
California Waste Tire Market Report: 2013



California Department of Resources Recycling and Recovery

July 2014

Contractor's Report
Produced Under Contract By:



STATE OF CALIFORNIA

Edmund G. Brown Jr.
Governor

Matthew Rodriguez


Secretary, California Environmental Protection Agency

DEPARTMENT OF RESOURCES RECYCLING AND
RECOVERY

Caroll Mortensen
Director

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

Publication # DRR 2014-1503

 To conserve resources and reduce waste, CalRecycle reports are produced in electronic format only. If printing copies of this document, please consider use of recycled paper containing 100 percent postconsumer fiber and, where possible, please print images on both sides of the paper.

Copyright © 2014 by the California Department of Resources Recycling and Recovery (CalRecycle). All rights reserved. This publication, or parts thereof, may not be reproduced in any form without permission.

Prepared as part of contract number DRR 13003 for \$1.5 million, including other services.

The Department of Resources Recycling and Recovery (CalRecycle) does not discriminate on the basis of disability in access to its programs. CalRecycle publications are available in accessible formats upon request by calling the Public Affairs Office at (916) 341-6300. Persons with hearing impairments can reach CalRecycle through the California Relay Service, 1-800-735-2929.

Disclaimer: This report was produced under contract by Leidos Engineering, LLC. The statements and conclusions contained in this report are those of the contractor and not necessarily those of the Department of Resources Recycling and Recovery (CalRecycle), its employees, or the State of California and should not be cited or quoted as official Department policy or direction.

The state makes no warranty, expressed or implied, and assumes no liability for the information contained in the succeeding text. Any mention of commercial products or processes shall not be construed as an endorsement of such products or processes.

Table of Contents

Table of Contents	3
List of Tables	3
List of Figures	4
Section 1 Introduction	5
Background	5
Interpreting and Using Report Findings	5
Industry Overview	6
Section 2 Market Snapshot.....	8
2013 Diversion Rate.....	8
Synopsis of Trends	10
Section 3 Key Trends by Market Segment	12
Supply and Demand Balance.....	12
Reuse	16
Ground Rubber.....	17
Civil Engineering	23
Alternative Daily Cover	24
Other Recycling Uses	24
Tire-Derived Fuel.....	25
Disposal.....	25
Imports and Exports	27
Section 4 Outlook for Increasing Waste Tire Diversion.....	30
Historical Waste Tire Diversion Trends.....	30
Short-Term Diversion Outlook.....	31
Long-Term Diversion Outlook.....	32
Barriers to Expanding Diversion.....	33
Concluding Remarks	35
Appendix A Methodology and Data Limitations	36

List of Tables

Table 1 Estimated End Uses for California-Generated Waste Tires, 2011– 2013	9
Table 2 Analysis of Historical TDP Grant Expenditures and Crumb Rubber Use	15
Table 3 Analysis of Historical Rubberized Paving Grant Expenditures and Crumb Rubber Use	16
Table 4 Estimated Ground Rubber Shipments by Market Category	18

Table 5 Short-Term (Two-Year) Diversion Outlook	31
Table 6 Estimated Theoretical Market Size, 2013 Penetration	32
Table 7 Barriers to Expanding Market Penetration for Waste Tire Market Segments.....	33

List of Figures

Figure 1 California Waste Tire Recycling Industry Flow Chart	7
Figure 2 Twelve-Year Trend in California Waste Tire End Uses	10
Figure 3 Annual Waste Tire Disposal in California, 2011 – 2013 (Million PTEs).....	26
Figure 4 Monthly Flows of Tires to Four Landfills Receiving Majority of California Tires (PTEs/Month).....	27
Figure 5 Trends in Export of Waste Tires/TDF and Used Tires	28
Figure 6 Waste Tire Diversion and Disposal Trends	30

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 (TDPs).

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 published in December 2013.

This report summarizes information on the waste tire diversion rate, market trends, and supply/demand balance in 2013, based on research conducted from January 2014 through April 2014. The report was prepared under CalRecycle contract by Leidos Engineering, LLC, with research, analysis, and writing support provided by Boisson Consulting and DK Enterprises.

Following this introduction, Section 2 provides a snapshot of key findings on diversion activities and markets for California waste tires. 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:

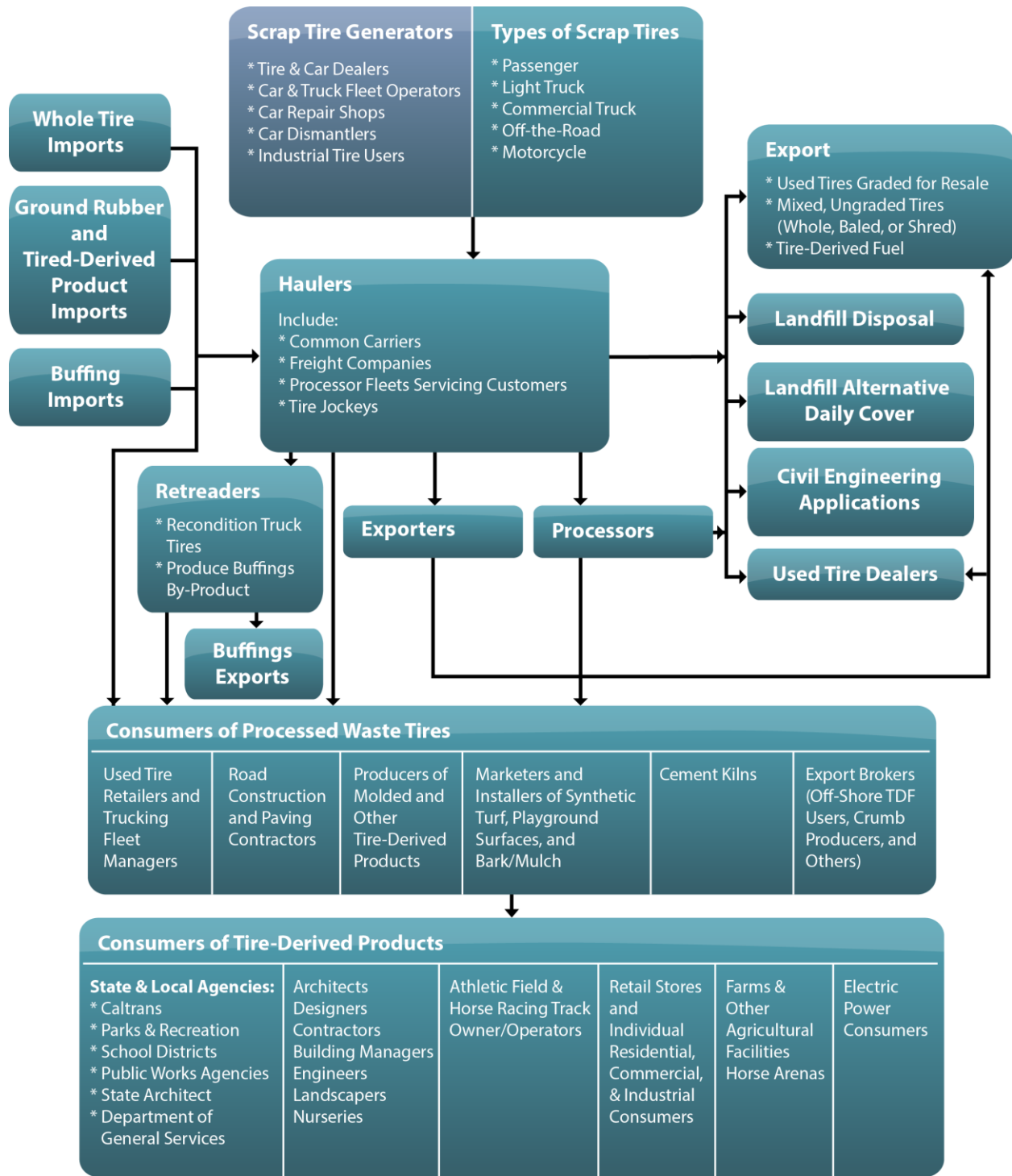
- **Uncertainty but Reasonable Trend Information:** As is described in Appendix A, there are several limitations in the data associated with the estimated market flows. For most market segments, the estimates are thought to be accurate to plus or minus 10 percent and can reasonably be used to evaluate trends over time. In this year's report, the level of uncertainty associated with exports and with used tires (both domestic and exported) is higher than in past years. For used tires, this is because an increasing portion of used tires are being culled and resold by haulers and/or generators, and several processors (which represent one of the main sources of information used in this study) have adjusted their operations in ways that reduce the number of used tires they handle. This complicates documenting trends for these used tire flows because contacting the large number of firms involved is outside the scope of this study. The dynamic nature of waste tire exporters during 2013, with multiple facility closures and startups, complicated data gathering for this segment.
- **Many Sources are Combined and Cross-Checked:** The estimates are generally derived from primary data and information gathered from processors, baler/exporters, tire-derived product producers, landfills, tire-derived fuel (TDF) users, retreaders, CalRecycle's Waste Tire Manifest System (WTMS) and Disposal Reporting System (DRS), CalRecycle staff, and other stakeholders. Data from these sources is combined and analyzed to eliminate double-counting, and cross-checked to derive the most accurate estimates possible given the information available.

- **Estimates Are for Use of California-Generated Waste Tires, Not Total Market Size:** The 2013 estimates presented in the report indicate the approximate number of California waste tires flowing into each market segment. The report does not “count” imported whole tires, ground rubber, or finished products, nor does it “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 Data Is 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 and processed tires that are stored as inventory are not necessarily captured by this methodology.
- **Tire Diversion Rate is Not Adjusted for Residuals:** As with most state and national tire recycling market studies, in this report the tire diversion rate is based on whole passenger tire equivalents (PTEs) that go to different market segments. Adjustments for steel and fiber residuals that may occur as a result of producing ground rubber have not been made. However, in 2013, the vast majority of tire wire, rims, and fiber residuals were recycled, so incorporating these residuals would not appreciably affect the overall tire recycling rate.

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 facilities such as cement kilns using whole tires and landfills that use shred or cut tires. Additionally, five “exporter” facilities were identified which, in 2013, received significant quantities of whole waste tires and generally baled or shredded them for export. The number of facilities involved in export shifts rapidly, and as of May 2014, one of these facilities had ceased operations, while at least two additional facilities had started up and were expanding operations.

**Figure 1
California Waste Tire Recycling Industry Flow Chart**



Section 2

Market Snapshot

This section provides a snapshot of California waste tire markets in 2013 and high-level trends as of spring 2014. More detailed, segment-specific trend information is provided in Section 3.

