California Waste Tire Market Report: 2012

CalRecycle

California Department of Resources Recycling and Recovery

May 2013

Contractor's Report
Produced Under Contract By:

SAIC®

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Publication # DRRR-2013-1462

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Prepared as part of contract number DRR 10033 for $1.2 million, including other services.

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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) 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 approved by CalRecycle in March 2013 and is currently awaiting formal approval by Cal/EPA.

This report supports CalRecycle's efforts by providing information on the waste tire diversion rate, market trends, and supply/demand balance in 2012 based on research conducted from January 2013 through April 2013. 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. Finally, Section 4 analyzes the outlook for increased diversion, including opportunities and barriers.

Interpreting and Using Report Findings

Appendix A provides a detailed summary of the study methodology, data limitations, 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 limitations in the data 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. In this year's report, the level of uncertainty associated with waste tire exports is particularly high because of the rapid rise in flow to exporters and abrupt shift in practices late in 2012. However, we still believe the results are within the +/- 10 percent range.
- **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.

- **Estimates Are for Use of California-Generated Tires Not Total Market Size:** The 2012 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.

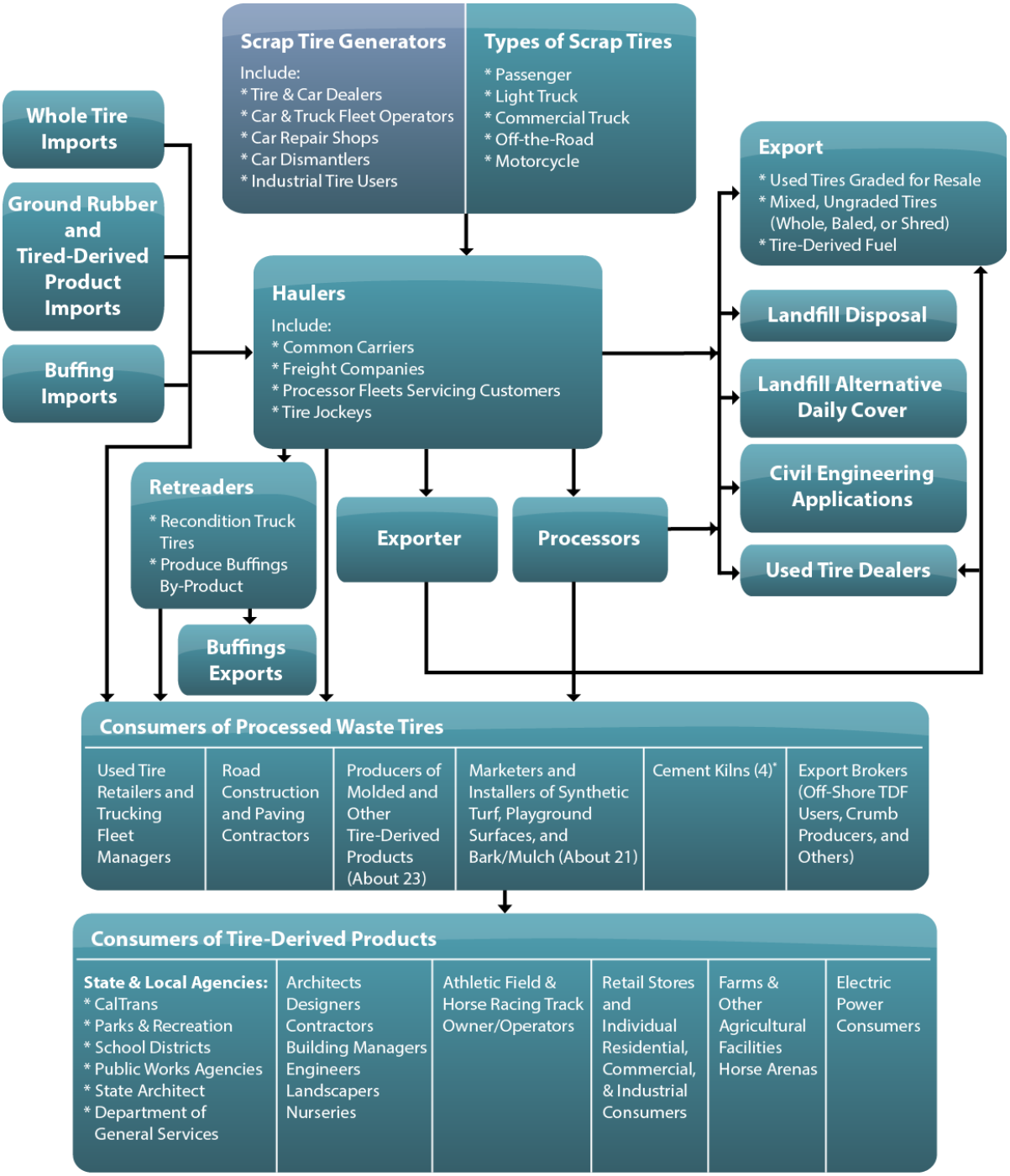
- **Waste Tire Management Based on Documented Flows:** The report does not directly estimate waste tire generation. Rather, the total estimate of waste tires managed is estimated based on the sum of all documented flows, mainly to and from processors and other recipients of whole tires, derived from 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 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 illustrates California waste tire flows and identifies the types of firms involved in California waste tire management. For this year's report, 14 "processors" were surveyed 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, eight "exporter" facilities were identified which received whole waste tires and baled or shredded them for export.

Figure 1
California Waste Tire Recycling Industry Flow Chart



* The last cogeneration facility accepting waste tires ceased operating in March, 2012.

Section 2
Market Snapshot

This section provides a snapshot of California waste tire markets in 2012 and high-level trends as of spring 2013. More detailed segment-specific trend information is provided in Section 3.

2012 Diversion Rate

Table 1 lists the number of passenger tire equivalents[1] flowing to each market segment and the percentage of the total passenger tire equivalents managed, for 2010 through 2012. As in the previous year, the overall waste tire diversion rate (e.g., diverted from the landfill) increased significantly, from 87.8 percent in 2011 to 92.7 percent in 2012, marking the first year that CalRecycle's long-standing 90 percent goal has been achieved. However, some stakeholders focus on a more refined recycling rate that excludes waste tire exports (but not used tire exports), alternative daily cover and tire-derived fuel, which CalRecycle is statutorily prohibited from promoting. Excluding these segments, the 2012 diversion rate would have been 43.3 percent. Regardless of one's view on how to measure recycling or diversion, tire disposal in California hit another all-time low in 2012, with 3.3 million passenger tire equivalents landfilled, representing 7.3 percent of all tires.

Table 1
Estimated End-Uses for California Generated Waste Tires, 2010– 2012[2]

Category	Sub-Category	2010		2011		2012		Percent change 2011-2012
		Million PTE	Percent of Total	Million PTE	Percent of Total	Million PTE	Percent of Total	
Export	Waste Tires	6.4	15.5%	9.6	23.4%	13.5	29.9%	40.8%
	Used Tires (Exported)	1.8	4.3%	1.8	4.3%	1.8	4.1%	3.4%
	Subtotal	**8.1**	**19.8%**	**11.3**	**27.7%**	**15.3**	**34.0%**	35.0%
Reuse	Retread	3.6	8.8%	4.1	10.0%	4.0	8.9%	-2.0%
	Used Tires (Domestic)	2.0	4.9%	2.8	6.9%	3.3	7.4%	18.6%
	Subtotal	**5.6**	**13.7%**	**6.9**	**16.9%**	**7.3**	**16.3%**	6.4%
Ground Rubber	RAC & Other Paving	5.0	12.2%	4.9	11.9%	4.4	9.8%	-9.6%
	Turf & Athletic Fields	1.4	3.3%	1.7	4.2%	2.2	4.8%	27.1%
	Pour-in-Place Playground	0.1	0.4%	0.1	0.4%	0.0	0.1%	-68.6%
	Loose-Fill Play/Bark/Mulch	1.1	2.7%	1.1	2.6%	1.8	3.9%	66.8%
	Molded & Extruded	0.7	1.7%	0.9	2.2%	1.3	2.9%	44.8%
	Other	0.2	0.4%	0.1	0.3%	0.1	0.1%	-49.2%
	Subtotal	**8.6**	**20.8%**	**8.8**	**21.6%**	**9.8**	**21.7%**	10.8%
Civil	Landfill Applications	1.8	4.4%	0.6	1.4%	0.6	1.3%	-1.2%

[1] PTE stands for passenger tire equivalents, which is defined by the State of California to equal 20 pounds. Data for 2010 and 2011 are from the "California Waste Tire Market Report: 2011."

