expand ground rubber production capacity should proceed with caution due to the current North American oversupply situation and the other competitive pressures described above. The issue of supply and demand balance is particularly important for ground rubber, which requires a more significant level of investment than other processing operations and therefore puts facilities at greater risk during downturns. Furthermore, it is particularly important for operations relying on truck tires as raw material to be cautious, as truck tires are in short supply, as described above. Projects to expand recycling should consider supply constraints posed by expanding exports. However, with 5 million PTE still being disposed and 2 million PTE flowing to ADC, there may still be room for some expansion of certain domestic recycling market segments even if exports continue to expand as expected. Competition and pricing pressures are likely to be exacerbated in 2012 unless and until the export trend peaks.

Second, CalRecycle has committed to investigating illegal activities taking place among exporters and transporters to curtail illegal waste tire activities that may be associated with balers/exporters and otherwise tracking and addressing concerns related to expanding exports. Depending on the timeliness and outcomes of these efforts, some of the effects of the illegal flows may be mitigated.

Market Segment Updates

Reuse

Reuse, including retreading and sale of partially worn used passenger tires, is strong and increased significantly in 2011 with about 6.9 million PTE being reused in 2011 as compared with 5.5 million PTE in 2010. When the economy recovers, there is the potential for demand for used tires to decline if purchasers return to buying new instead of used/retreaded tires. However, the "fear" of reusing tires or using retreads may be overcome for some buyers, provided that they have a positive experience, and they may be receptive to continuing with tire reuse.

RETREAD TIRES

Retreading of tires in California is limited to truck tires and other specialty tires (e.g., airplane tires). Prior to the 2010 market analysis report, the quantity of tires retreaded was based on estimates from industry experts and was reported to be 4.4 million PTEs from 2003-2009. However, beginning in the 2010 market analysis report, a new approach was utilized that included a combination of surveying retread companies and a 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 and 4.1 million PTEs (an increase of 13 percent over 2010 levels) for retreading in 2011.

California is home to 28 truck tire retreading companies that operate 38 retreading locations. Some tires also leave the state to be retreaded elsewhere. Although retreaders receive some casings from haulers and processors, they most often provide services directly to trucking companies and other companies that manage truck fleets.

Truck tire retreading is highly economical and considered mainstream by many trucking companies and fleet managers. While some retreaders opined that retread volumes may have grown in part to cost-saving measures implemented in response to the sustained economic downturn and increases in fuel prices, the stagnant economy also means that fewer truck miles are being driven, which has resulted in less tires needing to be retreaded compared to before the recession began. In recent years there has been a shift in the industry with small local retreading businesses losing market share to large retreading operations that operate more than one retreading location. These large operations now represent more than 40 percent of the retreading performed in California. The recession has accelerated the consolidation trend, and since 2010 SAIC estimates that as many as twenty small retreading locations have closed with the retreading volume shifting toward larger retreading operations.

Most retreaders surveyed indicated that they anticipate growth in 2012, although at a moderate level. As the economy recovers and more road miles are driven by trucks resulting in higher rates of tire wear, it is expected that both truck tire retreading and the generation of waste truck tires will increase. Another driver for increasing retread use is the escalating cost of new tires, with some tires reportedly increasing in cost by 50% over the past year. While many retreaders expect growth in 2012, some say there is not much room for additional growth in retreading.

USED TIRES

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 for market (consisting of inspection and grading), 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.

Reuse of used passenger vehicle tires within California was estimated at 2.8 million PTEs in 2011, a 40 percent increase over 2010 levels. Additionally, as discussed under "Imports and Exports" later in this section, in 2011 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 appear to be sold domestically may be subsequently resold and exported south of the border.

As with retreads, some processors report that the economic downturn is resulting in increased demand for used tires both domestically and internationally. This is reportedly true for both passenger tires as well as truck tires. The main constraint to increasing used tire shipments is the limited number of waste tires that are in suitable condition for reuse.

Ground Rubber

OVERVIEW

California is home to eight producers of ground rubber. These ground rubber producers used approximately 8.8 million PTEs in 2011 to produce more than 120 million pounds of ground rubber, a 3 percent increase over the estimated amount produced in 2010. 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 2 provides a summary of California ground rubber production by market segment for 2010 and 2011. General factors and trends that affect all of the market segments are discussed after the table. Unique factors and trends that affect each market individually follow this general discussion.

Table 2
Estimated Ground Rubber Shipments by Market Category[9]

Category	2010		2011	
	Million Pounds[1]	Percent of Total	Million Pounds[1]	Percent of Total
RAC & Other Paving	70.4	59%	68.1	55%
Turf & Athletic Fields	19.2	16%	23.7	19%
Pour-in-Place Playground	2.0	2%	2.1	2%
Loose-Fill/Bark/Mulch	15.5	13%	14.9	12%

[9] Production volumes assume an average yield of 70 percent ground rubber per ton of whole tires – individual company yields will vary based on the mix of truck and passenger tires processed and equipment used.

Category	2010		2011	
	Million Pounds[1]	Percent of Total	Million Pounds[1]	Percent of Total
Molded & Extruded	10.1	8%	12.8	10%
Other	2.5	2%	1.8	1%
Total	**119.7**	**100%**	**123.4**	**100%**

As Table 2 shows, increases in turf and athletic fields and molded and extruded products supplemented by an increase in pour-in-place playgrounds helped offset a decrease in RAC and a slight decrease in loose fill/bark/mulch and "other" products. Although there are some private purchases in certain ground rubber categories (e.g., molded and extruded products, athletic fields), and some retail sale of mulch to the general public, the overwhelming majority of ground rubber is purchased by state and local government entities (RAC is entirely governmental). The economy continues to have a particularly negative impact on state and local government purchasing. Local government budgets will likely remain challenged for several more years because of the time lag associated with real property sales/revaluations and its impact on local government property tax revenues.

Ground rubber production is capital intensive, and finer ground rubber is more costly to produce than coarser ground rubber, both from an energy perspective (operational cost) as well as from a capital equipment perspective. Ground rubber producers have financed multi-million dollar investments in facilities and equipment under business plans that were based on revenues from tip fees for incoming tires as well as revenues from the sale of ground rubber product. Tip fee revenues have fallen as a result of the increase in export activity in 2011 (discussed in detail in Section 4). Meanwhile, price competition by alternative materials and crumb produced from outside of California has not allowed California ground rubber producers to significantly raise prices on finished products. This overall revenue reduction hurt ground rubber producers in 2011 more than other tire market segments that are less heavily capitalized and saddled with long term debt based on anticipated tip fee revenues.

General factors driving demand for all ground rubber products in 2011 remain largely unchanged from those driving demand in 2010, and include: state rubberized asphalt concrete use mandates in Caltrans projects, 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, which some survey respondents indicate is still an issue. Another issue facing manufacturers of California crumb is the fact that California processors are competing with less expensive crumb rubber imports from provinces and countries that provide crumb manufacturers with subsidies. Some processors of crumb indicate that they are aware of crumb selling for as low as $0.06 per pound, although typical pricing is still much higher than this level at 10 – 17 cents per pound. It is difficult for California processors to compete with such pricing, particularly when they are also forced to reduce their tip fee revenues in order to compete with the export markets for waste tires.

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 declined in 2011. In 2011 some 4.9 million PTEs of California waste tires were processed into 68.1 million pounds of ground rubber for use 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 governments. While in the past there were only a limited number of blenders and paving companies that 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 and raised the demand for RAC in recent years.

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. Caltrans' use of RAC has continued to increase steadily since 2009, when usage was 3.6 million PTE in pavement projects. In 2010 Caltrans used 4.1 million PTE, and in 2011 an estimated 7.0 million[10] PTE in state highway RAC paving projects. Obviously, Caltrans' RAC use of 7.0 million PTEs far exceeds California processors' RAC production of 4.9 million PTEs. This is because Caltrans is not required to include in its specification that crumb rubber must come from California producers – only from U.S. sources – so a very large percentage of crumb rubber used by Caltrans contractors clearly comes from outside the state. Alternatively, local governments who qualify for CalRecycle RAC grants must use California tire crumb for their projects in order to qualify for the grants.

Although Caltrans paving project projections do not necessarily drive demand for RAC from California processors, there is still a market correlation and it is still worthwhile to understand Caltrans paving trends. 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 the broader RAC market and California crumb rubber producers as well. Caltrans indicates, however, that limited construction budgets has led to more competitive bidding, which has lowered individual project costs, allowing for additional projects to be completed. Caltrans has increased its use of tires in pavement in part by employing rubberized warm mix asphalt, which can be used in more distant locations than rubberized hot mix asphalt, thus expanding the potential projects for RAC.

[10] 7 million PTE estimated to be used. At the time that Caltrans' 2011 report to the legislature was published, 5.4 million PTE had already been used, and an additional 1.6 million PTE were forecasted for use by year end based on scheduled paving projects that were not complete. The 2011 report to the legislature is available at: http://www.dot.ca.gov/hq/oppd/rescons/sb876/Final-2011-SB-876-Waste-Tire-Report.pdf. An additional 236,128 PTE were used in 2011 in other applications. Caltrans, for example, purchases mats made from waste tires for vegetation control under guardrails and uses chip seal that contains rubber binder material derived from waste tires. Although Caltrans states that TDA is their preferred material for lightweight fill, Caltrans has not used TDA in highway projects since 2009.

Rubberized asphalt concrete is also used by local governments, sometimes with financial grant support and technical assistance provided by CalRecycle. As mentioned above, the source of tire rubber must come from California tires in order to qualify for grant support. While Caltrans usage increased in 2010 and 2011, local government projects using rubberized asphalt appear to have decreased significantly in 2011 (assuming a moderately significant percentage of California crumb is used for Caltrans RAC projects). This decline appears to be due primarily to the financial hardships being faced by local governments. In 2010/2011 28 targeted RAC grants were awarded to California jurisdictions at a total value of $4,897,097. In addition, 20 Chip Seal grants were awarded to California cities and counties at a total value of $3,249,856. Information is not yet available on which of these grants were executed and the total quantity of California tires used. (It is not uncommon for local governments to cancel grant-funded projects since they must also provide matching funds, and sometimes local agencies may reallocate funds designated for this match.) Local government RAC demand is likely to remain depressed until public entities' financial conditions improve.

Terminal blend is made 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 future increases in market demand. Terminal blend also 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 very limited. In the 2010/2011 grant cycle, two of 42 RAC grant applications were for a terminal blend product, expected to cover about 381,000 square yards.

SYNTHETIC TURF AND ATHLETIC FIELDS

Crumb 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 2011 is estimated to be 23.7 million pounds, equivalent to 1.7 million PTEs, which is an increase of nearly 24 percent over 2010 levels. This increase follows a modest increase in 2010, with the only decline in recent years being in 2008. Because most installations are for municipal recreational facilities and school systems, the market segment is susceptible to reduced funding when governmental budgets fall short, although there are private projects as well. Projects are also susceptible to concerns about potential health impacts, especially where field use is intended for children.

The market for crumb rubber as a fill material in artificial turf applications still faces barriers. A limiting factor in recent years may be receding as there appears to be less concern that artificial turf may pose certain health and safety risks. Several scientific studies and literature reviews have evaluated these concerns, including a study funded by CalRecycle, conducted by the Office of Environmental Health Hazard Assessment (OEHHA). Even so, many processors indicate that there is still a need to publicize the results to dispel myths regarding the safety of crumb rubber in this application. Some local governments are using ethylene propylene diene monomer (EPDM)

which is often imported from China and is reportedly more costly than crumb rubber. However, fewer suppliers indicate these concerns being an issue relative to past years.

Artificial turf is a very narrow market that is dominated nationally by three firms. 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 2011, about 14.9 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 slight decline from 2010 levels of 15.5 million pounds. 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 segment, as municipalities, housing authorities 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 (material only, not labor or equipment, and excludes truck tire buffing from retreaders), 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.

Another constraint is the relatively high up-front cost of rubber playground materials compared to engineered 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.

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).

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. Rubber bark/mulch is more expensive than natural mulches in terms of up initial costs. 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 demand by California processors declined in 2011, as it did in 2010. Initial interest and sales of the product by big box retailers have cooled since the product has a less rapid turnover than alternatives (i.e., less retailer revenues for equal amounts of invested shelf space). There was continued reduced demand from municipal parks and recreation divisions in 2011, as well, except where funded by CalRecycle grants. The decline in demand appears 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, but is dependent upon economic recovery.

Pour-in-Place/Other Playground Surfacing

In 2011, about 2.1 million pounds of ground rubber from of vehicle tires and buffings that processors produced from waste truck tires (0.1 million PTEs in total) were used in pour-in-place playground surfacing applications; this is a slight increase over 2010 estimates. This amount does not include buffings produced as a by-product of retreading that were sold to multiple markets, including pour-in-place playground surfacing, and therefore does not reflect the quantity of tire rubber actually used in pour-in-place installations (doing so would result in double-counting under both retreading and this category), which can make it difficult to isolate and compare processor trends to general pour-in-place installation trends. In this application, buffings and in some cases a percentage of ground vehicle tire rubber, are combined with a urethane binder and overlaid with EPDM rubber surface layer to produce a bound surface. Pour-in-place markets only qualify for CalRecycle grants unless they are made with buffings from processors or ground rubber derived from California waste tires.

Pour-in-place surfacing generally satisfies ADA requirements for wheelchair accessibility, and given its bound state, is less vulnerable to concerns about 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 2011, about 12.8 million pounds of ground rubber, derived from about 0.9 million PTEs, were used to produce molded and extruded products, a 28 percent increase in the estimated volume over 2010. In this application, crumb 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. The production of more premium molded and extruded products in California is limited by lack of

production capacity 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" crumb rubber have emerged, and one firm in California is now specializing in production of fine crumb rubber. 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 virgin rubber, 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 about 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 is 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. Several TDP manufacturers indicate that they face challenges because their product is more costly than those made with traditional materials. However, this category showed high growth from 2010 to 2011, largely because a significant amount of its markets are not governmental.

