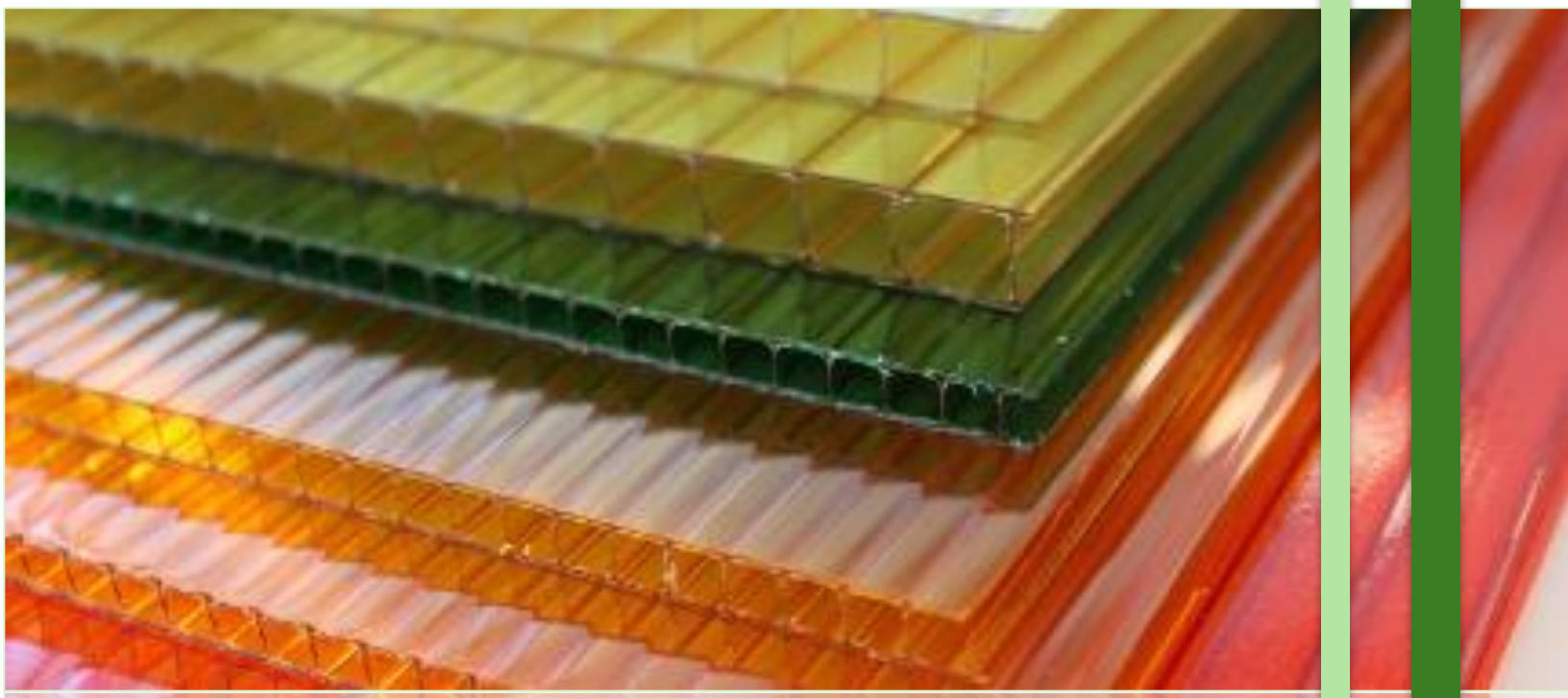
CalRecycle

The Current State of End Markets

A Plastic Pollution Prevention and
Packaging Producer Responsibility Act
Needs Assessment Technical Report

February 2026



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Executive Summary

The Plastic Pollution Prevention and Packaging Producer Responsibility Act (Senate Bill (SB) 54, Allen, Chapter 75, Statutes of 2022) (the Act) established an extended producer responsibility (EPR) program to manage single-use packaging and single-use plastic food service ware (covered material) in California. The Act requires the Department of Resources Recycling and Recovery (CalRecycle) to conduct a statewide needs assessment to aid its implementation. CalRecycle awarded a contract to investigate the actions and investments needed to meet the Act's requirements, including ensuring that, by 2032, all covered material is recyclable or compostable and that plastic covered material achieves a 65% recycling rate.