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

Category	Sub-Category	2010		2011		2012		Percent change 2011-2012
		Million PTE	Percent of Total	Million PTE	Percent of Total	Million PTE	Percent of Total	
Engineer -ing	Non-Landfill Applications	0.0	0.1%	0.0	0.0%	0.0	0.0%	NA
	Subtotal	**1.8**	**4.4%**	**0.6**	**1.4%**	**0.6**	**1.3%**	-1.2%
Alternative Daily Cover		**0.8**	**1.9%**	**2.0**	**4.8%**	**1.0**	**2.3%**	-46.5%
Other Recycling		**0.0**	**0.1%**	**0.1**	**0.2%**	**0.0**	**0.0%**	NA
Tire-Derived Fuel	Cement	7.4	18.0%	5.6	13.8%	7.6	16.9%	34.9%
	Co-Generation	1.0	2.3%	0.6	1.4%	0.1	0.3%	-76.6%
	Subtotal	**8.4**	**20.3%**	**6.2**	**15.2%**	**7.7**	**17.2%**	24.7%
Landfill Disposal		**7.8**	**19.0%**	**5.0**	**12.2%**	**3.3**	**7.3%**	-34.2%
Estimated Total Managed		**41.1**	**100%**	**40.8**	**100%**	**45.0**	**100%**	10.3%
Total Diverted from Landfill		**33.3**	**81.0%**	**35.8**	**87.8%**	**41.7**	**92.7%**	16.5%
Imports		1.0	2.5%	1.2	3.0%	**0.7**	1.6%	-38.8%

Synopsis of Trends

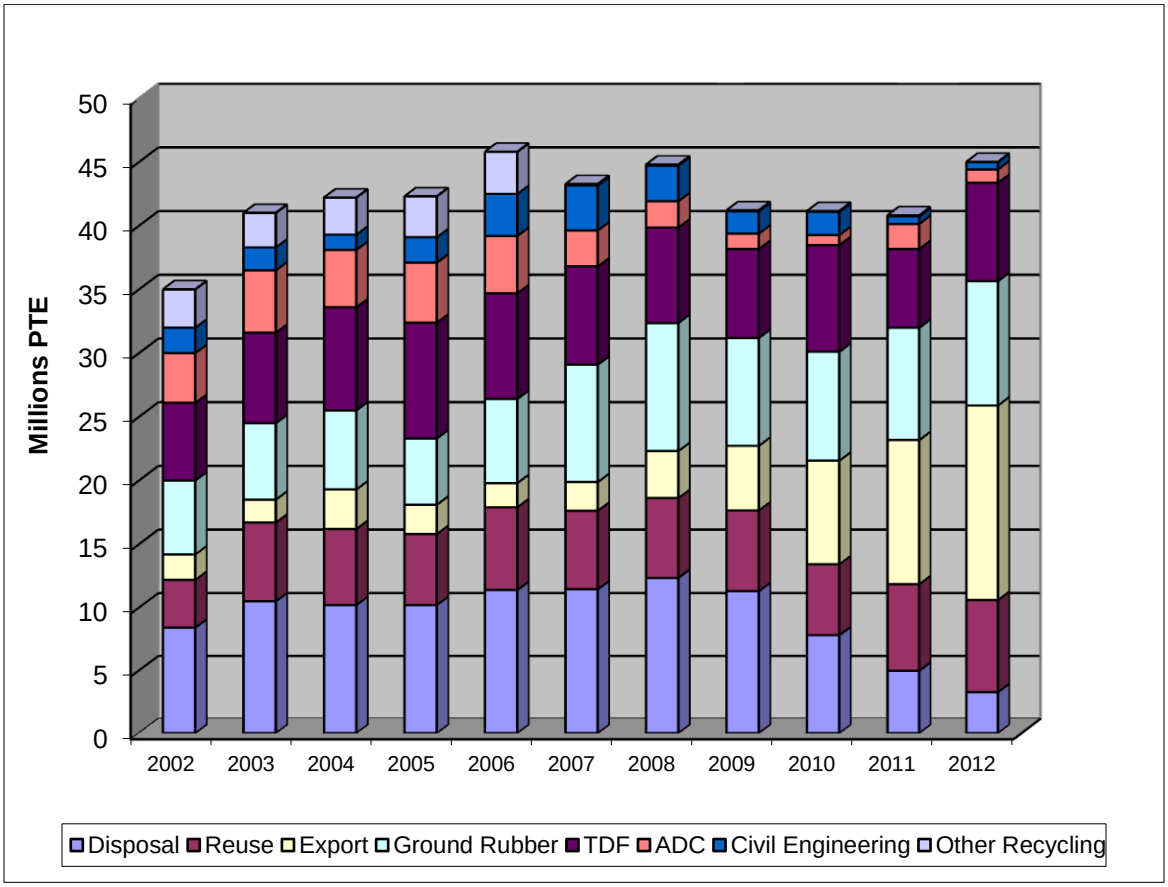
Figure 2 shows trends in end uses for waste tires by broad market category since 2002.[3] As in 2011, the diversion rate increase during 2012 was largely due to unprecedented growth in exports of tires to Pacific Rim nations, including processed tire-derived fuel tire chips and waste tires bales or shreds that are also ultimately used mainly as tire-derived fuel.[4] Waste tire exports increased by 41 percent from 2011 to 2012 after a 39 percent increase in the previous year. However, waste tire bales/shred exports appear to have peaked in late 2012 and declined in the first half of 2013.

This trend, combined with increased enforcement of export operations, has reduced the competitive pressure for tire collection accounts (e.g., from new tire retailers and other facilities that generate waste tires) and pricing that many established processors have been experiencing in recent years as new export operations were quickly established as waste tire export demand boomed. Exports of processed tire-derived fuel, especially to Japan and Korea, however, continue to be strong and are expected to grow in 2013. This demand is being met, however, by established processors and not by dedicated exporters established in recent years.

[3] Data for 2002-2006 are from CalRecycle's annual "California Waste Tire Generation, Markets and Disposal" reports. Methodological differences complicate direct comparisons between 2002 and 2006 and later statistics. See Appendix A for details.

[4] In this report, the waste tire exports category includes both bales/shreds as well as tire chips processed to meet TDF standards, typically 1.5 to 2 inch chips.

Figure 2
Ten-Year Trend in California Waste Tire End-Uses



The peak in waste tire bale/shred exports may also indicate that the recently rising diversion rate has also peaked. On the other hand, if ground rubber and processed tire-derived fuel (both domestic and export) continue to grow in addition to expected growth in the use of waste tires for civil engineering, this could offset reductions in diversion through export and potentially keep the overall diversion rate near or above 90 percent in 2013.

The reuse and ground rubber market segments both consumed more passenger tire equivalents in 2012 than in previous years, up 6 and 11 percent from the number consumed in 2011, respectively. Reuse does not appear to have much further room for increased diversion because the number of potentially reusable tires is limited. There may be room for growth in retreading; however, retreaders reported slightly reduced demand in 2012 and this segment is expected to remain flat in the coming year.

The trend for increasing the passenger tire equivalents used to manufacture ground rubber is uncertain. Rubberized asphalt concrete declined by almost 10 percent; while the 2013 trend is not yet clear, there is some potential for this segment to grow. Some anticipate noticeable increases in rubberized asphalt concrete sales in 2013, although this has reportedly not been seen yet as of publication of this report. Use of California ground rubber in turf was up 27 percent in 2012 and is reportedly on track to grow again in 2013, and use of California tires in loose-fill/mulch increased by two-thirds in 2013 and appears on track to grow again in 2013. These two segments,

however, may be most susceptible to competition from out-of-state suppliers. Use of California ground rubber in pour-in-place applications declined in 2012, but this segment usually uses buffings from retreader operations, not ground rubber, and so the decline is not significant in the overall context of our-in-place sales. Use of ground rubber in molded products also increased by nearly 45 percent from 2011 to 2012, in part due to increased demand for tiles, which compete with pour-in-place in some markets. Although the total volume used in the molded product segment remains rather low, there is potential for sustained growth in coming years.

Sales of tire-derived fuel to California cement kilns rebounded in 2012, growing by 25 percent after a 27 percent decline the previous year, and it may be on track for more modest but continued growth in 2013. While civil engineering was essentially flat in 2012, CalRecycle has recently funded five projects expected to use 21,263 tons of tire-derived aggregate in coming months and years, and is tracking additional projects, indicating this segment is poised for significant growth in the coming year.

The use of waste tires for alternative daily cover declined by 46 percent in 2012, and is expected to remain flat or decline only slightly in 2013. However, a single facility's decision to begin or end using alternative daily cover could have a significant impact on tonnages flowing to this segment. Waste tire generation, as estimated by the volume of tires documented in this study, was up in 2012 by 10.3 percent, in part due to increased new tire sales as the economy began to rebound to a degree from the sustained deep recession of the past few years.