OTHER GROUND RUBBER APPLICATIONS

In 2011 about 1.8 million pounds of ground rubber was derived from about 0.1 million PTEs and used to make a variety of products including horse arena material, products used in ballistics applications, and buffings from waste truck tires used in products other than pour-in-place surfacing. Comparison with previous years is difficult for two reasons. Because this is a relatively small category that includes sale of raw materials and other miscellaneous uses, it is difficult to draw clear trends from year-to-year changes in this category; however 2011 quantities reflect a 28 percent decline from 2010 quantities.

Civil Engineering

Civil engineering applications used about 0.6 million PTEs in California during 2011, a 68 percent decrease from the estimated volume in 2010. In California, civil engineering applications are segmented into two primary applications: use at landfills, which have historically dominated 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 for drainage; 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 very 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.
- **Institutional** – Since it is not widely used in California, some decision makers and engineers are unfamiliar with the material and may be reluctant to use tire-derived aggregate, or to switch suppliers.
- **Suppliers** – Due to the large quantity of tire-derived aggregate that may be needed on a particular project, and the infrequent nature of those projects, existing processors may not be able to provide the needed material unless they are processing tires for disposal, alternative daily cover, or TDF. While a few processors have stated they are interested in being a large-scale supplier, others are reluctant 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 more value-added material to other markets.

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.

CalRecycle began a TDA grant program in 2011, with Notice of Funds Availability being issued on September 28, 2011. To be eligible, projects must use only California-derived TDA, and must use at least 750 tons of TDA (which can be for multiple projects). The grants were awarded in January 2012. There were two applicants – Mendocino County, which planned to use TDA as

lightweight fill at three slide repair sites on Mountain House Road and Sacramento County, which proposes to use TDA at Kiefer Landfill as a permeable backfill in the horizontal landfill gas collection and leachate recirculation trenches as well as lightweight fill material to be used in the construction of landfill roadways and winter tipping areas. The combined value of these grants is $609,223. It is SAIC's understanding that Mendocino County has had to cancel its project due to lack of available funds for its share of the project costs. While Caltrans indicates that they see TDA as the preferred material to use for lightweight fill, they have not used any TDA in the past two years.

LANDFILL CIVIL ENGINEERING APPLICATIONS

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 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 deliver materials free of charge.

In 2011 an estimated 0.6 million PTEs were used as tire-derived aggregate in civil engineering applications at landfills, a 67 percent decrease from the amount reported in 2010. 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. A significant portion of the total comes from one landfill that has a tire processor co-located with it. At this landfill, shredded tire material is readily available in large quantities, so the landfill uses tire-derived aggregate liberally, unlike landfills that do not have an on-site processor (these landfills must pay for transporting in tire-derived aggregate and so they only use the material in the quantities required by an efficient engineering design). Two other landfills used most of the remaining TDA used in landfill civil engineering applications. One is a publicly owned facility that expects to use TDA in similar applications in 2012, although a slightly smaller quantity of TDA use is anticipated, and a third landfill that used a relatively small amount from an off-site tire processor.

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, which in combination with its new grant program may result in increased usage in the future.

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 lack experience with tire-derived aggregate and may be reluctant to use it. There are also 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

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, this application is not 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 2011 no TDA was used in non-landfill civil engineering applications in California. This is the third consecutive year of decline in non-landfill civil engineering use, as about 700,000 PTEs were used in several projects in 2008 and 350,000 PTEs used in 2009, and only 35,000 PTEs were used in non-landfill civil engineering applications in 2010. As with landfill civil engineering, non-landfill applications normally involve a small, sporadic number of relatively large projects – there have been only eleven projects in the past fifteen years. As CalRecycle continues its efforts to boost Caltrans' and others' use of tire-derived aggregate, abrupt increases or decreases in use from year-to-year are likely to occur.

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 county projects, most of which were conducted with considerable financial and/or technical support provided by CalRecycle. As described above, CalRecycle has developed a new TDA grant program, for which two applications were approved in January, 2012. One project was for landslide repair projects in Mendocino County; however, it is SAIC's understanding that the project will not be performed due to lack of available funds from the county. The use of TDA in civil engineering applications is expected to increase as the economy recovers. Also, CalRecycle is aware of two light rail projects that plan to utilize TDA for vibration mitigation – a BART project slated for the end of 2012, and an MTA Project in Los Angeles, which may go into 2013. These two projects are expected to consume 1,500,000 PTEs.

Alternative Daily Cover

Tire shreds are used as alternative daily cover at some landfills to cover disposed waste at the end of each day. Tire ADC replaces dirt, and can substitute for other ADC materials such as green waste or wood waste.

Use of tires for alternative daily cover increased significantly in 2011 from 0.8 million PTE in 2010 to 2.0 million PTE in 2011, with an increase of 147 percent over 2010. Use of ADC is based on a relationship between a processor and a landfill for tire shreds that otherwise have no market demand. The landfill's operating permit must allow for this use, the shreds must meet a specification, and use as ADC is limited to dry weather conditions.

Tire ADC 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 at most landfills, and the regulatory and operational hurdles to its use mean that very few California landfills (only three) use appreciable quantities of tire ADC. Landfills that do use it, however, can consume large quantities of tires. 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.

As diversion of tires to more value-added uses continues to increase, including exports or non-landfill civil engineering uses, use of tires as alternative daily cover is expected to decrease.

Other Recycling Uses

Products in this "other recycling" category include rings cut from truck tires used to weigh down construction traffic barrels, weights for agricultural film plastic, and cut and stamped products such as dock bumpers, and shipment of tire intermediates such as crumb to unknown uses. In 2011 fewer than 100,000 PTEs (735 tons) were used in this market segment, which is slightly higher than the estimated 490 tons of PTE used in this category in 2010. This category is likely to remain a small (currently comprising less than one percent of all PTEs generated) but stable use in future years.

Tire-Derived Fuel

In California, waste tires have historically been 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. Both types of facilities primarily use other fuels, and tire-derived fuel (TDF)[11] typically is not needed by them – it is only used to supplement these other fuels if the economics favor combusting TDF or if the cleaner-burning tires are needed to offset emissions from "dirtier" primary fuels.

While tire-derived fuel use steadily declined between 2005 and 2009, this trend was reversed in 2010, but declined once again in 2011. While favorable pricing for tire-derived fuel compared to the price of coal in 2010 contributed to the up-tick in demand, 2011 saw an overall decrease in the demand. Higher coal prices in late 2011 and early 2012 are again driving increased demand for TDF. Cement kilns contacted as part of this study expect an increase in use during 2012 as they hope for a recovery of the economy and increased construction activity. The overall decline in TDF in 2011 is attributable to the slowing of a co-gen facility (which shut down fully in early 2012) and one cement kiln's reduced demand. In 2011 6.2 million PTE were used as tire-derived fuel in California, a 26 percent decline from 2010 levels.

In 2011 there were four California cement plants and one cogeneration plant that used significant amounts of tire-derived fuel. Three of the cement plants use whole tires, which they may accept for a small tip fee, or more recently for no revenue at all. The fourth California cement plant and the cogeneration plant used processed waste tires that had been chipped to pieces of a couple of inches in size, for which they must pay. An additional cement plant that has used whole tires as fuel in previous years remained shut down for all of 2011 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; however, the only co-generation facility that used significant quantities of TDF has ceased operating, so overall TDF usage may be flat or only show a moderate increase, assuming economic conditions continue to improve and demand for cement increases.

Tire-derived fuel is desired by cement kilns because it 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. In some cases using tire-derived fuel can allow the use of more high-sulfur petroleum coke

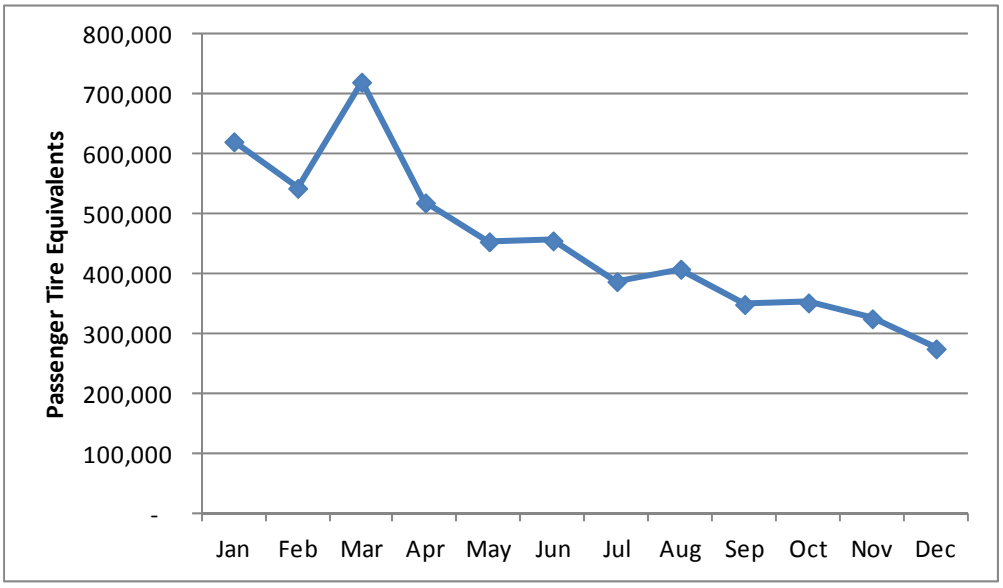
[11] Tire-derived fuel is generally shredded tires, sometimes of a specified size (e.g., 3-inches) often with bead wire removed. Some facilities, generally specific cement kilns, can use whole tires as a fuel. Usually TDF supplements other types of fuel such as coal or biomass.

(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 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 using biomass in lieu of coal/TDF is rewarded as California strives to meet its renewable portfolio standard. The last cogeneration facility to use significant quantities of waste tires as a fuel source stopped using them in 2011 and fully ceased operating in March 2012. We do not expect that significant quantities of TDF will be combusted by any co-generation facility in the future.

Disposal

In 2011 5.0 million PTEs were disposed in landfills, a 36 percent decrease from 2010 levels. This estimate is based on an analysis of 12 landfills identified through surveys, CalRecycle's Disposal Reporting System, and the Waste Tire Manifest System (WTMS) as accepting significant quantities of tires. The primary factors leading to a reduction in waste tire disposal are increased demand for export and increased demand for reuse. Export demand can be volatile, which can lead to market instability. Figure 3 shows a month-by-month analysis of the flows of waste tires to the five landfills that receive the greatest quantities of California tires. As the figure shows, disposal at these five landfills was reduced by half at the end of 2011, relative to quantities of waste tires delivered to these landfills for disposal at the beginning of 2011. The driver of this trend, export demand, has continued and intensified into 2012.

Figure 3
Monthly Flows of Tires to Five Landfills Receiving Majority of California Tires



Approximately 40 percent of landfilled tires were sent to landfills in Northern California or Oregon, with the remaining 60 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 half of all 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 by other markets for tires at an acceptable price; lack of processing capability to produce higher value tire-derived 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 these areas are described briefly below; however, an in-depth discussion of waste tire exports is provided in Section 4.

USED TIRE IMPORTS AND EXPORTS

Used tires that have been culled and graded depending on their type and quality 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 other 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 2011 used tire exports from California were estimated to be 1.8 million PTEs, or the same quantity as in 2009 and 2010. 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

domestic distributors who in turn exported a portion of the used tires they manage. 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 $10-$13 each for passenger tires, and $15-$35 per truck tire, 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.

WASTE TIRE IMPORTS AND EXPORTS

Approximately 3 percent of waste tires handled by processors are imported into California from states such as Hawaii and Washington. These tires have been subtracted from the statistics provided in this report to ensure the quantities are only indicative of the disposition of California tires.

Continuing growth in waste tire exports from California is the dominant trend in 2011, with the quantity exported in 2011 estimated at 9.6 million PTE, or more than 23 percent of all tires managed. Export is now the single largest market destination for California waste tires. Waste tire exports increased more than 50 percent in 2011 over 2010, and this growth trend appears to be continuing in early 2012. Section 4 below analyzes waste tire export trends and implications in detail.

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. Imported ground rubber competes with in-state production, and sometimes benefits from subsidies (e.g., in British Columbia, Alberta, and Utah). Several California processors and product manufacturers indicate that it is challenging to compete with this tire-derived material, as it can cost up to 50 percent less than locally processed material due to the subsidies. While some indicated that they are in favor of an incentive program being paid to California processors (and/or perhaps manufacturers of products made with California tire-derived material), several processors and manufacturers indicated that the system is working “well enough” in California and are leery of unintended negative consequences that could result from such a program. 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.

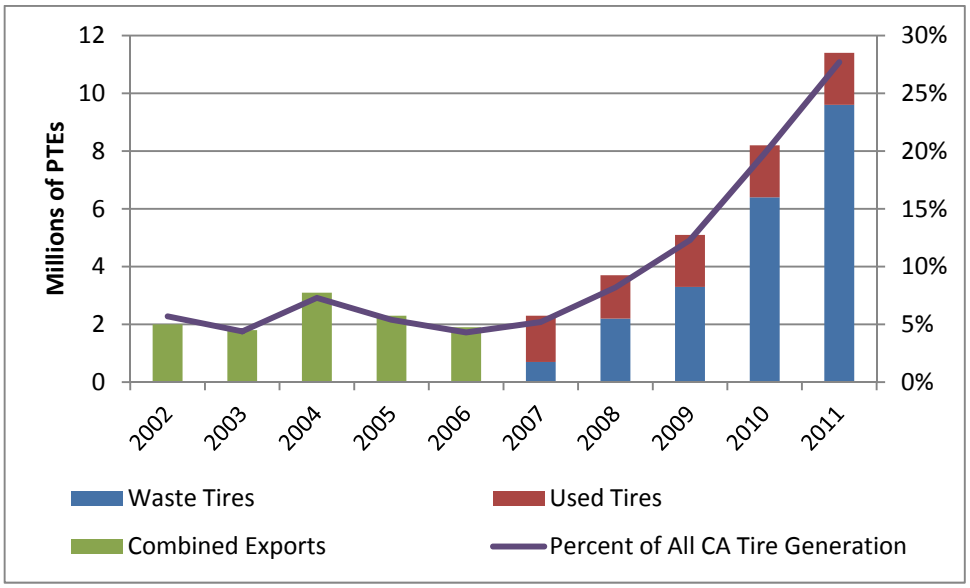
Section 4
Waste Tire Export – Detailed Analysis

Overview

This section provides a detailed analysis of waste tire export trends, drivers and implications. The analysis generally excludes used tires and focuses primarily on waste tires. A discussion of used tire markets and trends was provided in Section 3.

