California Waste Tire Market Report: 2021

Contractor's Report
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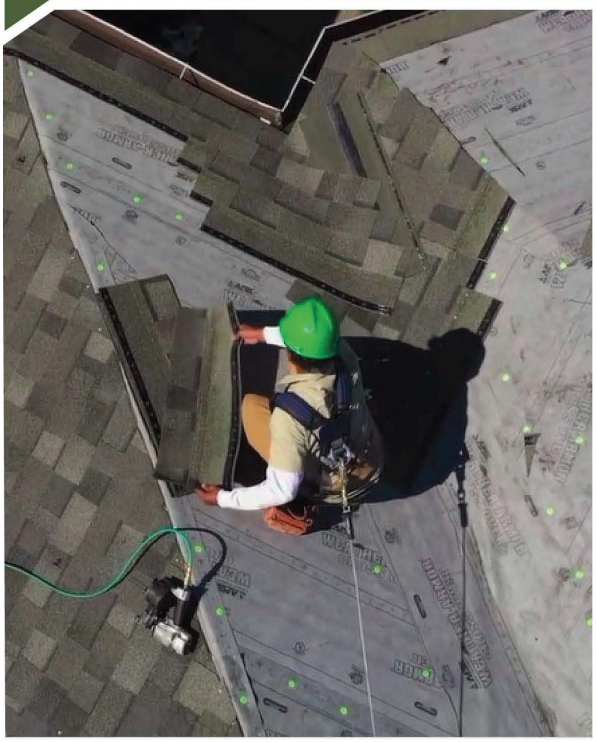

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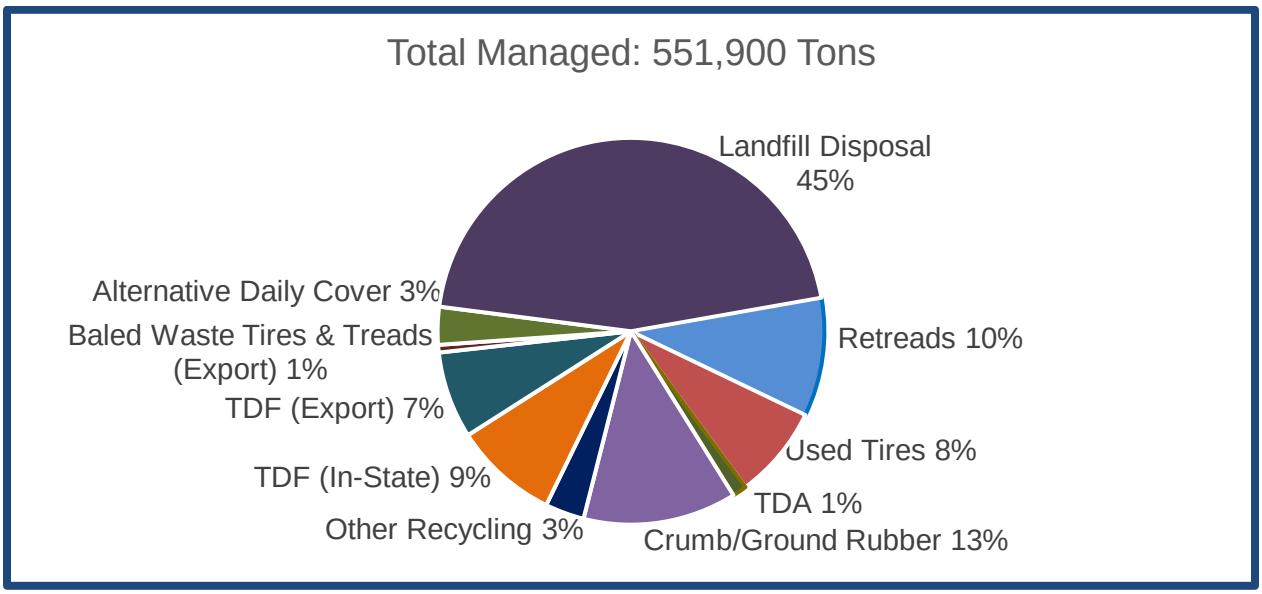
Acknowledgments

This report was prepared by Boisson Consulting in partnership with subcontractor DK Enterprises (tire recycling industry expert and liaison) and RWR Strategies (research support). We sincerely thank the many industry stakeholders who contributed their information, data, and insights as well as CalRecycle staff who coordinated access to department databases and clarified program policies and trends.

Executive Summary

This report describes California waste tire flows in 2021 and trends as of Spring 2022, based on analysis of data from industry surveys, interviews, CalRecycle databases, and other sources. As shown in Figure 1, in 2021 an estimated 551,900 tons (55.2 million PTEs[*]) of California-generated waste tires were managed. California waste tires flowed to 10 different market segments and a variety of disruptions impacted business operations and markets, including ongoing shifts in: COVID infections, health impacts and restrictions; economic growth followed by high inflation and the prospect of a potential 2022 recession; persistent staffing and hiring challenges; high trucking and ocean shipping costs combined with logistical challenges; and a variety of supply chain disruptions impacting diverse commodities and products related to tire-derived products (TDPs).

Figure 1
California-Generated Waste Tire Flows in 2021



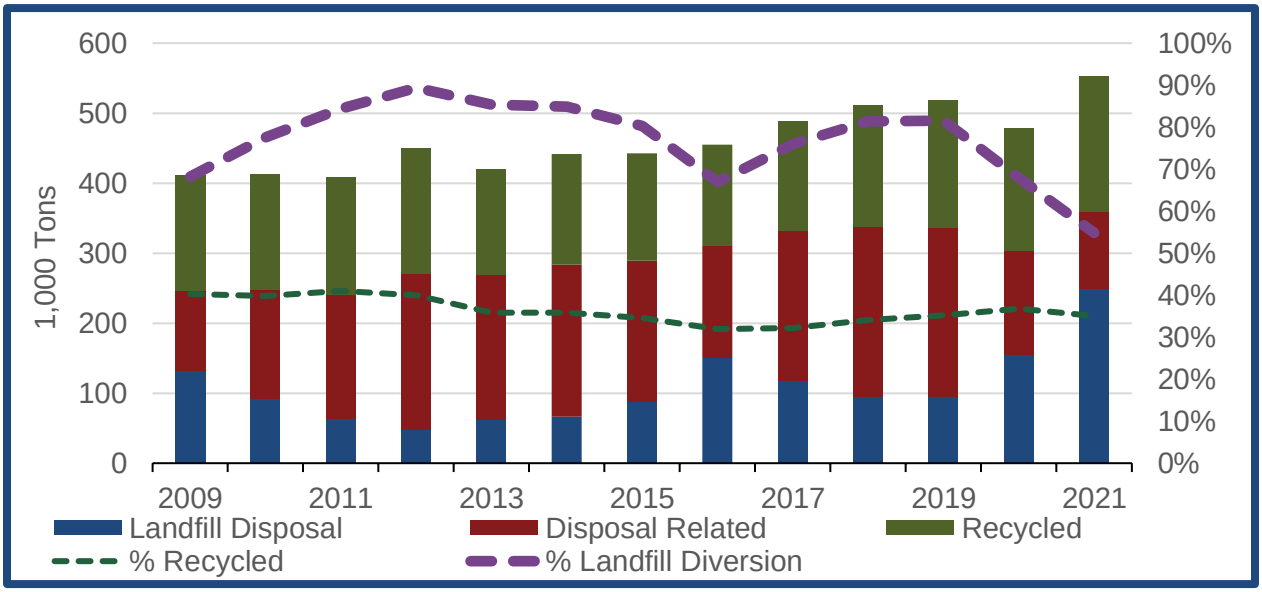
See source data for Figure 1 in Appendix C.

CalRecycle has informally adopted a 75 percent waste tire recycling goal, consistent with a statewide 75 percent recycling goal covering all waste materials mandated by AB 341 (Chesbro, Chapter 476, Statutes of 2011). As Figure 2 shows, after modest gains over four years, the California waste tire recycling rate dropped slightly in 2021 to 35

[*] PTE means Passenger Tire Equivalent, defined by CalRecycle (14 CCR § 17225.770) as 20 pounds. The PTE is a useful standardized reporting metric; but actual tire weights vary significantly by type, and passenger tires typically weigh more than 20 pounds.

percent. Recycled tons increased by 10 percent to 193,200 tons (19.3 million PTEs); however, this was offset by a 15 percent increase in total generation. Retreading grew by 20 percent in 2021, driven by significant supply chain disruptions that reduced new tire supplies and increased new tire pricing. Crumb rubber and ground rubber production increased 40 percent, driven by gains in the paving segment, although the molded/other product, synthetic turf infill and ground rubber market segments all saw gains as well. Used tire sales dropped in 2021 but remained a strong market. Use of tire-derived aggregate (TDA) in civil engineering dropped but may well rebound in 2022 due to new projects underway. Landfill disposal increased in 2021 by 62 percent, after a similar increase in 2020, to 249,400 tons (24.9 million PTEs or 45.2 percent of all waste tires managed), a 20-plus year record. Exported tire-derived fuel (TDF) declined 45 percent due to high port costs and logistical challenges, and in-state TDF shipments also declined 16 percent as cement kilns adjusted their fuel use.

Figure 2
California-Generated Waste Tire Recycling, Disposal Related and Landfill Disposal Trends, 2008-2021



See source data for Figure 2 in Appendix C.

In 2022 and 2023, there is potential for recycling to grow further if 2021 gains hold, especially in the retreading, paving and molded/other market segments. Recent changes in ownership and investments to expand or enhance waste tire recycling operations may also support continued growth. There is a need for continuing expansion and diversification in TDP markets and the types of California-made TDPs and TDM applications. While the conditions for transformational growth in tire recycling do not yet appear to be in place, there is good potential for incremental progress, and California's waste tire management system continues to be strong, enabling sound management of waste tires generated throughout the state.

1. Introduction

The Department of Resources Recycling and Recovery (CalRecycle) oversees management of waste and used tires in California as authorized by Senate Bill 876 (Escutia, Statutes of 2000, Chapter 838).† CalRecycle's long-term, informal goal is to achieve a 75 percent waste tire recycling rate consistent with requirements of AB 341 (Chesbro, Chapter 476, Statutes of 2011) that established a 75 percent statewide recycling rate goal for all materials by 2020.

This report estimates the 2021 California tire recycling rate and describes current and historical trends in the flow of California-generated waste tire and TDM to different market segments. Boisson Consulting prepared the report in partnership with industry specialist DK Enterprises with research support from RWR Strategies. Findings are based on detailed analysis of data and information provided by California waste tire management companies, CalRecycle staff and databases, and other sources.