2013 Diversion Rate

Table 1 on the following page lists the number of passenger tire equivalents (PTE)¹ flowing to each market segment and the percentage of the total PTE managed annually, for 2011 through 2013. After reaching an all-time high of 92.9 percent in 2012 (and exceeding CalRecycle's 90 percent goal) the overall waste tire diversion rate dipped to 87.3 percent in 2013. However, some stakeholders focus on a more narrowly defined recycling rate that excludes waste tire exports (not including used tire exports), alternative daily cover (ADC), and tire-derived fuel (TDF), which CalRecycle is statutorily prohibited from promoting. Excluding these segments, the 2013 diversion rate would have been 38.7 percent, down from 43.3 percent in 2012. Tire disposal, conversely, increased proportionately in 2013 to 12.7 percent from an all-time low in 2012 of 7.3 percent of all tires.

¹ PTE stands for passenger tire equivalent, which is defined by the State of California to equal 20 pounds. Data for 2011 and 2012 are from the "California Scrap Tire Market Report: 2012."

Table 1
Estimated End Uses for California-Generated Waste Tires, 2011– 2013²

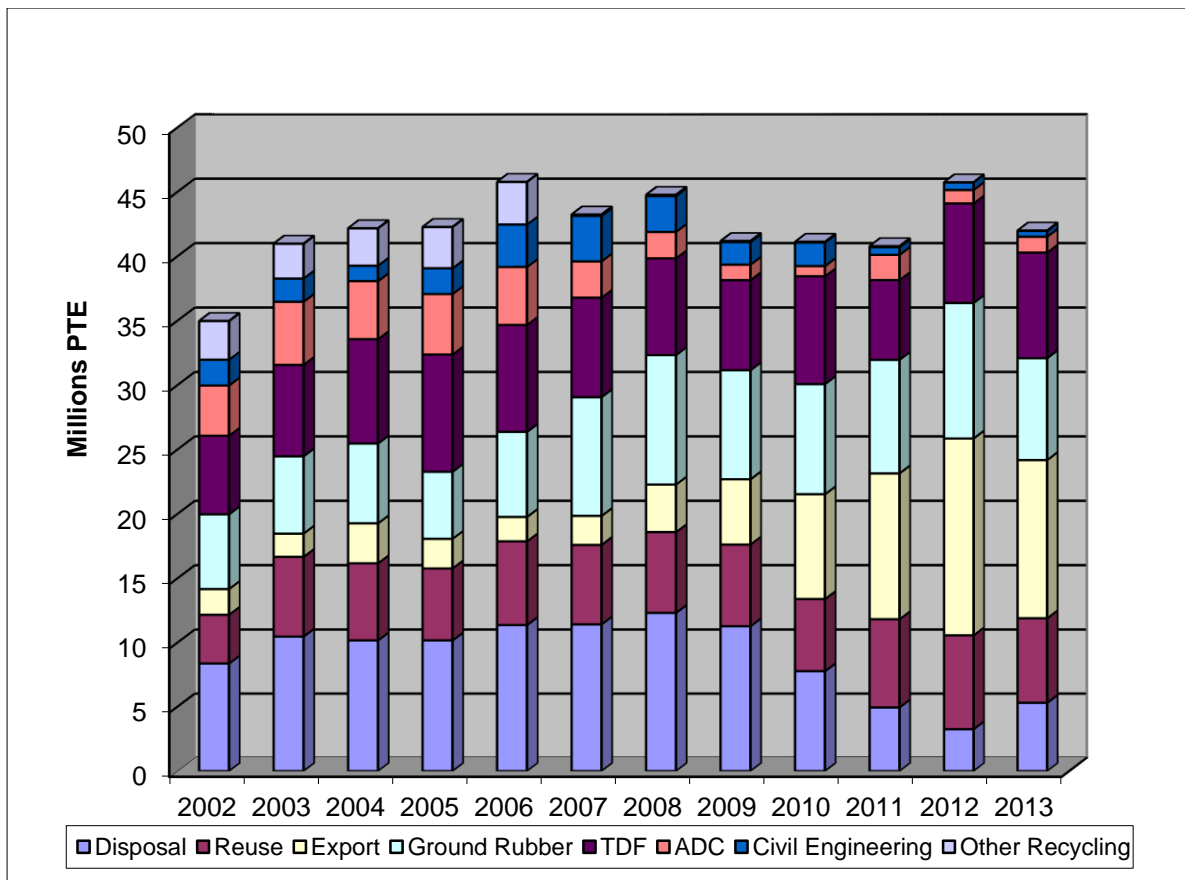
Category	Sub-Category	2011		2012		2013		Percent change 11-12
		Million PTE	Percent of Total	Million PTE	Percent of Total	Million PTE	Percent of Total	
Export	Waste Tires and Processed TDF	9.6	23.4%	13.5	29.4%	11.0	26.2%	-18.2%
	Used Tires (Exported)	1.8	4.3%	1.8	4.0%	1.3	3.0%	-30.5%
	Subtotal	11.3	27.7%	15.3	33.4%	12.3	29.2%	-19.7%
Reuse	Retread	4.1	10.0%	4.0	8.7%	4.1	9.7%	2.0%
	Used Tires (Domestic)	2.8	6.9%	3.3	7.3%	2.5	6.0%	-24.2%
	Subtotal	6.9	16.9%	7.3	16.0%	6.6	15.7%	-10.0%
Ground Rubber	RAC & Other Paving	4.9	11.9%	5.2	11.3%	3.5	8.4%	-31.4%
	Turf & Athletic Fields	1.7	4.2%	2.2	4.7%	2.0	4.8%	-7.0%
	Loose-Fill Play/Bark/Mulch	1.1	2.6%	1.8	3.9%	1.4	3.4%	-19.9%
	Molded & Extruded	0.9	2.2%	1.3	2.9%	0.9	2.1%	-32.5%
	Other	0.1	0.3%	0.1	0.1%	0.0	0.1%	-33.5%
	Subtotal	8.8	21.6%	10.5	23.0%	7.9	18.8%	-24.9%
Civil Engineering	Landfill Applications	0.6	1.4%	0.6	1.3%	0.3	0.6%	-55.3%
	Non-Landfill Applications	0.0	0.0%	0.0	0.0%	0.2	0.5%	NA
	Subtotal	0.6	1.4%	0.6	1.3%	0.5	1.1%	-22.0%
Alternative Daily Cover		2.0	4.8%	1.0	2.3%	1.2	2.9%	17.5%
Other Recycling		0.1	0.2%	0.0	0.0%	0.0	0.0%	NA
Tire-Derived Fuel		6.2	15.2%	7.7	16.9%	8.2	19.5%	6.2%
Landfill Disposal		5.0	12.2%	3.3	7.1%	5.3	12.7%	63.1%
Estimated Total Managed		40.8	100.0%	45.8	100.0%	42.0	100.0%	-8.2%
Total Diverted from Landfill		35.8	87.8%	42.5	92.9%	36.7	87.3%	-13.7%
Imports		1.2	3.0%	0.7	1.6%	1.2	3.0%	68.5%

²Table 1 Notes: a) Numbers may not sum to subtotals or totals exactly due to rounding; b) 2012 data reflects revised estimate of RAC & Other Paving, which affected 2012 total flows and percentages slightly; c) Of 2013 total waste/TDF exports, at least 4.8 million PTEs were shipped as processed TDF; d) Exports and used tires (domestic and export) subject to higher uncertainty than other categories; e) The co-generation TDF category was removed as the last plant in this category closed in 2012, with prior year data combined into the TDF category; f) The pour-in-place category within ground rubber was removed as the category uses a relatively small amount of ground rubber, relying mainly on buffings produced by retreaders, which is excluded from this study to avoid double-counting; g) Virtually all wire, rims, and fiber residual from California processing operations were recovered in 2013; and h) The tonnages listed in Table 1 reflect adjustments for tires imported into California and managed by California processors. The portion imported was allocated across all market segments that a processor sells into.

Synopsis of Trends

Figure 2 shows waste tire end-use trends by broad market category since 2002.³ In recent years, rapid and unprecedented growth in exports of tires to Pacific Rim nations was largely responsible for boosting the overall diversion rate beyond the 72-75 percent level (where it had hovered for more than 10 years). Year-over-year, exports are estimated to have declined by nearly 20 percent in 2013, compared to growth of nearly 30 percent between 2012 and 2013. While overall, exports are estimated to have declined in 2013, this market segment is very dynamic. Exports appear to be on the rebound in 2014, and some established processors continue to feel the impacts from the multi-year export surge, with markedly reduced and/or adjusted operations.

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



Retreading is estimated to have increased in 2013 by about 2 percent, based on survey reports, while some processors report greatly reduced used tire diversion. Used tire volumes were particularly challenging to estimate in 2013 as an increasing portion is handled by haulers prior to their reaching processors.

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.

The decline in diversion in 2013 was also due in part to a drop in sales of crumb rubber⁴ produced from California tires of about 25 percent, caused by competitive pressures and soft markets, exacerbated by lingering impacts from the collection revenue decline and tire supply shifts caused by the export surge. (See the 2012 California Waste Tire Market Report for a detailed analysis.) The decline was most apparent for paving, mulch, and molded products, and continuing softness in these markets makes the 2014 trend uncertain. A growing number of firms produce diverse products in the molded/extruded segment, but these products are still using relatively low volumes of crumb rubber as they seek to ramp up production and sales.

Some California processors and tire-derived product (TDP) vendors continue to express concern regarding competition from out-of-state importers of ground rubber and tire-derived products. While there were no major expansions in California crumb rubber production capacity in 2013, there is overcapacity at the national and global level. Crumb rubber suppliers in other states, Canadian provinces, and even Europe are currently supplying California projects at competitive prices.

Civil engineering declined by 22 percent in 2013, although several landfill and transportation projects funded or otherwise supported by CalRecycle are scheduled in 2014, which should boost volumes. Use of tire shreds as alternative daily cover increased by 17.5 percent, largely due to an increase at a single Northern California landfill. Finally, use of California-produced tires at California cement kilns increased by approximately 6.2 percent, excluding additional TDF produced from imported tires. Cement kiln demand is strong and, depending on California construction trends, TDF could continue to grow in 2014 and in future years.

As detailed in the current Five-Year Tire Plan, CalRecycle is adjusting its waste tire market development programs, including shifting approximately half of the traditional budget allocated to the TDP Grant Program (supporting the purchase of a wide range of products made from ground rubber) to a new Tire Incentive Program that will focus on promoting new tire-derived product (TDP) development and shifting established product manufacturers to use of ground rubber from other feedstock (i.e., feedstock conversion). Also, the Tire-Derived Product Business Assistance Program (TBAP), which offered a wide variety of technical, market, and product testing assistance over the past six years, has been replaced by the Tire Outreach and Market Analysis (TOMA) program. TOMA focuses exclusively on outreach and education to promote TDPs to various government and private-sector potential purchasers, along with continuing annual waste tire market studies. While the full effect of these shifts is hard to predict, they are intended to effectively focus CalRecycle resources on diversifying and expanding markets. Analysis of past grants indicates that about 25 percent of the total sales of California-produced non-paving TDPs were supported by CalRecycle TDP grants, while about 12.5 percent of California crumb rubber sold to paving applications was supported by CalRecycle paving grants. (See Section 4 for more details.)