Beginning around 2007 waste tires (i.e., mixed discarded tires that may or may not include reusable tires) began to be shipped in significant quantities, primarily to Asian nations (see Figure 4). Driven by favorable economics and strong demand, waste tire exports have grown rapidly and in 2011 became the single largest outlet for California tires at 9.6 million PTE or more than 23 percent. When combined with export of used tires, nearly 28 percent of all California tires generated were exported in 2011. Anecdotal information suggests that California waste tire export volumes have continued to increase in 2012 at a steady pace. Waste tires are shipped in three specifications: bales of whole tires, primary shreds, and TDF from 2-6 inches in size. Primary destinations for California waste tires include Viet Nam, China (via Viet Nam), South Korea, Japan, Pakistan and India.

Figure 4
California Exports of Used and Waste Tires to Other Countries[12]



Elsewhere in the U.S., waste tires are also being exported in significant quantities, especially from Washington, Oregon and Florida, and reportedly exporters are increasingly sourcing tires

[12] These estimates are based on surveys of California waste tire management firms and analysis of Waste Tire Manifest Data. The analysis methodology changed in 2007, but it is believed that very few waste tires were exported prior to 2007.

from the mid-Atlantic and Northeast states as well as Puerto Rico. While not analyzed here, waste tires are also exported in notable quantities from British Columbia, Canada, but export appears to be much less pronounced in some other provinces with international cargo ports such as Ontario, apparently due to the strong incentive payment programs in place for tires managed within the province. Waste tires are also being exported to Asia from other developed countries. For example, according to a video report by the Australian news program Today-Tonight, more than 50 percent of the 22 million tires generated in Australia are now exported, primarily to China.[13]

The remainder of this section describes the underlying export trends, drivers and impacts in more detail, beginning with an analysis of how exports are affecting California's waste tire management industry and markets. Next, international market trends and drivers are examined. This is followed by a review of options to address concerns raised related to growing waste tire exports. .

California Industry and Market Impacts

Industry Structure and Dynamics in 2011

The vast majority of waste tires generated in California flow through a relatively small number of facilities. SAIC's analysis of 2011 waste tire flows focused on 25facilities that received significant quantities of whole waste tires generated in California in the study year. These facilities include 15 established processors that ship processed tires (often including culled reusable whole tires) to a variety of end-uses. In addition, for the first time this annual market report identified and analyzed ten facilities, termed baler/exporters, that primarily bale waste tires and export them overseas. SAIC's analysis also included several cement kilns and landfills that received whole tires directly from haulers, bypassing processors.

The waste tire processors have long been the linchpins of California's tire recycling infrastructure as they turn whole tires into crumb rubber, tire-derived aggregate, tire-derived fuel and other products, as described earlier in this report. Five of these processors serve multiple market segments including exporting waste tires to other countries. Separate from these established processors serving domestic and foreign markets, a minimum of 10 facilities were identified that mainly or exclusively shipped baled or shredded tires to ports for export to other countries in 2011. Five of these facilities were located in Southern California and five in Northern California.

While five baler/exporters were identified in Southern California, their volumes were relatively small and most tires exported from Southern California were shipped by established processors as shreds or TDF. In contrast, those baler/exporters still operating at the end of 2011 (one closed in 2011) in Northern California were responsible for the bulk of exports from Northern California, with relatively small quantities exported by Northern California processors. Because of this regional difference, rising exports may have been more disruptive in 2011 to previously established waste tire collection and supply chains in the North than in the South, although the effects are being felt statewide.

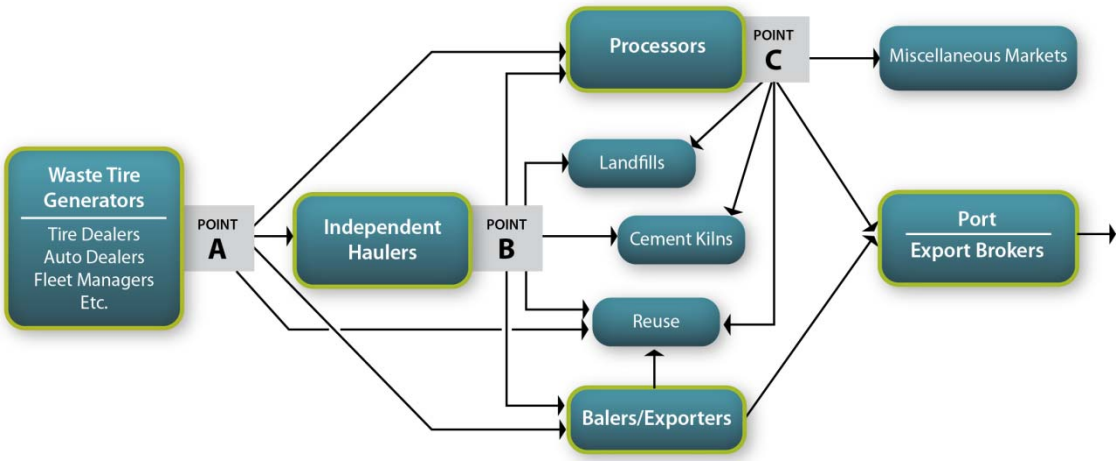
It should be noted that the number of different types of facilities operating in California, especially baler/exporters, is constantly changing. This report focuses on facilities operating

[13] The video report is available on-line at: http://www.youtube.com/watch?v=3orMZL9Kreo.

during 2011. As of May, 2012 a CalRecycle staff person had identified 19 such facilities – 10 in Southern California and nine in Northern California.

Figure 1 in Section 2 presented a flow chart of the entire current California waste tire management system. Figure 5 provides a more detailed look at upstream tire recycling flows, and identifies three critical points where decisions are made regarding whether tires are exported.

Figure 5
Flow Chart Highlighting Export Decision Points



Point A in the figure is where established processors, baler/exporters and independent haulers compete to establish collection accounts with the more than 27,000 California waste tire generators. Some generators sell reusable tires to small collectors (colloquially called "coyotes" by some) prior to their tire loads being picked up, but otherwise each generator establishes a relationship with a firm to pick-up and "dispose" of their waste tires. Processors and baler/exporters may provide generators with trailers which they pick up when full. Or, they may service the account via a collection route or "milk run" in which they load tires from multiple generators onto a truck. Finally, hundreds of independent haulers also operate in California and compete for collection accounts, with the majority selling used tires for resale. Price is the main factor influencing which firm generators select to pick-up their tires, but other factors include quality of service and whether there is a long-standing relationship. Some generators, especially national chains, often have policies restricting sale of used tires, and may have stated concerns or specific directions regarding how their waste tires are managed.

Point B is where independent haulers determine where to deliver the tires they pick up from generators. After culling out reusable tires, haulers may direct loads to processors, baler/exporters, landfills or cement kilns. Again, price is the main determinant, but relationships, proximity, market knowledge, and historical practices also come into play.

Point C is where processors determine how they will handle their flow of tires. Processors have far more options than haulers in terms of how to manage tires since they are equipped to varying degrees to chip, shred and/or produce crumb rubber from whole tires, and may also produce tire-derived products like molded mats or colorized rubber mulch. Although they are equipped to serve multiple markets, in practice they may have less flexibility to quickly or completely change

the market segments they target. This is because they have made substantial investments in land, buildings, equipment and labor, and have business plans predicated on production and sale of crumb rubber. By adding value to waste tires locally, these firms create economic activity within California, and provide a stable market outlet over the long term.

The Role of Export Brokers

Waste tire exports in California appear to be handled mainly by export brokers who generally: 1) Arrange for the delivery of cargo containers to processors or baling facilities for them to fill with baled or shredded tires, and 2) Arrange for the freight forwarding of those containers to California ports and overseas destinations. Although shippers remain legally responsible, these brokers greatly simplify the process of exporting, as the logistics and requirements for exporting products from U.S. ports can be complex and daunting, especially for firms without prior export experience. Exporters must be licensed and must ensure that they comply with a variety of laws, regulations and procedures in the U.S. and in destination nations. Exporters must agree with purchasers on all shipping, product specifications, packaging and pricing terms, and typically must execute a letter of credit with purchasers, administered by an independent banking institution, unless cash payment terms are used, which is less common and risky to the exporter. Some baler/exporters and processors who are exporting have been successful in requiring cash on delivery terms. Some baler/exporters have established relationships with overseas end user destinations and work directly with them; however, it is more common to rely on independent brokers to facilitate shipments and sometimes processors and baler/exporters may have little knowledge, understanding or contact with the ultimate users or destination of the tires they handle. A large number of export brokers are currently seeking to source waste tires from California sources. Several processors and others in the industry report that they receive numerous calls and emails each week from such individuals.

Economics

Increasingly, waste tires that used to flow through established processors or directly to end markets or disposal are now flowing to export markets. The fundamental drivers of this trend are strong export demand and highly favorable economics. Pricing and terms vary considerably and are constantly changing; however, following is a broad summary of how economics are driving tires to export at each of the three key decision points identified in Figure 5 above.

Table 3 compares costs and revenues at a high level for established processors and baler/exporters. These costs and revenues are based on information as of spring 2012, and it must be emphasized that pricing and terms are constantly changing. For example, while waste tire bales delivered to port are currently receiving a positive payment, there were times in 2011 when exporters did not receive payment. However, this still provides favorable economics in comparison with higher cost disposal options. Among the many factors influencing pricing is the availability of low cost cargo containers heading toward Asia, where they are in high demand due to very high exports from that region of the world. The table greatly simplifies the industry's nuanced pricing practices by providing examples of cost/price ranges related to collection tip fee revenue, capital investment and operating costs and product revenues. Notwithstanding the simplifications, the table illustrates the currently attractive economics of waste tire export. In short, baler/exporters can begin operations in a leased warehouse with a relatively modest investment that includes $20,000 - $60,000 for a baling machine (or somewhat higher for a shredding machine), material handling equipment, and low-cost unskilled labor. Also, recently,

brokers are beginning to offer to provide balers to baler/exporters to expedite deliveries. The baler/exporters receive relatively strong prices of $35 - $48 per ton for baled whole tires, with rapid inventory turnover that strengthens cash flow. Baler/exporters also benefit from relatively low freight rates for export containers that otherwise may be shipped back empty to Asian ports. Moreover, some large baler/exporters have not yet obtained waste tire facility permits and/or have been cited for other non-compliance issues. While this puts such firms at risk of government action and fines, in the mean time it allows them to operate with a somewhat lower cost structure than fully permitted facilities.

Table 3
Comparison of Select Costs and Revenues for Baler/Exporters and Established Processors[14]

Type of Facility	Examples of Collection Tip Fee Revenue	Capital Investment and Operating Cost Examples	Examples of Revenue from Sale of Product[15]	Synopsis
Baler/ Exporters	Trailer Pick-Ups Current: $400-$600 per 45 ft. trailer ($30 - $45 per ton) Historic[16]: $1,000 - $1,500 per 45 ft. trailer ($75 - $112 per ton) Collection Routes Current: $0.20 - $0.85 per tire ($20 - $85 per ton) Historic: $1.50 - $2.00 per tire ($150 - $200 per ton) Delivery by Hauler Current to Baler/ Exporter: $0 - $0.50 per tire ($0 - $50 per ton) Current to Processor: $0.50 - $0.85 per tire ($50 - $85 per ton) Historic: $0.50 - $1.50	Very Low Baling Machine: $20,000 - $60,000 or Shredder: $50,000 - $250,000 Warehouse; Low Labor; Rapid Inventory Turnover	Bales: $700 - $1,250 per 40 ft container ($35 - $48 per ton) Shreds: $500 - $900 per 40 ft container ($19 – $34 per ton)	Low Operating Costs and Solid Product Revenue Allows for Low Collection Tip Fees
Established Processors Serving Multiple Markets		Relatively High Equipment: $250,000 - $5+ million; Land and Buildings; More specialized labor ; Long Inventory Turnover	Highly Variable 10-30 Mesh Crumb: $200 - $340 per ton TDF:$7.60 - $31.00 per ton (National Published Estimate[17]) Disposal Tip Fee: Up to $75 per ton or more	High Operating Costs and Variable Product Demand/ Revenue Leads to Strong Reliance on Collection Tip Fee Revenue

[14] Note that this table is based on information available in Spring 2012. Pricing and terms are constantly changing in response to many factors.

[15] Pricing for exported products are based on "payload rates" that assume a full container. This presents exporters with a dilemma as a full container may exceed California maximum load regulations.

[16] "Historic" here means pricing that was generally in place four – ten years ago, prior to the rapid rise in waste tire exports.

[17] Scrap Tire & Rubber 2012 Users Directory. Published by the Recycling Research Institute.

Type of Facility	Examples of Collection Tip Fee Revenue	Capital Investment and Operating Cost Examples	Examples of Revenue from Sale of Product[15]	Synopsis
	per tire ($50 - $150 per ton) Truck Tires Current: $1.00 - $3.50 per truck tire ($25 - $58 per ton) Historic: $5.00 - $7.00 per truck tire		ADC: Tip fee up to $20 per ton	

Established processors serving multiple markets, on the other hand, may have investments of $250,000 to several million dollars for equipment to grade and handle tires, produce TDF, TDA or crumb rubber, as well as investments in land and buildings that allow them to store and process large quantities of tires on site. They have specialized labor needs, for example, to maintain equipment, oversee and optimize production, develop and implement marketing plans, and execute sales. When processors move tire shreds to ADC or disposal, they typically incur a tip fee cost (albeit lower than the one paid by their suppliers). TDF sold in California may offer revenues comparable to those received by baler/exporters, but established processors have higher overhead costs. Crumb rubber producers have the highest revenues at $200 - $340 per ton for 10-30 mesh material (although some grades of ground rubber may sell for $500 per ton or more), but they also have the highest investment and operating costs of all. California costs for workers compensation insurance, licensing, permitting and bonding are all reportedly much higher than in many other states or countries, putting California established processors at a competitive disadvantage with out-of-state firms and competitors in California who may be out of compliance with these business requirements. Moreover, markets for crumb rubber and other processed tire products are cyclical throughout the year, resulting in low inventory turnover which weakens cash flow.