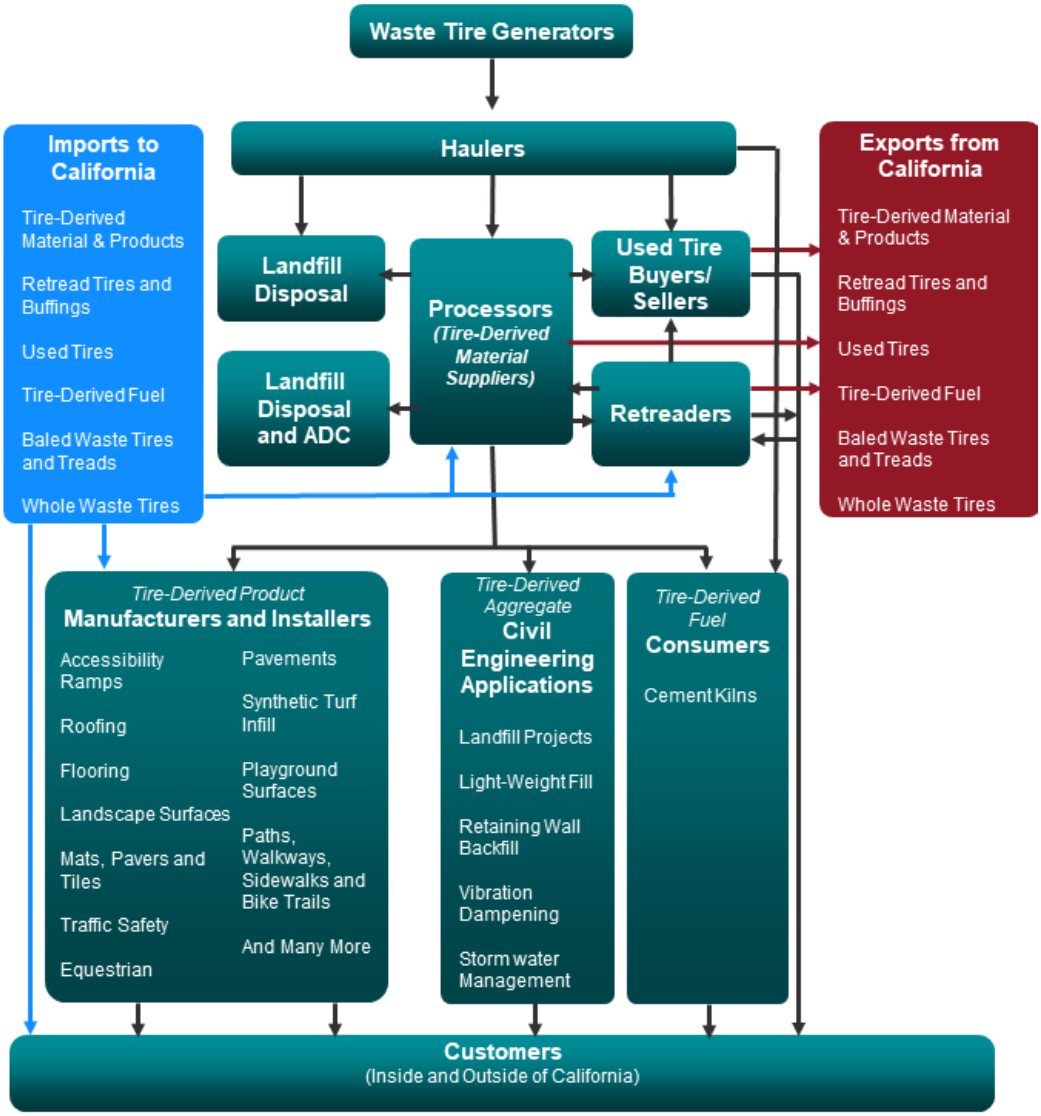
Following this introduction, Section 2 summarizes California waste tire management infrastructure. Section 3 identifies broad trends influencing waste tire markets. Section 4 provides detailed findings by market segment. The main report concludes with Section 5, discussing the outlook for increased tire recycling. Appendix A is a glossary of key terms and acronyms. Appendix B covers the report methodology. Appendix C provides notes and source data for graphs and charts to make this report fully accessible to readers of all abilities in compliance with the American Disabilities Act, Government Code sections 11546.7, 7405, and 11135, and Web Content Accessibility Guidelines 2.0. Finally, the End Notes section at the end of the report lists cited information sources.

† Unlike some tire recycling studies, this report covers waste tires, used tires and retread tires. See definitions and regulatory references in Appendix A.

2. California Waste Tire Management Infrastructure

Figure 3 illustrates flows of California-generated waste tires and tire-derived materials (TDM). Table 1 lists the number of distinct types of facilities and companies serving California. Waste tire collection and processing companies serve all areas of the state. CalRecycle's California Tire-Derived Product Catalog provides detailed product information, maps, and directories with company contacts. The TDP Catalog is available online.

Figure 3
California Waste Tire Recycling Industry Flow Chart



See detailed description of Figure 3 in Appendix C.

Table 1

California Waste Tire Management Active Facilities and Companies in 2021

Category	Counts
Registered Waste Tire Haulers	> 13,000[1]
Registered Waste Tire Generators	> 23,000[2]
Number of 2020 Waste Tire Shipments (Each Documented with a Comprehensive Trip Log in CalRecycle's Waste Tire Manifest System)	> 594,000[3]
Retreaders	37[4]
Facilities with a Major Waste Tire Facility Permit (Specified onsite maximums range from 9,960 to 336,300 PTEs)	14[5]
Facilities with a Minor Waste Tire Facility Permit (Allowing up to 4,999 PTEs onsite)	20[6]
Processors Reporting Crumb Rubber or Ground Rubber Shipments	6
Processors Reporting TDA Shipments	3
Processors Reporting In-State TDF Shipments (Includes size-reduced TDF, whole tire TDF and residual fluff from crumb rubber production)	7
Processors Reporting Exported TDF (e.g., chips, shreds) and/or Baled and Cut Waste Tire Tread Shipments	5
Tire-Derived Product Manufacturers Listed in the California TDP Catalog	16[7]
Tire-Derived Product Installers Listed in the California TDP Catalog	9[8]
California Cement Kilns Consuming TDF	4
California Landfills Disposing Size Reduced Waste Tire Material On-Site (Two additional landfills in Nevada received California waste tires in 2021)	15

3. Broad Trends Influencing Markets

As in 2020, important trends continued to create uncertainty and disrupt business operations and markets to varying degrees in 2021 and early 2022. These trends include:

- **The COVID 19 Pandemic – continued infection waves but with less restrictions.** Repeated variant-fueled spikes in infections occurred in 2021 and early 2022, with decreasing hospitalizations and deaths due to increasing vaccination rates and infection-acquired immunity. A trend towards relaxing restrictions has eased concerns over shut down orders, while staffing shortages sometimes disrupt specific workplaces due to periodic spikes in infections.
- **Shifting economic outlook**. Strong federal and state relief programs for small businesses and industry in 2020 were extended in early 2021 and helped support some California waste tire management companies. After a net decline of 2.8 percent in California's 2020 economy, the state saw a surge in growth of 7.8 percent in 2021.[9] By early 2022 the state had accumulated a near $100 billion surplus,[10] with separate, dedicated funding identified for roads and other infrastructure previously allocated at the state and local levels. However, inflation, which in January 2021 was a negligible 1.5 percent, has grown steadily, reaching 8.6 percent by May 2022.[11] In 2022, the economic outlook has come full circle with widely acknowledged recession risks as interest rates rise.
- **Staffing challenges**. With continuing low unemployment, waste tire management companies (as in other industries) have continued to deal with persistent staffing and hiring challenges, along with rising wages. This is a widely cited issue for companies in all market segments covered in this report.
- **Trucking and ocean shipping costs and challenges.** The staffing shortage is particularly an issue in the trucking industry, and costs have skyrocketed in recent years. Ports continue to be severely disrupted by increased volumes and worker disruptions caused by COVID and other factors. As a result, shipping costs are extremely high and securing shipping containers has become extremely challenging. This, in turn, has made export of TDF and baled waste tires uneconomical for certain processors.
- **Supply disruptions.** Companies in most market segments said they had experienced a degree of supply disruptions. While sometimes this led to reduced production, some respondents said the main effect was merely to slow and/or complicate ordering and scheduling of projects. Retreaders had an extraordinarily strong year as supply disruptions reduced new tire supplies and caused prices for new tires to increase significantly in 2021.
- **Additional potential global disruptions.** Further, additional disruptions and uncertainty may arise. For example, Russia's invasion of Ukraine has disrupted

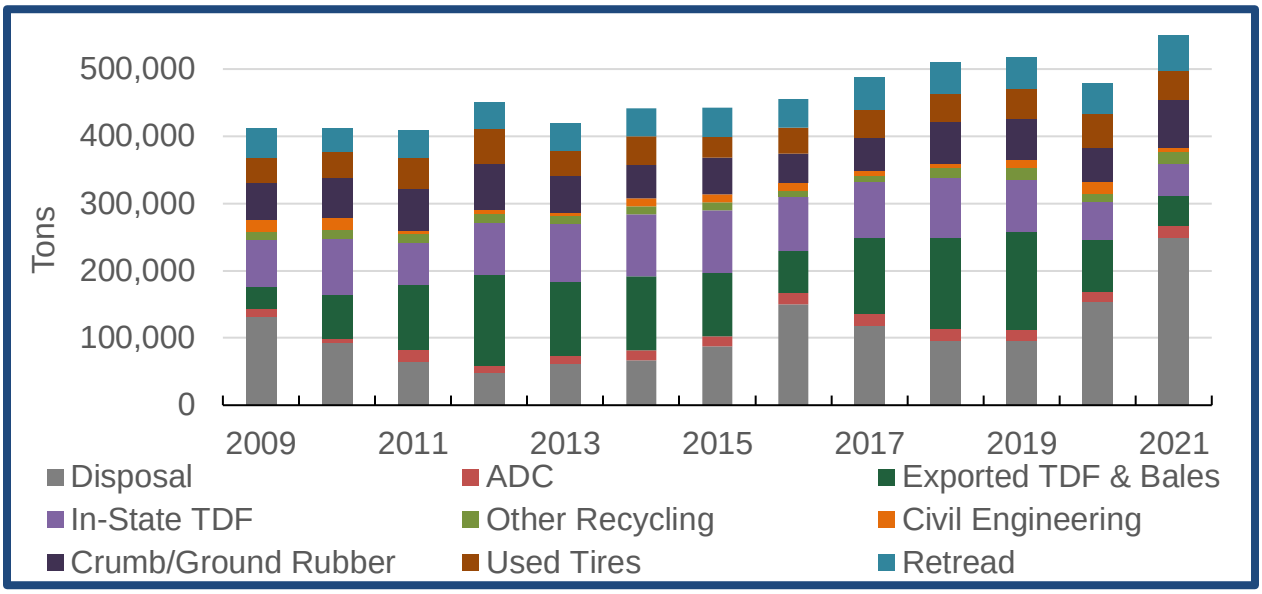
flows of many commodities, from food to carbon black, and could potentially lead to greater shipping and economic disruptions if it escalates. China's continued adherence to a zero COVID policy has triggered broad shutdowns of major cities and industrial sectors in China with associated supply chain disruptions of a variety of goods.

4. Trends by Market Segment

4.1 Historic Trends

Figure 4 shows the long-term trend in uses of California-generated waste tires and TDM, and Table 2 (on the next page) provides additional detail for the past three years. These findings are based only on California-generated waste tires and exclude imports. Likewise, the flow estimates exclude buffings from retreader operations. Appendix B describes the report methodology. The remainder of Section 4 describes trends in each market segment.

Figure 4
Historical Market Trends for California-Generated Waste Tires by Segment, 2009-2021



See Figure 4 source data in Appendix C.

Table 2

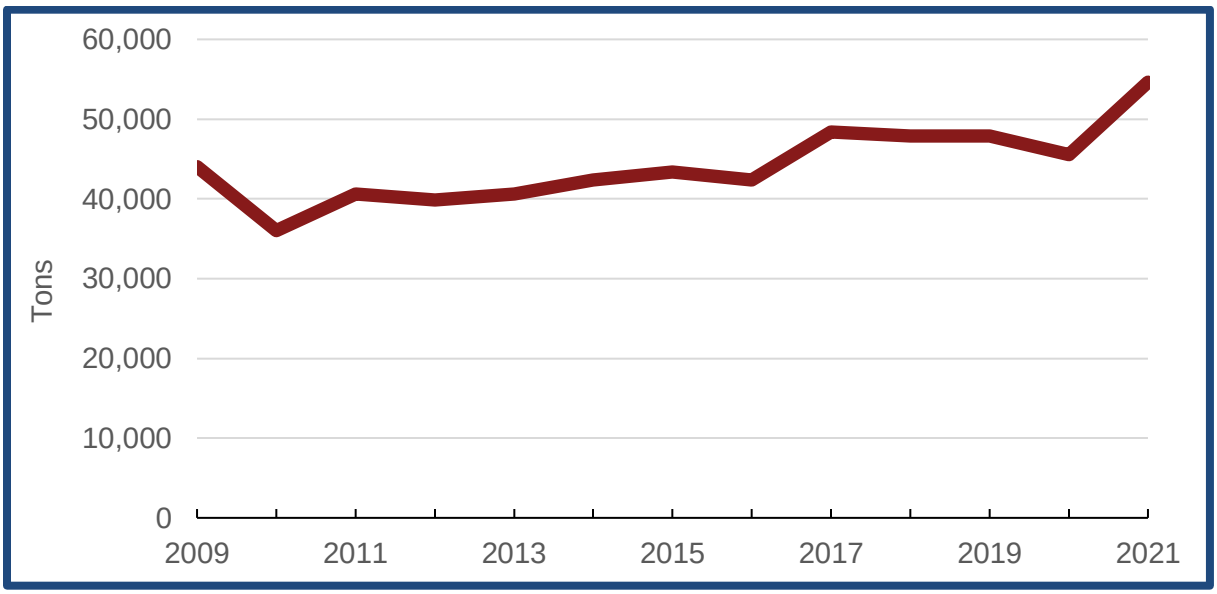
Estimated End-Uses for California-Generated Waste Tires, 2019 – 2021