Taking all of the above into account, the overall market development outlook is mixed, and it appears the 2014 waste tire diversion rate may hover near the 2013 level of 88 percent, although it is possible that renewed export demand could boost the rate over the 90 percent mark again, as it did in 2012.

⁴ The terms ground rubber and crumb rubber are used synonymously in this report.

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 feedstock used to make a wide range of products.

Supply and Demand for Whole Tires

California has a large, dynamic infrastructure for collecting and processing waste tires. In 2013, the vast majority of tires generated in California flowed to one of 14 processors or to one of four exporter facilities (i.e., facilities that primarily or exclusively ship baled or shred tires overseas). For the purposes of this report, processors are defined as facilities that receive significant quantities of whole, waste tires, and process them to meet market requirements by culling and grading used tires or by producing tire shreds or chips, tire-derived fuel, and/or crumb rubber. Exporters are defined as facilities that accept whole tires for the exclusive or nearly exclusive purpose of preparing them for export overseas. While several of the 14 processors analyzed export some TDF or tire shreds, they also ship tires to several other end uses, whereas the four exporters analyzed are focused exclusively on export. While the 14 processors are well established and have been in operation for several years, the export facilities are much more dynamic, and in recent years several facilities have started or ceased operations abruptly. One of the four export facilities active in 2013 has since closed, while at least two new facilities have started up.

As described in detail in the 2011 California Waste Tire Market Report (available at <http://www.calrecycle.ca.gov/publications/Documents/Tires%5C2012021.pdf>), the explosion of exported used and processed tires in recent years greatly disrupted the supply and demand balance for whole tires in California. Export facilities, with low capital requirements (and in some cases without permits), were able to start up rapidly and greatly reduce tip fees charged to generators. This reduced access to supply and collection-related revenues to established processors operating under a much different business model than the exporters. While export demand softened somewhat for a time in 2013 and crumb rubber sales were down, overall competition for whole tires remained strong and is apparently increasing again in 2014. Some established processors continue to be severely impacted by the trend, with lower volumes and profitability.

As shown in Table 1, the supply of waste tires was estimated to be lower in 2013 compared to 2012. However, it is possible that inventory holdovers and uncertainty in market estimates (generally estimated at +/- 10 percent) account for part or all of this difference. Although whole tires and processed feedstock material 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, and with each region having somewhat different market dynamics.

As in previous years, it should also be noted that a number of developers are investigating the potential to establish new facilities in California that could use significant quantities of California-generated waste tires for crumb rubber production, pyrolysis, and other types of processes and technologies. So far, none of these proposed or discussed facilities has materialized on a commercial scale. However, if one were to be sited and compete for tires, it could have a significant impact on the supply-demand balance and could negatively affect existing firms involved in managing California scrap tires in terms of access to tires, collection revenues, and competition for sales. Given the current strong demand for California tires, such a venture would likely require attractive pricing to secure an adequate feedstock supply.

Supply and Demand for Processed Tires

Overall, use of California tires to produce crumb rubber declined by approximately 25 percent between 2012 and 2013, with sales of crumb rubber to paving applications down 31 percent, loose-fill/mulch down about 20 percent, and molded/extruded products down about 32 percent. In addition to softening demand, as in past years, ground rubber producers cite strong competition from out-of-state ground rubber producers as a factor in keeping prices and sales lower than they would otherwise be. Moreover, according to the Rubber Manufacturers Association, national crumb rubber sales held steady in 2012 and 2013 at approximately 1.3 billion pounds, even though a significant amount of new production capacity has come online. This has led to significant overcapacity for crumb rubber production at the national level, which is exacerbated by imports from Canada and even from Europe. As a result, crumb rubber producers report that crumb rubber from these suppliers is readily available in California at very competitive prices, and this is dampening sales and revenues.

While no expansions in overall tire processing capacity or crumb rubber production were identified in California in 2013 or early 2014, as mentioned above, some firms have expressed interest in establishing new crumb rubber facilities in California. Given the current overcapacity and strong competition for whole tires in the state, it is far from certain that such a venture will materialize. But any new capacity in the near term, without a significant expansion of market demand, would appear likely to increase overcapacity, with further detrimental impacts to existing producers in terms of competitive pricing and supply-and-demand pressures.

As in past years, several processors state they are interested and prepared to produce tire-derived aggregate (TDA) 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, however, because they view current markets as more profitable.

Implications for Tire Market Development Efforts

As in recent years, given the continuing strong demand for waste tires, strong export demand, national crumb rubber overcapacity, and relatively soft demand for crumb rubber and civil engineering products (notwithstanding expected increases in TDA demand), investment in new processing capacity should be viewed very cautiously. While it is unclear how these trends will play out ultimately, in the near term continued competitive pressures combined with flat or reduced demand for products produced from crumb rubber appear likely to constrain growth. In

this context, the need for expanding and diversifying market demand for TDPs has never been more important.

CalRecycle has implemented, or is in the process of implementing, several program adjustments aimed at market expansion and diversification. Because funding is limited, CalRecycle is eliminating or reducing some programs in order to focus resources on new approaches. These include:

Elimination of the Tire-Derived Product Business Assistance Program (TBAP) and shift to a focus on outreach and market analysis. The TBAP program provided a range of technical, marketing and product testing assistance to numerous processors and TDP manufacturers through four application cycles, between 2006 and 2013, along with a variety of other industry-wide market development activities and research. The program has been eliminated, with the rationale that most eligible firms in California had participated in one or more grant cycles and have received significant support. In its place, a new Tire Outreach and Market Analysis program is focused exclusively on two areas: Outreach to prospective public and private purchasers of TDPs and continued market analysis. The program also supports the Tire Incentive Program and Tire conference. The focus on outreach is consistent with advice from many stakeholders who see the need to increase TDP awareness, demand, and sales as the top priority.

Shift in resources from TDP Grants to the new Tire Incentive Program (TIP). For several years CalRecycle had funded the popular Tire-Derived Product (TDP) Grant Program at about \$4 million per year. However, due to high demand and available funding, allocations during FY 2010/11 and FY 2011/12 were about twice this level. In FY 2012/13, funding levels were approximately \$4 million, dropping to \$1.4 million in FY 2013/14, with the savings being shifted to a new Tire Incentive Program (TIP), which is funded at about \$2.6 million in FY 2013/14 and \$3 million in FY 2014/15. The TIP is focused on promoting feedstock conversion and market expansion by providing payments of 10 cents per pound to manufacturers of established products that increase sales, 20 cents per pound for manufacturers shifting feedstock from virgin rubber to crumb rubber for at least 5 percent of feedstock needs, and 20 cents per pound for manufacturers of compound plastic-rubber products (or other combinations of materials) or those using fine crumb rubber of 50 mesh or greater mesh size. This can result in a combined incentive of up to 40 cents per pound to select manufacturers.

CalRecycle adopted adjustments to these incentive rates during its August 2014 monthly meeting. Among other changes, the adjustments provide a new 5 cents per pound incentive for all TDP production, increasing the feedstock conversion incentive to 30 cents per pound (which also includes combining tire crumb rubber with other materials), and setting the incentive for using fine crumb rubber (50 mesh or finer) at 40 cents per pound. (The 10 cents per pound incentive continues for established products that increase sales.) The program is being operated as a pilot, and additional adjustments may be made over time based on lessons learned. It is focused on expanding demand and the range of TDPs produced in California by California-based companies. Past experience suggests that, to the extent the Tire Incentive Program triggers increased crumb rubber demand, it is likely to do so relatively slowly over several years.

Launching a new TDA grant program and continuing significant funding for the paving product grants. A new Tire-Derived Aggregate (TDA) grant program was launched in 2012-13, with a total of eight grants awarded through two application cycles, including four lightweight fill and five landfill civil engineering projects expected to use more than 2.8 million PTEs. Going forward, \$1.6 million is budgeted for TDA grants in each of FY 2014/15 and 2015/16.

CalRecycle’s Rubberized Paving Grant Program is budgeted at \$8 million in FY 2014/15, due in large part to an approved budget change proposal increasing available funding by \$5 million.

Some stakeholders have expressed concern that certain California TDP markets, such as playground surfacing, may be highly reliant upon these grant programs and/or that reducing funding for them could have a significant detrimental impact on sales. In the current competitive environment with overcapacity of crumb and TDP production at the national level, any reduction in CalRecycle grant funding, which can only be used for projects using California tires, is likely to have some level of detrimental impact on short-term sales of California-produced products. However, over time the Tire Incentive Program will provide incentives for expansion and diversification into new product types that will benefit the industry and California tire recycling markets.

To help gauge the role of CalRecycle grant programs in the waste tire market, Leidos analyzed expended grants and use of crumb rubber based on final reports of completed projects. To account for shifts in annual funding and the fact that funded projects are implemented over a two- or three-year period, and that some are not implemented at all or may be implemented at a reduced level, the analysis considered grant projects over a four-year period, from FY 2008/09 through FY 2011/12.

As shown in Table 2 below, analysis of the TDP Grant Program indicates that on average during the four-year study period, CalRecycle issued 48 TDP expended grants per year (comprising 83 percent of all awarded grants), with total expenditures of \$3.5 million and an average grant of \$73,290. On average, these annual grants used 11.8 million pounds of ground rubber per year, in aggregate for an average of 246,386 pounds each. These grant-funded crumb sales constituted about 25 percent of total sales of California crumb rubber into non-paving products. (Paving products are analyzed separately in Table 3.)

**Table 2
Analysis of Historical TDP Grant Expenditures and Crumb Rubber Use**

Year	# of CA Grants Expended	% of Awarded Grants Expended	CA TDP Grant Expenditures	CA Crumb Used in TDP Grant Projects (lb.s)	Total Non-RAC CA Crumb Sales (lb.s)	% of Total CA-Made Sales Covered by Grants
2008/2009	31	91%	\$ 1,963,437.69	6,500,225	39,746,525	16.4%
2009/2010	36	97%	\$ 2,441,318.33	7,912,377	39,200,000	20.2%
2010/2011	71	86%	\$ 5,115,824.82	17,356,548	42,500,000	40.8%
2011/2012	52	70%	\$ 4,551,158.28	15,536,985	70,600,000	22.0%
Average	48	83%	\$ 3,517,934.78	11,826,534	48,011,631	24.6%

As shown in Table 3, analysis of the Rubberized Paving Grant Program indicates that on average during the four-year study period, CalRecycle issued 36 paving grants per year that were expended (comprising 79 percent of all awarded grants), with a total expenditure of \$4.8 million and an average grant size of \$132,195. On average, these annual grants used 9.2 million pounds of ground rubber per year, in aggregate, or an average of 254,701 pounds each. These grant-funded crumb sales constituted about 13.5 percent of total sales of California crumb rubber into rubberized paving projects.