In summary, relatively high capital and operating costs, seasonality and variable product pricing with some product price caps set by alternative competing materials make established processors more reliant upon collection tip fee revenues. These business models may have been developed before the rapid rise in exports, which has put downward pressure on tip fee revenues. In contrast, low capital and operating costs with relatively strong pricing and strong cash flow allows baler/exporters to adjust their tip fees more readily to secure collection accounts. As exports have grown since 2007, average tip fee revenues have been reduced, especially near ports, to as low as half of their levels prior to the rise of exports. This has occurred at a time when pricing for crumb rubber has fallen, in part due to a current oversupply of crumb rubber relative to demand throughout North America, with some out-of-state producers benefitting further from incentive payment policies and/or lower operating costs than in California.

Industry Impacts

The rise of waste tire exports has caused significant disruptions that have mainly impacted established processors with invested capital to serve multiple market segments, as well as cement kilns using whole tires as TDF. Processors complain that the increased competition and pricing

pressures described above are curtailing their ability to obtain sufficient quantities of waste tires at acceptable tip fee prices (especially in the North). In some cases, processors will adjust pricing or other terms in order to retain collection accounts, for example, for large, nearby generators or for generators with sought after tire supplies that may be rich in used tires or truck tires needed for certain crumb markets. In other situations, processors may choose to let accounts go rather than reduce prices, for example, for small or far-away accounts that may already have above average collection costs. On the whole, processors are very concerned about how far the trend may go, and their long-term ability to maintain tire supplies and remain profitable if collection tip fee revenue drops further. While some established processors have begun to export whole or shredded waste tires, or processed 2-6-inch TDF, others say that it is not feasible for them to do so because of their investments and business plans, as noted above.

Cement kilns have also seen increased pricing pressure. While cement kilns have historically received a tip fee for whole tires delivered to their facility by independent haulers or processors, tip fee levels are dropping and cement kilns may need to accept tires with no tip fee or pay a positive value if they desire them as a supplement to their primary fuel.

Some waste tire generators have seen significant cost reductions for waste tire disposal as established processors and export processors compete for their tires. It is unclear at this point whether in such cases these tire generators have passed on such cost savings to tire consumers.

Market Impacts

Overall, expansion of the export market segment has resulted in California waste tire diversion levels spiking from the low 70s where they were for about a decade, to 88 percent in 2011. Waste tire exports, on the other hand, comprised 23.4 percent of tires generated in 2011, up from 1.5 percent of the total as recently as 2007. Statewide, it appears that most exported tires have been diverted from flows previously sent to landfills, with the estimated increase in exported tires since 2009 exactly equal to the amount of reduced flow to disposal during that timeframe of 6.3 million PTE. However, markets do not operate in a 100 percent efficient manner, and some processors may experience strong supply pressures due to loss of their established collection accounts, even if elsewhere tires are concurrently flowing to landfills for disposal or use as ADC. Anecdotally, these supply pressures appear to have increased sharply towards the end of 2011 and have continued into early 2012.

Following is a synopsis of impacts to date on each market segment.

Reuse does not appear to be strongly impacted by rising exports, although some established processors show reduced reuse as a result of overall flows being down. Both truck tire retreads and sales of used passenger vehicle tires are up significantly in 2011. While it is certainly possible that some quantity of reusable tires are being exported by balers and shredders who choose not to cull loads for reusable tires, in general the strong demand and high value of used tires and retread casings makes their diversion highly attractive to both established processors and baler/exporters.

Some **crumb rubber** producers have said that their production is down due to difficulties in securing supply, although statewide crumb rubber production is up by about three percent. Some also identify flat demand as an impediment and it is unclear to what extent growing exports may have resulted in fewer tires flowing to some crumb rubber producers or markets. However, crumb suppliers in Northern California are experiencing strong price and supply pressures that

appear to have intensified in late 2011 and into 2012. If the export growth trend continues, supply and pricing pressures will be exacerbated and it is possible that some crumb rubber producers and/or other processors may be forced to reduce their volumes or potentially cease to operate.

Civil engineering is down more than 67 percent in 2011, compared to 2010, but this is apparently due largely or entirely to low demand, and not to growing exports. Use of TDA in civil engineering applications can rise or fall abruptly by its nature, as it involves use of a large quantity of tires in a very few sporadic projects of limited duration, and even one or two large projects can use a significant quantity of tires. In 2011 there were no road or rail related civil engineering projects that used tires. Furthermore, the liberal use of TDA (in excess of efficient design levels) by a few landfills has been curtailed. CalRecycle is aware of non-landfill civil engineering projects that could consume about 1.5 million PTE beginning in late 2012 and into 2013. At current export levels, it is possible that it may be difficult to identify suppliers, or that pricing may need to be higher than it otherwise would be for TDA. If export growth continues, the already significant supply barriers for civil engineering projects may be further exacerbated.

Use of tire shreds as **alternative daily cover** has not been impacted by exports and is up sharply in 2011 to 2.0 million PTE from 0.8 million PTE, due largely to new, large-scale use at one landfill. This new, large use in a market segment that generally requires suppliers to pay a (relatively small) tip fee occurred during a period of rapid export rise, implying that export market pressures have yet to reach all flows.

Tire-derived fuel use was down 26 percent to 6.2 million PTE in 2011, from 8.4 million PTE in 2010. However, while exports are placing price pressure on cement kilns using whole tires, and cement kiln representatives say it is becoming more difficult to secure supplies, the decline appears to be wholly or nearly entirely a result of continuing low construction activity and consequent low demand for cement. This decline was augmented by the closure in early 2012 of the last California co-generation facility that had regularly used TDF. Cement kilns generally indicate they anticipate increased use of TDF in 2012 as demand for cement increases. They are increasingly receiving tires at zero tip fees, or paying for supplies of waste tires for which they previously had received tip fee revenue.

It appears that, to date, growing exports have had the largest impact on **landfill disposal**, which has declined 6.3 million PTE since 2009 to 5.0 million PTE in 2011, as waste tire exports increased by the exact same amount.

On the whole, it appears that if exports continue to increase as expected, there is still some potential to meet that demand by diverting tires from landfill disposal and alternative daily cover. However, exports may soon reach a tipping point where increased flows will necessarily begin to impact established processors to the extent that some are forced to curtail, shift or shutdown operations entirely. Some processors have suggested that such a tipping point has already occurred. A worst case scenario would be a significant decline in California's established processing and market infrastructure, followed by a rapid decrease in exports. This would impact the significant investments made by CalRecycle and private industry over the past two decades and also leave the state poorly equipped to maintain waste tire diversion levels similar to current ones. On the other hand, if export demand and economics continue to be strong, it is likely that baler/exporters will become established, fully compliant businesses that assume a lasting role in California's waste tire management infrastructure. While this will surely disrupt established

processors, to the extent that current pricing continues it could result in reduced costs for waste tire management and a pillar, for better or worse, of a newly cast waste tire recycling marketplace.

International Trends and Drivers

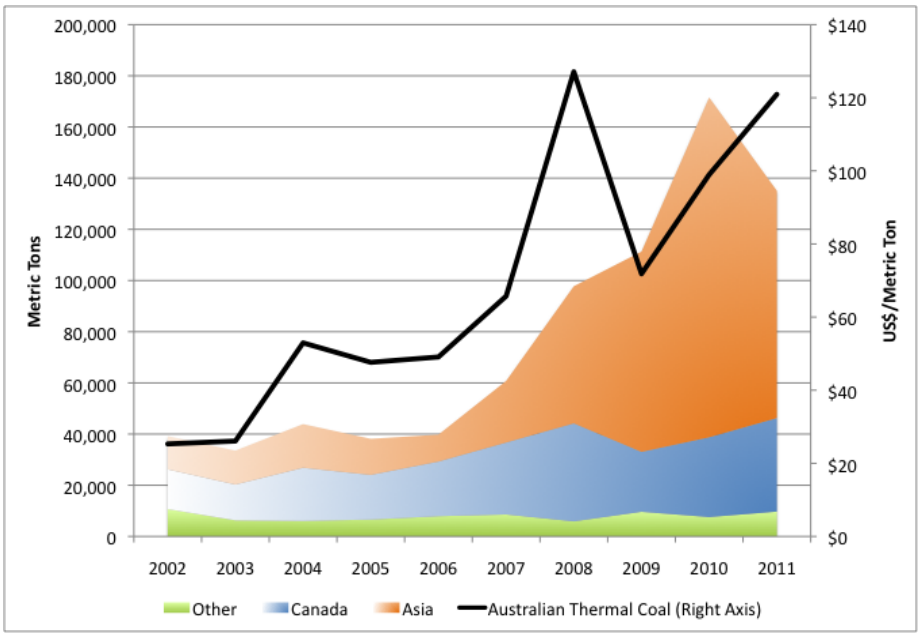
The previous sections evaluated growing waste tire exports from California and the implications for the state's waste tire management industry and markets. In contrast, this section more broadly examines U.S. waste tire exports to Asia and other nations from the vantage point of national/international export and industrial trend data.[18] The data generally document exporter statements that waste tires and processed TDF are mainly flowing to a variety of industrial fuel applications. However, data also show growing demand for fine rubber powders made from tires that is tied to Chinese car and tire production, with U.S. suppliers (outside of California) apparently shipping material to meet this demand. While this is a potential opportunity, the demand may decline as Asian scrap tire generation and management infrastructure evolves.

Based on International Trade Commission data, U.S. exports of waste tires, waste tire crumb rubber and waste tire rubber powder and rubber recovered from waste tires[19] have increased dramatically in the last five years from almost 40,000 metric tons (mt) in 2006 to 135,063 mt in 2011, with a peak of 171,547 mt in 2010 (see Figure 6). Exports to Asia account for most of this increase. International trade data is notoriously unreliable, with the same goods being categorized differently in the exporting and importing countries. However, U.S. export data indicate a clear change in waste tire rubber exports to Asia starting in 2007, when Australian coal, a benchmark for the Asian market, breached $60/mt.

[18] The primary researcher and author of this section is Densert Energy, a subcontractor to SAIC.

[19] Waste tires, crumb rubber and rubber powder recovered from waste tires are exported under section 4004 of the Harmonized Tariff Schedule of the United States (HTS) and are described as "Tire Rubber Waste, Parings and Scrap (Other Than Hard Rubber) and Tire Rubber Powder, Granules, Crumb, Chips and Mulch Obtained from" Used and retreaded tires are covered by HTS code 4012 and are not addressed in this section.

Figure 6
U.S Waste Tire and Waste Tire Rubber Exports & Coal Prices, 2002-2011[20]



Overview of Waste Tire Exports to Asia

Combustion of tire-derived fuel is the primary demand driver for whole and shredded waste tires in Asia. As in the U.S., whole tires and TDF are often co-fired with coal in power plants, cement kilns, and other industrial boilers, and co-fired with biomass by pulp and paper manufacturers. Exports under Harmonized Tariff Schedule (HTS) code 4004 to Asia grew from around 13,000 mt in 2002 to a peak around 133,000 mt in 2010 (see Figure 7). This coincided with significant coal price increases on the international market and China becoming a net coal importer in 2009.

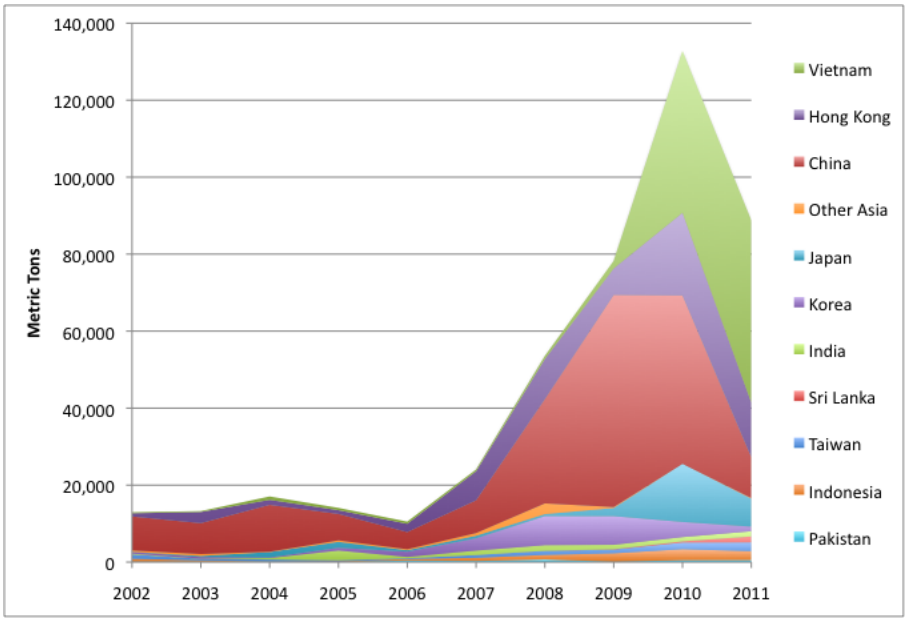
China's automobile and tire production industry served as a significant demand driver for waste tire rubber powder as a replacement for some natural and synthetic rubber used in tire manufacturing. Unfortunately, HTS does not distinguish between whole tires, shredded tires, crumb rubber and rubber powder. There is no evidence that California producers shipped crumb rubber to Asia for this use.

Measures to halt the import of waste tires and shredded waste tires to China were initiated in 2008/2009 and full enforcement started in 2011. This Chinese prohibition of importing whole or shredded waste tires is part of a concerted effort by the Chinese government and domestic rubber industry companies to enhance recovery of China's own waste tires and alleviate raw material shortages plaguing the rubber industry. After the prohibition, the flow of U.S. tires was redirected primarily to Vietnam but also partially to Hong Kong, for forwarding to China, (see

[20] Source: US International Trade Commission (USITC) and World Bank Commodity Price Data.

Figure 7). Combined exports to China, Hong Kong and Vietnam went from around 7,200 mt in 2006 to 72,100 mt in 2011, with a peak in 2010 of around 107,300 mt.