Category	2019 Tons	2019 M PTEs	2019 %Total	2020 Tons	2020 M PTEs	2020 %Total	2021 Tons	2021 M PTEs	2021 %Total	% Tons Change 2020 - 2021
Retreads	47,900	4.8	9.2%	45,500	4.6	9.5%	54,600	5.5	9.9%	20%
Used Tires	44,800	4.5	8.6%	51,000	5.1	10.7%	43,000	4.3	7.8%	-16%
Crumb Rubber and Ground Rubber	60,000	5.7	11.6%	50,500	5.1	10.5%	70,900	7.1	12.8%	40%
Tire-Derived Aggregate	13,300	1.3	2.6%	16,900	1.7	3.5%	6,600	0.7	1.2%	-61%
Other Recycling	16,400	1.6	3.2%	11,900	1.2	2.5%	18,100	1.8	3.3%	52%
Sub-Total, Recycled	182,400	18.0	35.2%	175,900	17.6	36.7%	193,200	19.3	35.0%	10%
Tire-Derived Fuel (In-State)	78,300	8.0	15.1%	57,600	5.8	12.0%	48,200	4.8	8.7%	-16%
Tire-Derived Fuel (Export)	114,400	11.4	22.1%	73,400	7.3	15.3%	40,100	4.0	7.3%	-45%
Baled Waste Tires and Treads (Export)	31,000	3.1	6.0%	3,200	0.3	0.7%	3,500	0.4	0.6%	10%
Landfill Alternative Daily Cover	16,800	1.7	3.2%	14,900	1.5	3.1%	17,400	1.7	3.2%	17%
Sub-Total, Disposal Related	240,500	33.5	46.4%	149,100	14.9	31.1%	109,300	10.9	19.8%	-27%
Landfill Disposal	95,400	9.3	18.4%	154,000	15.4	32.2%	249,400	24.9	45.2%	62%
Total Managed	518,400	51.5	100.0%	479,000	47.9	100.0%	551,900	55.2	100.0%	15%
Whole Waste Tire Imports	5,700	0.6	1.1%	26,800	2.7	5.6%	29,500	3.0	5.4%	10%

4.2 Retreading

Retreaders experienced an extraordinarily strong year in 2021 and into 2022. Figure 5 shows an estimated 20 percent increase in the quantity of retread tires in 2021, to 54,600 tons (5.5 million PTEs, or 9.9 percent of all waste tires managed), based on California and national industry interviews. This was reportedly caused by significant supply chain disruptions that affected new tire supplies and increased new tire pricing, while retreaders continued to build on their inventory enabling them to seize the growth opportunity. Demand for retread tires remains high and, despite some ongoing constraints on rubber supply and workers needed by retreaders, the retread industry appears to be experiencing continued growth in 2022. In 2021, the CalRecycle sponsored Retread Services Contract (led by DK Enterprises) compiled data on retread benefits, conducted a series of seven workshops supported by the five leading retread and new tire manufacturers to educate fleet managers about retread tires, and produced new retread tire educational materials now available on CalRecycle's web site.

Figure 5
Estimated California-Generated Retread Tire Shipments, 2009-2021



See Figure 5 Source Data in Appendix C.

4.3 Used Tires

In 2021, an estimated 43,000 tons of used tires (4.3 million PTEs, or 7.8 percent of all waste tires managed) were culled from the waste tire stream. The used tires are sold in tire shops throughout California and exported primarily to Mexico, which maintains a quota limiting such imports of used tires to approximately 750,000 per year. Used tires is a profitable market and is expected to remain strong in 2022.

4.4 Crumb Rubber and Ground Rubber

In this report, crumb rubber and ground rubber are combined into a single category for the purpose of reporting total quantities shipped, as in Figure 6 below and Table 2 above. However, in this section we describe each of four sub-categories, with total quantities shipped estimated as a range. Specific estimates of the amount of crumb rubber and ground rubber shipped in each sub-category are no longer provided in this report series, due to the competitive nature of this market segment.

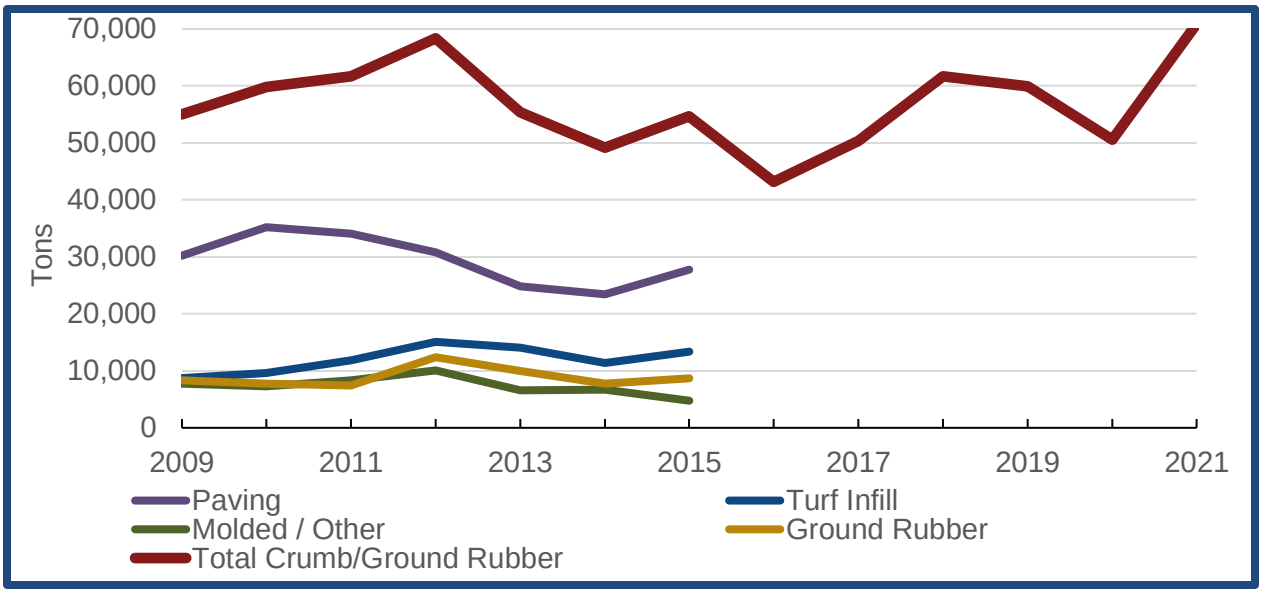
Crumb rubber is defined as TDM equal to or less than ¼ inch in size, and is commonly used in the following three sub-categories of products as described below in this report section:

- Paving, including rubberized hot mix asphalt and chip seal surface treatments
- Infill used on synthetic turf athletic fields
- Molded and Other – A catch-all grouping of other products made with crumb rubber including molded products like flooring tiles, ADA transition ramps, traffic safety devices, and pipe couplings, as well as non-molded products such as SBS modified bitumen roofing membranes

A fourth sub-category of products in the Crumb Rubber and Ground Rubber category is Ground Rubber products. Ground rubber is defined as TDM greater than ¼ inch and typically up to one inch in size. Products and uses made with ground rubber include landscape surfaces, playgrounds, and ballistics applications, among others.

As illustrated in Figure 6, estimated shipments of California-generated crumb rubber and ground rubber increased by 40 percent in 2021 to 70,900 tons (141.8 million pounds, 7.1 million PTE, or 12.8 percent of all waste tires managed). This increase came after declines in the previous two years. A description of trends for each sub-category follows Figure 6.

Figure 6
Shipments of California-Generated Crumb Rubber and Ground Rubber, 2009-2021



See Figure 6 source data in Appendix C.

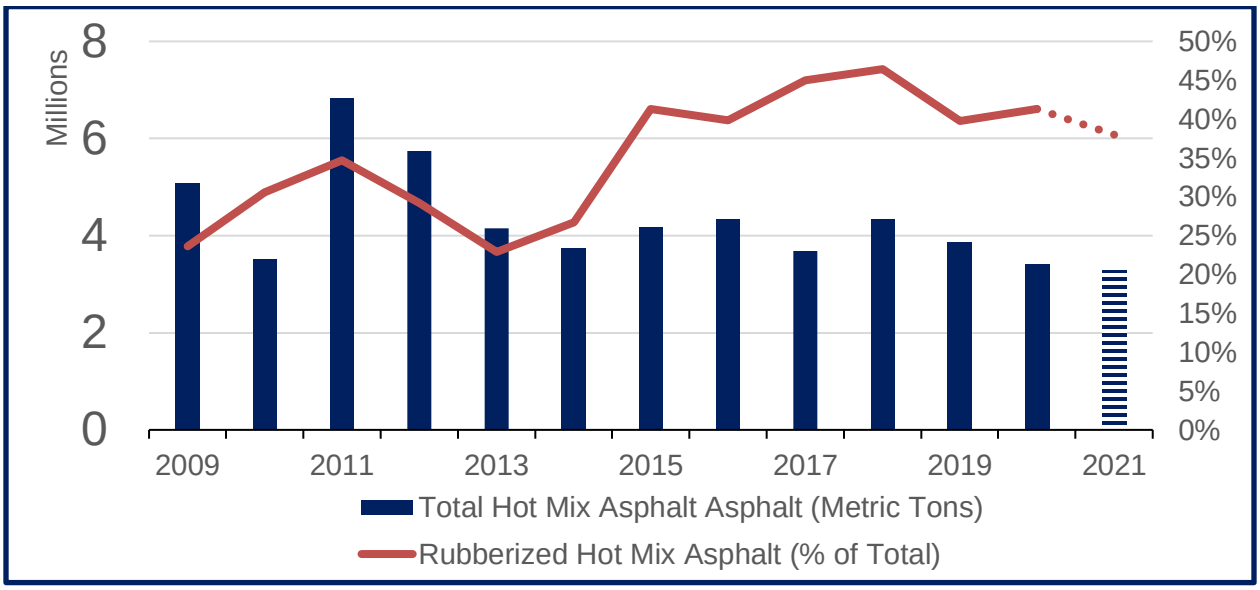
In addition to crumb rubber and ground rubber, raw and screened buffings of different specifications are also used in certain TDPs, especially pour-in-place playground surfacing, molded products, landscape mulch, and turf infill. Buffings are produced as a by-product of the retreading process, and we estimate that well over 15 million pounds were shipped by California retreaders in 2021. It is important to note that buffings are excluded from crumb rubber and ground rubber estimates and are not counted in recycling rates because the retreaded tires they originated from are already counted under retreads. Buffings continue to be in high demand

Paving

California producers shipped 72-92 million pounds of crumb rubber for use in asphalt paving projects, an increase over the 60-70 million pounds reported in 2020. Many industry representatives said they had expected greater increases in demand by Caltrans due to enactment of SB1, the Road Repair and Accountability Act of 2017. However, Caltrans staffing changes have contributed to delays in preparing and publishing bid documents for some projects, and the net result has been fewer, larger bids and an increase in bids for materials and services other than asphalt paving.

Figure 7 illustrates this trend, showing reductions in the total amount of asphalt placed over each of the last four years. While Caltrans has satisfied the mandate that at least 35 percent of its paving projects be rubberized hot mix asphalt (RHMA), the actual percentage has declined in recent years. Some survey respondents suggested a need for additional training, especially in districts with relatively low RHMA usage rates, to reinforce policies calling for use of RHMA as the surface of choice.

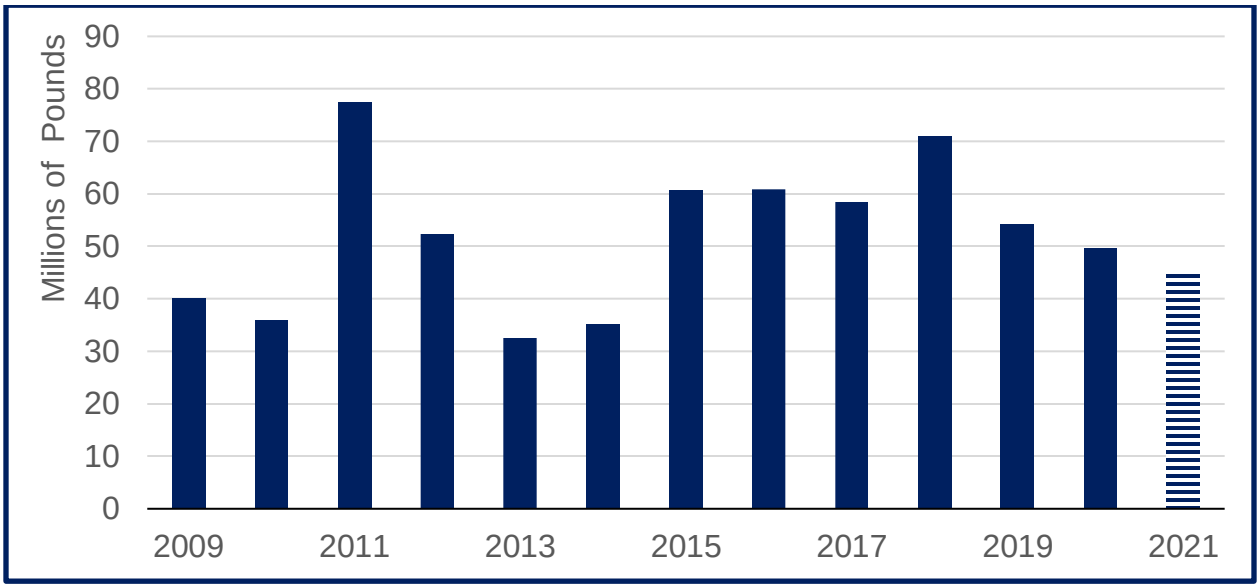
Figure 7
Caltrans Asphalt Placement and Rubberized Asphalt Percent of Total, 2009-2021[12]



Source: Caltrans annual Crumb Rubber Reports. (2021 data are estimates based on discussion with Caltrans representatives.) See Figure 7 source data in Appendix C.