Some California processors and tire-derived product vendors continue to express concern regarding competition from out-of-state importers of ground rubber and some tire-derived products. While there were no major expansions in California ground rubber production capacity in 2012, ground rubber suppliers located in Utah, British Columbia, Washington, and Germany are selling material in the state at competitive prices, and this is reportedly having an impact on local sales from California producers. There is no publicly available data, but imports appear to be a factor primarily in the turf and mulch ground rubber segments, and certain tire-derived products like mats and playground tiles.

Rubberized asphalt concrete blenders uniformly report that they purchase ground rubber only from California suppliers, although one major terminal blend asphalt producer using recycled tire rubber reportedly had to import material from out-of-state due to equipment issues in California. Information on imported ground rubber is sometimes contradictory, with some industry players stating unequivocally that certain suppliers are importing rubber, while these suppliers deny that is the case. It is undisputed, however, that large quantities of imported ground rubber are available in California at prices that are competitive, if not lower, than that of California suppliers in some cases.

As detailed in the current Five-Year Tire Plan, CalRecycle is adjusting its waste tire market development programs. In future years, the Tire Outreach and Market Analysis Program will focus exclusively on tire-derived product promotion, market analysis and other industry-wide activities. The tire-derived products grants program may be scaled back in favor of a pilot Tire Incentive Program, while the new Tire-Derived Aggregate Grants Program is gaining traction and the Rubberized Pavement Grant Program has very strong demand. The overall impact of these changes is difficult to predict, but they could potentially result in increases in waste tires used by the civil engineering and molded product segments as a result of increased emphasis on the tire-derived aggregate and incentive programs respectively, with possible reduced sales in loose-fill/mulch and turf to local government agencies that typically receive most tire-derived product grant funding, due to reductions in that program.

Section 3
Key Trends by Market Segment

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

Supply and Demand Balance

As in any commodity market, the balance between supply and demand is constantly in flux, and this balance directly impacts pricing, competitive pressures and, generally, the profitability and resiliency of firms operating in the market. In the case of California tire recycling markets, there are two sets of supply and demand issues: those involving the supply and demand for whole tires generally, and those involving the supply and demand for various specifications of ground rubber and other processed tire feedstocks used to make a wide range of products. Following is a brief update on the current status of these issues.

Supply and Demand for Whole Tires

California has a large, dynamic infrastructure for collecting and processing waste tires, including over one thousand registered haulers and exempt common carriers, several facilities with a major waste tire facility permit, and more than two dozen facilities with a minor waste tire facility permit. In 2012, the vast majority of tires generated in California flowed to one of 14 processors or seven exporters analyzed in this study, with the remainder hauled directly to disposal or end uses such as reuse or cement kilns consuming whole tires, which were also surveyed for this report.

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.

The supply of waste tires was up by as much as 10 percent in 2012. Driven by strong export market demand, competition for whole California tires hit what might be an all-time high in summer 2012. As detailed in the 2011 California Waste Tire Market Report, highly favorable economics combined with strong export demand for baled or shred waste tires and for processed tire-derived fuel had catalyzed a number of firms to quickly set up operations to compete for waste tire collection accounts with generators across the state. These new export operations competed with established processors and drove down tip fee revenues, while disrupting supplies of tires to some firms that process tires for ground rubber production and other markets. This trend appears to have hit its high point in late 2012 as export demand began to decline and the economic drivers became less favorable. (See discussion under exports below.)

As a result of this market shift and concurrent CalRecycle enforcement of permit and operating requirements, the aggressive competition for California waste tires has subsided somewhat, and processors report that tip fees in many cases are moving back up. However, while reduced, export demand does remain strong and several exporters continue to handle a large number of tires, exports of waste tire bales/shreds (as opposed to export of used tires or tire-derived fuel) may not return to their pre-export rise levels any time soon. Outside of the exporters, no significant expansions in waste tire processing capacity occurred in 2012 or early 2013. Overall, demand for whole waste tires is expected to remain relatively strong for the duration of 2013.

It should also be noted that developers of pyrolysis and other types of facilities that would consume California tires have expressed interest in California projects. This is not different than in previous years, and so far none of the proposed or discussed facilities has materialized on a commercial scale. However, some pyrolysis ventures could consume very large quantities of tires. If one were to successfully be sited and compete for tires, it would have a very significant impact on existing firms involved in managing California scrap tires. Given the currently strong demand for California tires, such a venture would likely require very attractive pricing to secure an adequate feedstock supply.

Supply and Demand for Processed Tires

Overall, use of California tires to produce ground rubber was up by more than 10 percent. Although rubberized asphalt concrete use was down by a similar percentage, increased use of tires in turf, mulch, and molded products more than made up for this. As in past years, ground rubber producers cite strong demand from out-of-state ground rubber producers as a factor in keeping prices and sales lower than they would like. While no major expansions in overall tire processing capacity or crumb rubber production were identified, two firms are establishing capacity to produce colorized mulch for the first time. Combined with growing out-of-state suppliers, this could fuel increased competition for sales in landscaping, playground, and other market segments.

Ground rubber from suppliers in Utah, British Columbia, Washington, and Germany continue to be available in California at competitive prices, and a new 10 million passenger tire equivalents/year facility planned for Houston is targeting sales across the country. (See discussion of imports later in this section.) So, while no ground rubber production capacity expansions have recently occurred in California, competition may continue to put pressure on prices and sales for the foreseeable future.

Several processors state they are interested and prepared to produce tire-derived aggregate as demand increases in civil engineering projects, as long as the prevailing economics are favorable compared to other market opportunities. Some established processors and ground rubber producers state they do not expect to enter that market in the foreseeable future. In a change from the situation just a few years ago, the supply of buffings produced by retreaders is now much greater than demand, and prices have declined markedly in the past year.

Implications for Tire Market Development Efforts

Given continuing strong demand for waste tires and hard-to-predict trends in exports, investment in new processing capacity should be viewed cautiously. There are indications that demand for ground rubber, tire-derived aggregate, and tire-derived fuel may grow in 2013, but there appears to be ample capacity to meet that demand. While demand for waste tire bales/shreds has subsided in the past eight months, exports of processed tire-derived fuel continue to be strong, and it is not entirely clear what the future holds for exports. If the U.S. economy continues to strengthen as many predict, and export demand for tire-derived fuel remains strong as expected, competition by established processors and exporters will continue to be strong, even if not as fierce as in most of 2012.

As mentioned above, the potential for a reduction in CalRecycle's tire-derived products grant program in 2014 could have an impact on some sales to local government agencies and other grant recipients. The extent of any such impact, however, is hard to predict at this time. Moreover, the prospect of greatly expanded ground rubber capacity in North America could exert

continuing price and sales pressure, even in states relatively far away from where that new capacity is being located. These factors combine to make investment in new processing or ground rubber production something that should be evaluated carefully.

Competitive pressures related to export of waste tires and relatively low cost import of ground rubber and certain tire-derived products may mean that CalRecycle will need to provide additional scrutiny over funding awards in coming years to ensure that only California tires are covered. While documentation requirements are in place and CalRecycle staff already scrutinized applications, the SAIC team has heard credible statements from some industry players stating unequivocally that other players are in fact importing rubber that may be purported to be from California sources.

Finally, CalRecycle funding for tire market development efforts is scheduled to decline in 2015 when the state tire retail fee declines from $1.75 to $0.75 per tire. Discussions and proposals are being heard in the Legislature, but it is as yet unclear whether or how the fee may be adjusted. CalRecycle's spending authority will remain unchanged until adjustments are made through an approved Budget Change Proposal and included in the state's enacted budget.

CalRecycle estimates that sufficient funds exist in Tire Fund to support the current level of expenditures, and will closely monitor the impact of the January 1, 2015, fee reduction on the revenue, fund balance, and cash flow to determine if further adjustments are necessary. These changes in revenue availability and spending authority could impact CalRecycle tire market development programs in future years.

Reuse

Reuse, including retreading and sale of partially worn used passenger tires, is strong and increased by an estimated 6 percent in 2012 overall, with about 7.3 million passenger tire equivalents being reused in 2011 as compared with 6.9 million in 2011.

Retread Tires

Although retreading markets in California remain strong, overall SAIC estimates that use of California tires in retreading declined by 2 percent, based on a survey of retreaders. While some firms reported growth, several others reported slight declines. All firms, however, report continuing strong demand for retread truck tires. Retreading of tires in California is limited to truck tires and other specialty tires (e.g., airplane tires). California is home to about 30 truck tire retreading companies that operate more than 40 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. Several retreaders surveyed indicated that they anticipate growth in 2013 assuming the economy continues to strengthen, although it is unclear whether the overall volume will increase much as competition continues to shake out the industry to a degree, with some smaller facilities being acquired by larger ones.