Figure 7
U.S Waste Tire and Waste Tire Rubber Exports to Asia, 2002-2011[21]



Demand Drivers for Exports to China

Chinese demand for the products included within HTS section 4004 is bifurcated. The majority of China's direct and indirect imports of waste tires, in terms of volume, have gone to supply power and process steam generation facilities. However, higher value exports of rubber powder go to foreign and domestic tire manufacturers in China as a partial replacement for natural and synthetic rubber.[22] There are reports of waste tires being exported to China for the purpose of producing fuel oil and carbon black using pyrolysis. However, the relatively small scale of such operations makes it unlikely that it would constitute a major demand driver.

ENERGY UTILIZATION

China's power plant fleet is dominated by thermal capacity (as opposed to hydroelectric and wind). In 2010, thermal generation accounted for 81 percent of China's total generation of 4,228 billion kWh. Coal-fired generation alone represented 76 percent of total generation, or 3,216 billion kWh[23]. Coal-fired boilers are able to use up to 10-15 percent of TDF with only minor

[21] Source: US International Trade Commission (USITC).

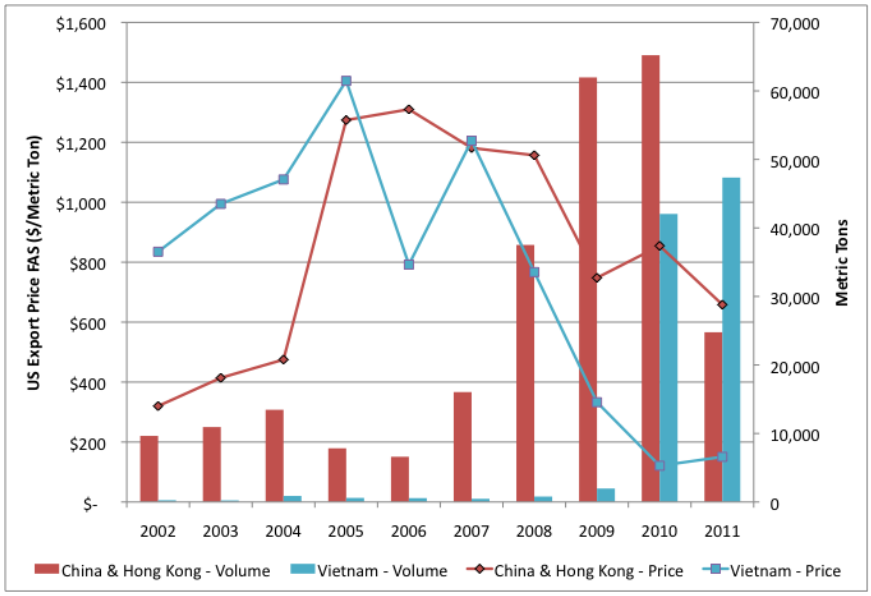
[22] HTS data available from the ITC does not distinguish between exports of whole tires in bales, shredded tires, and processed waste tire products, e.g. fine crumb powder, obtained using highly advanced technology including cryogenic processing. Hence, specific export data on the different types of products is not available at the time of this report.

[23] Source: China Electricity Council (CEC)

modifications. China's electricity production has kept up with economic growth over the last few years, although in recent years there are continued reports of a supply shortfall, according to the China electricity Council (CEC). While waste tires may be used by both industrial and power generation boilers, China's cement industry does not currently use waste tires, according to the China Concrete and Cement Products Association (CCPA).

Despite the prohibition of waste tire and TDF imports (see next section on "Industrial Utilization"), demand for tires as fuel in China has not disappeared and a large share of foreign waste tires is now baled and shipped to Vietnam for trans-shipment to China. The existence of this practice is supported by interviews with California exporters and news reports, as well as the actual export data. The export prices of HTS section 4004[24] further confirm the conclusion that whole tires are shipped via Vietnam while rubber powder for industrial use is shipped directly to China. As the volumes shipped through Vietnam increased significantly in 2010, unit prices also dropped dramatically. In 2007 average prices to China, Hong Kong and Vietnam were around $1200/mt, which equates to 54.4 cents per pound, a level to be expected for fine crumb rubber. In 2010, this average price for shipments to Vietnam had dropped all the way to $121/mt, or 5.5 cents per pound or $1.10 per PTE, assuming the shipments consisted of whole tires. A price of $1.10 per PTE is extremely attractive based on California waste tire markets, and would support the pricing being offered to California baler/exporters in the range of 35 to 48 cents per tire. At the same time unit prices to China also declined but much less dramatically, remaining at $855/mt in 2010, or 38.8 cents per pound (see Figure 8).

Figure 8
U.S Waste Tire and Waste Tire Rubber Export Prices, 2002-201125



[24] Export prices provided by ITC are Free Alongside Ship (FAS), i.e. cleared for export and ready to be loaded onto the transport vessel.
[25] Source: US International Trade Commission (USITC).

INDUSTRIAL UTILIZATION

Demand for U.S. exports of higher value waste tire products, specifically rubber powder to be used as an input in tire manufacturing, was sparked by an opening of the domestic Chinese tire market in 2005 and the explosive growth of Chinese vehicle production. Starting in 2005, greater competition was allowed in the domestic tire market and foreign manufacturers were allowed to own majority shares in their companies in China. Today, there are 300 – 500 domestic Chinese tire manufacturers. A slew of international tire manufacturers have production in China and supply more than 50 percent of the Chinese domestic market and almost all of the high-end tire market. China produced 832 million tires in 2011, 40 percent of which were exported.

Export volumes under HTS code 4004 to China declined dramatically between 2009 and 2011, from 55,107 mt to 10,571 mt, although waste tire volumes appear to have shifted to Vietnamese points of entry (See Figure 7). During this time, China implemented new laws prohibiting the importation of "solid waste" that cannot be used directly as a raw material, which included waste tires and shredded waste tires.[26] Waste tire rubber powder as a raw material in industrial production is controlled by permit.[27] Moreover, the domestic rubber industry, represented by the China Rubber Industry Association (CRIA), has stepped up its advocacy for greater use of China's own waste tires over the last three years and laws promoting the recycling of waste materials in general, with waste tires being among the areas targeted, entered into force in 2009[28]. Hence, one may conclude that the majority of U.S. exports direct to China (as opposed to trans-shipments through intermediary countries) under HTS code 4004 consisted of rubber powder to be used as a raw material by the tire and rubber industry.

The demand for rubber powder in China is driven by the demand for rubber as a raw material by the automobile industry and the tire manufacturing industry, which serves both the domestic and the international market. Because rubber powder can also serve as a replacement for natural rubber in some applications, demand is also impacted by the international price of natural rubber.

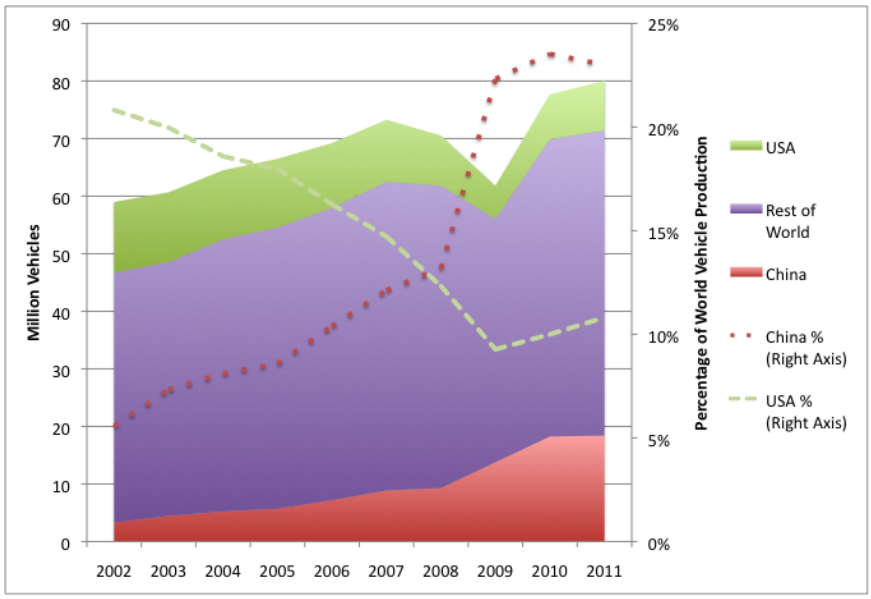
Chinese car and light truck manufacturing have increased dramatically, both in absolute terms and as a percentage of global production, over the last 10 years. In 2002, China produced 3.3 million vehicles representing 5.6 percent of global production. In 2011, China produced 18.4 million vehicles and had increased its share of global production to 23.0 percent (see Figure 9).

[26] The "Catalogue of Solid Waste Forbidden to Import in China" was introduced in 2008/2009 and entered into full force in mid-2011.

[27] The "Catalogue of Restricted Import Solid Wastes that Can Be Used as Raw Materials in China" was introduced in 2008/2009 and strict enforcement started in 2011.

[28] Circular Economy Promotion Law of the People's Republic of China, 2009.

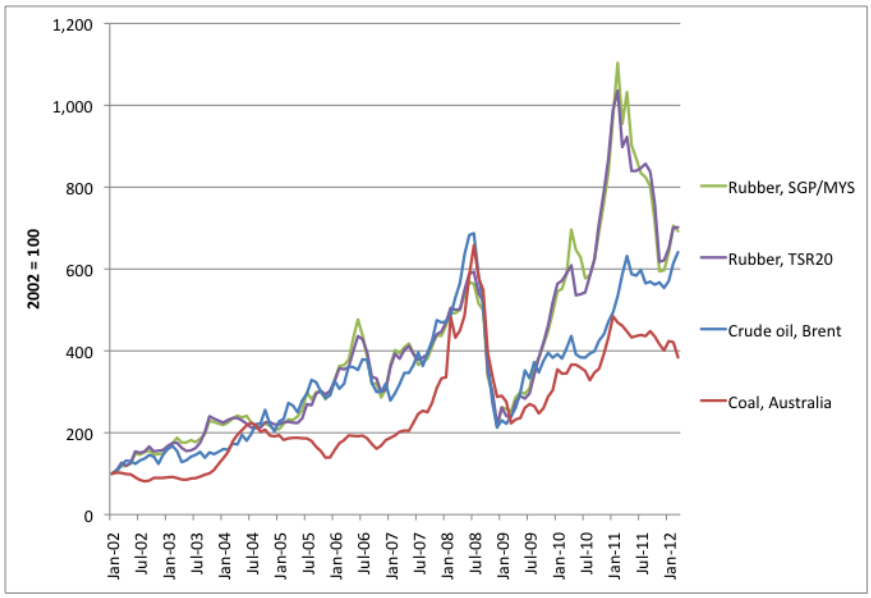
Figure 9
Car and Light Truck Production, 2002-2011[29]



The number of tires produced in China increased from 163 million in 2002 to 832 million in 2011, according to the National Bureau of Statistics of China. At the same time domestic natural rubber production remained relatively flat and able to satisfy only a fraction of domestic natural rubber demand. As Chinese demand for NR hit international markets, international rubber prices experienced an 11-fold increase from 2002 to their peak in early 2011, with a notable price drop in 2008 as the financial crisis decimated world economic growth (see Figure 10). As China's automobile and tire production slowed down in 2011, NR prices have also receded from their highs in early 2011.

[29] Source: International Organization of Motor Vehicle Manufacturers (OICA)

Figure 10
Raw Materials Price Indices, 2002 = 100[30]



As shown in Figure 10, strong demand for tire manufacturing inputs led dramatic price increases of key inputs. The natural rubber price reached unprecedented highs in 2011 due to supply disruptions in Southeast Asia, which accounts for 90 percent of global natural rubber production. At the same time, tire price increases have been limited since several domestic and foreign tire manufacturers compete in China and internationally.[31] For example, in early 2010, natural rubber prices in China had more than doubled from a year earlier, but tire companies raised prices by only around 5 - 10 percent.[32] A similar situation occurred in 2011. The resulting margin compression led to many public complaints by tire manufacturers, and the China Rubber Industry Association (CRIA) organized industry meetings on the issue of high rubber prices. High rubber prices also drove some manufacturers to use excessive amounts of waste tire rubber in their tires (i.e. above 5 - 7 percent by weight).[33] U.S. manufacturers that use rubber powder usually keep the amounts around 1 percent.

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[30] Source: World Bank Commodity Price Data.

[31] Among the Top 100 Chinese Rubber Companies in 2011, according to CRIA, 18 companies were Chinese tire manufacturers with combined revenues of around $283 billion.

[32] Source: China Daily, 4/1/2010

[33] For example, on March 15, 2011, China Central Television (CCTV), China's national TV station, exposed that Kumho, a South Korean tire manufacturer in China, had used "excessive amounts" of waste tire rubber at its Tianjin plant, thereby jeopardizing the structural integrity of the tires. Kumho has four plants in China and had a market share of approximately 20 percent. Considering the pressures leading to the overuse of waste tire rubber, Kumho is unlikely to be the only manufacturer in China to have done so.

Demand Drivers for Exports to Other Asian Countries

Exports to the remaining countries of Asia (i.e., excluding China, Hong Kong, and Vietnam) consist almost exclusively of shredded tires that are used for electricity and heat generation in the power and industrial sectors.

Of these remaining countries in Asia, Japan and Korea are the most significant destinations of U.S. waste tire exports, receiving a combined 8,466 mt in 2011. Other countries that received more than 1,000 mt in 2011 include India, Indonesia, Sri Lanka, and Taiwan.

While data on the use of imported waste tires and TDF in Japan and Korea is not available, research and conversations with representatives from the Japan Automobile Tyre Manufacturers Association (JATMA) and the Korea Tire Manufacturers Association (KOTMA) indicate that virtually all of the imports are for energy utilization. Data on the use of domestically generated waste tires indicate that the pulp and paper industry is the leading consumer of TDF in Japan and that the cement industries are key consumers in both countries (see Table 4).