The net result is seen in Figure 8, showing a reduction in estimated annual Caltrans crumb rubber use to about 45 million pounds in 2021. Since 2009, Caltrans has used an average of 51.8 million pounds of crumb rubber each year.

Figure 8
Caltrans Annual Use of Crumb Rubber in Paving Applications, 2009-2021[13]



Source: Caltrans annual Crumb Rubber Reports. (2021 data are estimates based on discussion with Caltrans representatives.) See Figure 8 source data in Appendix C.

Several California local governments use crumb rubber in paving projects, including rubberized hot mix asphalt (known as rubberized asphalt concrete, or RAC, in CalRecycle's programs) and in chip seals. CalRecycle supports a portion of this use through the Rubberized Pavement Grant Program (TRP). In the most recent grant cycle for the 2021-22 fiscal year, 37 projects were approved with a combined projected total use of 10.9 million pounds, which may be used in projects through the end of the grant cycle in April 2024. Historically, the program has funded average annual use of 9.0 million pounds of crumb rubber each year. This average figure is based on analysis of eight years of completed grants culminating in the 2018/19 fiscal year. Data from the most recent grant cycles are not used because historically, actual TDM use is typically less than the amount estimated in grant applications due to changes in, postponement, or cancelation of some projects.

Molded and Other Products

California producers shipped 27-34 million pounds of crumb rubber to molded and other product manufacturers/installers in 2021, an increase over the 20-25 million pounds shipped in 2020. This diverse category includes a variety of roofing, flooring, tiles, traffic sign bases, ADA transition ramps and more. The quantity of crumb rubber feedstock consumed by firms in this category ranges widely, with several using less than 50,000 pounds per year, while a few commonly use at least five million pounds each year.

CalRecycle's Tire Incentive Program (TIP) provides grants that support most of the crumb rubber used in this category. The program provides direct payments to tire-derived product (TDP) manufacturers of 10 cents per pound for new and existing products; 40 cents per pound for feedstock conversion projects involving new use of recycled feedstock in existing products, or for use of devulcanized TDM; and 50 cents per pound for fine mesh crumb rubber of at least 50 mesh.

In the most recent TIP grant cycle, for the 2021-22 fiscal year, six companies were awarded grants, with combined projected use of 22.1 million pounds of crumb rubber through April 2014. Based on analysis of six years of completed grants culminating in 2018-19, the TIP program supported an average of 10.9 million pounds per year. Data from the most recent grant cycles are not used because historically, actual TDM use is typically less than the amount estimated in grant applications due to changes in, postponement, or cancelation of some projects. TDM purchases and use can occur anytime within the three-year grant cycle.

CalRecycle's Feedstock Conversion Technical Assistance and Material Testing Services Contract provides additional support for uses in this category. Through this contract (currently led by DK Enterprises) CalRecycle offers a variety of material and product testing services and technical assistance services to help manufacturers design and develop new TDPs. In recent years, the contractor has worked with 11

manufacturers to produce 25 newly designed product specifications and has conducted over 640 certified laboratory tests.

Turf Infill

California producers shipped 12-18 million pounds of crumb rubber for use as infill in new and replacement synthetic turf athletic fields in 2021, an increase over the 8-12 million pounds shipped in 2020. It was reported that the percentage of fields using crumb rubber as infill had been declining, with significantly lower numbers in northern California. However, industry representatives said there is growing recognition that alternative infill materials do not perform as well from a fall height safety perspective. They also indicated there were approximately 140-150 fields constructed in California in 2021, including mostly new fields and some replacements of dismantled fields at the end of their useful lifetime, with a modest increase in crumb rubber use in this category. For a small portion of replacement fields in California, the end-of-life crumb rubber/sand mixture extracted from the dismantled field was reused in the new replacement field. While this practice is reportedly more common in the northeast and other U.S. regions, it is currently not a widespread practice in California. CalRecycle is not providing funding support for this category pending publication of a long-awaited study on crumb rubber environmental health and safety issues, expected to be available at the end of 2022.

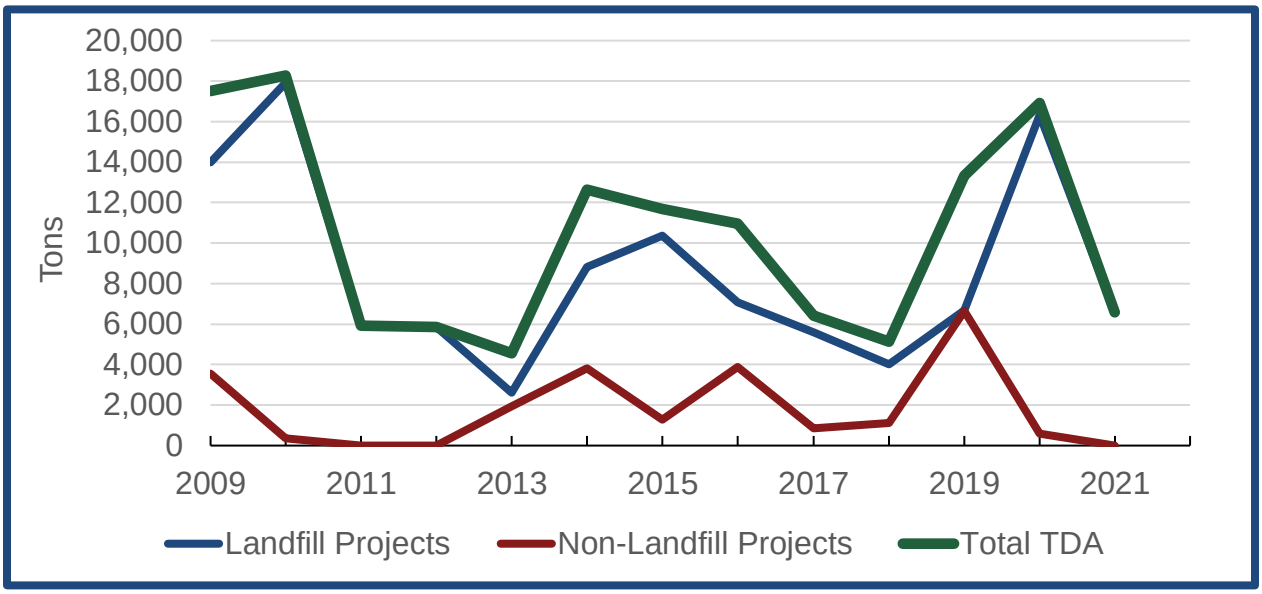
Ground Rubber Applications

California producers shipped 5-9 million pounds of ground rubber in 2021, an increase over the 5-7 million pounds reported for 2020. Tire-derived materials in this broadly defined category are used in playgrounds, landscaping, and ballistics applications, among others. CalRecycle's TDP Grant Program supports a portion of these uses. In the latest grant cycle for the 2021-22 fiscal year, five projects were approved with a combined total estimated use of 1.1 million pounds through April 2024. In recent years, the program has been offered only every-other-year, with less funding than in prior years. Based on analysis of six years of completed grants culminating in the 2019-20 fiscal year, the program has supported 2.7 million pounds per year of TDM use. Data from the most recent, not-yet-completed grant cycles are not used because historically, actual TDM use is typically less than the amount estimated in grant applications due to changes in, postponement, or cancelation of some projects.

4.5 Civil Engineering

Figure 9 shows how use of California-generated TDA in civil engineering projects has varied in recent years. In 2021, TDA use declined 61 percent compared to 2020 use of 6,600 tons (0.7 million PTEs or 1 percent of all waste tires managed). TDA was used in projects at landfills, primarily related to landfill gas collection systems, although some of those uses also involved road construction. Outside of landfills, common TDA uses involve roadside repair, retaining wall backfill, embankment fill, stormwater infiltration galleries and light rail sound dampening projects, among others. However, there were zero non-landfill uses in 2021.

Figure 9
California-Generated Tire-Derived Aggregate Shipped for Use in Civil Engineering Projects, 2009-2021



See Figure 9 source data in Appendix C.

CalRecycle's TDA Grant Program support for these uses can lead to ongoing usage. In 2021, for example, one landfill that previously received TDA Grant Program support accounted for 73 percent of total use, outside of the grant program.

According to CalRecycle's TDA technical assistance team, one factor that reduced demand for TDA was the initial reaction to a 2020 study[14] linking a chemical known as 6PPD-quinone derived from tire road wear particles with urban runoff mortality syndrome in coho salmon. The California Department of Toxic Substances Control's (DTSC's) Safer Consumer Product Program has proposed listing motor vehicle tires containing 6PPD as a priority product. CalRecycle is conducting research to understand how 6PPD-quinone may relate to TDA uses and projects.

Separately, DTSC has also proposed listing motor vehicle tires containing zinc as a priority product under the Safer Consumer Products Program. A recent CalRecycle sponsored Humboldt State University study[15] found that "…use of rubberized hot mix asphalt pavement plays a minor role in determining the zinc concentration in runoff from road surfaces. Leaching of zinc from tire wear particles generated by vehicles on the roadway and from galvanized materials along the roadway are the largest sources of zinc in the runoff from roads identified in this work, and both deserve additional study."

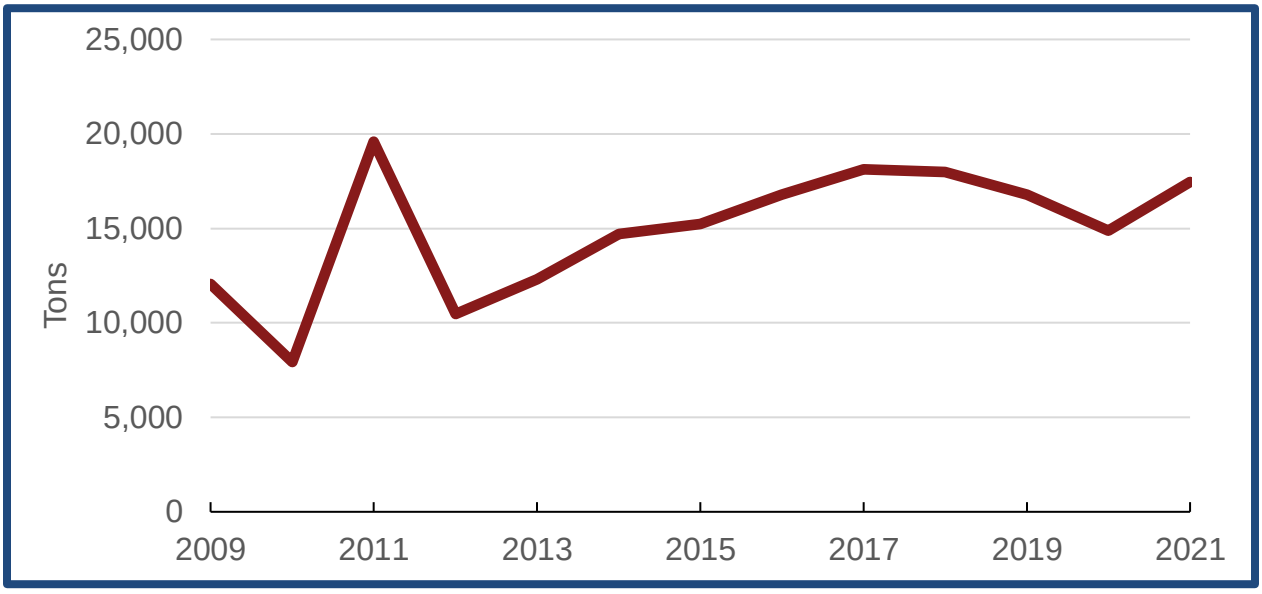
Two newly funded projects involving light rail sound dampening are underway and could use an estimated 6,700 tons of TDA in 2022. The TDA Grants Team is in discussions with project managers that could further increase the number of TDA in civil engineering

projects. Historically, based on analysis of eight years of completed grants culminating in the 2018-19 fiscal year, the TDA Grant Program has supported 4,700 tons (9.4 million pounds) per year of TDA use. Data from the most recent grant cycles are not used because actual TDM use is typically less than the amount estimated in grant applications due to changes in, postponement, or cancelation of some projects.