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. Many haulers and processors view markets for used tires as an attractive market because of the relatively low cost to meet these specifications (consisting of inspection and grading), and the relatively consistent price and demand. 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 3.3 million passenger tire equivalents in 2012, a 7.4 percent increase over 2011 levels. Additionally, as discussed under "Imports and Exports" later in this section, in 2012 an estimated 1.8 million passenger tire equivalents 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 seven ground rubber producers. These firms used approximately 9.8 million passenger tire equivalents in 2012 to produce more than 136 million pounds of ground rubber, 10 percent more than in 2011. This includes coarse ground rubber of ¼ to ¾ inch (generally used for loose-fill playground, mulch, and horse arenas) and finer ground rubber of 4 to 30 meshes (used in rubberized asphalt concrete, synthetic turf infill, and molded products). Small quantities of very fine ground rubber of greater than 30 mesh is used to produce certain emerging products like sealants.

Table 2 provides a summary of California ground rubber production by market segment for 2011 and 2012. Increases in production of ground rubber shipments for turf and athletic fields, molded and extruded products, and loose-fill/bark/mulch helped offset a decrease in shipments for rubberized asphalt concrete. Although the pour-in-place segment shows a steep decline, the impact on total ground rubber markets as this is a small portion of the total ground rubber shipments, limited to use by two vendors, with the vast majority of pour-in-place being made with retreader buffings.

Table 2
Estimated Ground Rubber Shipments by Market Category[5]

Category	2011		2012	
	Million Pounds	Percent of Total	Million Pounds	Percent of Total
RAC & Other Paving	68.1	55%	61.6	45%
Turf & Athletic Fields	23.7	19%	30.2	22%
Pour-in-Place Playground	2.1	2%	0.6	0%
Loose-Fill/Bark/Mulch	14.9	12%	24.8	18%
Molded & Extruded	12.8	10%	18.6	14%

[5] 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	2011		2012	
	Million Pounds	Percent of Total	Million Pounds	Percent of Total
Other	1.8	1%	0.9	1%
Total	123.4	100%	136.7	100%

Some common market constraints impacting ground rubber sales include: recession-driven declines in demand, especially in the construction industry; declining government budgets; and for turf applications in particular, perceived environmental and health concerns which some survey respondents indicate is still an issue. If the economy continues to improve, it could help to strengthen ground rubber sales. However, local and state 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.

A large portion of ground rubber products appear to be purchased by state and local government entities, although private purchases do occur, including retail sales of consumer products. Rubberized asphalt concrete use is mandated in Caltrans projects, and CalRecycle provides grants and other financial/technical/promotional support efforts. As noted above, changes in CalRecycle programs could have a notable impact on sales of certain products to government agency customers that have benefited from tire-derived product grants (e.g., playground surfacing and turf) while potentially increasing sales of ground rubber to other products, such as molded and extruded products, over the long-term. However, the impact of any grant reductions on overall demand is uncertain.

Another issue facing manufacturers of California ground rubber is the fact that California processors are competing with less expensive ground rubber imports from provinces and countries that provide ground manufacturers with subsidies. (See imports section below)

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. Meanwhile, price competition by alternative materials and ground produced from outside of California has complicated the ability of California ground rubber producers to significantly raise prices on finished products.

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

Rubberized Asphalt Concrete and Other Paving

Based on data provided by California ground rubber producers supplying rubberized asphalt concrete projects use of California tires in this segment declined by about 10 percent in 2012 compared to 2011. This was due in part to a continuing, sluggish construction industry. In 2012 some 4.4 million passenger tire equivalents of California waste tires were processed into approximately 62 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 number of firms in the asphalt paving industry that have invested in the equipment required to produce rubberized asphalt concrete and also increasingly, to terminal blend asphalt producers.

Firms involved in the paving market operate under several different business models. They include blending subcontractors and major materials suppliers as well as traditional general contractors that are vertically integrated and can handle all aspects of the paving supply chain.

These firms operate either as prime contractors to Caltrans or local governments, or as subcontractors under such contracts. While in the past only a limited number of blenders and paving companies had the equipment to produce rubberized asphalt concrete, more companies are now active, and the increased competition has raised the demand for the product in recent years with accompanying lower pricing. According to one source, approximately 18 separate companies now own blending equipment, not counting terminal blend production which is reportedly dominated in California by one firm currently.

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 reports that they exceeded this target in 2011 with a rate of 35.9 percent; an estimate for 2012 is not yet available.

Caltrans' use has continued to increase steadily since 2009, when usage was 3.6 million passenger tire equivalents (PTEs) in pavement projects. In 2010 Caltrans used 4.1 million passenger tire equivalents, and in 2011 an estimated 7.0 million passenger tire equivalents in state highway rubberized asphalt concrete paving projects, an amount that Caltrans refers to as exceptional in its annual report due to some particularly large projects.

In 2012 Caltrans estimated it used 4.5 million passenger tire equivalents in paving projects.[6] This is equivalent to 63 million pounds of crumb rubber, assuming a 70 percent yield rate, slightly more than the 62 million pounds California crumb producers report selling to paving firms. A portion of this crumb rubber went to local projects, so it is clear that some percentage of Caltrans crumb supplies are coming from sources outside of California.

Caltrans is not required to include in its specification that crumb rubber must come from California producers—only from U.S. sources— so a portion of crumb rubber used by Caltrans contractors comes from outside the state. California blenders uniformly state that they purchase the vast majority of crumb rubber used in California paving projects from California producers. Local governments that use CalRecycle's rubberized paving grant program funds must use California tire crumb for their projects in order to qualify for the grants.

As discussed under the imports section below, the SAIC team frequently hears statements from some industry players that some California-based firms are selling crumb rubber or tire-derived products that are sourced from out-of-state, though they may be reporting it as California-sourced. SAIC did not seek to validate these claims, but this analysis of the paving market segment seems to lend support to the contention. Depending on the various processes used to incorporate crumb rubber into asphalt, the ability to verify both the amount of crumb rubber being consumed and the origin of the crumb rubber can vary greatly.

Some market players involved with rubberized asphalt concrete say they expect sales to increase in 2013, although this reportedly had not yet occurred as of April 2013. Caltrans also has increased its use of tires in pavement in part by employing rubberized warm mix asphalt thus expanding the potential projects for rubberized asphalt concrete. According to one industry expert, warm mix technology offers a solution to many issues that have long been associated with rubberized asphalt concrete such as fumes, odor, workability, shortened haul distances and limited seasonal availability. Warm mix technology is also opening up usage of asphalt rubber in

[6] The 2012 estimate is based on actual figures through September 2012 and projections for the remainder of the year. The report is available at: http://www.dot.ca.gov/hq/oppd/rescons/sb876/2012-SB-876-Report-Final.pdf.

spray applications by providing alternative solutions to opacity solutions. As the warm mix technology continues to mature, some industry participants say they increasingly view rubberized asphalt/asphalt rubber and warm mix as synonymous.

Rubberized asphalt concrete is also used by local governments, sometimes with financial grant support and technical assistance provided by CalRecycle. In the spring 2013 rubberized pavement grant cycle, CalRecycle received 58 eligible applications totaling $9.7 million, and was able to fully fund 16 of these, plus partially fund one additional application, totaling $3.3 million. (CalRecycle may fund additional applications as funds become available.) About two-thirds of this amount was for rubberized asphalt concrete projects and one-third for chip seal projects.

A growing portion of tire rubber used in paving in California is used in terminal blend asphalt products. Terminal blend is made when fine rubber crumb is dissolved using special equipment 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. These two technologies result in very different products and each has a niche in their best usage.

According to some industry experts, in the past confusion in equating these two products has resulted in some project failures, and there is a need to clearly define the various products and their correct usage. There are relatively few sources of terminal blend in California, and this could potentially constrain 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).

On the national level, increasing costs for binders such as Styrene-butadiene-styrene (SBS) in performance grade paving products is spurring strong interest in the use of crumb rubber. Performance grade specifications are used for a large portion of projects funded by the Federal Highway Administration.

While use of crumb rubber has long been allowed in such projects, it has not been used in large quantities in practice. This appears to be changing now as the economics are becoming much more favorable. This trend has the potential to greatly expand use of crumb rubber in paving nationwide, including in California. One national supplier of crumb rubber has established a branded product specifically aimed at this market. While the trend could open up new opportunities for California crumb suppliers, it could also cause imported crumb rubber to increase market share in the California market.

Synthetic Turf and Athletic Fields

Ground rubber in the 10-20 mesh range is used as infill between the blades of grass in synthetic turf athletic fields and in a variety of running tracks, horse racing tracks, and other applications. The statewide use of California produced ground rubber in synthetic turf and athletic fields in 2012 is estimated to be 30.2 million pounds, equivalent to 2.2 million passenger tire equivalents, which is an increase of 27 percent over 2011 levels. This increase follows a modest increase in 2011, with the only decline in recent years being in 2008. Nationally, sales of artificial turf are up about 5 percent, according to the Synthetic Turf Council.