This report is part of a broader study commissioned by CalRecycle for the statewide needs assessment. The study examines the flow of covered materials sent for recycling and composting in 2024, both within California and exported outside the state. This report focuses on end markets that currently receive covered material from California.

Data collection for this evaluation included end market identification, a market survey, and desk research. The data were used to develop a model estimating current volumes of covered material, including the amount accepted by or sent to end markets, the extent of contamination, and the quantity of recovered material produced by end markets.

Table ES-1 and Table ES-2 present the overall quantitative findings by covered material category (CMC) material class, with additional detail provided for certain plastic CMC groups. This report provides detailed information on end market facilities located in California, with limited information on covered material exported out of state. Future studies are needed to further identify facilities that receive covered material exported outside California, particularly international end markets.

Table ES-1: Summary of Covered Material Accepted by or Sent to Conventional End Markets in 2024 (tons)

CMC Class/Type	Accepted by or Sent to Conventional End Markets	Recovered Material Produced	CMC Conversion Rate (%)
Glass	223,300	216,600	97%
Ceramic	No end markets found	No end markets found	No end markets found
Metal	14,850	Unknown	Unknown*
Paper and Fiber	5,582,800	5,071,400	91%
Polyethylene terephthalate (PET #1) Rigid	31,300	20,800	66%
High-density polyethylene (HDPE #2) Rigid	46,120	37,770	82%
Polypropylene (PP #5) Rigid	17,200	9,600	56%
PE Plastic Films	33,730	29,900	89%
Other Plastic	5,243	Unknown	Unknown
Wood and Other Organic Materials**	80,700	Unknown	Unknown

*Limited information is currently available for end markets accepting metal covered material.
**Conventional end markets considered for wood were chip-and-grind operations that produce items such as mulch or animal bedding.

Table ES-2: Summary of Covered Material Accepted by or Sent to Organics End Markets in 2024 (tons)

CMC End Market Group	Weight Accepted by or Sent to Organics* End Markets	Weight Integrated into Organics Recovery Process	Weight Screened Out
Mixed Papers	73,600	22,080	51,520
Kraft Paper	13,400	4,020	9,380
Old Corrugated Cardboard (OCC)	77,400	23,220	54,180
Molded Pulp	42,000	12,600	29,400
Plastics and Polymers Designed for Compostability - Rigid Items	25,100	2,510	22,590
Plastics and Polymers Designed for Compostability - Flexibles and Films	1,200	120	1,080

*Organics end market types considered include composting and in-vessel digestion facilities.

Glass Key Findings:

- Seven glass end market facilities were identified that manage glass covered material in California.
- Almost 100% of glass material grades remain in-state for recycling. Because it is heavy, transportation distances for inputs and outputs are generally short.
- Of the 762,130 tons of glass material grades accepted by or sent to end markets, an estimated 223,300 tons are covered material. Glass beverage containers covered by the Beverage Container Recycling Program (BCRP) are excluded from the Act (PRC section 42041(e)(2)(E)), but they make up a large share of all glass sent to end markets, with more than 200,000 tons estimated.
- Contamination levels in glass material grades are high. Of the 762,130 tons accepted by end markets, more than 260,000 tons are estimated to be contamination, including small plastics, paper, and ceramics that move with broken glass during processing.
- Some end market facilities have capacity to accept more glass, including covered material. Five reported operating between 15% and 76% capacity, presenting opportunities to increase recycling with what's already in place.