4.6 Landfill Alternative Daily Cover

California landfills are required to apply an approved type of daily cover to the top of active landfill faces at the end of operations each day, and some landfill permits allow use of alternative materials such as tire shreds. As Figure 10 shows, a significant quantity of tire shreds is used as alternative daily cover (ADC) in California by two landfills. In 2021, 17,400 tons (1.7 million PTEs or 3.2 percent of all waste tires managed) were used in this application. We expect this amount to remain roughly stable in coming years.

Figure 10
California-Generated Tire-Derived Material Used as Landfill Alternative Daily Cover, 2009-2021



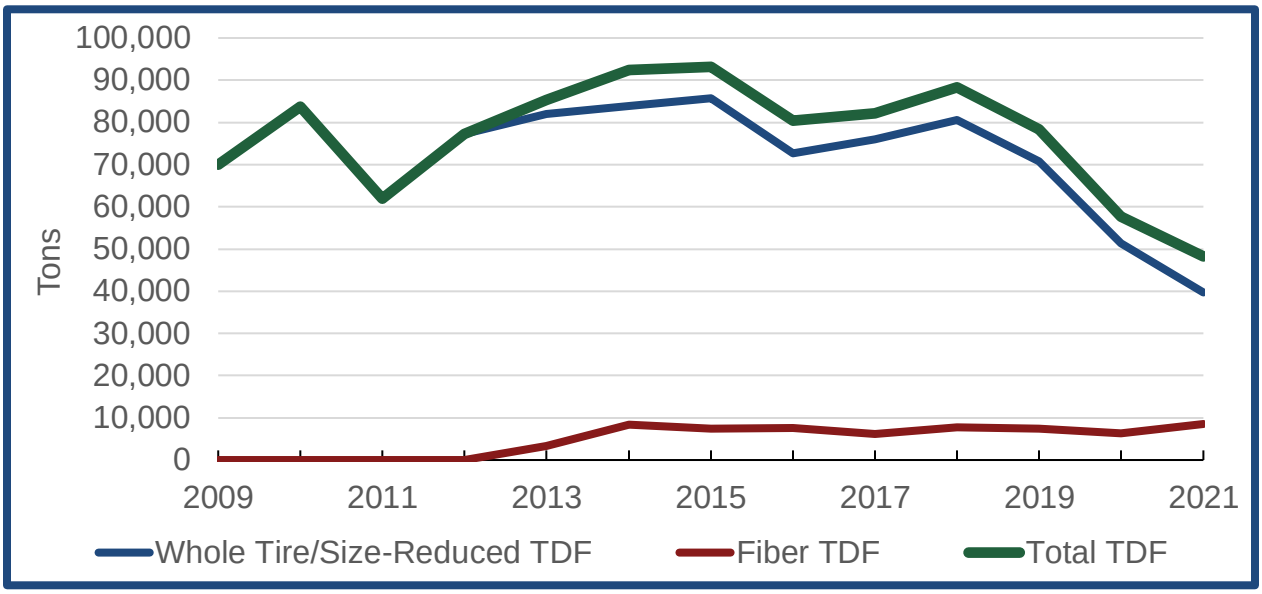
See Figure 10 source data in Appendix C.

4.7 Tire-Derived Fuel (In-State)

Four California cement kilns continued to consume TDF in 2021. As illustrated in Figure 11, reported shipments of California-generated TDF declined in 2021 by 16 percent, to 48,200 tons (4.8 million PTEs, or 8.7 percent of all waste tires managed). This amount includes 39,700 tons (4.0 million PTEs) of whole waste tires and size-reduced TDF as well as 8,500 tons of tire fiber generated as residual by processors. An additional 7,300 tons of whole tire and size-reduced TDF, plus over 10,000 tons of tire fiber shipped to

California cement kilns, is estimated to have been derived from out-of-state sources. Cement kiln fuel use patterns have changed over the past two years as use of TDF generally declined, reportedly as demand and production increased and other types of fuel became preferred. Also, a portion of demand has shifted from whole tires to size-reduced TDF. Finally, an increasing share of TDF consumed is comprised of residual tire fiber from processors. According to cement kiln respondents, overall use may remain flat or increase moderately in 2022.

Figure 11
California-Generated Whole Waste Tires, TDF and Residual Fiber Consumed at California Cement Kilns, 2009-2021



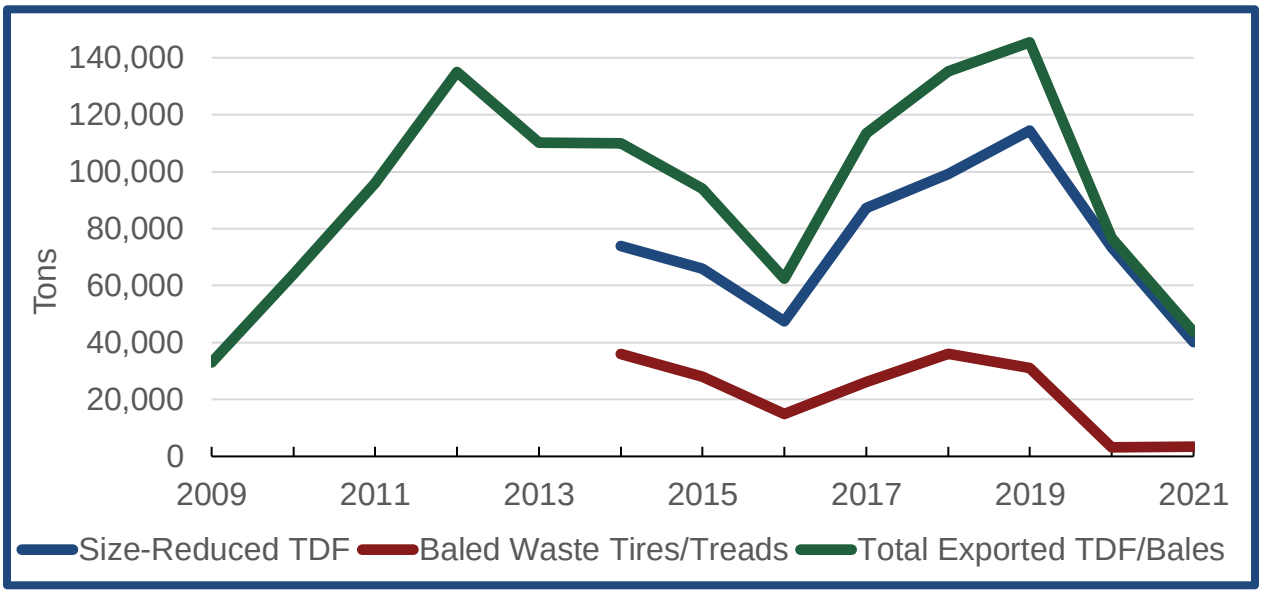
See Figure 11 source data in Appendix C.

4.8 Tire-Derived Fuel and Baled Waste Tires and Truck Treads (Export)

As Figure 12 shows, export of California-generated TDF (including size-reduced TDF, baled waste tires and baled truck tire treads) peaked in 2019 but declined markedly in 2020 and again in 2021 by 43 percent to 43,700 tons (4.4 million PTEs, or 7.9 percent of all waste tires managed). Export of size reduced TDF, primary to Japan and Korea dropped by 45 percent to 40,100 (4.0 million PTEs or 7.3 percent of all waste tires managed). California processors exported an additional 3,700 tons of TDF; however, this was derived from waste tires imported from out of state and allocated to shipments from these processors. Export of baled waste tires and truck tire treads primarily to India and Pakistan (baled separately as two distinct products) remained at very low levels in 2021 at 3,500 tons. This represented a 10 percent increase over the very small amount shipped in 2020, which was down 90 percent from the amount in 2019. We are not aware of any export of baled waste tires since early 2021.

The reduction in exports is due to poor economics and logistical challenges. Costs have increased significantly due to a variety of port and shipping related challenges including trucking to and from ports, difficulty securing access to containers, and unpredictable delays and changes to established bookings. Customer pricing on the importing end has not adjusted to account for these increased costs. There is also competition from suppliers in other countries. As of mid-2022, these conditions have not substantially changed, and consequently exports are expected to remain very low in 2022.

Figure 12
California-Generated Exported TDF and Baled Waste Tires and Truck Treads, 2009-2021

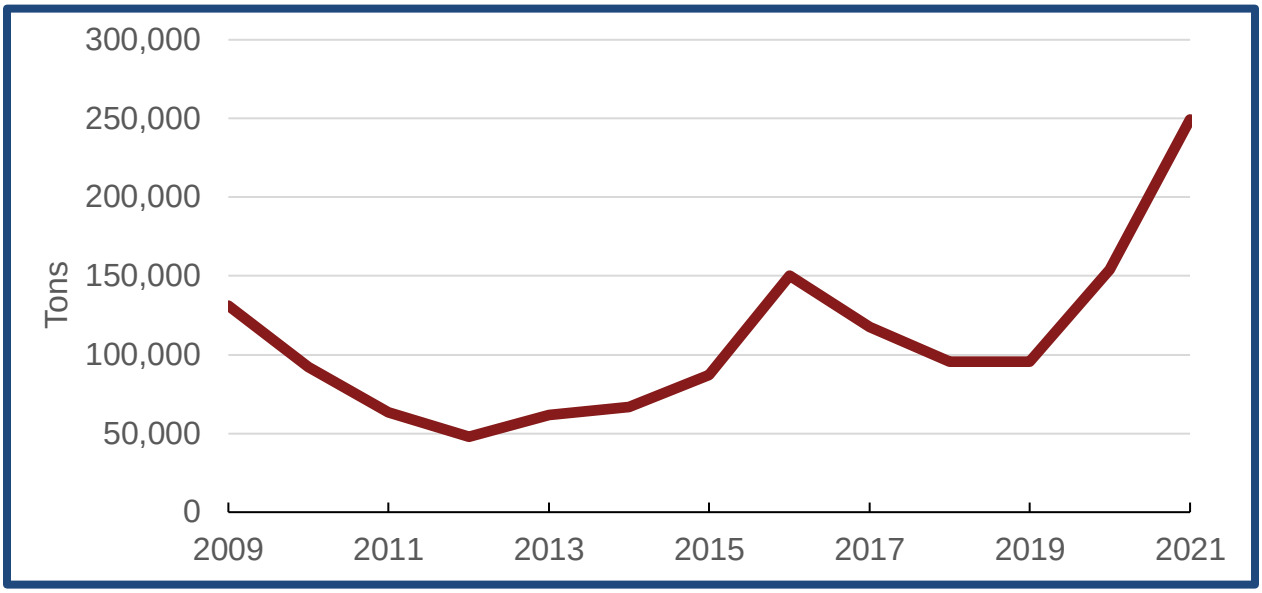


See Figure 12 source data in Appendix C.

4.9 Landfill Disposal

As shown in Figure 13, after a 61 percent rise in 2020, landfill disposal of California-generated waste tires increased markedly again in 2021 by 62 percent to 249,400 tons (24.9 million PTEs or 45.2 percent of all waste tires managed). An additional 12,300 tons (1.2 million PTEs) were also shipped for landfill disposal by California processors; however, this was derived from out-of-state flows processed at California facilities. This shattered the previous 20+ year record for waste tire landfill disposal in California. As discussed in Section 4.8 above, the main cause of the landfill disposal spike was the disrupted export economics and logistical feasibility which left companies that typically export with few options. An additional cause was a reduction in TDF demand at California cement kilns as discussed in Section 4.7 above. These factors caused TDF producers and exporters to redirect waste tire flows to landfills, including a significant amount to one landfill located in Nevada. Landfill disposal is expected to remain extremely high in 2022.

Figure 13
California-Generated Waste Tires Disposed in Landfills, 2009-2021



See Figure 13 source data in Appendix C.