Because many 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 also are susceptible to concerns about potential health impacts, especially where field use is intended for children. The market is also fueled to a degree by CalRecycle's tire-derived product grants, for which 2014 funding may be reduced.

Despite steady growth nationwide, the market for ground 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 and conducted by the Office of Environmental Health Hazard Assessment. However, contrary to this trend is a lawsuit filed by the Public Employees for Environmental Responsibility against the U.S. EPA and Consumer Product Safety Commission. The suit contends that the research and findings of these two organizations related to environmental health and safety concerns of rubber used in turf products was flawed, and should be revisited.

A growing trend with established synthetic turf and athletic fields is their deconstruction, and reuse of rubber and other materials used in their original construction. The Synthetic Turf Council reports that 365 deconstruction projects across the U.S. are expected in 2013, and this could grow to 1,000 nationally by 2017. Some communities are beginning to require deconstruction and reuse of materials. While not impacting new turf sales, this trend could impact demand for ground rubber which had been expected as the first wave of turf fields become due for refurbishment.

Artificial turf sales are 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 ground rubber), strongly influence whether California ground rubber processors supply the ground rubber for field installations or whether ground rubber 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 2012, about 24.8 million pounds of ground rubber derived from approximately 1.8 million California passenger tire equivalents were used in loose-fill playground surfacing applications or sold as bark or mulch for landscaping and other applications, a 66 percent increase from 2011 levels. 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. Buffings from retreaders are also used as loose-fill playground surfacing and landscaping mulch. As noted above, demand for buffings has decreased substantially in recent years, with prices falling significantly. This could be an indicator of declining demand for products using buffings, including mulch and loose-fill playground surfacing.

LOOSE-FILL PLAYGROUND SURFACING

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

According to stakeholders, this market segment may be more dependent upon CalRecycle grant funding than other segments, as municipalities, housing authorities, and school districts, most of which have budget constraints, comprise a large portion of this market segment. 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.

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 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 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. Rubber bark/mulch is sold in California by several firms located outside of the state, both to national retailers and directly in projects or through distributor/alliances within the state.

Pour-in-Place/Other Playground Surfacing

In 2012, about 0.6 million pounds of California ground rubber from vehicle tires (0.05 million passenger tire equivalents in total), as opposed to buffings from retreaders, were used in pour-in-place playground surfacing applications; this is nearly a 69 percent decrease over the amount estimated in 2011.

As with other data in this report, however, this is not an estimate of the total sales of pour-in-place market, as it does not count sales from outside of the state and the 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.

Two vendors offer pour-in-place products that make use of ground vehicle tire rubber in some product offerings, in lieu of buffings. The rubber is combined with a urethane binder and overlaid with an ethylene propylene diene monomer (EPDM) rubber surface layer to produce a bound

surface. Pour-in-place products only qualify for CalRecycle grants if they are made with buffings from processors or ground rubber derived from California waste tires. In general, ground rubber is used in the base layer of pour-in-place surfacing while buffings tend to be used in the surface layer.

Pour-in-place surfacing generally satisfies the federal Americans with Disabilities Act (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.

As noted above, demand for buffings produced by retreaders has declined markedly in the past couple years, possibly as a result of reduced demand for products using the material, such as pour-in-place surfacing. Tiles compete with pour-in-place products in many markets and sales may be growing at the expense of pour-in-place in some cases.

Molded and Extruded Products

In 2012, about 18.6 million pounds of ground rubber, derived from about 1.3 million passenger tire equivalents, were used to produce molded and extruded products, a 28 percent increase in the estimated volume over 2011. In this application, ground rubber generally in the 10- to 30-mesh range, but sometimes higher mesh sizes, is combined with urethane and other materials, including recycled plastics in some applications.

A wide range of products are produced in California, including playground and other tile products, flooring, mats, wheelchair transition ramps, drainage channels, erosion control devices, traffic control devices, wheel stops, roofing materials, underlayment, sealants, and more.

Although higher mesh material is now available in California, the use of California tires in the production of more premium molded and extruded products in California may still be somewhat limited by low production capacity to produce fine rubber powders with particle sizes of 80-mesh or even 200- to 300-mesh. Several new producers of “very fine” ground rubber have emerged nationwide, and one firm in California is now specializing in production of fine ground 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.

Despite its promise, feedstock conversion is notoriously challenging and is slow to show results. 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.

Perhaps the most critical barriers, though, are internal to the companies seeking to develop new products or use recycled tire rubber for the first time. Experience shows that the effort requires a sustained commitment of time, resources, and focus by management and production personnel. This can be very challenging for small manufacturers because of the need to turn attention away from established products and customers while work continues on expanding in the new recycled tire products.

Several feedstock conversion firms have received support through CalRecycle's Tire-Derived Product Business Assistance Program and have marked progress towards expanding ground rubber demand in their products; however, the full potential promise of this work has not yet been seen. Despite these challenges, this category showed high growth for the past three years, with a 45 percent increase in 2012 over 2011.

Other Ground Rubber Applications

In 2012 about 0.9 million pounds of ground rubber was derived from about 0.1 million passenger tire equivalents 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.

Civil Engineering

Civil engineering applications used about 0.6 million passenger tire equivalents in California during 2012, a slight decrease over the level in 2011, which was down about 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 and which can use large quantities of tires in discrete 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-deriver 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 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, provides 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 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 new light rail lines.

Obstacles to its increased use 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 it 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 tire-derived fuel. 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.

Over the past year CalRecycle has also conducted numerous outreach efforts to local government public works engineers to educate them about the benefits of using tire-derived aggregate in highway products and to promote the assistance programs. CalRecycle has also conducted research on its use as a backfill behind retaining walls and identification of its material properties. In addition, CalRecycle has conducted research and developed a demonstration project using tire-derived aggregate in onsite wastewater treatment systems.

Landfill Civil Engineering Applications

Tire-derived aggregate usage at landfills includes use in landfill gas and leachate collection and redistribution layers, and in landfill road construction, generally replacing rock aggregate materials. The specification used in these applications varies, and sometimes a rough shred with a forgiving specification can be used. Landfill tire-derived aggregate is usually a low- or no-value market—processors delivering it 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.

All of the tires used in civil engineering applications in 2012 were used in landfill projects. Although the quantity was down slightly compared to 2011, this volume is expected to increase markedly in 2013 and 2014. CalRecycle staff has been focusing on outreach and technical assistance in recent months, and just completed the second cycle of the new Tire-Derived Aggregate Grant Program.

In April 2013, five applications were approved totaling $718,955, nearly half of the $1.5 million that CalRecycle had allocated to the program. The five projects will all occur at landfills, including one lightweight fill project and four involving use of chips in methane gas collection systems, and are expected to use a total of 21,263 tons. Much of this amount is expected to be used in 2013. Outside of the grant-funded projects, there are two other landfills that used tire-derived aggregate in 2012, one of which indicated their use would remain about the same as in 2012, and the other of which said usage would decline somewhat. Overall, its use in landfill applications is expected to increase significantly in 2013, compared to 2012.

Non-Landfill Civil Engineering Applications

Non-landfill applications include Caltrans' and local governments' use of tire-derived aggregate in landslide stabilization projects and as vibration dampening in local commuter rail systems. 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, non-landfill applications, depending on a range of factors, may provide modest positive revenue to processors. Although no tires were used in non-landfill projects in 2012 or in the previous year, CalRecycle reports there are some projects expected in the coming months and years, including a vibration dampening project associated with expansion of the Bay Area Rapid Transit system. Hence, this use of tire-derived aggregate in the non-landfill civil engineering application is expected to grow in the coming year.

As with landfill civil engineering, non-landfill applications normally involve a small, sporadic number of relatively large projects: there have been only 11 projects in the past 15 years using tire-derived aggregate. As CalRecycle continues its efforts to boost Caltrans' and others' use of the product, abrupt increases or decreases in use from year-to-year are likely to occur.

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 shreds replace dirt, and can substitute for other cover materials such as green waste or wood waste.

This use of tire shreds decreased by about 45 percent in 2012 compared to 2011 to 1.0 million passenger tire equivalents, largely due to one landfill that had used a significant quantity in 2011 reducing its use. Use of tire shreds that otherwise have no market for alternative daily cover is based on a relationship between a processor and a landfill for tire shreds. The landfill's operating permit must allow for this use, the shreds must meet specifications, and use is limited to dry weather conditions.

The tire shreds can provide landfills with a cost advantage if the landfill would be required to purchase other materials for use as cover; however, materials such as green waste are readily available onsite at most landfills, and the regulatory and operational hurdles to use alternative cover means that very few California landfills (only three) use appreciable quantities of tire shreds. Landfills that do use tire shreds, 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.