Table 3
Analysis of Historical Rubberized Paving Grant Expenditures and Crumb Rubber Use

Year	# of CA Grants Expended	% of Awarded Grants Expended	CA Paving Grant Expenditures	CA Crumb Used in Paving Grant Projects (lb.s)	Total CA-Made Crumb Sold for Paving (lb.s)	% of Total CA-Made Sales Covered by Grants
2008/2009	31	72%	\$ 4,666,915	12,295,996	60,320,000	20.4%
2009/2010	36	73%	\$ 3,945,199	8,725,945	70,400,000	12.4%
2010/2011	39	81%	\$ 5,326,390	7,848,593	68,100,000	11.5%
2011/2012	38	88%	\$ 5,097,619	7,806,454	72,200,000	10.8%
Average	36	79%	\$ 4,759,031	9,169,247	67,755,000	13.5%

Both TDP and paving grants are awarded mainly to local government agencies, while California crumb rubber is sold to a wide variety of customers, so the share of the local government market funded by CalRecycle is not discernable. Rubberized paving sales are mostly to Caltrans, which is mandated to use specified percentages of U.S.-produced crumb rubber, although there is no requirement that the crumb rubber be produced in California. (See the “RAC and Other Paving” Section below for more details.)

Finally, it should be noted that legislation adopted in 2013 (AB 8, Perea and Skinner) has extended the California tire fee of \$1.75 to January 1, 2024. The fee was previously scheduled to sunset on January 1, 2015. CalRecycle receives \$1.00 of each fee paid, indicating that the agency’s tire market development programs will remain well funded through the next 10 years at least.

Reuse

Reuse, including retreading and sale of partially worn used passenger tires, remains strong in California. However, shifts in used tire handling appear to have caused a reduction in the number of used tires diverted, with the overall domestic reuse category declining by about 24 percent between 2012 and 2013, from 7.3 million PTEs to 6.6 million PTEs.

Retread Tires

After two years of modest declines and a number of plant closures and acquisitions, Leidos estimates that retreading in California grew by about 2 percent in 2013, compared to 2012, based on retreader survey responses, indicating a total of about 4.1 million PTEs retread. While some firms reported flat or slight declines in sales, several others reported modest increases. Retreading of tires in California is limited to truck tires and other specialty tires (e.g., airplane and industrial equipment tires), and demand remains strong. California is home to about 30 truck tire retreading companies that operate more than 40 retreading locations. In addition, some tires are exported and retreaded in other states. 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 2014.

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. Historically, many haulers and processors have viewed markets for used tires as attractive because of the relatively low cost to meet

specifications (consisting of inspection and grading), and the relatively strong demand, and thus, price. A large network of dealers purchase used tires for wholesale distribution to tire outlets, for direct resale to consumers, and/or for export.

Increasingly, however, haulers and even some generators are becoming more actively involved in culling discarded tires and selling them prior to their receipt by processors. The extent to which this occurs depends on the type of generator (e.g., small tire shops vs. large chains), which influences both the quality and quantity of potentially reusable tires, and may in some cases curtail culling prior to receipt by the processor. For example, many large chains that contract exclusively with a single processor to handle their tires are not subject to this trend because their policies preclude it. Some processors with such accounts continue to successfully focus on reuse. However, some other processors are reducing the level of effort allocated to culling used tires and are even adjusting their business model to focus more on steady collection revenues through higher fees rather than variable used tire revenues. In some cases, the portion of incoming tires sold to reuse markets has dropped as significantly as from about 8 percent to about 1 percent.

One result of this trend is that it has become more challenging to estimate trends in tire reuse, including both the overall volume reused and the portion that is exported versus reused domestically. This is because surveying the hundreds of haulers that are actively involved in used tire sales is beyond the scope of this study. Based on documented flows and processor survey and interview responses, we estimate that the total quantity of used tires culled from the scrap tire flows in California during 2013 was about 3.8 million PTEs, with approximately one-third of these being used tires that were shipped outside of the country. This analysis implies that exported used tires declined between 2012 and 2013 by 30 percent, from just under 1.8 million PTEs to just under 1.3 million PTEs, while domestically sold used tires declined by nearly 24 percent, from 3.3 million PTEs to 2.5 million PTEs. However, as previously noted, the used tire market segment is subject to higher uncertainty than other categories. Leidos intends to examine alternatives for estimating used tire volumes prior to undertaking the next market report.

Ground Rubber

Overview

California is home to six ground rubber producers. These firms used approximately 7.9 million PTEs in 2013 to produce and sell approximately 111 million pounds of ground rubber, a 25 percent decline compared to the amount shipped in 2012. The terms ground rubber and crumb rubber are generally used synonymously in this report, although some distinguish between ground rubber of ¼ to ¾ inch (generally used for loose-fill playground, landscape mulch, and horse arena footing) and crumb rubber of 4- to 30-mesh (used in rubber-modified asphalt, synthetic turf infill, and molded products). Small quantities of finer crumb rubber of 30+- mesh is used to produce certain products like coatings, sealants and tire rubber-plastic products.

Table 2 summarizes California crumb rubber production by market segment for 2012 and 2013. In 2013, the amount of California-produced crumb rubber sold into each market segment declined compared to 2012, by 20 percent (for loose-fill/mulch) to about a 32 percent decline for RAC/Other Paving and Molded/Extruded products.

**Table 4
Estimated Ground Rubber Shipments by Market Category⁵**

Category	2012		2013	
	Millions of Pounds	Percent of Total	Millions of Pounds	Percent of Total
RAC & Other Paving	65.1	49%	49.6	45%
Turf & Athletic Fields	30.0	20%	28.1	25%
Loose Fill/Bark/Mulch	23.8	17%	19.8	18%
Molded & Extruded	16.6	13%	12.5	11%
Other	0.8	1%	0.6	1%
Total	138.2	100%	110.7	100%

Market-specific factors influencing this decline are described below. In general, it appears that California crumb rubber production and sales declined in 2013 due to a combination of factors. These include:

- **Soft or Declining Demand in Most Market Segments.** As described below, the factors constraining soft demand vary by market segment.
- **Competition from Crumb Rubber Producers from Outside California.** As in past years, the majority of the crumb rubber producers report that imported crumb rubber from other states and countries has impacted their ability to compete, resulting in reduced sales and revenue. According to the Rubber Manufacturers Association, national crumb rubber production capacity grew from 928 million pounds in 2011 to 1.3 billion pounds in 2013, while market demand was flat or declining. And, a large new crumb rubber producer recently began operations. Crumb rubber from these out-of-state producers, as well as from producers in Canada and Europe, continues to be sold in California at very competitive prices, reflecting an over-abundance of crumb rubber nationally and globally.
- **Competitive Pressures Within California, Especially Those Related to Export Growth.** As previously described in the “Supply and Demand Balance” some established processors in California have been negatively impacted by the rise of exports over the past few years. These impacts may include reduced access to supplies and reduced collection account revenues that in some cases disrupted established business models and historical cash flow patterns. Some crumb rubber producers have adjusted their business models in ways that may de-emphasize crumb rubber production in some cases.

Looking forward, these constraints may continue to suppress crumb rubber production in 2014 and possibly beyond. CalRecycle’s new Tire Incentive Program and other activities hold the potential to incentivize expanded and diversified markets for products that have not benefitted significantly from previous grant programs, such as molded/extruded products and certain flooring products, through new product development and feedstock conversion. However, based on past experience, to the extent that these programs succeed, new demand is likely to grow relatively slowly over time. Also, reduced funding for the TDP Grant Program may result in

⁵ The estimated quantity shipped reflects adjustments to reflect a portion of imported tires and for yield rates. The 2012 estimates were revised somewhat from those published in 2012 California Waste Tire Market Report.

somewhat reduced sales to local government agencies and school districts in the short run. As shown in Table 3, based on an analysis of expended grants over a four-year period, the TDP grant program funded approximately 25 percent of all sales of California-produced crumb rubber sold into non-paving applications. In the long run, the vitality of California's crumb rubber infrastructure will depend on the ability of established markets to rebound, new markets to grow, and on crumb rubber producers to adapt to changing market dynamics. At the national level, if the trend of increasing crumb rubber production capacity and flat market demand persists, it could ultimately lead to capacity reductions through plant closures and/or acquisitions.

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 RAC and other paving projects, use of California tires in this market segment declined by about 31 percent in 2013 compared to 2012. This was apparently a result of all three factors discussed above generally for the crumb rubber segment – reduced demand, competition from outside California and competitive challenges and corresponding processor operational adjustments triggered in part by the export market disruptions also discussed above.

The largest consumer of crumb rubber for paving projects in California is Caltrans, which was required by statute to increase the percentage of all flexible pavements that use RAC to 25 percent by 2010 and 35 percent by 2013. Caltrans reports that it exceeded this target in 2011 with a rate of 35.9 percent while using more than 6.6 million PTEs in paving projects.⁶ Although the 2012 Caltrans Waste Tire Report indicates they used approximately 4.5 million PTEs in paving, Caltrans representatives say the percentage of paving using rubber was 29 percent. According to the Caltrans 2012 Waste Tire Report, the large amount of crumb rubber used in 2011 was exceptional. And while the Caltrans 2013 Waste Tire Report is not yet available, representatives indicate that in 2013, overall paving was down significantly, as was the percentage of paving that incorporated crumb rubber, and that this situation is likely to continue in 2014. The reasons cited for this include constrained funding for paving in general and an increase in the price differential between rubber asphalt and traditional hot mix asphalt.

Through 2014, statute currently requires Caltrans to use asphalt rubber for the “wet process” (based on ASTM D 6114) to meet at least 50 percent of their mandated usage level; however, the agency is increasingly using the “terminal blend” process as well. Terminal blend is made when fine rubber crumb is dissolved in the asphalt blend mixture to form a liquid concentrate using special equipment at the asphalt refinery, eliminating the need to blend and mix crumb rubber in the field. 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 different products and each has a variety of applications. 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).

⁶ Caltrans, 2012 Annual Report to the Legislature and Department of Resources Recycling and Recovery, Senate Bill 876 Waste and Used Tires. Available at: <http://www.dot.ca.gov/reports-legislature.htm>.

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 for both the field blend and the terminal blend may come from outside the state.