4.10 Waste Tire Imports

In 2021, an estimated 29,500 tons (3.0 million PTEs or 5.4 percent of all waste tires managed) of whole waste tires were imported from out-of-state and flowed to multiple California processors. The study methodology allocates a proportionate share of all outbound shipments from these processors to imports, based on the percentage of inbound tires that were imported, as presented in Table 3 below. These amounts were excluded from the California tire use estimates presented in Table 2 above and throughout this report.

Table 3
Estimated Flows in Tons of Out-of-State Waste Tires Imported to California Processing Facilities (2021)

Category	Allocated Import Adjustments
Retreads	NA
Used Tires	4,700
Crumb Rubber and Ground Rubber	200
Tire-Derived Aggregate	1,300
Other Recycling	Neg.
Total Recycled	**6,200**
Tire-Derived Fuel (In-State)	7,300
Tire-Derived Fuel (Export)	3,700
Baled Waste Tires and Truck Tire Treads (Export)	0
Landfill Alternative Daily Cover	0
Total Disposal Related	**11,000**
Landfill Disposal	**12,300**
Total Managed	**29,500**

5. The Outlook for Increased Waste Tire Recycling

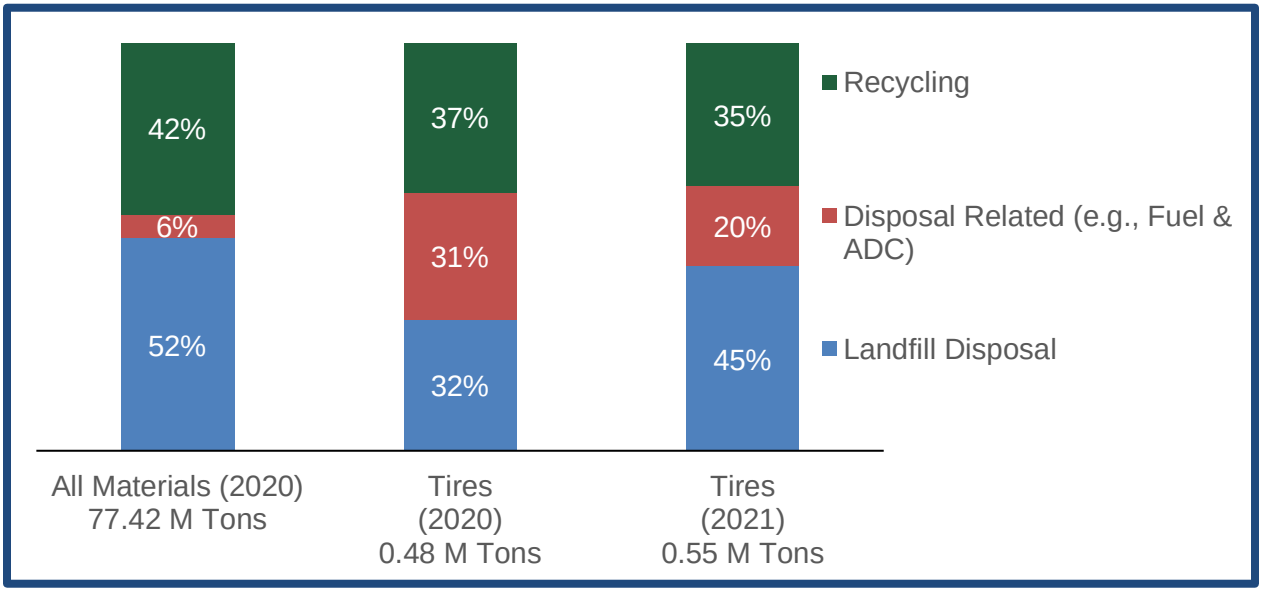
The following sections examine California waste tire management and recycling in the context of all types of waste, historical trends in waste tire recycling, and the outlook for increasing California waste tire recycling.

5.1 Waste Tire Recycling in the California Context

California has a mandatory statewide 75 percent recycling rate goal by 2020 for all waste types per AB 341 (Chesbro, Chapter 476, Statutes of 2011). While not codified in statute, CalRecycle has also informally adopted a 75 percent recycling goal specifically for waste tires. Consistent with AB 341, the recycling rate measurement excludes landfill ADC and fuel related uses, including TDF (included in the "disposal related" category to distinguish them from recycling (broadly defined to include reuse) and landfill disposal.

Figure 14 illustrates how California waste tire management compares to management of the entire waste stream. The figure shows the 2020 breakdown for all waste materials (the most recent data available) along with 2020 and 2021 high level data on waste tires management for comparison.

Figure 14
Comparison of All California Waste Materials and California Waste Tires Management

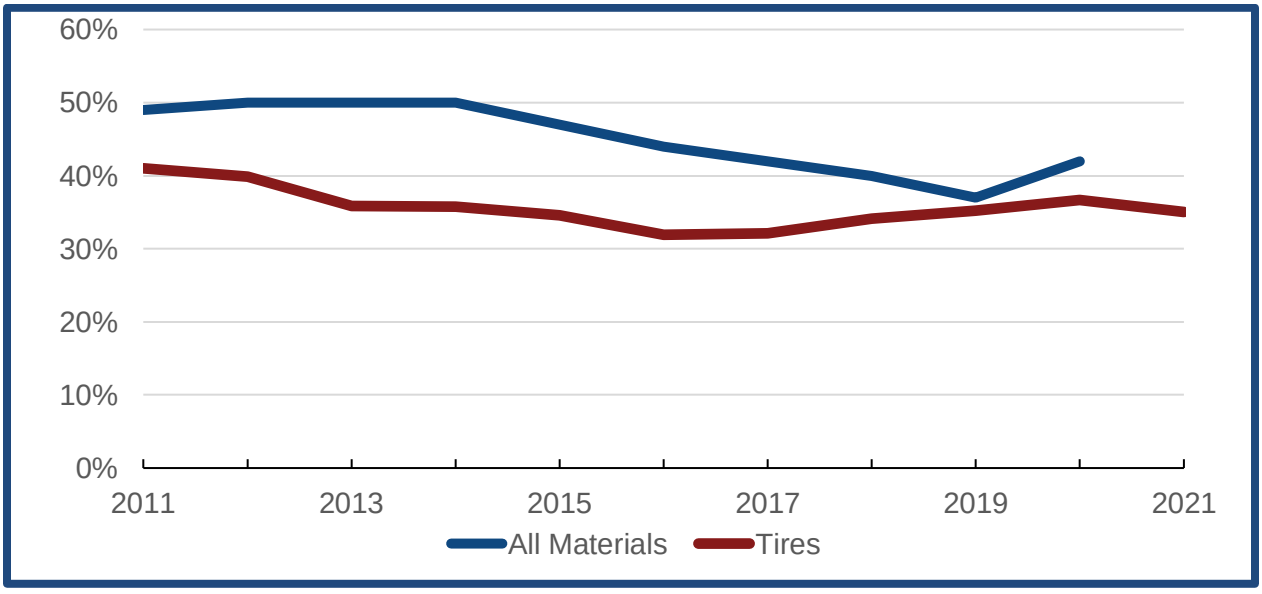


See Figure 14 source data in Appendix C. Source for all materials: CalRecycle, State of Disposal and Recycling in California for Calendar Year 2020.

Waste tires represent about 0.6 percent of the total California waste stream. The big increase in 2021 waste tire landfill disposal resulted in a disposal rate of 45 percent, close to the 2020 all materials landfill disposal rate of 52 percent. Over the last decade the waste tire landfill disposal rate has been much lower than the all-materials landfill disposal rate. For all materials the disposal related category (again, defined to include ADC and fuel related uses such as TDF) is more stable and comprises a much lower portion than for tires, even after the disposal related quantity dropped to a 20+ year record low in 2021. Compared to tires, there is less incineration or other fuel use for all materials, and the bulk of the all materials disposal related category is comprised of ADC.

Finally, the 2020 all-materials recycling rate of 42 percent is a jump of five percent from 2019, when the 37 percent recycling rate was comparable to waste tire recycling of 37 percent in 2020 and 35 percent in 2021. As shown in Figure 15, since 2011 the waste tire recycling rate has fluctuatedbetween 32 percent and 41 percent. During this period the waste tire recycling rate was significantly lower than the all materials recycling rate until 2019 when the two recycling rates came within two percentage points of each other. The waste tire recycling rate subsequently increased two percentage points in 2020 before dropping back to the 2019 level of 35 percent in 2021. The all materials recycling rate jumped five percentage points in 2020, and may be poised to accelerate further as several new and significant statewide policies are implemented in coming years.

Figure 15
California All Waste Materials and California Waste Tires Recycling Rates, 2011-2021

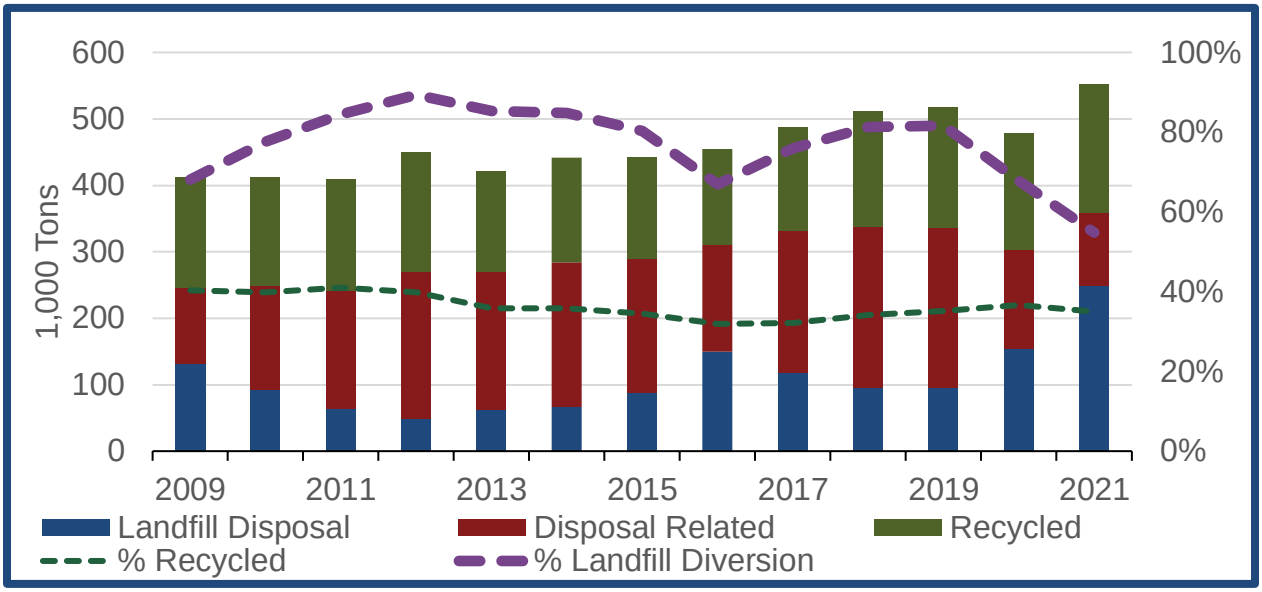


See Figure 15 source data in Appendix C.

5.2 Historic Recycling, Disposal Related and Landfill Disposal Trend

As shown in Figure 16, the California waste tire recycling rate has fluctuated within a narrow range over the past 12 years before reaching a low point in 2016 of 32 percent, but has inched up slowly since then, reaching 37 percent in 2020. Then in 2021, recycling tons increased by 10 percent to 193,200 tons (19.3 million PTEs or 35 percent of all waste tires managed). At the same time, the recycling rate declined by 1.7 percentage points to 35 percent, because overall waste tire generation increased at a greater pace than the increase in recycled tons.

Figure 16
California Waste Tire Recycling, Disposal Related and Landfill Disposal Trend, 2009-2021



See Figure 16 source data in Appendix C.

5.3 Future Tire Recycling Trends and Considerations

Table 4 summarizes the short-term outlook for each market segment in 2022, based on the trends identified earlier in this report. The outlook for growth in 2022 and 2023 is difficult to predict. Considerations include:

- **Can 2021 recycling gains be maintained or expanded?** As discussed above, retreading increased by 20 percent in 2021 and the crumb rubber/ground rubber market segment increased by 40 percent. Industry feedback suggests retreading is on track for continued growth in 2022. Crumb rubber markets, especially in the paving and molded/other segments, appear strong with further growth in paving if Caltrans can increase the pace of new paving bids utilizing SB1 transportation funding and local governments do the same with separate dedicated transportation funding which is available in certain cities and counties.