Ceramics Key Findings:

- No end market facilities were identified for ceramic covered material. One glass end market facility reported stockpiling and crushing ceramic material received as contamination in glass streams, for potential future sales as aggregate in the construction industry.

Metal Key Findings:

- No in-state end market facilities managing metal-covered material were identified, suggesting that the amount sent to end markets may be underestimated. Seven end market facilities that manage metal-covered material were identified in the U.S.
- Of the 213,500 tons of metal material grades accepted by end markets, an estimated 400 tons are covered material. Aluminum beverage containers covered by the BCRP are excluded from the Act but make up a large share of material sent to metal end markets, with more than 195,000 tons estimated.
- All identified end market facilities that accept metal covered material are located outside California. An estimated 53% is exported domestically, with the remaining 47% exported internationally.

Paper and Fiber Key Findings:

- Three paper and fiber end market facilities were identified in California. Their feedstock consists primarily of old corrugated cardboard (OCC) and mixed paper CMC end market groups.
- It is the category with the largest amount of covered material accepted by or sent to end markets by weight. Much of it is exported outside the U.S. OCC, at approximately 4.7 million tons, comprises the majority of covered material sent to end markets, followed by mixed paper, paperboard, and kraft paper.
- Conversion rates are high for OCC, kraft paper, and paperboard (96%), but considerably lower for mixed paper (48%).
- Relatively small quantities of cartons (5,600 tons) are accepted by identified end markets, and most are exported internationally (4,500 tons). Markets for lined paper, waxed OCC, and molded pulp are limited.
- Feedstock purchases represent a large part of operating costs, and price volatility of both recovered and virgin materials is challenging to business viability.

Plastic Key Findings:

- Seventeen end market facilities were identified that manage plastic covered material from California; 13 located in-state and four elsewhere in the U.S. It is also exported internationally, although specific facilities were not identified.
- Specific end market facilities were identified only for PET Rigids, HDPE Rigids, PP Rigids, and PE film materials.
- Of the 269,100 tons of PET material grades accepted by or sent to end markets, an estimated 31,300 tons are covered material. PET beverage containers covered by BCRP are excluded from the Act but make up a large share of plastic sent to end markets, with more than 200,000 tons estimated.
- International exports of plastic scrap material to Asia have decreased over the last 10 years, while exports to Mexico have increased.
- Conversion rates for CMC end market groups vary by polymer type, ranging from 56% to 90%.
- End markets face ongoing viability challenges. Increased exports to Mexico reduce access to domestic supply, and low virgin resin prices create strong competition for recovered material.

Wood and Other Organic Materials Key Findings:

- Wood chipping and grinding is an end market for untreated wood, but generally not for treated or painted wood. Based on discussions with organics processing facilities, untreated wood packaging is assumed to be chipped and ground into mulch, animal bedding, and other products, rather than incorporated into composting or in-vessel digestion processes.

Compost and In-vessel Digestion Findings:

- Some composting and in-vessel digestion facilities accept and incorporate covered materials, such as plastics designed for compostability and certain paper products, into the organics conversion process. However, most of this material is screened out during processing.

1.0 Introduction

1.1 Background

The Plastic Pollution Prevention and Packaging Producer Responsibility Act (Senate Bill (SB) 54, Allen, Chapter 75, Statutes of 2022) (the Act), established an extended producer responsibility (EPR) program to manage single-use packaging and single-use plastic food service ware (covered material) in California. The Department of Resources Recycling and Recovery (CalRecycle) is required to conduct a statewide needs assessment to aid its implementation and investigate the actions and investments needed to meet the requirements of the Act.

The law requires that by 2032:

- Plastic covered material be source reduced by 25%
- Covered material be recyclable or eligible to be labeled compostable and
- Plastic covered material achieves a 65% recycling rate.

1.2 Study Overview

CalRecycle contracted with HF&H Consultants (the contractor) to investigate the actions and investments needed to meet the requirements of the Act. Specifically, by 2032 all covered material must be recyclable or compostable, and plastic covered material must achieve a 65% recycling rate.