Table 4
Heat Utilization of Domestic Waste Tires, Japan & Korea, 2011 (Thousands mt)[34]

Heat Use	Japan	Korea
Cement Calcining	95.0	99.2
TDF	500.0	66.8
Paper Manufacturing	388.0	
Gasification Furnace	49.0	
Steel Manufacturing	30.0	
Chemical Factories	9.0	
Tire Manufacturing	23.0	
Metal Refining	1.0	
Boilers	8.0	1.5
Total	**603.0**	**167.5**

Waste Tire Exports to Other Nations

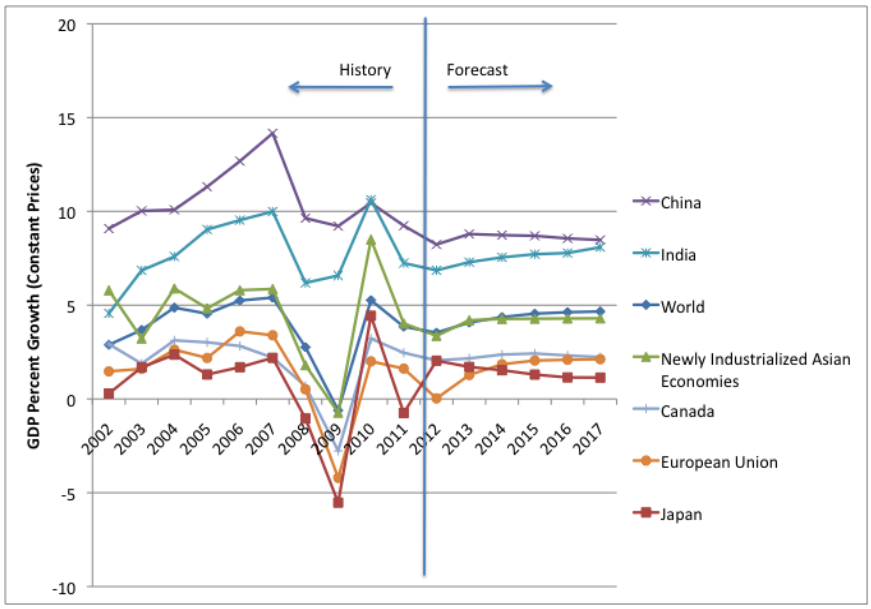
In addition to Asia, waste tires are reportedly being shipped to several other global regions, including Pakistan, India, South America and Africa. As with Asia, the primary use is apparently for fuel in industrial boilers and is tied to the cost of coal. In addition, relatively small amounts of waste tires are exported to Canada and Mexico, and small amounts of material, presumably crumb rubber, are exported to Europe.

[34] Sources: JATMA and KOTMA.

Global Demand Outlook

Overall, global demand for U.S. waste tires and TDF for heat utilization is expected to track economic growth and coal prices, primarily in Asia. In its latest forecast, the International Monetary Fund (IMF) forecasts that China will grow at rates between 8.2 percent and 8.8 percent over the next five years, which is faster the Newly Industrialized Asian Economies[35] at around 4.3 percent annually (see Figure 11). Chinese electricity production is projected to remain at growth rates above economic growth. The China Electricity Council estimates that electricity production will increase by an average of 9.5 percent per year over the next few years.

Figure 11
IMF World Economic Outlook GFP Growth forecasts, 2012 - 2017[36]



Raw material commodity prices are expected to decline from their recent highs in 2012 due to a slowdown in demand and generally improved supply prospects as high prices have driven investment in capacity expansion.[37] Nevertheless, commodity prices are still expected to remain elevated compared to the early parts of last decade, barring a catastrophic outcome of the European debt crisis (see Figure 12). The World Bank's (WB) most recent commodity price forecast projects that Australian coal prices will decline gradually over the next five years, but still remain above $90/mt, as continued growth in Asian power generation demand sustains thermal coal prices. At such levels, coal prices will support sustained demand for whole and

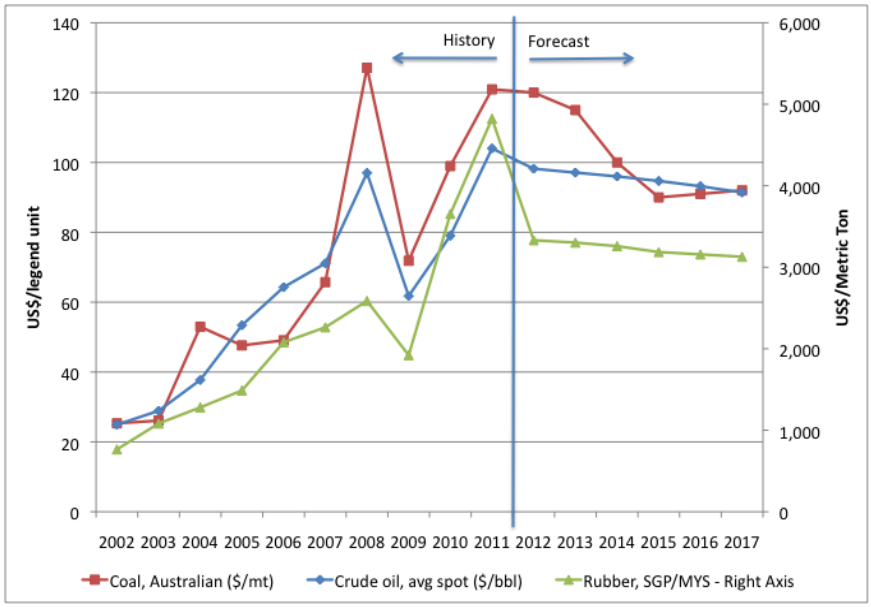
[35] Newly Industrialized Asian Economies include Hong Kong SAR, Korea, Singapore, and Taiwan Province of China

[36] Source: IMF World Economic Outlook, April 2012. Database code: NGDP_RPCH

[37] Source: World Bank Global Economic Prospects, January 2012

shredded tires to be used for fuel power and heat generation. Rubber prices are expected to decline approximately 30 percent in 2012 along with declining prices for energy and fertilizer. However, first quarter rubber prices indicate that the decline may be closer to 15 - 20 percent for 2012. Nevertheless, rubber prices are still projected to remain above the levels experienced when the boom in rubber powder exports started in 2006/2007, indicating that Chinese demand for fine rubber powder will continue to grow along with automobile and tire production.

Figure 12
World Bank Commodity Price Forecasts, 2012-2017 (Current Dollars)[38]



There are a number of factors tempering the demand outlook for U.S. waste tire exports, particularly in China.

The Chinese government's prohibition of whole and shredded waste tire imports has decreased the ability of foreign waste tires to reach China, though trans-shipment through Vietnam has become a booming business. Moreover, while Chinese demand for waste tires is expected to increase along with economic growth or possibly faster, overall domestic Chinese demand for **imported** waste tires is likely to be tempered by increasing availability of domestically generated waste tires and waste tire products as China develops its tire industry and its waste tire recycling programs.

China is aggressively developing its domestic waste tire and rubber industry. Government regulations have been implemented to move Chinese production to 100 percent radial tires by 2015, which will facilitate retreading and raise the retreading rate from the currently dismal 5 percent. Moreover, China generates around 230 – 250 million waste tires annually, a number that is expected to grow as car production and sales increase. Under the pressure of these domestic waste tire flows, China is promoting the development of its domestic scrap collection and

[38] Source: WB Commodity Price Forecast, 2012/01/17 (Current Dollars)

recycling systems through regulations and taxes under the general drive towards a more sustainable economy, an aggressive, federally sponsored version of California's recycling market development policies.

Additional factors that could potentially impact global demand for California waste tires include:

- As waste tires are increasingly sourced from a variety of states and countries, demand for California tires may be diluted. However, California's vibrant ports and relative proximity to Asia will continue to make California an attractive source and export route;
- As Chinese scrap tire generation and its collection and processing infrastructure mature, it may reduce demand for imported waste tires;
- A substantial slide in industrial production could temper demand across industries using tires as fuel;
- A global war or disturbance could disrupt the availability of cargo containers, complicating exports; and/or
- A disruption in currently highly favorable shipping terms from California to Asia (due to the need for back haul of cargo containers) could diminish the strong economics currently driving California exports.

While not currently linked to California waste tire management, Chinese demand for U.S. rubber powder is likely to remain relatively strong, as both vehicle and tire manufacturing are expected to grow by an average of 5-10 percent per year over at least the next five years. This potentially provides an opportunity to help develop California production capacity for fine rubber powder made from tires. However, according to CRIA, China is developing the ability to produce the highly engineered rubber powders used for tire manufacturing, which ultimately may replace at least part of U.S. supply.

The demand for rubber powder is closely linked to the development of China's automobile industry. The growth of China's automobile industry is a hotly debated issue. The Development Research Center (DRC) of the State Council, a government and industry supported entity estimates annual vehicle sales of 50 million by 2021, up from 18.4 million in 2011. This would imply annual growth of more than 10 percent for the next 10 years. However, growth is likely to be limited by additional factors such as "the rising price of gasoline, urban restrictions on vehicle registrations, controlled demand of official fleets, and the possibilities of traffic congestion surcharges on vehicles in downtown areas of large metropolises"[39]. Moreover, growth in vehicle production stalled in 2011 and is likely to remain relatively flat in 2012 due to the elimination of government incentives to purchase cars and slightly lower economic growth. DRC estimates are also likely to be high because it ignores the underdeveloped used vehicle market in China. More conservative estimate puts the vehicle market at around 30 million by 2021, which still implies an annual growth rate of around 5 percent.

Demand for rubber powder as an industrial raw material is also likely to be dampened by further development of China's recycling industry. In 2010, the Deputy Secretary-General of CRIA, Mr.

[39] Source: http://www.chinaautoreview.com/pub/CARArticle.aspx?ID=7292

Xu Wenying indicated in a meeting in Brussels that China had more than 300 producers that specialize in the production of rubber powder and that annual rubber powder production capacity was around 5 million mt. Over the next five years, an increasing share of these producers is likely to implement the technology required to produce the high quality rubber powder utilized in tire manufacturing.

Potential Approaches to Address Export Issues

There has been much discussion about what can and should "be done" about growing waste tire exports. Established processors and some other stakeholders are very concerned that the trends described above could place the waste tire management infrastructure that California has nurtured for more than two decades in jeopardy. Baler/exporters have argued that they are providing a valuable service and meeting an economic need, while helping to divert more tires from disposal and offering reduced disposal costs to waste tire generators. While the exportation of tires, as with any commodity, is legal, CalRecycle is faced with ensuring the storage and handling of the used and waste tires in baling and exporting operations located within California complies with California's laws. Following is a synopsis of approaches, along with some pertinent considerations.

Strengthen Permitting and Enforcement

Several established processors have been very vocal in expressing their concerns to CalRecycle about growing exports, emphasizing that the agency should step up compliance monitoring and enforcement activities – in short, to immediately shut down baler/exporters that do not have a valid permit.[40] CalRecycle has discussed these concerns in a number of monthly public meetings and workshops, issued bulletins explaining legal requirements regarding baled waste tires to all tire businesses and a zero tolerance bulletin to waste tire haulers regarding hauling to unpermitted facilities, and has increased the number of enforcement actions, while emphasizing that it is obligated to provide due process afforded to all tire businesses under the Constitution. In an effort to speed up enforcement, CalRecycle initiated a streamlined penalty process for haulers whereby the hauler stipulates the he or she violated the law and pays a reduced penalty amount rather than contesting the violations at a hearing where CalRecycle will ask the administrative law judge to assess the full penalty amount authorized by statute and regulations. In late 2011 and early 2012, 27 haulers received streamlined penalties of $500 for delivering waste tires to unpermitted facilities and about the same number were penalized for issues related to manifest documentation. CalRecycle issued 12 Clean-up and Abatement Orders (CAOs) to waste tire facilities that exceeded their allowed waste tire limits; some of these included baling operations. The CAOs were issued after the unpermitted site or waste tire facility failed to comply with a previously issued violation. Then, if the operator fails to comply with the CAO, CalRecycle will serve an Administrative Complaint for penalties. The operator may request a hearing before an administrative law judge to make a determination of the penalty amount based on the facts set forth in the Administrative Complaint. CalRecycle issued one Administrative Complaint in early 2012 and several more Administrative Complaints are being prepared. Three baler/exporters applied for a minor or major waste tire facility permit in late 2011 and early 2012. Of these, one has been denied, and is scheduled for an administrative hearing take will occur in six months.

[40] Because more than 500 tires are needed to fill one export container, all baling facilities require at a minimum at least a minor waste tire permit.

CalRecycle's permitting and enforcement staff indicates they are taking the issue very seriously, and are considering a range of additional options to step up compliance monitoring and enforcement. In March 2012 CalRecycle conducted a workshop to discuss a number of concepts under consideration that would significantly step-up permitting and enforcement activity. These included 13 potential adjustments in business practices, such as allowing CalRecycle to move more quickly in substantively responding to non-compliant facilities and permit requests, publicizing facilities issued CAOs and Administrative Complaints, limiting consideration of extenuating circumstances when responding to non-compliance issues, restricting non-compliant sites from accepting more tires under certain conditions, and expanding relationships with County District Attorneys statewide. Six of the concepts have been implemented and another five will be implemented before the end of the year. In addition, nine concepts that would require legislation to enact were discussed, but not acted on as legislators are responsible for changes to legislation. These included, for example, changing requirements to allow CalRecycle to hold its own hearings rather than requesting a hearing before an administrative law judge and removing the requirement that an operator fail to comply with a CAO before CalRecycle can request the Attorney General to issue an injunction.

CalRecycle will initiate a formal regulatory revision process for waste tire facility enforcement, storage, disposal and permitting in late spring. And, a recently proposed bill in the legislature (AB 1647, Gordon) was passed out of the Assembly Natural Resources Committee on April 23 and will now head to Fiscal committee. As of May 2, the bill would make changes to statute intended to authorize CalRecycle to hold its own hearings rather than requesting a hearing before an administrative law judge and move more quickly and decisively in taking enforcement action to stop the flow of waste tires through non-compliant facilities exceeding waste tire storage or other regulations.