Table 4
The Outlook for California Waste Tire Recycling

Category	2021 Tons	2021 M PTEs	2021 % Total	Outlook in 2022
Retreads	54,600	5.5	9.9%	Continued growth after sizable increase in 2021
Used Tires	43,000	4.3	7.8%	Steady
Crumb Rubber and Ground Rubber	70,900	7.1	12.8%	Steady or modest decline after sizable increase in 2021
Tire-Derived Aggregate	6,600	0.7	1.2%	Modest increase as new grant-funded light rail projects begin
Other Recycling	18,100	1.8	3.3%	Flat, sustained by residual wire recycling, pressed tire products and agricultural applications
Total Recycling	193,200	19.3	35.0%	Unclear. May stay roughly flat
TDF (In-State)	48,200	4.8	8.7%	Steady or modest increase per cement kilns
TDF and Baled Waste Tires & Treads (Export)	43,700	4.4	7.9%	Steady at low level due to ongoing port/shipping issues and poor economics
Landfill Alternative Daily Cover	17,400	1.7	3.2%	Steady use at two landfills
Total Disposal Related	109,300	10.9	19.8%	Roughly steady
Landfill Disposal	249,400	24.9	45.2%	Steady or modest decline
Overall Diversion	302,500	30.3	54.8%	Roughly steady
Waste Tires Managed	551,900	55.2	100.0%	Modest decline after significant increase in 2021

- **To what extent will new or expanded products and markets emerge?** The Tire Incentive Program and Feedstock Conversion Services Contract discussed above target expansion and diversification of TDP manufacturing in California. As of the time of writing new application cycles are open. To the extent that new, high-volume products and markets can be identified, this could open the door for new investments and expanded production of recycled tire products.
- **To what extent will disruptions continue to negatively impact business operations and markets?** Unfortunately, the main disruptions impacting waste tire management and recycling companies, as summarized in Section 2, do not appear to be subsiding so far in 2022. These include persistent staffing and hiring challenges, high trucking and ocean shipping costs, high inflation and supply disruptions involving a wide range of disparate commodities and products, potential additional disruptions that may occur related to evolving COVID spikes and shutdowns (especially in China), and from the Russian invasion of Ukraine. While some market segments may benefit from certain disruptions, such as retreader gains in 2021 at the expense of new tire supply disruptions, these factors are likely to continue to constrain efficient business operations and market expansion in most waste tire management and recycling industry segments by adding complications and costs.
- **How may recent business ownership changes and investments benefit recycling?** In 2021, there were some key changes in ownership involving California waste tire TDM suppliers, TDP manufacturers, retreaders and other market segments, including new investments to expand or enhance operations. While the impact of these changes is not yet clear, investments that satisfy customer needs, especially in high-volume uses, hold the potential to drive expansion of tire recycling.

5.4 Concluding Remarks

California has a strong, diverse existing waste tire management infrastructure. In 2022 and 2023, there is potential for recycled tire tonnages to grow if 2021 gains hold, especially in the retreader, paving and molded/other market segments. Recent changes in business ownership and investments to expand or enhance waste tire recycling operations may also support continued growth. However, the industry disruptions discussed above do not appear to be receding as of mid-2022, and there is a need for continuing expansion and diversification in TDP markets and the types of California TDPs and TDM applications. While the conditions for transformational growth in tire recycling do not yet appear to be in place, there is good potential for incremental progress, and California's waste tire management system continues to be strong, enabling sound management of waste tires generated throughout the state.

Appendix A
Glossary of Key Terms and Acronyms

ADC: Alternative Daily Cover used at landfills instead of soil.

Buffings: Tire rubber produced as a by-product of the tire retreading process.

California-Generated: As used in this report, this term refers to waste tires generated in California and/or tire-derived materials or products made from waste tires generated in California, excluding any amounts derived from waste tires imported into California.

Caltrans: California Department of Transportation.

CARB: California Air Resources Board.

Circular Economy: An economic system where products and services are traded in closed loops or cycles. It tackles global challenges like climate change, biodiversity loss, waste, and pollution. Circular Economy aims to redefine growth, focusing on positive society-wide benefits. It is based on three principles: Design out waste and pollution; keep products and materials in use; regenerate natural systems.

Comprehensive trip log (CTL): Paper or electronic forms used by haulers and waste tire facilities to document waste and used tire pickup or delivery transactions. Forms are submitted to CalRecycle and entered in the Waste Tire Manifest System database.

Crumb rubber: Tire-derived material equal to or less than ¼ inch in size, free of wire and fiber. In this report the broad category Crumb Rubber and Ground Rubber is defined to include the following three sub-categories of products made from crumb rubber:

- Paving, including rubberized hot mix asphalt and chip seal surface treatments
- Infill used on synthetic turf athletic fields
- Molded and Other – A catch-all grouping of other products made with crumb rubber including molded products like flooring tiles, ADA transition ramps, traffic safety devices, and pipe couplings, as well as non-molded products such as SBS modified bitumen roofing membranes

A fourth sub-category of products in the Crumb Rubber and Ground Rubber category is Ground Rubber products, defined to include any products or applications made with ground rubber as defined below.

Disposal-Related Activities: As defined in CalRecycle's annual State of Disposal and Recycling Reports, a set of activities considered as part of overall disposal: alternative daily cover, alternative intermediate cover, other beneficial reuse at landfills (such as construction activities, landscaping, and erosion control), transformation, engineered municipal solid waste, and waste-tire derived fuel.

DTSC: California Department of Toxic Substances Control

End-of-Life (EOL): Refers to products that have reached the end of their useful life and are ready to be discarded and managed, whether through reuse, recycling, landfill disposal, or another means.

Feedstock conversion: The process whereby a manufacturer converts a portion of the raw materials (e.g., virgin rubber, EPDM, plastic, aggregate, or other raw material) used to make a product with recycled tire rubber.

Ground rubber: Tire-derived material greater than ¼ inch and up to one inch in size, sometimes referred to as nuggets depending on the specification and application. In this report Ground Rubber is also a sub-category of products within the broader Crumb Rubber and Ground Rubber category that includes any product made with ground rubber.

Landfill Disposal: Disposal of waste materials at a landfill, excluding materials disposed as part of disposal-related activities.

OEHHA: California Office of Environmental Health Hazard Assessment.

Passenger tire equivalent (PTE): Defined as 20 pounds of tire rubber for the purpose of making consistent comparisons in this and other reports. (The actual weight of waste passenger tires may vary considerably.)

Retread tire: A quality casing satisfying established standards to which a new tread has been affixed to extend the usable life of the tire.

Tire-derived aggregate (TDA): Tire-derived material used to replace conventional aggregates like rock in civil engineering applications.

Tire-derived fuel (TDF): Whole waste tires or tire-derived material consumed as fuel (referred to as size reduced TDF in this report). Residual tire fiber from crumb rubber operations sent used as fuel in California cement kilns is also categorized as tire-derived fuel in this report.

Tire-derived material (TDM): Tires processed to meet market specifications, for example, crumb rubber, ground rubber, tire-derived aggregate, and tire-derived fuel.

Tire-derived product (TDP): Product made entirely or in part from tire-derived material.

Tire Incentive Program (TIP): A CalRecycle program launched in June 2015 to promote feedstock conversion and the use of crumb rubber as feedstock by California manufacturers.

Used Tire: 30 PRC § 42806.5 defines "used tire" as a tire that: a) is no longer mounted on a vehicle but is still suitable for use as a vehicle tire; b) meets applicable

requirements of the Vehicle Code and Title 13 of the California Code of Regulations; and c) meets specified storage requirements.

Waste Tire Manifest System (WTMS): Waste Tire Management System. A CalRecycle database containing information on waste tire management firms, permits, and submitted comprehensive trip log data.

Waste Tire: 30 Public Resources Code (PRC) § 42807 defines a "waste tire" as a tire that is not mounted on a vehicle and is no longer suitable for use as a vehicle tire due to wear, damage, or deviation from manufacturer original specifications.

Appendix B
Methodology

The main goal of the annual Waste Tire Market Report series is to document California waste tire recycling trends, the recycling rate and the quantity of California-generated waste tires managed (including used tires and retread tires) along with trends in each segment they ultimately flow to.

Conducting the annual market analysis involves the following steps:

- Update a list of currently operating California facilities and companies waste tire management, including processors, TDP manufacturers and installers, asphalt rubber blender operators, brokers, retreaders, cement kilns, and landfills that dispose waste tires. Sources include CalRecycle databases, industry networking online searching.
- Compile information on these facilities through surveys, CalRecycle databases (especially the Waste Tire Manifest System) and online searches.
- Enter facility specific data into a customized flow model spreadsheet and systematically analyze flows, with emphasis on flows to and from waste tire facilities to end-use market segments. This is an iterative process in which researchers identify issues and follow up with facilities repeatedly to refine and validate the analysis. The process continues until researchers conclude the findings are as complete and accurate as possible, while avoiding double-counting.
- Where data are unavailable or contradictory, estimations are made based on the information available and perspectives offered by industry representatives.

Readers should keep the following in mind when interpreting and using findings:

- Findings reported in the main body of the report are rounded to the nearest one hundred tons, reflecting a reasonable level of accuracy. However, the underlying source data used to generate charts, as presented in Appendix C, lists the exact numerical estimates generated through use of the customized flow model.
- The findings quantify California-generated waste tires and TDM/TDPs made from them. Imported waste tires and TDM/TDPs made from them are excluded from the California-generated findings, as are buffings from retread operations, since the rubber has already been “counted” as part of the retreading process.
- The findings do not represent estimates of California’s total market for TDM or TDPs.
- The waste tire market report series employs a consistent methodology that the authors strive to refine and improve over time. This includes extensive data

gathering and validation through multiple sources wherever possible, as well as rigorous and systematic data analysis. Because of this, despite the need to address data gaps and inconsistencies, the authors believe the findings provide reasonably accurate information that can be used to evaluate trends over time.

Appendix C
Accessibility Notes and Source Data

Following is the source data used for charts and figures in this report. Note that in the body of the report, findings are rounded to the nearest one hundred, reflecting a reasonable level of accuracy. However, in this appendix we present the exact estimates as generated in the waste tire flow model used by the study team to produce charts that reflect the best information available.

Table C-1

Source Data for Figure 1 California Waste Tire Flows in 2021

Category	2021 Tons	2021 Percent
Retreads	54,635	9.90%
Used Tires	43,044	7.80%
Crumb/Ground Rubber	6,575	1.19%
Tire-Derived Aggregate	70,862	12.84%
Other Recycling	18,082	3.28%
Tire-Derived Fuel (In-State)	48,243	8.74%
Tire-Derived Fuel (Export)	40,148	7.27%
Exported Baled and Cut Waste Tires	3,516	0.64%
Alternative Daily Cover	17,440	3.16%
Landfill Disposal	249,377	45.18%
Total Managed	**551,921**	**100.00%**
Total Recycled	**193,197**	**35.0%**
Total Disposal Related	**109,347**	**19.8%**

Table C-2

Source Data for Figure 2 California Waste Tire Recycling, Disposal Related and Disposal Trends, 2009-2021

Category	2009	2010	2011	2012	2013	2014
Landfill Disposal	131,152	92,033	63,444	47,908	61,682	66,770
Disposal Related	114,968	155,603	177,500	222,695	207,754	217,043
Recycled	165,997	164,206	167,516	179,768	150,741	158,094
% Recycled	40.3%	39.9%	41.0%	39.9%	35.9%	35.8%
% Landfill Diversion	68.2%	77.7%	84.5%	89.4%	85.3%	84.9%

Category	2015	2016	2017	2018	2019	2020	2021
Landfill Disposal	87,170	150,226	117,448	95,401	95,412	154,050	249,377
Disposal Related	202,382	159,654	213,707	241,597	240,503	149,099	109,347
Recycled	152,767	145,288	156,994	174,264	182,438	175,868	193,197
% Recycled	34.5%	31.9%	32.2%	34.1%	35.2%	36.7%	35.0%
% Landfill Diversion	80.3%	67.0%	75.9%	81.3%	81.6%	67.8%	54.8%

Accessibility Notes for Figure 3, California Waste Tire Recycling Industry Flow Chart

This chart illustrates how California waste tires, tire-derived material (TDM) and tire-derived products (TDPs) flow between various entities. Haulers pick up waste tires from generators and may deliver them to either: a landfill for disposal; a processor (who may produce TDM); a used tire buyer or seller; or a TDF consumer (i.e., one of four California cement kilns). Processors may send tires or TDM to a landfill for disposal, use in civil engineering projects or other beneficial uses, a used tire buyer or seller, an exporter, a TDP manufacturer or installer, a TDF consumer, or a civil engineering project. Imports into and exports from California include: TDM and TDPs, retread tires and buffings, used tires, tire-derived fuel, baled and cut waste tires, and whole waste tires. Such imports may flow to California processors, TDP manufacturers and installers, TDF consumers, or directly to customers. Such exports may flow from California processors, TDP manufacturers, used tire buyer and sellers, and retreaders.