The Collection, Processing, and End Market Needs Assessment Study (CPEM Study) was conducted under contract (DRR24043) and is one component of the statewide needs assessment. The CPEM Study findings are divided into an analysis of the current state and the needed state of collection, processing, and end markets as they pertain to covered material and meeting the requirements under the Act. The CPEM Study includes three reports for the current state (collection, processing, and end markets) and one combined report for the needed state.

The CPEM Study spans the full value chain for the recovery of material that may be covered and addresses the following:

- Collection: Where material (both dry and organic) is collected for recycling and organics recycling, including curbside and alternative collection systems.
- Processing: Where the material is sorted, segregated, and prepared to meet specifications for sale to end markets.
- End Markets: Where the material is recovered to be used in lieu of virgin material to produce new or reconstituted products.

This report is part of a wider study commissioned by CalRecycle as part of the statewide needs assessment to understand the flow of covered materials sent for recycling and composting in 2024, both within the state and exported out.

1.3 End Markets (Current State) Report

This report covers the current state of end markets for covered material. Data analyzed for this report cover 2024. CMCs are grouped into six material classes: ceramic, glass, metal, paper and fiber, plastics, wood, and other organic materials. For each of these material classes, except glass and ceramics which are considered together (see Section 6.0 Glass and Ceramics), the following characteristics were analyzed:

- Material Acceptance – estimating the weight of covered material accepted by or sent to end markets.
- Contamination – assessing contaminants found in end market feedstock and causes of contamination.
- Material Recovery – estimating the weight of covered materials recovered by end markets and technologies utilized.
- Markets and costs – assessing the costs and viability of end markets.

In addition, the report evaluates the environmental and public health impacts of end markets at the system level and identifies the risks, the causes of negative impacts, and the communities most affected.

The sources for evidence are cited in the report or have been calculated through the data gathered and modeled as explained in Appendix A.

2.0 Methods

The contractor implemented a multistep research process that included primary research, secondary research, and data modeling. This section of the report details the methodological approach for the following stages:

- End market facility identification – summarizes how end market facilities were identified inside and outside California, how contacts were identified, and how these lists were verified.
- Survey development and implementation – summarizes the steps taken to develop a comprehensive survey and maximize responses.
- Model development – summarizes how data gathered were used in an Excel spreadsheet to produce quantitative report outputs, including but not limited to the quantity of material accepted by or sent to end markets, the quantity of contamination identified at end markets, and the quantity of covered material recovered.

A more detailed methodology is provided in Appendix A.

2.1 California End Market Facility Identification

The contractor used online databases**,** Association of Plastic Recyclers (APR) Buyers and Sellers Directory, the Glass Recycling Coalition's Glass Recycling Map, and the U.S.EPA's Recycling Infrastructure and Market Opportunities Map to develop a preliminary list of end market facilities in California .[1] [2] [3] The contractor further refined the list by reviewing company websites and industry news articles to confirm the facility manages covered material. For example, end market facilities that manage primarily scrap metal or electronic plastic rather than single-use packaging and single-use plastic food service ware (covered materials) were removed from the list. The contractor then identified a contact for each end market facility who would have the knowledge needed to answer the survey. The list of end market facilities was compared against data in the Recycling and Disposal Reporting System (RDRS), which details reported waste flows between processors and end market facilities. Finally, the project list of end market facilities was verified by representatives of relevant industry associations.

End market facilities were identified using the definition created for the purposes of this study (see Glossary for definition) and were not further evaluated for meeting any additional requirements or definitions associated with the implementation of the Act.

The contractor did not evaluate end market facilities for consideration as a responsible end market. Whether the end markets identified in the study are responsible end markets will need to be identified by the Producer Responsibility Organization (PRO) based on the process specified in their plan.