Industry stakeholders expressed concern that the future demand for crumb rubber in California paving applications is uncertain, as are the specific technologies and specifications of rubber that will be required. Under current legislation, after 2015, Caltrans will have the ability to use any technology it chooses to satisfy its legislative mandate to use crumb rubber in paving, and the mix of wet process, terminal blend, and/or other technologies they may use is uncertain, as is the overall level of paving and the percentage that will involve crumb rubber use. Moreover, legislation currently under consideration could potentially alter this Caltrans mandate.

RAC is also used by local governments, sometimes with financial grant support and technical assistance provided by CalRecycle, and recent legislation (AB 513, Frazier) made various changes to eligible applicants, projects, and the reimbursement approach. The legislation shifts awards to a fixed dollar amount for reimbursements of \$2 per 12 pounds of rubber, unless CalRecycle determines a different amount is appropriate to further the purpose of the statute. CalRecycle is budgeting \$8 million for the FY 2014/15 year. As described above under the “Market Development Implications” section, an analysis of four years of expended paving grants indicates that, on average, CalRecycle issued 36 paving grants per year that were expended (comprising 79 percent of awarded grants), with a total expenditure of \$4.8 million and an average grant size of \$132,195. On average, these annual grants used 9.2 million pounds of ground rubber annually, in aggregate, or an average of 254,701 pounds each. These total grant-funded crumb rubber sales constituted about 13.5 percent of total sales of California crumb rubber into rubberized paving projects over the four-year study period.

Synthetic Turf and Athletic Fields

Ground rubber in the 10- to 20- mesh range is used as infill between the blades of grass in synthetic turf athletic fields and in a variety of running tracks and other applications. The statewide use of California-produced ground rubber in synthetic turf and athletic fields in 2013 is estimated to be 28.1 million pounds, a decrease of 7 percent over 2012 levels.

Synthetic turf sales have been strong for several years, and currently about 9,500 fields have been installed nationally, with about 900 in California.⁷ The total number of fields installed annually has continued to grow; however, about 22 percent of the fields are replacements, suggesting that demand for new fields has been flat.

As synthetic turf fields reach the end of their useful life, there is growing interest in reclaiming the fields and reusing the materials, including the ground rubber infill component. Indeed, industry representatives indicate that within three years, 75 fields per year could be reclaimed in California alone, producing approximately 15 million pounds of used ground rubber. Reclaiming this ground-rubber infill and using it in new applications is a relatively new activity; therefore, there is little collective experience in doing so. If challenges can be addressed, such as those associated with removing contaminants and ensuring that original performance specifications can

⁷ Much of the information presented in this section is based on presentations by Mark Heinlein, President, Turf Reclamation Systems and John Baize, President, ACT Global and Chairman, Synthetic Turf Council, at the 2014 CalRecycle Tire Conference. Available at: <http://www.cce.csus.edu/conferences/CalRecycle/tw14/index.cfm?pid=668>.

be achieved, then it is possible that this reclaimed ground rubber could be reused in new turf installations and/or used in other market applications, including those described in this report. While that would help to maximize the ongoing value of recycled ground rubber used in turf fields, it could also place additional downward pressure on demand for newly produced ground rubber, exacerbating the ground rubber market constraints previously described.

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. The market is also fueled to a degree by CalRecycle TDP grants, for which funding in FY 2013/14 and FY 2014/15 will be somewhat reduced.

In recent years, some environmental organizations have raised potential concerns about environmental health and safety issues related to synthetic turf fields, and a few local agencies have chosen to avoid the products. However, these concerns appear to be diminishing.

Also constraining demand is the fact that established industry relationships often dictate suppliers of ground rubber used in turf installations, and in some cases this means that out-of-state suppliers are used rather than California ground rubber suppliers.

Looking forward, it appears that demand for ground rubber in California turf installations will remain flat or decline in the coming years.

Loose-Fill Playground Surfacing, Bark, and Mulch

This section focuses on loose-fill playground surfaces made with rubber nuggets of ¼- to ¾- inch size, which is usually colored. Material with this same specification is used to replace wood bark and other products in a variety of landscaping applications, typically referred to as mulch. Because they use rubber material with the same specification, this section analyzes both loose-fill playground surfacing and mulch sales together.

Several types of tire-derived products are used as playground surfacing, including crumb rubber produced from tires. These applications present considerable opportunities as loose rubber crumb and buffings, poured-in-place, and manufactured tiles. The enforcement of the DOJ 2010 ADA Standards for Accessible Design, and inclusion of accessibility requirements to the 2013 California Building Code and the California Health and Safety Code, present significant opportunities for expanding the market. Buffings from retreaders are also used as loose-fill playground surfacing and landscaping mulch but are excluded from quantification in this analysis. In recent years, some pour-in-place playground surfacing suppliers have begun using crumb rubber to replace a portion of buffings, and these uses were quantified in this report in a separate “pour-in-place” section. However, no use of California crumb rubber in pour-in-place applications was documented in 2013 as rubber buffings from retread facilities is used nearly exclusively in this application (as opposed to crumb rubber produced from discarded tires), and in future years it will be analyzed as part of the “Other Ground Rubber” category. Crumb rubber and/or buffings are also used in tiles, which have a growing market in playground surfaces. The use of ethylene propylene diene monomer (EPDM) in poured-in-place systems rather than colored crumb rubber reduces cost and increases the recycled tire content in playground surfaces. The use of crumb in playground turf systems similar to those for athletic surfaces is also making inroads. In 2013, about 19.8 million pounds of ground rubber derived from approximately 1.4 million California PTEs were used in loose-fill playground surfacing applications or sold as bark or mulch for landscaping and other applications, a 20 percent decrease over 2012 levels.

Loose-fill playground surfaces are marketed and installed in California by numerous firms located both in California and in other states. Customers are largely local school districts and parks but also include other government agencies as well as architects, contractors, and designers responsible for new and renovated building construction projects. Key sales drivers for loose-fill playgrounds include enhanced fall safety, longer life, and lower maintenance costs. The tire-derived products in playgrounds must meet ADA technical performance requirements. They can be used separately or in combination, and can thus provide unique features with poured-in-place rubber and rubber tiles that do not exist with engineered wood fiber or sand. This allows for positive growth expectations, provided market education and enforcement of the mandated requirements takes place.

Just as loose-fill rubber is colored and used in playgrounds, it is also used as a replacement for wood mulch in landscape applications; however, it is often made from tire buffings. Rubber mulch in the form of bark or nugget is one of the few TDPs to be sold directly to consumers in national “big box” retail outlets such as Walmart, Costco, and Lowe’s, and this has contributed to significant national market growth in recent years. Rubber bark/mulch offers benefits of lower maintenance costs and convenient performance characteristics such as long life, lack of deterioration, and color choices.

Molded and Extruded Products

In 2013, about 12.5 million pounds of ground rubber, derived from about 0.9 million PTEs, were used to produce molded and extruded products, a 32 percent decrease from the amount used in 2012. This comes after three years of steady growth in this market segment. In this application, use of crumb rubber in the 10- to 30-mesh range is common; however, there is growing use of 40- to 80-mesh crumb rubber as well for membranes, sealants, and rubber-plastic compound products. Crumb rubber is combined with urethane and other materials and processed in compression or extrusion molding machines to produce products. A wide range of molded and extruded tire-derived products are produced in California, including playground and other tile products, flooring, mats, wheelchair transition ramps, erosion control devices, traffic control devices, wheel stops, roofing materials, flooring underlayment, sealants, and others.

Because of the wide range of molded and extruded products that can potentially be produced, including converting established producers to the use of crumb rubber instead of virgin rubber or other feedstock, this segment is being targeted by CalRecycle for market expansion. As described above in the “Market Development Implications” section, CalRecycle’s new Tire Incentive Program aims to incentivize increased sales of molded/extruded products, as well as diversification through new product development and feedstock conversion. The TIP is funded at about \$2.6 million in FY 2013/14 and \$3 million in FY 2014/15. The TIP is focused on promoting feedstock conversion and market expansion, providing payments of 10 to 40 cents per pound to manufacturers, depending on a number of factors, with the highest payments going to manufacturers who convert products made with virgin rubber to use of fine crumb rubber higher than 50-mesh size. Past experience suggests that, to the extent the TIP triggers increased crumb rubber demand, it is likely to do so relatively slowly, over several years.

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. A 2009 CalRecycle study projected that a plausible long-term goal for California feedstock conversion would be to establish demand of about 52 million pounds annually, roughly a fourfold increase over the amount consumed in 2013. Given the wide range of products in the category, and the potential for

new product development, it is conceivable that growth could far exceed this level, and the coming years will provide valuable information to help refine projections and pathways to expand demand.

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. There is also an important need to define detailed specifications for crumb rubber needed by manufacturers for each specific product, based on analysis of particle size distribution and material composition. 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 personal. 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 developing and expanding new products using tire-derived material. Several feedstock conversion firms have received support through CalRecycle's Tire-Derived Product Business Assistance Program and have made marked progress toward expanding ground rubber demand in their products; however, the full potential of this work has not yet been seen as the companies continue to ramp up production and sales.

Despite these challenges and the decline in demand in 2013, there is considerable activity among California molded/extruded product producers and, combined with newly focused CalRecycle programs, this market segment may see significant growth in 2014 and beyond.

Civil Engineering

Civil engineering applications used about 0.5 million PTEs in California during 2013, a 22 percent decrease over the level in 2012. In California, such applications are divided into two primary categories: landfill use, and other uses such as for lightweight fill in road/transportation projects. Tires are used in civil engineering applications in the form of tire-derived aggregate (TDA), which competes with rock aggregate and/or a range of aggregate or lightweight fill materials.

As described above in the "Market Development Implications" section (see page 14), CalRecycle recently implemented a new TDA grant program. A total of nine grants have been awarded through two application cycles, including four lightweight fill projects and five landfill projects. Combined, the nine projects are expected to use more than 2.8 million PTEs. Going forward, \$1.6 million is budgeted for TDA grants in each of FY 2014/15 and 2015/16.

CalRecycle provides extensive technical assistance to civil engineering projects using TDA. The department also conducts outreach to local government public works engineers and to Caltrans to educate them about the benefits of using TDA in highway products and to promote the assistance programs. CalRecycle has also conducted research on using TDA as a backfill behind retaining walls and on identification of TDA material properties. In addition, CalRecycle has conducted research and developed a demonstration project using TDA in onsite wastewater treatment systems.

Landfill Civil Engineering Applications

Landfill use has historically been the largest civil engineering category for waste tires. This includes use in landfill gas and leachate collection and redistribution layers, and in landfill road construction, generally replacing rock aggregate materials.

In 2013, California landfills used about 0.3 million PTEs in CE projects, a 55 percent decline compared to 2012. However, the TDA grant approvals described above are expected to result in projects using 700,000 PTEs in the coming year or two, indicating an increase is expected.