Implement Incentives to Restrict Waste Tire Exports

CalRecycle released a draft report in April of 2012 evaluating the pros and cons of establishing an incentive payment program under the waste tire management program, or instituting extended producer responsibility (EPR). Although there are many potential variants, the incentive concept would make monetary payments on a per-ton basis to California firms processing waste tires into crumb rubber or tire-derived aggregate that is then sold to qualifying end-users, and/or provide payments to tire-derived product manufacturers, product installers and/or civil engineering contractors that use California tire rubber materials. The payment system alone could provide an incentive for firms to use California tires within the state, helping them to compete with export markets. The system could also help mitigate lost tip fee revenues experienced by processors as export market growth has reduced tip fees. A somewhat related bill focused on electronic waste (E-waste) is currently being considered in the legislature (AB 960, Lowenthal). As currently written, this bill would require E-waste recyclers operating under the California Electronic Waste Recycling Program (and receiving per-pound payments for the amount of material handled under the program) to conform their export practices to established standards intended to ensure environmentally sound practices, as a condition of receiving existing recycling payments under the program. While a distinct policy, if adopted EPR could potentially include an incentive payment system, and/or enabling legislation could potentially include restrictions on waste tire exports.

Seek Federal or State Legislation Requiring Notification of Waste Tire Exports

The federal government conceivably could impose requirements on waste tire exporters, perhaps similar to a recent proposal by the U.S. EPA that would require any company exporting cathode ray tubes to give the agency notice of the shipment. Under the proposal, exporters shipping covered products for recycling would be required to notify the EPA at least 60 days before shipping the material. (Cathode ray tubes are used in televisions and computer monitors. Although being rapidly replaced by flat screen technologies, there are still large quantities entering recycling and disposal streams.) The notification must include contact information about the exporter, the recycler and an alternate recycler as well a description of the manner in which the cathode ray tubes will be recycled, means of transport, total quantity of cathode ray tubes and information about transit countries the items will pass through. The importing country could refuse the shipment and the EPA would inform the exporter in writing.

While this proposal focuses on one specific type of E-waste, it is being implemented under authorization of the federal Resource Conservation and Recovery Act (RCRA). In principle this authority would likely extend to waste tires. While the rule would not ban exports, it would require a new step providing government agencies with far more information that could be useful in potentially regulating or at least monitoring shipments, trends and especially management practices in other countries. The rule was published in the Federal Register, 15336, Volume 77, No. 51 on March 15, 2012. (Available online at: http://www.gpo.gov/fdsys/pkg/FR-2012-03-15/pdf/2012-6276.pdf.) It may be possible that the California legislature could consider similar legislation, but analysis of the legal and regulatory implications of such an action is beyond the scope of this report.

Seek Federal Action to Impose Tariffs on Waste Tire Exports

In principle, the federal government could impose export tariffs on waste tires. Currently, there are a number of tariffs imposed on imported rubber products, including tariffs of 20 percent on several varieties of synthetic rubber. Although there is an established category of "waste parings and scrap rubber (other than hard rubber) and powders and granules obtained there from," there is no import or export tariff imposed.[41] Imposing tariffs is highly political and may not be viable for a product that represents a relatively small portion of overall exports.

Seek to Ban or Constrain Waste Tire Exports to Certain Nations under the Basel Convention

While it does not appear to be a viable option, SAIC investigated the potential to leverage international agreements to address waste tire exports. The pertinent agreement is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention), an international treaty designed to reduce shipments of hazardous waste between nations, with a focus on preventing transfer of hazardous waste from developed to less developed countries.

The Basel Convention does not appear to provide any viable options for a state agency to pursue in relation to curtailing waste tire exports. While the U.S. is not a signatory to the treaty, it has

[41] This waste category is coded 4004 and is the same category used to track exports of waste tires and associated products, as described above.

been ratified by 175 signatory nations, including Canada, China, Japan and most European nations. According to the Director of the Basel Action Network (BAN), however, tires are considered under the treaty to be a non-hazardous product if shipped for recycling purposes, but a hazardous waste if combusted without energy recovery. Also according to BAN, countries may designate any product or material to be hazardous waste, and that will trigger the importation restrictions under the treaty to come into effect. European nations, which are parties to the Basel Convention, have proactively contacted non-OECD nations to request clarification on which products and materials should be considered hazardous, and they impose these restrictions on exports from their ports. BAN and other non-governmental organizations have leveraged the Basel Convention in the U.S. to raise awareness about concerns about hazardous waste shipments, especially shipments of E-waste to China which reportedly sometimes follow the same path through Vietnam as waste tires sometimes do.

Encourage Voluntary Programs to Certify and Encourage Environmentally and Socially Sound Export Uses

Two voluntary certification programs for E-waste processors have been developed that could serve as models for a similar tire recycling program. They both offer U.S. E-waste processors the opportunity to receive certification based on documented compliance with standards for E-waste handling and exporting practices. The documentation is provided by a qualified, independent organization. The standards vary between the two programs, but include consideration of the type of end use and environmental standards for facilities receiving materials in other countries, and avoidance of exports to nations where prohibited by law.

The Responsible Recycling Certified Electronics Recycler Program (R2) is operated by a stand-alone non-profit organization (R2 Solutions), and has been endorsed by the Institute of Scrap Recycling Industries, among other organizations. According to their web site, the R2 Standard sets forth requirements relating to environmental, health, safety, and security aspects of electronics recycling. R2 also requires E-waste recyclers to assure that more toxic material streams are managed safely and responsibly by downstream vendors-all the way to final disposition. It also prohibits E-waste recyclers and their downstream vendors from exporting these more toxic materials to countries that have enacted laws making their import illegal. Eighteen of 186 certified recyclers in the program are based in California.

The e-Stewards program is operated by the Basel Action Network. According to their web site, e-Stewards Certification is open to electronics recyclers, refurbishers and processors in all developed countries. Certified e-Stewards recyclers adhere to the *e-Stewards Standard for Responsible Recycling and Reuse of Electronic Equipment*, which includes (among other items): consideration of ISO 14001 environmental management system practices and the R2 practices covered by the program described above; full compliance with existing international hazardous waste treaties for exports and imports of electronics, and specifically prohibits the export of hazardous waste from developed to developing countries; and extensive protections for and monitoring of recycling workers in every country, including developed nations where toxic exposures may routinely taking place. Five of 31 certified e-Steward facilities are located in California, and an additional eight California facilities have contracted with third parties to become certified.

According to CalRecycle's E-waste program manager, there have been some concerns raised about the ability of sponsoring organizations to consistently validate and enforce the certification

standards. However, the certification standards have been used in Requests for Proposals and included in contracting terms between generators or local agencies and the recycling firms in several instances.

Accept that Exports May Play a Significant Role in California's Waste Tire Management System Over the Long-Term, and Plan Accordingly

While it is difficult to predict if and when waste tire export growth will stabilize, and at what level of volume, it appears likely that waste tire exports will play a significant role in California's waste tire management system for years to come. To be sure, there is uncertainty about how trends will play out. Export markets for other recycled materials like plastic, steel and paper are notoriously unstable, and there is the potential for abrupt shifts in demand, pricing, shipping costs, delivery terms and cargo container availability. Also, as the global waste tire market evolves, tires are being sourced from an increasing number of nations, which could potentially dilute demand in California. However, the drivers for international waste tire demand appear very strong, and the export expansion trend appears to be continuing at an increased pace in the first half of 2012.

The approaches discussed above to address the export trend involve ensuring that exporters comply with all laws and regulations, the potential implementation of incentives to promote in-state waste tire management, and/or incentives to ensure that tires which are exported are managed in a sound manner. Short of an outright ban at the federal level, none of the options would seem likely to substantially reduce or eliminate waste tire exports.

Given this backdrop, it seems prudent to begin to plan for a restructured waste tire market that includes a significant role, at as yet undetermined levels, for waste tire exports. Following are some considerations relevant to future planning:

- Export volumes may always be subject to abrupt and unexpected shifts up or down. It is currently difficult to predict when or at what level waste tire exports from California will peak. Unlike other market segments, tracking trends and drivers for export demand is far more challenging, and it may be impossible to anticipate trends in advance.

- Current concerns about lack of compliance among baler/exporters may be reduced as enforcement practices and policies are adapted. Although complying with waste tire facility and other laws and regulations will increase current costs, the economics of export currently would appear to still be highly favorable.

- It is possible that established processors may steadily increase export volumes over time. Currently, many are heavily invested in land, buildings and equipment predicated on other markets, which complicates a shift to a streamlined, low-cost baler/exporter model. However, over time, if export remains an attractive market, a shift may occur. As noted above, five of fifteen established processors analyzed in this report that serve a variety of markets are already exporting shredded and chipped tires, some at a substantial level.

- The market impacts of crumb producers potentially shifting their practices to take advantage of export markets is difficult to predict. It may prove difficult or impossible for a single firm to sustain both investment-heavy crumb production and low-investment exports, potentially resulting in a decline in crumb production capacity as discussed above. On the other hand, if viable business models can be developed, there may be potential for exports to serve as a

market of last resort and/or to augment revenues from crumb production, potentially strengthening California's crumb production infrastructure over the long-term.

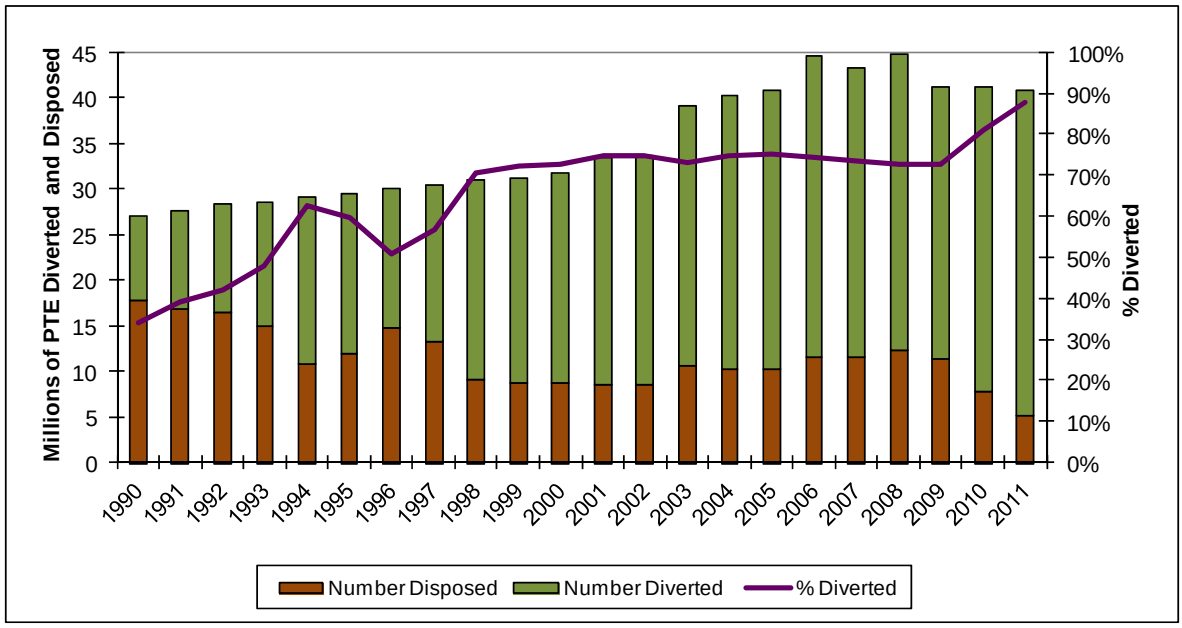
Section 5
Outlook for Increasing Waste Tire Diversion

This section analyzes the outlook for increasing waste tire diversion in California, starting with a look at historical trends. Next, the short-term diversion outlook over the next two years is described. This is followed by a broad look at opportunities for expansion and barriers in each market segment. The section and the report finish with brief concluding remarks. .

Historical Waste Tire Diversion Trends

CalRecycle has adopted a goal of increasing the diversion rate to 90 percent by 2015. As shown in Figure 13, California waste tire diversion steadily increased from about 31 percent in 1990 to about 75 percent in 2001, and then hovered between 72 and 75 percent throughout the 2000s. In 2010 the diversion rate jumped to more than 80 percent and in 2011 diversion jumped again to nearly 88 percent, with the amount of tires landfilled declining by 36 percent from 2010 levels to an all-time low. In both 2010 and 2011 the increase in diversion was largely due to the rising waste tire exports and not the result of CalRecycle efforts or the growth of domestic tire-derived product markets.

Figure 13
Waste Tire Diversion and Disposal Trends



Short-Term Diversion Outlook

Given sustained export increases and generally stable to growing domestic recycling markets, it appears likely that CalRecycle will achieve its 90 percent diversion goal in 2012. However, CalRecycle is currently focused on increasing diversion through ground rubber and civil engineering, and these segments are currently diverting only 21.6 percent and 1.4 percent,

respectively. If waste tire export (but not used tire export), ADC and TDF were excluded, the 2011 diversion rate would be only 44.4 percent.

Table 5 summarizes expected short term diversion trends, based on specific activities and trends anticipated over the next two years, as identified by facility operators and other stakeholders. The analysis indicates that there is a good chance for several market sectors to achieve growth in 2012, with overall diversion expected to increase slightly to moderately, mainly depending on the extent of export growth. Growth in several markets is largely dependent upon improvement in the general economy.

Table 5
Short-Term (Two Year) Diversion Outlook

Category	2011 Diversion		Two-Year Diversion Outlook	Basis for Outlook
	Million PTE	Percent		
Reuse	6.9	16.9%	Flat to Slight Increase	▪ The number of used passenger vehicle tires that are suitable for reuse is limited and may be approaching its upper limit ▪ As the economy recovers, more goods will be shipped by truck, increasing demand for truck tires ▪ Many retreaders indicate they expect increases in 2012
Ground Rubber	8.8	21.6%	Uncertain	▪ RAC is increasingly accepted by local governments and Caltrans; however, paving is limited budget constraints and the slow economy. ▪ One Caltrans district has reportedly shifted away from RAC use. ▪ Crumb producers continue to be squeezed by supply side by competition with exporters and reduced tip fee revenue, and on the demand side by increased competition with out-of-state producers that are reportedly reducing sales and selling prices Some crumb producers and manufacturers said they expect business to increase slightly in 2012.
Civil Engineering	0.6	1.4%	Growth Expected	▪ Transportation (rail) projects scheduled for 2012 and 2013 will result in large increases of TDA for that segment. ▪ Landfill TDA use is expected to remain flat or show a modest increase. ▪ Expanding CalRecycle focus and support through technical assistance and grants.