Categories of manufacturers and installers include:

- Accessibility ramps
- Roofing
- Flooring
- Landscape surfaces
- Mats, pavers, and tiles
- Traffic safety
- Equestrian applications
- Pavements
- Synthetic turf infill
- Playground surfaces
- Paths, walkways, and sidewalks

Types of civil engineering applications include:

- Landfill projects
- Light-weight fill
- Retaining wall backfill
- Vibration dampening
- Storm water management

Finally, TDP manufacturers and installers, civil engineering project leads, and TDF consumers sell products directly to their customers, inside and outside of California.

Table C-3

Source Data for Figure 4 Historical Market Trends by Segment, 2009-2021

Category	2009	2010	2011	2012
Landfill Disposal	131,152	92,033	63,444	47,908
ADC	12,042	7,928	19,589	10,486
Exported TDF & Bales	33,000	64,000	96,000	135,000
In-State TDF	69,926	83,675	61,911	77,209
Other Recycling	12,221	12,121	13,427	14,059
Civil Engineering	17,510	18,274	5,915	5,844
Crumb/Ground Rubber	55,000	59,850	61,700	68,350
Used Tires	37,266	37,942	45,823	51,678
Retread	44,000	36,018	40,651	39,838
Total Managed	**412,117**	**411,842**	**408,459**	**450,372**

Category	2013	2014	2015	2016	2017
Landfill Disposal	61,682	66,770	87,170	150,226	117,448
ADC	12,316	14,691	15,217	16,798	18,108
Exported TDF & Bales	110,144	110,000	94,000	62,476	113,405
In-State TDF	85,295	92,352	93,165	80,380	82,194
Other Recycling	12,166	11,643	12,114	9,790	10,433
Civil Engineering	4,557	12,632	11,668	10,961	6,431
Crumb/Ground Rubber	55,350	49,200	54,700	43,165	50,345
Used Tires	38,033	42,278	30,927	39,032	41,375
Retread	40,635	42,341	43,358	42,341	48,409
Total Managed	**420,177**	**441,907**	**442,318**	**455,168**	**488,149**

Category	2018	2019	2020	2021
Landfill Disposal	95,401	95,412	154,050	249,377
ADC	17,975	16,784	14,876	17,440
Exported TDF & Bales	135,236	145,412	76,612	43,664
In-State TDF	88,386	78,307	57,611	48,243
Other Recycling	16,791	16,442	11,862	18,082
Civil Engineering	5,127	13,330	16,911	6,575
Crumb/Ground Rubber	61,728	59,985	50,530	70,862
Used Tires	42,692	44,757	51,036	43,044
Retread	47,925	47,925	45,529	54,635
Total Managed	**511,262**	**518,353**	**479,017**	**551,921**

Table C-4
Source Data for Figure 5 Estimated California-Generated Retread Tire Shipments, 2009-2021

Category	2009	2010	2011	2012	2013	2014
Retreads	44,000	36,018	40,651	39,838	40,635	42,341

Category	2015	2016	2017	2018	2019	2020	2021
Retreads	43,358	42,341	48,409	47,925	47,925	45,529	54,635

Table C-5

Source Data for Figure 6 Shipments of California-Generated Crumb Rubber and Ground Rubber, 2009-2021

Category	2009	2010	2011	2012	2013	2014
Paving	30,160	35,206	34,043	30,793	24,806	23,429
Turf Infill	8,723	9,605	11,871	15,089	14,034	11,355
Molded / Other	7,733	7,308	8,357	10,076	6,583	6,719
Ground Rubber	8,383	7,731	7,428	12,392	9,927	7,698
Total Crumb/Ground Rubber	**55,000**	**59,850**	**61,700**	**68,350**	**55,350**	**49,200**

Category	2015	2016	2017	2018	2019	2020	2021
Paving	27,808	NA	NA	NA	NA	NA	NA
Turf Infill	13,415	NA	NA	NA	NA	NA	NA
Molded / Other	4,759	NA	NA	NA	NA	NA	NA
Ground Rubber	8,718	NA	NA	NA	NA	NA	NA
Total Crumb/Ground Rubber	**54,700**	**43,165**	**50,345**	**61,728**	**59,985**	**50,530**	**70,862**

Table C-6
Source Data for Figure 7, Caltrans Total Asphalt Placement and Rubberized Asphalt Percent of Total, 2009-2020

Year	Total Asphalt Placed (Tons)	RHMA % Total
2009	5,589,914	23.60%
2010	3,860,646	30.60%
2011	7,522,354	34.70%
2012	6,333,678	29.20%
2013	4,578,258	22.90%
2014	4,120,457	26.70%
2015	4,602,421	41.30%
2016	4,785,160	39.80%
2017	4,056,991	45.03%
2018	4,767,951	46.43%
2019	3,860,363	39.75%
2020	3,405,088	41.31%

Table C-7

Source Data for Figure 8 Caltrans Use of Crumb Rubber in Paving Projects, 2009-2020

Year	Crumb Rubber Used (Million Pounds)
2009	40,103,331
2010	35,919,690
2011	77,543,629
2012	52,286,289
2013	32,514,454
2014	35,220,943
2015	60,775,793
2016	60,892,762
2017	58,456,877
2018	70,839,587
2019	54,133,231
2020	49,611,420

Table C-8

Source Data for Figure 9 California-Generated Tire-Derived Aggregate Shipped for Use in Civil Engineering Projects, 2009-2021

Category	2009	2010	2011	2012	2013	2014
Landfill Projects	13,975	17,924	5,915	5,844	2,612	8,806
Non-Landfill Projects	3,535	350	0	0	1,945	3,826
Total TDA	**17,510**	**18,274**	**5,915**	**5,844**	**4,557**	**12,632**

Category	2015	2016	2017	2018	2019	2020	2021
Landfill Projects	10,374	7,083	5,583	4,021	6,682	16,311	6,575
Non-Landfill Projects	1,294	3,878	853	1,106	6,648	600	0
Total TDA	**11,668**	**10,961**	**6,431**	**5,127**	**13,330**	**16,911**	**6,575**

Table C-9

Source Data for Figure 10 California-Generated Tire-Derived Material Used as Landfill Alternative Daily Cover or in Beneficial Reuse Applications, 2009-2021

Category	2009	2010	2011	2012	2013	2014
ADC	12,042	7,928	19,589	10,486	12,316	14,691

Category	2015	2016	2017	2018	2019	2020	2021
ADC	15,217	16,798	18,108	17,975	16,784	14,876	17,440

Table C-10

Source Data for Figure 11 California Whole Waste Tires and TDF Consumed at California Cement Kilns, 2009-2021

Category	2009	2010	2011	2012	2013	2014
Whole Tire/Size-Reduced TDF	69,926	83,675	61,911	77,209	81,982	83,934
Fiber TDF	0	0	0	0	3,313	8,418
Total TDF	**69,926**	**83,675**	**61,911**	**77,209**	**85,295**	**92,352**

Category	2015	2016	2017	2018	2019	2020	2021
Whole Tire/Size-Reduced TDF	85,721	72,723	75,989	80,603	70,807	51,315	39,704
Fiber TDF	7,443	7,656	6,205	7,783	7,500	6,297	8,539
Total TDF	**93,165**	**80,380**	**82,194**	**88,386**	**78,307**	**57,611**	**48,243**

Table C-11

Source Data for Figure 12 California-Generated TDF and Bales of Waste Tires and Truck Tire Treads, 2008-2021

Category	2008	2009	2010	2011	2012
Size-Reduced TDF	NA	NA	NA	NA	NA
Baled and Cut Waste Tires	NA	NA	NA	NA	NA
Total Exported TDF/Bales	**22,000**	**33,000**	**64,000**	**96,000**	**135,000**

Category	2013	2014	2015	2016	2017
Size-Reduced TDF	NA	74,000	66,000	47,476	87,317
Baled and Cut Waste Tires	NA	36,000	28,000	15,000	26,089
Total Exported TDF/Bales	**110,144**	**110,000**	**94,000**	**62,476**	**113,405**

Category	2018	2019	2020	2021
Size-Reduced TDF	99,197	114,427	73,412	40,148
Baled and Cut Waste Tires	36,039	30,985	3,200	3,516
Total Exported TDF/Bales	**135,236**	**145,412**	**76,612**	**43,664**

Table C-12

Source Data for Figure 13 California-Generated Waste Tires Disposed in Landfills, 2009-2021

Category	2009	2010	2011	2012	2013	2014
Landfill Disposal	131,152	92,033	63,444	47,908	61,682	66,770

Category	2015	2016	2017	2018	2019	2020	2021
Landfill Disposal	87,170	150,226	117,448	95,401	95,412	154,050	249,377

Table C-13

Source Data for Figure 14 Comparison of California All Materials and Waste Tires Management

Category	All Materials (2020) 77.42 M Tons	Tires (2020) 0.48 M Tons	Tires (2021) 0.55 M Tons
Landfill Disposal	52%	32%	45%
Disposal Related (e.g., Fuel & ADC)	6%	31%	20%
Recycling	42%	37%	35%

Table C-14

Source Data for Figure 15 Historic California All Materials and Waste Tires Recycling Rates

Year	All Materials	Tires
2011	49.0%	41.0%
2012	50.0%	39.9%
2013	50.0%	35.9%
2014	50.0%	35.8%
2015	47.0%	34.5%
2016	44.0%	31.9%
2017	42.0%	32.2%
2018	40.0%	34.1%
2019	37.0%	35.2%
2020	42.0%	36.7%
2021	NA	35.0%

Table C-15

Source Data for Figure 16 California Waste Tire Recycling, Disposal Related and Disposal Trends, 2009-2021

Category	2009	2010	2011	2012	2013	2014
Landfill Disposal	131,152	92,033	63,444	47,908	61,682	66,770
Disposal Related	114,968	155,603	177,500	222,695	207,754	217,043
Recycled	165,997	164,206	167,516	179,768	150,741	158,094
% Recycled	40.3%	39.9%	41.0%	39.9%	35.9%	35.8%
% Landfill Diversion	68.2%	77.7%	84.5%	89.4%	85.3%	84.9%

Category	2015	2016	2017	2018	2019	2020	2021
Landfill Disposal	87,170	150,226	117,448	95,401	95,412	154,050	249,377
Disposal Related	202,382	159,654	213,707	241,597	240,503	149,099	109,347
Recycled	152,767	145,288	156,994	174,264	182,438	175,868	193,197
% Recycled	34.5%	31.9%	32.2%	34.1%	35.2%	36.7%	35.0%
% Landfill Diversion	80.3%	67.0%	75.9%	81.3%	81.6%	67.8%	54.8%

End Notes

[1] CalRecycle, Waste Tire Program, Facilities Search Web Page.

[2] See end note 1.

[3] Analysis of Waste Tire Manifest Data as provided by CalRecycle to Boisson Consulting, April 8, 2022.

[4] CalRecycle, California Tire-Derived Product Catalog, October 2021 Revision, Appendix A, Business Directories.

[5] Updated list of permitted waste tire facilities as provided to Boisson Consulting by CalRecycle on April 25, 2022.

[6] See end note 5.

[7] See end note 4.

[8] See end note 4.

[9] Statista, Annual percent change of the real GDP in California from 2000 to 2021, accessed on June 22, 2022.

[10] Cal Matters, "Behind Newsom's $301 billion budget, big financial concerns," May 16, 2022.

[11] U.S. Inflation Calculator, U.S Inflation Rates 2000-2022.

[12] Chart data is based on Caltrans annual Crumb Rubber Reports available online in various locations. The 2020 report is available here. 2021 data are unpublished estimates based on verbal discussion with Caltrans representatives.

[13] See end note 12.

[14] "A ubiquitous tire rubber–derived chemical induces acute mortality in coho salmon." The Journal Science, Vol 371, Issue 6525. December 3, 2020.

[15] "Contribution of Leachate from Rubberized Hot Mix Asphalt to Zinc Loading in Roadway Stormwater Runoff." Prepared by Humboldt State University under contract to CalRecycle. May 2021. Page 6.