Three landfills that have used alternative daily cover in the past said their use is down, or they do not have plans to use it in the future, suggesting its use may remain flat or declining in the near term. 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 cover is expected to further 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 ground to unknown uses. No processors reported these uses in 2012, although it is likely that a small volume of tires were in fact used for these purposes. In 2011, less than 100,000 passenger tire equivalents (735 tons) were used in this market segment, which is slightly higher than the estimated 490 tons used in this

category in 2010. This category is likely to remain a small (currently comprising less than 1 percent of all passenger tire equivalents generated) but stable 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 cogeneration facilities that produce steam and electric power, primarily using coal as fuel. Both types of facilities primarily use other fuels, and tire-derived fuel[7] typically is not needed by them. It is only used to supplement these other fuels if the economics favor combusting tires or if the cleaner-burning tires are needed to offset emissions from "dirtier" primary fuels.

There were four California cement plants and one cogeneration plant that used significant amounts of tire-derived fuel in 2012. 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.

Use of California tires for in-state tire-derived fuel facilities increased by nearly 25 percent in 2012 compared to 2011, with 7.7 million passenger tire equivalents being used. Almost all of it, 7.6 million passenger tire equivalents, was used at cement kilns. All four of these kilns are interested in increasing tire use if the economy, and the construction industry in particular, continues to strengthen. Representatives suggested that tire-derived fuel use by cement kilns, on the whole, would increase in 2013. While in 2012 some cement kilns said they experienced some supply and/or tip fee revenue or shipment pricing pressures, tire supply is not expected to be a limiting factor in 2013. Two of the four cement kilns also use tire fluff derived from ground rubber production as fuel in their operations, with 4,635 tons reported being used in 2012, an amount that is expected to grow in 2013.

The 0.1 million passenger tire equivalents used by one cogeneration facility in 2012 likely marks the last time tires will be used in this segment for the foreseeable future, as the last facility using tires stopped doing so in early 2012 as it shifted to biomass fuel sources. The number of cogeneration plants that use tire-derived fuel has declined over the last several years as several cogeneration plants have converted from combusting coal/tires to combusting biomass. These conversions have occurred because biomass is considered to be a renewable fuel and using biomass in lieu of coal/tires is rewarded as California strives to meet its renewable portfolio standard.

In addition to tire-derived fuel sold to California users, sale of California-produced product to overseas users is also very strong, as discussed under export markets below.

Disposal

As shown in Figure 3, waste tire disposal declined for the third year in a row in 2012. And for the second year in a row, waste tire disposal hit an all-time low in California with 3.3 million passenger tire equivalents disposed, a 34 percent decline over 2011. As discussed under exports below, declining disposal was largely driven by growth in exports over the past several years.

[7] 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 tire-derived fuel supplements other types of fuel such as coal or biomass.

Figure 3
Annual Waste Tire Disposal in California, 2010-2012 (Million PTEs)

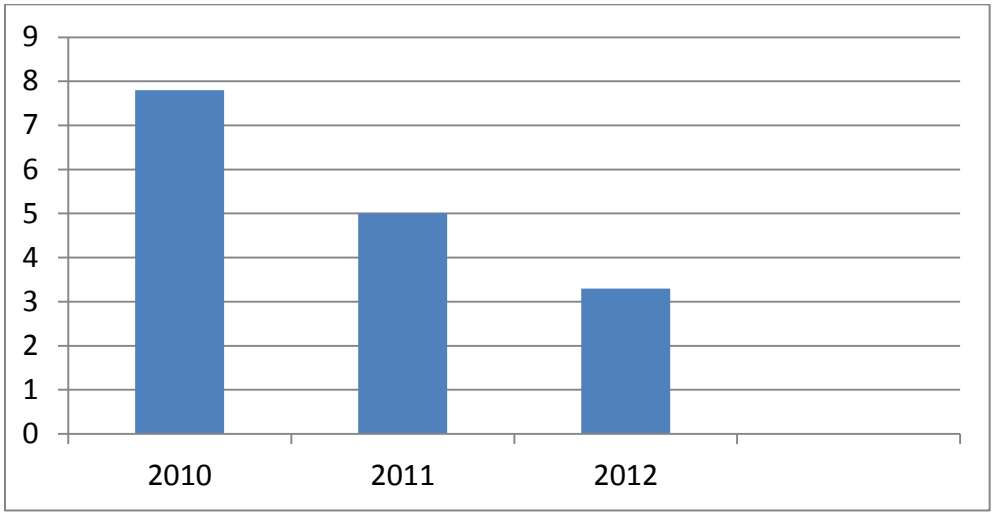
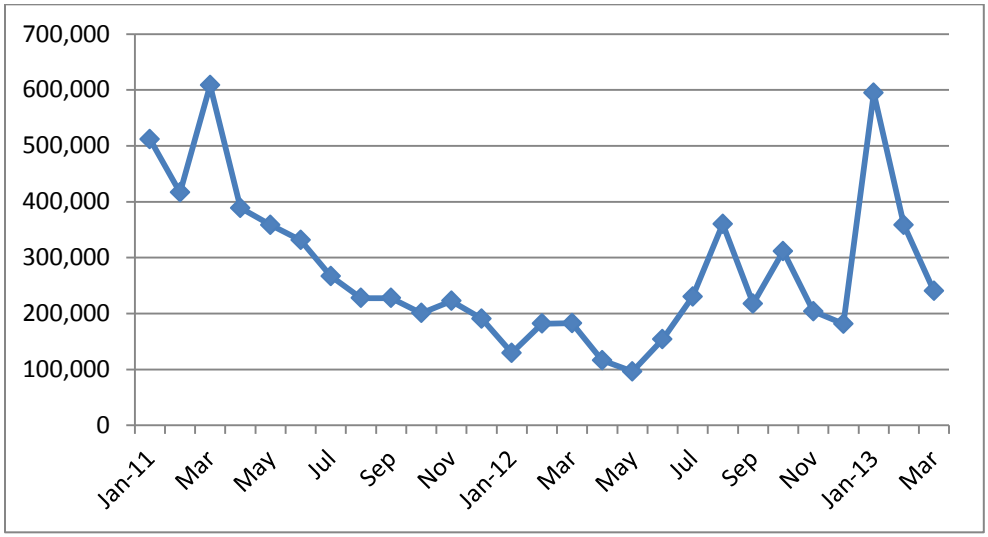


Figure 4 shows the trend in monthly disposal at the four landfills that accepted the most tires during the past two years. Together, these landfills accepted more than 90 percent of the tires documented to be disposed in 2012 in California. The chart indicates that as export markets hit their peak in summer 2012, disposal dropped to just below 100,000 passenger tire equivalents per month, and as export demand declined in late 2012, disposal began to increase. However, because disposal is subject to abrupt increases or decreases, it is difficult to gauge how the trend will play out for the duration of 2013. Although export growth appears to have stalled in late 2012, exported volumes remain high. This combined with stable or growing demand in other market segments means that disposal may remain more-or-less flat in 2013. Some processors say there will always be some measurable tire disposal, short of a regulatory ban. This is due to situations in which there is no economical alternative and not likely to be one, such as with Off-The-Road (OTR) tires and/or small quantities in remote areas.

Figure 4
Monthly Flows of Tires to Four Landfills Receiving Majority of California Tires (PTE/Month)



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 below.

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 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 2012 used tire exports from California were estimated to be 1.8 million passenger tire equivalents, the same quantity as in 2011. Estimating the portion of used tires that is exported is challenging because processors and haulers selling used tires do not always know where they may be sold. 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.

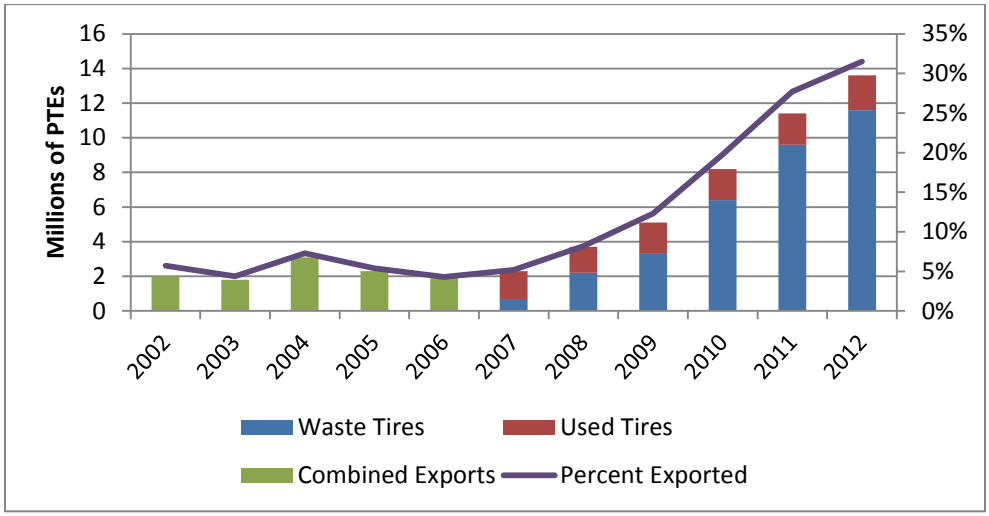
Waste Tire Imports

In 2012, approximately 1.6 percent of waste tires handled by processors were 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.