Non-Landfill Civil Engineering Applications

Non-landfill applications include Caltrans' and local governments' use of TDA in landslide stabilization projects and use of TDA for vibration mitigation in local commuter train systems. While other non-landfill civil engineering uses such as in septic leach fields, berms, and road base are used in other states, TDA use in these applications in Californian would be considered on a case-by-case basis.

In 2013, about 0.2 million PTEs were used in non-landfill CE projects, compared to no non-landfill TDA projects in 2012 or 2011. However, the TDA grant approvals described above are expected to result in more than 2.1 million PTEs being used over the next one or two years, resulting in a significant increase. Moreover, CalRecycle staff is in discussion with other project proponents that could boost this amount further.

Alternative Daily Cover

Tire shreds are used as alternative daily cover (ADC) at some landfills to cover disposed waste at the end of each day. Tire ADC replaces dirt and can substitute for other ADC materials such as ground green waste or wood waste. The landfill's operating permit must allow for this use, the shreds must meet specifications, and use of ADC is limited to dry weather conditions. Tire ADC can sometimes 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 operational hurdles to using tires as ADC limit their use. Landfills that do use tire ADC, however, can consume large quantities of waste tires. Processors typically must pay a tip fee or, at best, may have zero cost for delivering tire shreds to landfills for use as ADC.

About 1.2 million PTEs were used as ADC at three landfills in 2013, an 18 percent increase over 2012. The increase was caused by one landfill's significant increase in ADC use. This volume of use is expected to remain roughly flat in 2014.

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. As in 2012, no processors reported these uses in 2013, although it is likely that a small volume of tires were in fact used for these purposes. In 2011, fewer than 100,000 PTEs (735 tons) were reported used in this market segment, slightly more than the estimated 490 tons of PTEs used in this category in 2010.

Tire-Derived Fuel

In California, waste tires have historically been used as tire-derived fuel (TDF) 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. However, the last cogeneration facility that was using TDF ceased operating in 2012.

Four California cement plants use TDF, and in 2013, these plants consumed a total of about 8.2 million California-generated PTEs, a 6.2 percent increase over 2012. We estimate that these plants also used an additional 700,000 PTEs that were supplied by California processors but were imported from outside the state (based on allocation of imports across all of the California processor's shipments).

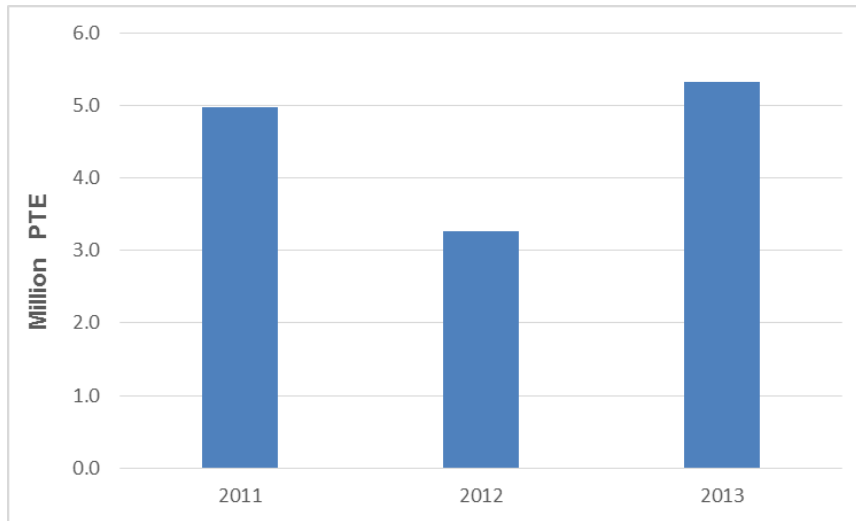
Use of TDF at California cement kilns has rebounded from a dip caused by the recession in 2009, and all four California cement kilns using TDF indicate interest in increasing TDF use if the economy, and in particular the construction industry, continues to strengthen.

In 2012, some cement kiln operators said they experienced some supply and/or tip fee revenue or shipment pricing pressures; however, tire supply was generally not a limiting factor in 2013. Two of the four cement kilns are now also consuming tire fluff generated from ground rubber operations, and California ground rubber producers sent nearly 9,000 tons of this material to cement kilns in 2013, comprising the vast majority of the total generated. In addition to TDF sold to California users, sale of California-produced TDF to overseas users is also very strong, as discussed in the "Imports and Exports" section.

Disposal

As shown in Figure 3, waste tire disposal increased in 2013 to 5.3 million PTEs, following an all-time low of 3.3 million PTEs in 2012. The decline in tire disposal since 2009 was largely a result of rapidly increasing exports. Exports briefly softened somewhat for a period in early 2013 and this, combined with reduced ground rubber production and the competitive pressures on California processors discussed previously, appear to have resulted in the increase in disposal in 2013.

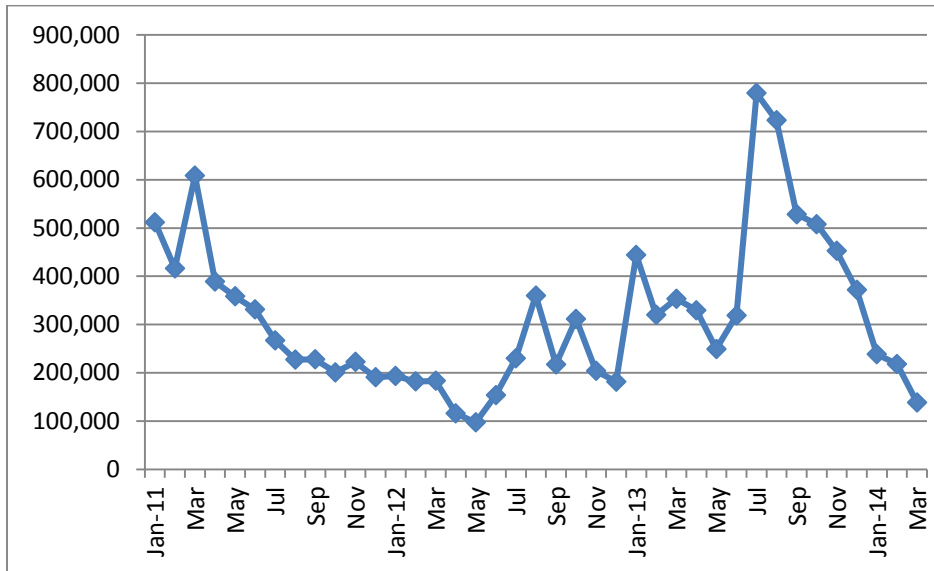
Figure 3
Annual Waste Tire Disposal in California, 2011 – 2013 (Million PTEs)



Waste tire exports appear to have begun to increase again in late 2013 and into 2014. One indicator of this trend may be the sharp decline in tire disposal, based on analysis of waste tire manifest system (WTMS) data for deliveries to four key landfills that receive and dispose the largest quantities of tires (more than 90 percent of the statewide total), as shown in Figure 4.. It must be noted that Figure 4 is based on WTMS data alone, and is not adjusted for landfill survey responses or for the portion of tires delivered to these landfills that may be forwarded to other end users. Nevertheless, the monthly data do provide a rough proxy for tire disposal and most importantly indicate the trend in disposal of tires. (Note: These waste tire disposal figures do not include tires used as ADC or TDA at landfills.)

As Figure 4 clearly shows, after declining in early 2013, disposal rapidly increased over a two-month period in mid-2013, which was followed by a sharp and continuing decline that has lasted into early 2014. These sharp dips in disposal may be associated with increasing export activity, which has the potential to abruptly shift flows from disposal markets. In 2013, no other market segment had the potential for causing such large and abrupt shifts. Given the 2014 trend shown in Figure 4, and anecdotal information indicating a rise in exports, it is possible that disposal may again approach the all-time low recorded in 2012 in the next couple of years.

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



Imports and Exports

To varying degrees, used tires, processed waste tires (e.g., bales or shreds), ground rubber, buffings, and TDPs 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 U.S. states. Though most California used tires are shipped to Mexico, they also are shipped to other parts of the world, including other Latin American countries, India, and Asia. No estimate of the number of used tires imported into California is available, although relatively small quantities are likely shipped from neighboring states.

In 2013, used tire exports from California were estimated to be 1.3 million PTEs, 30 percent less than 2012. As previously described in the “Reuse” section, estimating the amount of used tires produced, as well as the percentage that is exported, is challenging. This is because processors and haulers selling used tires do not always know where they may be sold, and also because of the trend toward used tires being culled and sold prior to their reaching processors, who are the focus of research under this study. An unknown percentage of the used tire (domestic) category that was described above under “Reuse” was 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 or haulers. The estimates cited in this report for used tires, both domestic and exported, are based on overall estimates that consider both the data and opinions expressed by processors and others involved in the industry. The methodology for estimating used tire sales will be reviewed prior to conducting the 2013 market study.

The main drivers and constraints for used tire exports are the same as for used tires (domestic) previously described in the “Reuse” section. In short, exporting used tires can be highly economical because of the low cost to cull and grade them, and because many consumers in Baja Mexico opt to purchase used tires rather than new tires, creating a relatively high value and a strong demand for them across the border.

Waste Tire Imports

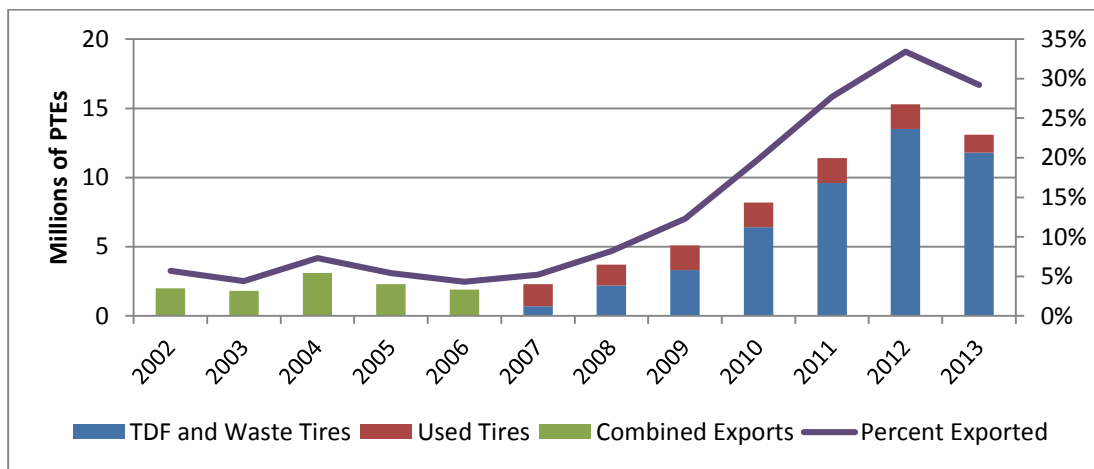
In 2013, approximately 3 percent of waste tires handled by processors were imported into California from other Western states. These tires have been subtracted from the statistics provided in this report to ensure the quantities are only indicative of the disposition of California tires.