Category	2011 Diversion		Two-Year Diversion Outlook	Basis for Outlook
	Million PTE	Percent		
ADC	2.0	4.8%	Flat or Declining	▪ ADC is a preferred use for waste tires at landfills with on-site shredding capability. ▪ Additional civil engineering and export demand may divert tires from this low-value use. ▪ Some landfills say TDA is challenging to use as ADC. ▪ High transportation costs inhibit ADC use unless processing is nearby, on site, or backhauls can be used.
Other Recycling	0.1	0.2%	Flat	▪ No significant changes expected.
TDF	6.2	15,2%	Flat to Slight Increase	▪ Cement kilns say demand is expected to increase as cement production increases with an improving economy. ▪ Export demand for tires may continue to compete with cement kilns for tires, reducing the economic attractiveness of TDF. ▪ Cogeneration demand is expected to decline to zero in 2012 as the last facility using TDF closed in 2012.
Export	11.3	27.7%	Continuing Growth	▪ Strong demand and favorable economics continue to drive steady growth in exports to Asia and other global regions.
Total Diversion	35.8	87.8%	Modest to Moderate Increase	▪ Expected increases in exports, retreads and TDA should lead to an overall diversion rate increase, most likely exceeding CalRecycle's 90 percent goal.

Long-Term Opportunities to Expand Diversion

The market size and penetration estimates in Table 6 broadly describe the long-term opportunities to expand waste tire diversion. The theoretical market size figures are rough estimates that were developed in 2008. The market size estimates for used tires have been increased somewhat, and now combine both exported and domestic used tire sales. No specific maximum market size for exports is provided. However, global waste tire market demand far exceeds California generation, as described in Section 4.

Table 6
Estimated Market Size, 2011 Penetration, and Potential Penetration by 2015[42]

Category	Estimated Theoretical Market Size (Million PTEs)		2011 Marketed (Million PTEs)	2011 Penetration (%)	
	Low	High		Low	High
Ground Rubber	**44.0**	**61.7**	**8.6**	**14**	**20**
Rubberized Asphalt Concrete (RAC)	*25*	*35*	*4.9*	*14*	*20*
Turf and Athletic Fields	*4.0*	*5.0*	*1.7*	*34*	*43*
Loose-fill Playground/Bark/Mulch	*4.5*	*7.5*	*1.1*	*15*	*25*
Pour-in-place Playground	*5.0*	*7.0*	*0.1*	*1*	*2*
Molded and Extruded	*4.0*	*5.0*	*0.9*	*18*	*23*
Other Ground Rubber	*1.5*	*2.2*	*0.1*	*5*	*7*
Alternative Daily Cover (ADC)	**35**	**40**	**2.0**	**5**	**6**
Civil Engineering	**17.1**	**24.7**	**0.6**	**3**	**4**
Non-Landfill Use	*14.1*	*20.7*	*0.0*	*0*	*0*
Landfill Use[1, 2]	*3.0*	*4.0*	*0.6*	*15*	*20*
Tire-Derived Fuels (TDF)	**15**	**20**	**6.2**	**31**	**43**
Exported Waste Tires	**50+**	**NA**	**NA**	**NA**	**NA**
Used Tires (Combines Exported and Domestic Use)	**4.6**	**5.0**	**4.6**	**92**	**100**
Retreading	**4.8**	**5.2**	**4.1**	**79**	**86**
Other Uses (Incl. Agriculture)	**1**	**2**	**0.1**	**5**	**10**
Total	**128**	**168**	**35.8**	**21**	**28**

[1] Estimated market size derived from Kennec estimates.

[2] Landfill uses market size estimate is for landfill gas and leachate recirculation applications only. The 2008 estimate should not be used as a benchmark to evaluate future effort as it was necessarily based on reported use that in some cases could not be validated by CalRecycle and may not comprise CalRecycle defined civil engineering uses. Regardless of the uncertainty, SAIC, Kennec, and CalRecycle agree that market penetration for landfill use is relatively low and that there is potential for more TDA to go to landfill gas applications. Landfill applications also include use of significant potential quantities of TDA in operational layers; however, this use is not listed separately because of significant regulatory and supply barriers. Despite the barriers, CalRecycle should be open to opportunities to expand such uses and this potential contributes to listing landfill TDA as a priority market segment.

[42] Supporting documentation for this table is provided in the 2008 report, *Waste Tire Market Development Program Evaluation, Working Paper #1: Market Penetration Report*, available on the CalRecycle Web Site. The 2008 market size estimates were updated for used tires (combining exported and domestic used tires). No specific maximum size for the export market is provided. Global waste tire demand far exceeds California generation.

As Table 6 shows, theoretically the greatest opportunity for market expansion in broad terms is in ground rubber markets, especially RAC and turf. However, the relatively small molded and extruded segment is a high value market with potential that could exceed the maximum market size, if technologies and business models are adapted to use crumb rubber in a growing number of consumer products. Ground rubber markets, in aggregate, have the largest market size potential of between 44 and 61.7 million PTE per year.

Within civil engineering, non-landfill has applications have the greatest potential to divert more tires, with an estimated capacity of 14.1 to 20.7 million waste tires annually, vs. 3 to 4 million PTE through landfill civil engineering uses. The TDF market reached a 31 to 41 percent market penetration rate in 2011. It has the potential to consume an estimated 8.8 to 13.8 million PTE annually; however, CalRecycle is statutorily prohibited from funding projects promoting this as an end use. It is expected that the consumption of TDF among the four cement kilns using waste tires/tire chips as a fuel source will increase in 2012, commensurate with economic recovery.

In 2011 it is estimated that the alternative daily cover market reached a market penetration rate of 5.0 to 5.7 percent, with an opportunity to potentially consume an additional 33 to 38 million PTE over 2011 levels. However, ADC is a low-value market which can be mutually beneficial to landfills and processors, but is considered by most to be a market of last resort, before landfilling.

Retreading has some room for growth, and many retreaders said they expected modest growth in 2012. Used tires appear to be at or near maximum size after a jump in 2012. Other uses for waste tires reached an estimated market penetration rate of 5 to 10 percent in 2011, with small potential for additional growth, estimated here at an additional 0.9 to 1.9 million PTE annually.

Barriers to Expanding Diversion

While there is opportunity to expand market penetration for the various market categories and segments, there are also important barriers to doing so. Table 7 summarizes some key barriers to growth, identifying them as either financial, policy, technical, research/informational or outreach/educational in order to indicate the types of activities that could potentially overcome them.

Table 7
Barriers to Expanding Market Penetration for Waste Tire Market Segments

Market Category/Sub-Categories	Barriers
Ground Rubber	
• All Ground Rubber	**Economic** – Crumb rubber producers are seeing reduced tip fee revenues and increased competition for tire supplies due to expanding exports, and reduced revenue and increased competition for product sales due to incentivized producers outside of California and a North American oversupply of crumb rubber.

Market Category/Sub-Categories	Barriers
• RAC and Other Paving	**Financial** – Specialized heating and blending equipment is needed by batch plants and chip seal contractors to use RAC, limiting use to larger project sizes and contractors with the required equipment. **Policy** – Caltrans is not required to use crumb from California in RAC. At least one Caltrans district has reportedly moved away from RAC to polymer paving materials. **Educational/Institutional** – Local governments are not exposed to the product or are loyal to their current suppliers and techniques. **Economic** – Some report that there is a shortage of waste truck tires, which is a preferred feedstock for crumb used in RAC.
• RAC and Other Paving • Turf and Athletic Fields • Pour-in-Place Playground • Mulch/Bark	**Economic** – The economic downturn has impacted local governments' budgets, delaying projects. Moreover, stimulus money that had funded some projects is now exhausted. This may also put RAC at a disadvantage when compared to traditional paving products, due to its higher up-front costs, despite the fact that long-term costs are generally lower.
• Turf and Athletic Fields • Loose-Fill Playground • Pour-in-Place Playground • Mulch/Bark • Molded and Extruded • Other	**Technical** – Lack of industry standards and specifications, testing protocols, and accessibility of testing equipment complicates quality control/quality assurance efforts, especially for molded-extruded products and rubber-plastic compounds.
• Turf and Athletic Fields • Loose-Fill Playground • Pour-in-Place Playground • Mulch/Bark	**Financial/Research** – High up-front costs are more than for alternative non-tire products; long-term product performance and life cycle costs have not been documented by independent agencies. This can make it difficult for consumers to justify the cost of installing such products over "traditional" products.
• Molded and Extruded	**Technical** – Inherent limitations of the material limit its usability as a feedstock. **Technical** – Lack of superfine crumb processing within California that is required to manufacture some products. **Economic** – Competition with lower-priced imported products can make it difficult to compete in the marketplace. **Financial** – Inconsistent financial benefit to feedstock conversion, as benefits depend upon price fluctuations of other materials, e.g., oil, etc.; processors have not invested in production capacity for ultra fine rubber due to unproven demand
• Molded and Extruded • Mulch • Turf and Athletic Fields • Other	**Economic** – Trucking transportation costs heading east are relatively costly (economic transportation is available, however heading back to California from produce delivery backhauls). This makes it challenging to sell products or tire-derived material cost effectively in neighboring states.

Market Category/Sub-Categories	Barriers
Alternative Daily Cover	
	Financial/Policy– Other ADC materials are readily available but tire ADC needs to be trucked in at a cost, unless a processor happens to be co-located at a landfill, and used in greater amounts than alternatives; requires prior CalRecycle and local Enforcement Agency approval and modification of landfill operating permit. **Technical** – ADC can be problematic to use – it often needs to be mixed with other material, like dirt, to flow properly, and takes up additional space in the landfill.
Civil Engineering	
• Transportation-Related Applications	**Financial/Policy –** At this point in time individual project sizes are relatively large and irregular in timing, and as a result are disruptive to their routine business operations, so that processors are hesitant to enter marketplace as a supplier or invest in equipment to produce Type A and B TDA. Regulatory issues related to storage of tires for large jobs are also a barrier. Cost of transporting TDA long distances also reduces its competitiveness with conventional aggregate, especially when local supplies are adequate.
Other Recycling	
• Emerging Fuel/Energy Technologies	**Research/Technical** – Technologies such as devulcanization, pyrolysis, gasification and others remain commercially unproven.
	Policy – Unresolved regulatory issues related to permitting of emerging fuel/energy technologies.
	Outreach/Financial – Lack of information about emerging fuel/energy technologies makes them difficult to implement/fund.
Export	
	Educational – Lack of information/knowledge regarding export regulations and how to export, especially when broker not used.
Cross Category	

Market Category/Sub-Categories	Barriers
• All	**Economic –** A sustained weak economy has made consumers, particularly local governments, hesitant or unable to complete projects/purchase goods, weakening demand for many tire-derived products and materials. **Economic** – Tire processor and TDP product manufacturing businesses are at an economic disadvantage when competing against older, larger, and more established incumbent products and materials and low margins leave little funds for improving business capitalization or extensive marketing campaigns. Similarly, TDP producers often compete against low-cost imports. **Financial/Technical/Educational –** Some businesses lack expertise regarding how to market their products, streamline operations, and otherwise improve and expand their business. **Informational/Research/Outreach/Technical –** Some potential consumers of tire-derived products have concerns regarding the health, safety, and environmental impacts of tire-derived products and feedstocks. There is a lack of information/awareness regarding best management practices to mitigate potential impacts. Although, with CalRecycle's support studies have been completed regarding this issue relative to artificial turf and mulch, some businesses surveyed indicate that this is still an issue.
• RAC • Civil Engineering	**Financial** – There are a relatively small number of tire processors and they are concentrated in population centers where tires are generated. However, many project locations are in remote unpopulated areas where freight costs are a disincentive to using materials from tires, particularly considering current fuel costs. This is especially the case for TDA and RAC.
• RAC and Other Paving • Landfill Applications • Transportation-Related Applications	**Educational/Technical** – Local government specifiers and engineers are not familiar with advantages of products and how to design/specify projects.

Concluding Remarks

California's waste tire recycling industry continues to be highly dynamic, with processors and TDP manufacturers adapting to changing markets and infrastructure. Increasingly, California's market is subject to the influence of trends outside of the state. An apparent oversupply of crumb rubber throughout North America, combined with producers benefitting from incentive payment systems in U.S. states and Canadian provinces, is exerting downward pressure on crumb prices and making sales more challenging. In addition, growing export demand is causing shifts in collection and processing pricing, and triggering cash flow and supply challenges for some established processors. The ultimate extent and impacts of these trends has yet to play out. However, although state-targeted crumb and civil engineering uses comprised only 23 percent of California tires in 2011, the state continues to enjoy a very well developed infrastructure servicing highly diversified markets, with a very high diversion rate (albeit increasingly dependent upon exports as with many other recycled materials). In short, while some industry

elements are facing important threats and barriers, the industry as a whole has continued to show resiliency and adaptability.

CalRecycle continues to review and develop its waste tire market development program in a very open and transparent way, with many opportunities for stakeholder input and involvement. With the impending reduction in state tire fund revenue in January of 2015, state decision makers are taking a close look at the tire program. CalRecycle is sponsoring broad workshops and seeking stakeholder feedback on topics ranging from restructuring permitting and enforcement practices, to investigation of incentive payments and extended producer responsibility. Workshops on the next Five Year Tire Plan are scheduled to begin in fall 2012. Given this context, the need for industry stakeholder involvement has perhaps never been more critical.

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.

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 is allowed to 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 20 pound 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. In 2011 approximately 15 percent of waste tire flows to ports were estimated to not have been recorded and manifested (or recorded as legal weights when containers were loaded overweight). For the purposes of reporting in this study, the midpoint between documented export flows and estimated flows (some 15 percent higher) was used for purposes of tabulation and presentation in graphs.

- **Discrepancies between Inputs and Output**s **–** Manifest data provides data on inputs to facilities, while surveys provide data on outputs sent to market uses. 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. This study reports all data on the basis of incoming tire equivalents (i.e., whole tire inputs) associated with reported product sales and utilizes average yield factors for this conversion

unless a processor provides their specific yield factor (yields reflect the removal of tire wire, polyester "fluff," rims, and rubber loss from incoming waste tires).

- **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 tires managed as presented in Table 1 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 2007-2010 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.
- **Number of landfills analyzed—**WTMS data for 28 landfills was analyzed and attempts were made to survey a majority of those facilities. Ultimately, data from fourteen landfills were included in this report, including some that may not have been included in previous CalRecycle reports.