Waste Tire and TDF Exports

As illustrated in Figure 5, in 2012 the dominant trend in California tire recycling markets continued to be growth in exports of waste tires and also of processed tire-derived fuel, sent largely to Asian nations but also to other regions.[8] The quantity exported in 2012 is estimated at 13.5 million passenger tire equivalents, or nearly 30 percent of all tires managed. Since 2011, export has been the single largest market destination for California waste tires. While this is a new trend for tires, it is a situation that is very common with other recyclables. Waste tire exports increased more than 40 percent in 2012, on top of a 50 percent rise in 2011.

Figure 5
Trends in Export of Waste Tires/Tire-Derived Fuel and Used Tires



During the initial years of the tire export boom, from 2008 through 2011, a large portion of exported tires were baled or shredded waste tires. While these tires were destined for tire-derived fuel, they were largely processed overseas. However, export of processed tire-derived fuel to Japan and other countries has also grown substantially and continues to be very strong and growing. In late 2012, China began increased enforcement that effectively closed the doors for continued importation of waste tire bales and shreds, which had by many accounts been continuing through Vietnam. China is currently stepping up scrutiny of all recycled commodities imported into the nation, through a new "green fence" policy, suggesting that slow or no demand for tires may continue indefinitely. Concurrent with this shift in export demand, CalRecycle enforcement activities, including some streamlined changes in administrative procedures, has also impacted the scale of operations at some exporters that had been baling or shredding tires but not further processing them to meet specifications such as those of tire-derived fuel.

[8] The 2011 California Waste Tire Market Report included a detailed analysis of waste tire export trends and issues.

This abrupt shift in Chinese policies had a profound impact on California firms that had set up exporting operations for baled or shred tires. Some have ceased operations, while others have reduced their scale. Some processors report that the severe reductions in tip fee revenue have begun to rebound a bit, although the low-end of tip fee revenues for some accounts reported last year continue to persist. The ability of established processors to obtain tire supplies appears to be rebounding as well.

A concern related to this trend is that several thousand containers of tire bales or shreds are reportedly being held at California and overseas ports. Several processors said they had received calls seeking to find a home for these tires. While the quantity is difficult to estimate, this backlog of stored tires could potentially reduce the demand for California tires generated in 2013.

While export demand for waste tire bales/shreds has plateaued, export demand for tire-derived fuel remains very strong, especially in Korea and Japan, driven by favorable pricing. Flows of California tires to these markets is expected to continue to grow in coming years, although currently it does not appear that this increasing demand will reach the level of waste tire exports in the past two years. This demand is being met, however, by established processors and not by dedicated exporters established in recent years.

Ground Rubber and Tire-Derived Products Imported into California

Ground rubber, buffings from retread operations and tire-derived products are also imported and exported from and to California. Imported ground rubber competes with in-state production, and sometimes benefits from direct government monetary subsidies (e.g., in British Columbia, Alberta, and Utah). Producers in Washington state and Germany are also offering competitively priced imports in California. And, a new facility planned in Houston is expected to have a capacity of up to 10 million passenger tire equivalents and is targeting sales nationwide, potentially further increasing ground rubber imports to California. Several California processors and product manufacturers indicate that these out-of-state suppliers can often match or beat the prices of local suppliers, placing competitive pressures on them to reduce their price to retain sales.

Based on discussions with processors, imported ground rubber appears to be most commonly used in the mulch and turf market segments. Several national firms sell rubber mulch to large retailers with locations in California, and some also have established partnerships with California firms to colorize and/or distribute product. Also, some out-of-state ground producers have national supply contracts with large turf installers and are used in California projects, although such firms generally state that they use California tires if required by the customers, usually due to the use of CalRecycle funding. In grant-funded projects, CalRecycle requires documentation that California tires were used. Asphalt blenders uniformly state that they use only California-based suppliers to meet demand for rubberized asphalt concrete and other paving products using recycled tire rubber. However, some industry players feel that out-of-state rubber is sometimes used in all of the above projects, even if a California-based firm is the supplier. (SAIC did not seek to validate such claims.) Also, some contend that one large terminal blend asphalt producer for a time in 2012 was meeting California demand with asphalt produced out of state, due to equipment issues. In terms of tire-derived products, some mats, playground tiles, and other types of products are sold into California. SAIC was not able to estimate quantities, however.

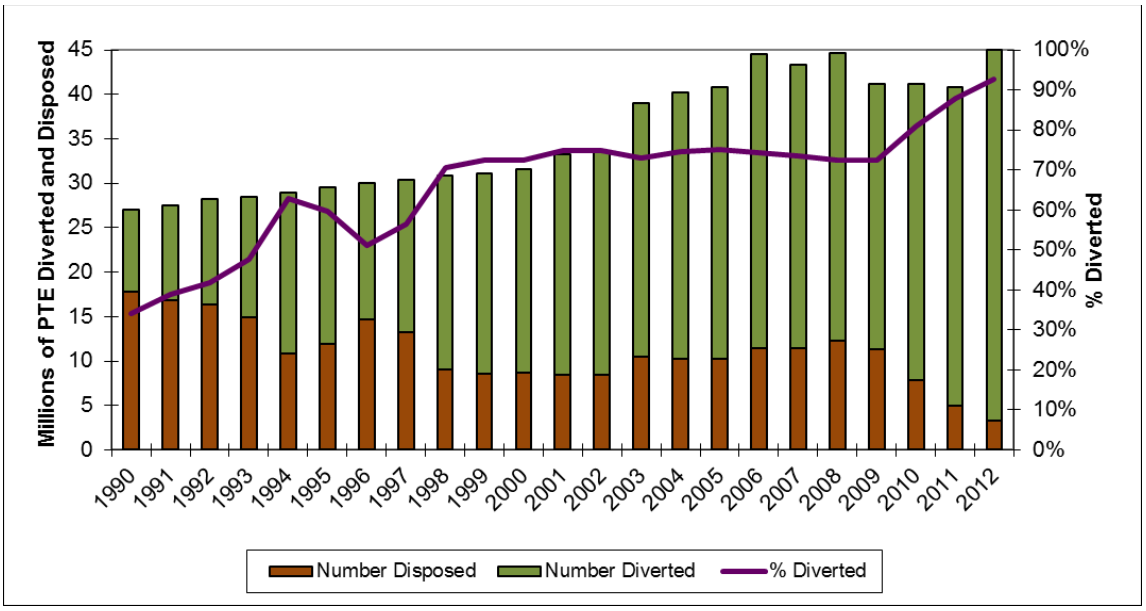
Section 4
Outlook for Increasing Waste Tire Diversion

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. Some brief concluding remarks finish out this section and the report.

Historical Waste Tire Diversion Trends

CalRecycle has adopted a goal of increasing the diversion rate to 90 percent by 2015. As shown in Figure 6, 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. In 2012 the rate exceeded CalRecycle's goal for the first time, at 92.7 percent, with the amount of tires landfilled declining to an all-time low for the third year in a row. Since 2009, rising diversion rates have been largely fueled by the growing waste tire and tire-derived fuel exports; however, this trend appears to have peaked for waste tire exports in late 2012.

Figure 6
Waste Tire Diversion and Disposal Trends



Short-Term Diversion Outlook

Table 3 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 the California waste tire diversion rate probably peaked in 2012, and appears likely to decline somewhat in 2013. While exports are expected to decline in 2013, this will likely be offset by increases in civil engineering and tire-derived fuel. Reuse is expected to remain flat, and alternative daily cover at landfills is expected to remain flat or decline slightly. The wild card is ground rubber, which is difficult to predict at this juncture. While some expect increased rubberized asphalt rubber demand, and turf, mulch and molded products have all grown in recent years, there are signs that rubberized asphalt rubber demand may not increase. It is unclear whether imported ground rubber may impact demand for California rubber in some segments, particularly with declining CalRecycle tire-derived product grant funds in coming years. Overall, SAIC believes the diversion rate is most likely to dip in 2013, though it is difficult to predict how far, and the diversion rate in 2014 will depend largely on how demand unfolds for exports and ground rubber.