Note: California processors sold quantities of processed tires higher than those shown in Table 1 to each market segment, since the portion of imported tires handled by each processor was allocated to all market segments to which the processor sells.

Waste Tire and TDF Exports

As illustrated in Figure 5, the dominant trend in California tire recycling markets over the past five years has been the rapid growth in exports of waste tires and of processed TDF, sent largely to Asian nations, but also to other regions.⁸ The quantity exported in 2013 is estimated at 11 million PTEs (excluding exports of used tires, which are covered separately above), or more than 26 percent of all tires managed. Since 2011, export has been the single largest market destination for California waste tires. While this is a relatively new trend for tires, it is a situation that is very common with other recyclables such as scrap paper, metals, and plastic. Waste tire and processed TDF exports decreased by an estimated 18 percent in 2013, but this came on the heels of sharp increases in the prior two years. Estimates of exports are subject to higher uncertainty than other market segments. This is due to the dynamic nature of the export facilities, which complicated data gathering for 2013.

Figure 5
Trends in Export of Waste Tires/TDF and Used Tires



⁸ The 2011 California Waste Tire Market Report included a detailed special report analyzing waste tire export trends and issues.

In early 2013, China stepped up enforcement of waste import regulations that had long been on the books. Dubbed the “green fence,” this new enforcement policy was strictly implemented and greatly impacted a wide variety of scrap exports from the United States to China. Partly due to this development, export of waste tires briefly declined in early 2013. However, strong demand for TDF in Japan and Korea, and sustained demand in Vietnam (with China) soon rebounded, and export demand has apparently been rebounding since. As previously described in the “Supply and Demand Balance” section, the rapid rise of waste tire and TDF exports has significantly disrupted established processors and their traditional collection revenue and business models. While the pace of change has slowed, the disruptions continue to affect certain processors in the state in the form of constrained access to supply and collection revenues. In some cases this has caused processors to adjust their business models: For example, they may focus on fewer collection accounts that can sustain relatively high pricing (compared to exporter prices), or they may enter the export market themselves. It appears that these influences, in some cases, may be affecting production and sales of ground rubber, one of CalRecycle’s priority market segments.

California facilities focused on exports are highly dynamic. Given the low capital costs involved and competitive environment, as well as stepped-up enforcement activities by CalRecycle, several companies have entered or left the market in recent years. In 2013, four export firms were tracked for this study, and since then one has closed and at least two more have started operations. Anecdotally, exports appear to be increasing in 2014, as indicated by the monthly tire disposal trends shown in Figure 4. While scrap export markets are notorious for abrupt shifts in demand, upward or downward, due to a variety of global or national factors (in both the U.S. and/or in importing nations), it appears likely that export volumes will again increase during 2014.

Ground Rubber and TDPs Imported into California

Ground rubber, buffings from retread operations, and TDPs are also imported to and exported from California. As discussed in the “Supply and Demand Balance” section, ground rubber from other states, Canadian provinces and even from Europe is being sold in California at competitive prices, despite transportation costs. This is possible due to the incentive payment subsidies offered in some of these jurisdictions, plus the significant overcapacity in ground rubber production nationally and globally at a time of flat or declining market demand. Several California processors and product manufacturers indicate that these out-of-state suppliers can often match or beat the prices of local suppliers, either constraining their sales or 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, although ground rubber from other U.S. states is also sometimes used in Caltrans paving projects. 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 rubber 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. In terms of TDPs, some mats, playground tiles, and other types of products are sold into California. Leidos was not able to estimate quantities, however.

Section 4

Outlook for Increasing Waste Tire Diversion

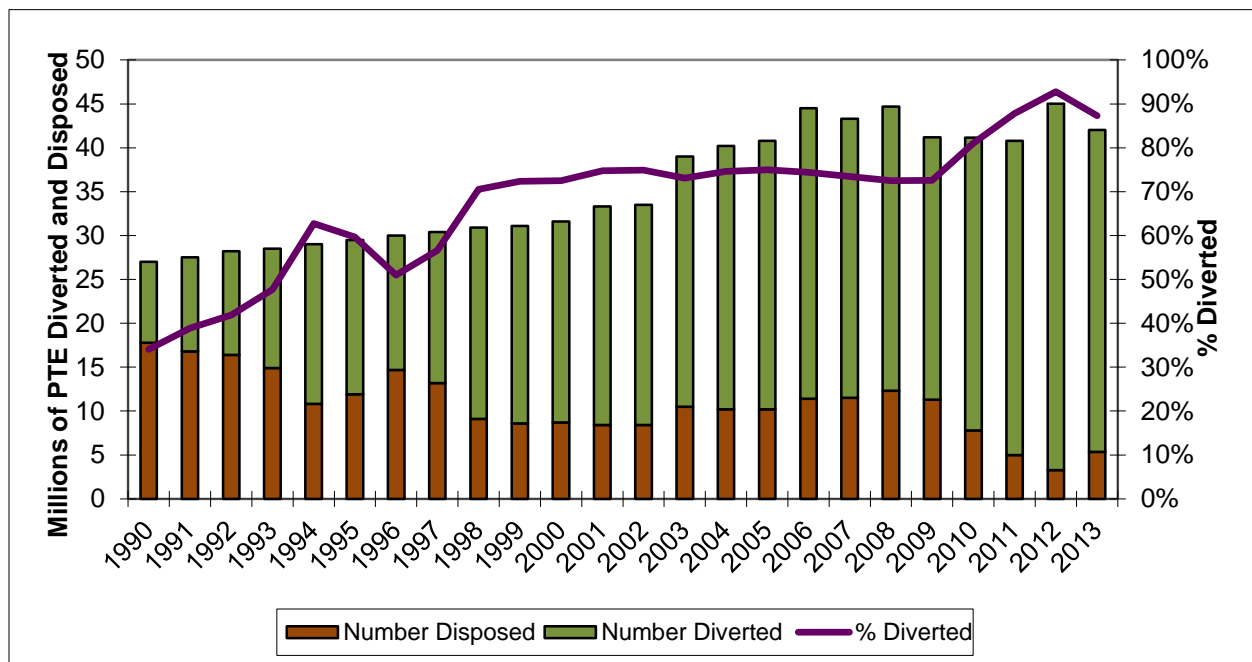
This section analyzes the outlook for increasing waste tire diversion in California, starting with a look at historical trends. This is followed by the short-term diversion outlook and a broad look at opportunities for expansion and barriers in each market segment.

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, total 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. Driven by surging export demand, in 2012 the rate exceeded CalRecycle’s goal for the first time, at 92.9 percent, and then declined again to 87.3 percent in 2013, due largely to softening ground rubber sales.

However, some stakeholders focus on a more refined recycling rate that excludes waste tire exports (but not used tire exports), alternative daily cover (ADC), and tire-derived fuel (TDF), which CalRecycle is statutorily prohibited from promoting. Excluding these segments, the 2013 diversion rate was 38.7 percent, down from 43.3 percent in 2012. Tire disposal, conversely, was up proportionately in 2013 to 12.7 percent from an all-time low in 2012 of 7.3 percent of all tires.

Figure 6
Waste Tire Diversion and Disposal Trends



Short-Term Diversion Outlook

Table 5 summarizes expected short-term diversion trends, based on specific activities and trends anticipated over the next two years, as identified by facility operators and other stakeholders.

The analysis indicates that the total California waste tire diversion rate, which peaked in 2012 at 92.9 percent and then declined to 87.3 percent in 2013, may move upward again in 2014, mainly due to potential increases in export and TDF. On the other hand, the more refined “recycling rate” which excludes export, TDF, and ADC, declined from 43.3 percent in 2012 to 38.7 percent in 2013, and may be headed for another slight decline in 2014, given the constraints hampering growth in the ground rubber and used tire markets, and despite expected growth in civil engineering.

**Table 5
Short-Term (Two-Year) Diversion Outlook**

Category	2013 Diversion		Two-Year Diversion Outlook	Basis for Outlook
	Million PTEs	Percent		
Reuse	6.6	15.7%	Flat	<ul style="list-style-type: none"> ▪ While some processors are moving away from used tire sales, some other processors continue to focus on it, and haulers have apparently increased culling of used tires. ▪ Retreaders report slow growth as the economy continues to rebound.
Ground Rubber	7.9	18.8%	Flat or Declining	<ul style="list-style-type: none"> ▪ The constraints of flat/declining market demand, competition with out-of-state suppliers, and export-fueled competitive disruptions appear likely to continue to hamper ground rubber growth.
Civil Engineering	0.5	1.1%	Growth Expected	<ul style="list-style-type: none"> ▪ Funded grant projects and other known projects in both the landfill and transportation sectors should expand use in 2014 and beyond.
ADC	1.2	2.9%	Flat	<ul style="list-style-type: none"> ▪ The three landfills reporting tire ADC use appear likely to continue at or near current levels. No other landfills indicated a likelihood of beginning use of tire ADC.
TDF	8.2	19.5%	Growth Expected	<ul style="list-style-type: none"> ▪ California cement kilns that use TDF say demand is expected to increase somewhat as cement production increases with an improving economy.
Export	12.3	29.2%	Growth Expected	<ul style="list-style-type: none"> ▪ Anecdotal information supported by declining monthly tire disposal data suggests exports are again increasing.
Total Diversion	36.7	87.3%	Growth Expected	<ul style="list-style-type: none"> ▪ Increasing diversion through export, TDF, and civil engineering appear likely to boost total diversion.

	2013 Diversion		Two-Year Diversion Outlook	
	Million PTEs	Percent		
"Recycling" Rate	16.2	38.7%	Flat or Decline Expected	<ul style="list-style-type: none"> With reuse holding steady and modest tonnage growth in civil engineering expected (compared to historically higher ground rubber use), continuing constraints on ground rubber may cause further declines in the "recycling" rate.

Long-Term Diversion Outlook

The market size and penetration estimates in Table 6 broadly describe long-term opportunities to expand waste tire diversion. The theoretical market size figures are rough estimates that were developed in 2008. No specific maximum market size for waste tire and TDF exports or used tires are provided. However, global waste tire market demand for these categories, combined, far exceeds California generation, as described in the "Key Trends by Market Segment" section.

Table 6
Estimated Theoretical Market Size, 2013 Penetration¹

Category	Estimated Theoretical Market Size (Million PTEs)		2013 Marketed (Million PTEs)	2013 Penetration (%)	
	Low	High		Low	High
Ground Rubber	39.0	54.7	7.9	14%	20%
<i>Rubberized Asphalt Concrete (RAC)</i>	25.0	35.0	3.5	10%	14%
<i>Turf and Athletic Fields</i>	4.0	5.0	2.0	40%	50%
<i>Loose-Fill Playground/Bark/Mulch</i>	4.5	7.5	1.4	19%	31%
<i>Molded and Extruded</i>	4.0	5.0	0.9	18%	23%
<i>Other Ground Rubber</i>	1.5	2.2	0.0	0%	0%
Alternative Daily Cover (ADC)	35.0	40.0	1.2	3%	3%
Civil Engineering (CE)	17.1	24.7	0.5	2%	3%
<i>Non-Landfill Use</i>	14.1	20.7	0.2	1%	1%
<i>Landfill Use^{2,3}</i>	3.0	4.0	0.3	8%	10%
Tire-Derived Fuels (TDF)	15.0	20.0	8.2	41%	55%
Exported Waste Tires/TDF	50+	60+	11.0	18%	22%
Used Tires (Combines Exported and Domestic Use)	4.6	5.0	3.8	76%	83%
Retreading	4.8	5.2	4.1	79%	85%
Other Uses (Including Agriculture)	1.0	2.0	0.0	0%	0%
Total (Excludes Exported Waste Tires/TDF)	166.5	211.6	21.9	10%	13%

- ¹ Supporting documentation for this table is provided in the 2008 report, “Waste Tire Market Development Program Evaluation, Working Paper #1: Market Penetration Report,” available on the CalRecycle website at <http://www.calrecycle.ca.gov/Publications/Documents/Tires/2010010.pdf> . 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 use market size estimate is for landfill gas and leachate recirculation applications only. The 2008 estimate should not be used as a benchmark to evaluate future effort as it was necessarily based on reported use that in some cases could not be validated by CalRecycle and may not comprise CalRecycle-defined civil engineering uses. Regardless of the uncertainty, SAIC, Kennec, and CalRecycle agree that market penetration for landfill use is relatively low and that there is potential for more TDA to go to landfill gas applications. Landfill applications also include use of significant potential quantities of TDA in operational layers; however, this use is not listed separately because of significant regulatory and supply barriers. Despite the barriers, CalRecycle should be open to opportunities to expand such uses and this potential contributes to listing landfill TDA as a priority market segment.

As Table 6 shows, theoretically the greatest opportunity for market expansion in broad terms is in export and ground rubber markets, especially RAC. 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.

In the short run, export markets hold the potential to continue to drive total tire diversion higher. However, the long-term potential for the tire recycling rate (excluding export, TDF, and ADC) to significantly expand may be more challenging. As described above, the potential for long-term diversion in CalRecycle’s priority markets of reuse, ground rubber, and civil engineering will depend on the ability of ground rubber market demand to greatly diversify and expand, and of national overcapacity in ground rubber production to abate, either through expanded demand or over the long term through reduced capacity by closures or acquisitions.

Barriers to Expanding Diversion

Table 7 lists some key barriers to growth and identifies them as 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 2012.

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

Market Category/ Subcategories	Barriers
Ground Rubber	
All Ground Rubber	Economic – Ground rubber producers have experienced disruptions in supply access and collection revenues. They are also competing with out-of-state suppliers in an oversupplied market.
RAC and Other Paving	Policy – Caltrans demand for rubberized paving products, and the specific technology to be employed, is uncertain. Educational/Institutional – Local governments are not exposed to the product or are loyal to their current suppliers and techniques.

Market Category/ Subcategories	Barriers
<ul style="list-style-type: none"> • RAC and Other Paving • Turf and Athletic Fields • Loose-Fill Play/Bark/Mulch 	<p>Economic – Although the economy is rebounding from a severe recession, local governments’ budgets remain constrained.</p>
<ul style="list-style-type: none"> • Turf and Athletic Fields • Loose-Fill Play/Bark/Mulch • Molded and Extruded • Other 	<p>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.</p>
<ul style="list-style-type: none"> • Turf and Athletic Fields • Loose-Fill Play/Bark/Mulch 	<p>Financial/Research – Up-front costs are higher than those 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.</p>
<ul style="list-style-type: none"> • Molded and Extruded 	<p>Technical – Inherent characteristics of the material limits its usability as a feedstock.</p> <p>Technical – Lack of fine ground processing within California that is required to manufacture some products.</p> <p>Economic – Competition with lower-priced imported products can make it difficult to compete in the marketplace.</p> <p>Financial – Costs for feedstock conversion and new TDP development hamper innovation.</p>
<ul style="list-style-type: none"> • Molded and Extruded • Loose-Fill Play/Bark/Mulch • Turf and Athletic Fields • Other 	<p>Economic – Interstate trucking transportation costs are relatively costly (economical transportation back to California is available, however). This makes it challenging to sell products or tire-derived material cost effectively in neighboring states.</p>
Alternative Daily Cover	
	<p>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.</p> <p>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.</p>
Civil Engineering	
<ul style="list-style-type: none"> • Transportation-Related Applications 	<p>Financial/Policy – Regulatory issues related to storage of tires for large jobs are a barrier. Cost of transporting TDA long distances also reduces its competitiveness with conventional aggregate, especially when local supplies are adequate.</p>
Other Recycling	
<ul style="list-style-type: none"> • Emerging Fuel/Energy Technologies 	<p>Research/Technical – Technologies such as devulcanization, pyrolysis, gasification, and others remain commercially challenging.</p>

Market Category/ Subcategories	Barriers
	<p>Policy – Unresolved regulatory issues related to permitting of emerging fuel/energy technologies.</p> <p>Outreach/Financial – Lack of information about emerging fuel/energy technologies makes them difficult to implement/fund.</p>
Export	
	<p>Educational – Lack of information/knowledge regarding export regulations and how to export, especially when a broker is not used.</p> <p>Regulatory – Restrictions in China and potentially other countries on waste tire imports.</p>
Cross Category	
All Categories	<p>Economic – TDP product manufacturing businesses are at an economic disadvantage when competing against older, larger, and more established incumbent products.</p> <p>Informational/Research/Outreach/Technical – Some potential consumers of tire-derived products have concerns regarding the health, safety, and environmental impacts of TDPs and feedstock, although CalRecycle and other sources have addressed the issue.</p>
<ul style="list-style-type: none"> • RAC • Civil Engineering 	<p>Financial – There are relatively few 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.</p>
<ul style="list-style-type: none"> • RAC and Other Paving • Landfill Applications • Transportation-Related Applications 	<p>Educational/Technical – Local government officials and engineers are not familiar with advantages of products and how to design/specify projects.</p>

Concluding Remarks

California’s waste tire recycling industry continues to be highly dynamic, with processors and TDP manufacturers adapting to changing markets and infrastructure, and with CalRecycle’s evolving programs continuing to play an important role in both the market development and enforcement arenas. The disruptive impacts of rapid export increases are still being felt by certain processors, and along with soft markets and competition from out-of-state producers, this is constraining growth in ground rubber and reuse. CalRecycle is focusing new programs on feedstock conversion and new product development through its new Tire Incentive Program and expanded outreach activities, and it is continuing its significant support for paving and TDA.

In California, as is the case nationally and globally, the potential for waste tire recycling to grow and thrive is highly dependent on expansion and diversification of demand for processed tire products. CalRecycle’s market development programs, including grants, technical assistance, and outreach, will be crucial in coming years as the industry adapts to changing circumstances.

Appendix A

Methodology and Data Limitations

This Appendix briefly summarizes the methodology used for this report, the presumed level of accuracy, 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 plus or minus 10 percent, which may be an upper bound on the potential accuracy of waste tire flow studies generally. For this 2013 report, the level of uncertainty associated with used tire diversion, including estimates of the portion exported versus used domestically, is subject to somewhat higher levels of uncertainty. This is due to a trend in which haulers are handling an increasingly higher proportion of used tires, with some processors (the primary source of survey data for this report) handling a smaller proportion.

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

Data limitations include:

- **Conversion Factors:** Firms and CalRecycle typically use a standard conversion factor of 20 pounds per tire, even though waste tire weights vary significantly. According to the Rubber Manufacturers Association, based on national average statistics, passenger tires weigh approximately 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-road tires may weigh hundreds or even thousands of pounds. WTMS data in particular can be subject to large errors as data may be entered in tons, pounds, number of tires, or cubic yards. CalRecycle converts weight and volume measures to tons in the WTMS system, but these conversions are subject to error. In this study, WTMS data alone is not used to estimate tire flows, but is considered along with several other data sources to develop the best overall estimate possible of tires flowing to each market segment.
- **Data Entry:** A significant portion of WTMS entries have errors, and other data entries may impact estimates considered in this report. A number of quality control checks are used during data analysis to identify and address potential data entry 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 comprehensive 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.
- **Discrepancies Between Inputs and Outputs, and End-of-Year Inventories:** Manifest information based on deliveries to facilities provides data on inputs to facilities, while surveys provide data on outputs sent to market uses. Output data is often based on shipping information or facility estimates that do not reflect stored inventories that were received in a previous year. This study reports all data on the basis of incoming tire equivalents (i.e., whole tire inputs) associated with reported product sales. It utilizes average yield factors for this

conversion for ground rubber producers unless a producer provides its specific yield factor (yields reflect the removal of tire wire, polyester “fluff,” rims, and rubber loss from incoming waste tires). In 2013, due to competitive pressures and lingering influences from the export surge, certain processors may have had higher than usual on-the-ground inventories at the end of 2013, potentially resulting in a somewhat lower estimate of the total number of tires managed.

- **Data Gaps and Inconsistencies:** The project team had to confront a number of data gaps in developing this report, including inconsistent survey responses and the failure of some companies to report data. Generally, the team followed up with respondents as needed and/or consulted past survey data and manifest records to develop estimates. In the vast majority of cases, the team was able to reconcile data concerns directly with respondents.
- **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 interpret categories or units differently. For example, 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 information 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. However, in 2013, the vast majority of wire, rims, and fiber residuals from processing and ground rubber operations were recycled, so consideration of these residuals would not appreciably impact the estimated diversion rate.

The methodology used for this report and those prepared for 2007-2012 is generally similar to that used for the previous “California Waste Tire Generation, Markets, and Disposal” reports prepared by California Integrated Waste Management Board 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. Additional category adjustments were made in this 2013 report:
 - The co-generation TDF category was removed, as the last facility operating closed in 2012.
 - The pour-in-place category was removed, as this segment uses nearly exclusively buffings generated by tire retreaders, which are excluded from the flow analysis due to double-counting concerns.
- **Different Survey Approach:** Different surveys were used for processors, tire-derived product (TDP) producers, tire-derived fuel (TDF) consumers, and retreaders, and the amount of data and information gathered through interviews was increased.

- **Number of Landfills Analyzed:** WTMS 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.