Table 3
Short-Term (Two-Year) Diversion Outlook

Category	2012 Diversion		Two-Year Diversion Outlook	Basis for Outlook
	Million PTE	Percent		
Reuse	7.3	16.3%	Flat	▪ 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 retread truck tires. Still, retreaders expect flat or only slightly increasing sales in 2012.
Ground Rubber	9.8	21.7%	Uncertain	▪ RAC is increasingly accepted by local governments and Caltrans; however, paving is limited by budget constraints and the slow economy. ▪ One Caltrans district has reportedly shifted away from RAC use. ▪ Ground producers continue to be squeezed on the 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 may have lower prices. Some ground producers and manufacturers said they expect business to increase slightly in 2012.
Civil Engineering	0.6	1.3%	Growth Expected	▪ Transportation (rail) projects expected in 2013 and/or 2014 will result in large increases of TDA for that segment. ▪ Five CalRecycle-funded landfill projects are expected to use 21,263 tons of TDA in coming months and years, in addition to two existing landfills, indicating significant growth in this segment.

Category	2012 Diversion		Two-Year Diversion Outlook	Basis for Outlook
	Million PTE	Percent		
ADC	1.0	2.3%	Flat or Declining	▪ Three landfills previously using ADC say use is down and/or has been discontinued, suggesting flat or declining use in near future. ▪ Additional CE demand may divert tires from this low-value use.
TDF	7.7	17.2%	Growth Expected	▪ All four California cement kilns that use TDF say demand is expected to increase as cement production increases with an improving economy. ▪ Two cement kilns cite concerns over tire supply or pricing, but this is not expected to impact use much. ▪ Cogeneration demand will remain zero since the last such facility using TDF closed in 2012.
Export	15.3	34.4%	Declining	▪ Demand for waste tire bales/shreds in China has plateaued, while demand for processed TDF, especially in Japan and Korea remains strong. Overall, total waste tire and TDF exports are expected to decline from the 2012 peak in the near term.
Total Diversion	41.7	92.7%	Flat or Declining	▪ Export demand has declined from the 2011 peak. Increased diversion in TDF and TDA is expected while the trend is uncertain for ground rubber and reuse demand is flat.

Long-Term Diversion Outlook

The market size and penetration estimates in Table 4 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 increased somewhat, and now combine both exported and domestic used tire sales. No specific maximum market size for waste tire and tire-derived fuel exports is provided. However, global waste tire market demand far exceeds California generation, as described in Section 4.

Table 4
Estimated Theoretical Market Size, 2012 Penetration[1]

Category	Estimated Theoretical Market Size (Million PTEs)		2012 Marketed (Million PTEs)	2012 Penetration (%)	
	Low	High		Low	High
Ground Rubber	**44.0**	**61.7**	9.8	16%	22%
Rubberized Asphalt Concrete (RAC)	*25*	*35*	4.4	13%	18%
Turf and Athletic Fields	*4.0*	*5.0*	2.2	43%	54%
Loose-fill Playground/Bark/Mulch	*4.5*	*7.5*	1.8	24%	39%
Pour-in-place Playground	*5.0*	*7.0*	0.0	1%	1%
Molded and Extruded	*4.0*	*5.0*	1.3	27%	33%
Other Ground Rubber	*1.5*	*2.2*	0.1	3%	4%
Alternative Daily Cover (ADC)	**35**	**40**	1.0	3%	3%
Civil Engineering (CE)	**17.1**	**24.7**	0.6	2%	3%
Non-Landfill Use	*14.1*	*20.7*	0.0	0%	0%
Landfill Use2[2,3]	*3.0*	*4.0*	0.6	15%	19%
Tire-Derived Fuels (TDF)	**15**	**20**	7.7	39%	51%
Exported Waste Tires/TDF	**50+**	**NA**	NA	NA	NA
Used Tires (Combines Exported and Domestic Use)	**4.6**	**5.0**	5.2	103 %	112%
Retreading	**4.8**	**5.2**	4.0	77%	83%
Other Uses (Including Agriculture)	**1**	**2**	0.0	0%	0%
Total (Excludes Exported Waste Tires/TDF)	**128**	**168**	28.3	17%	22%

[1] Supporting documentation for this table is provided in the 2010 report, Waste Tire Market Development Program Evaluation, Working Paper #1: Market Penetration Report, available on the CalRecycle website. 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.

[2] Estimated market size derived from Kennec estimates.

[3] 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 tire-derived aggregate to go to landfill gas applications. Landfill applications also include use of significant potential quantities of tire-derived aggregate 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 tire-derived aggregate as a priority market segment.

As Table 4 shows, theoretically the greatest opportunity for market expansion in broad terms is in ground rubber markets, especially rubberized asphalt concrete. 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 ground 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 passenger tire equivalents per year.

Within civil engineering, non-landfill 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 passenger tire equivalents through landfill civil engineering uses. The tire-derived fuel market reached a 39-51 percent market penetration rate in 2012. It has the potential to consume an estimated 15–20 million passenger tire equivalents annually; however, CalRecycle is statutorily prohibited from funding projects promoting this as an end use. It is expected that the consumption of tire-derived fuel among the four cement kilns using waste tires/tire chips as a fuel source will increase in 2013.

In 2012 it is estimated that the alternative daily cover market reached a market penetration rate of 3 percent, with an opportunity to potentially consume an additional 35-40 million passenger tire equivalents over 2012 levels. However, alternative daily cover 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 some retreaders said they expected modest growth in 2013. Used tires appear to be at or near maximum size after a jump in 2012.

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 5 lists 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. Note: these barriers remain largely unchanged from those reported in 2011.

Table 5
Barriers to Expanding Market Penetration for Waste Tire Market Segments

Market Category/Sub-Categories	Barriers
Ground Rubber	
All Ground Rubber	**Economic** – Ground rubber producers are seeing reduced tip fee revenues and increased competition for tires 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 ground 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 ground rubber 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 ground rubber 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/mulch • Pour-in-Place Playground • 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/mulch • Pour-in-Place Playground	**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 characteristics of the material limits its usability as a feedstock. **Technical** – Lack of superfine ground 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** – 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. **Regulatory** – Restrictions in China and potentially other countries on waste tire imports.
Cross Category	
• All Ground Rubber and Civil Engineering	**Economic/Policy** – CalRecycle has announced that some funding for the TDP grant program may be shifted to a pilot incentive program in 2014. Also, the reduction in the state tire fee scheduled for January, 2015 could significantly reduce funding for grants to purchasers of these TDPs. This could potentially have a significant impact on demand. No specific estimates or projections of the magnitude of such impacts are currently available.

Market Category/Sub-Categories	Barriers
All Categories	**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 TDPs and feedstocks. There is a lack of information/awareness regarding best management practices to mitigate potential impacts. Although 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 tire-derived product manufacturers adapting to changing markets and infrastructure. Indeed, processors and tire-derived product manufacturers have proven highly resilient to date in the face of pressures from expanding export demand, a weak economy and competitive pressures from ground rubber and tire-derived product importers.

For the first time, export growth has combined with in-state market development successes to push the California waste tire diversion rate over the 90 percent goal. However, some stakeholders call for measuring diversion focused on "high value" recycling, excluding alternative daily cover, tire-derived fuel, and exports from the calculation. By this measure, California's tire diversion rate in 2012 would have been 43.3 percent. SAIC projects the diversion rate will soften in 2013, while the rate in 2014 and beyond will depend heavily on how trends play out, especially in the export and ground rubber markets.

CalRecycle is embarking on some notable adjustments to its tire market development programs, doing away with the Tire-Derived Product Business Assistance Program service grants and shifting some funds from the tire-derived product grants program to a pilot Tire Incentive Program. Stakeholder's comments indicate a lack of consensus on these changes and on how CalRecycle tire market development funds should ideally be allocated. Moreover, funding for tire market development may decline in coming years as the statewide retail tire fee is scheduled to be reduced from $1.75 to $0.75 per tire. However, CalRecycle's existing spending authority and tire fund reserves may mean existing levels of effort will continue for the foreseeable future.

While the exact impact on markets of these trends and policy changes is uncertain, CalRecycle's efforts continue to be driven by a goal of expanding and diversifying demand for California waste tires. The industry has proven itself to be resilient and markets are among the most diverse in the nation. On the whole, this may bode well for the future of waste tire diversion in California, although there are sure to be some bumps in the road along the way.

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 +/- 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 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; 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. Manifest 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, the manifest system does not distinguish between that tire and a 22 pound passenger tire as both are counted as one 20-pound passenger tire equivalent.
- **Data Entry:** As one example, CalRecycle estimates that approximately 25 percent of comprehensive trip log 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 trip logs. 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. Approximately 15 percent of waste tire flows to ports in 2011 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 Outputs:** 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 2007-2011 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:** Manifest data for 28 landfills were analyzed and attempts were made to survey a majority of those facilities. Ultimately, data from 14 landfills were included in this report, including some that may not have been included in previous CalRecycle reports.