2.2 End Market Survey Development and Implementation

The contractor developed a unique end market survey for each major material class (plastics, paper and fiber, glass and ceramics, metal, and wood). Although glass and

ceramics are separate material classes in the list of the CMCs, they were combined for the purposes of report analysis (see section 6.0 Glass and Ceramics for more information on why they were combined).

Each survey contained seven sections, which collected the following information:

- Contact and General Information: Respondent contact information and general end market facility information, such as address and year the facility was built.
- Quantity of Material Managed: Information on the weight and composition of inbound material by grade. It also captured data on the geographic origin of the material and type of facility it came from (e.g., recycling processing facility, Bulk and Bale, or CRV Redemption Center).
- Contamination: The types and quantity of contamination encountered at the end market facility and systems for managing the contamination.
- Recovery and Technology: The technologies utilized at the end market facility, the types of products produced, and the approximate yield (output relative to input).
- Markets and Costs: The cost of implementing the processes described and the overall market dynamics for their business.
- Future Capacities: Opportunities for expansion and the requirements necessary to expand.
- Environment and Public Health: Strategies implemented to ensure the health and safety of employees and the environment.

The contractor sent surveys to the contacts identified during the end market facility identification phase. Contacts were given several weeks to complete the survey, and follow-up reminders were sent. If requested, extensions were given, calls were held in lieu of a survey, and shortened email questionnaires were sent to get priority information. Non-Disclosure Agreements (NDAs) were put in place for those end market facilities that requested it.

The primary challenges were obtaining participation in the time available and there was no requirement for facilities to participate. Several end market facilities declined to participate. The reasons they gave were the lack of any legal requirement and general wariness about sharing detailed business information.

2.3 Model Development

The contractor used the data gathered to assess the quantity of covered materials that end markets accept and recover. Because end markets do not characterize their materials in terms of CMCs, they were grouped to simplify the list and designed to reflect a list that end markets were more likely to recognize and provide data for.

This report relies upon the CMC list that was published on December 31, 2024, by CalRecycle and contains 94 CMCs that categorize covered material under the Act.[*] However, based on the nature of the recycling system, at each stage in the process, the granularity of the accepted materials will differ. For example, collection contains the least granularity, as it is focused on what post-consumer items are intended to be included in each onsite collection container (or accepted at a drop-off site or alternative collection system), compared to recycling processing facilities that segregate materials into marketable commodities by grade, and facilities that may qualify as end markets that may further disaggregate the materials based on physical and chemical properties. As such, for the purposes of this report, the contractor aggregated the list of CMCs into 52 CMC end market groups that better align with how material reaching end markets is typically tracked and evaluated.

Appendix A, Table A-1 explains how each CMC fits into the corresponding CMC end market group.

The contractor analyzed the data to produce various outputs:

1) CMC end market groups sent to end market facilities in California, shipped from California to other states (domestic exports), and shipped from California to other countries (international exports).
2) CMC end market groups considered to be contamination at end market facilities in California.
3) Recovery of CMC end market groups at end market facilities in California.
4) End market costs and viability.

All modeled results are for 2024. Weights are estimated in tons.

1) Estimating CMC end market groups sent to end market facilities in California, shipped from California to other states, and shipped from California to other countries

To estimate the quantity of CMC end market groups accepted by end markets in California, the contractor compiled data for each identified end market facility based on survey responses and RDRS data. If neither survey responses nor RDRS data were available for an end market facility, then secondary research such as industry news articles or company websites was used to estimate feedstock tonnages.

For domestic and international exports, the contractor could not identify the specific end market facilities that receive the materials. RDRS data were used from calendar year 2024 for domestic exports, as it specifies the receiving state for the CMC material sent for recycling. WISERTrade data were used for international exports, as it includes data on tonnage of scrap material sent to other countries.

[*]CalRecycle, Plastic Pollution and Packaging Producer Responsibility Act – SB 54 Covered Materials Category List, 2025, calrecycle.ca.gov/packaging/packaging-epr/cmclist, (09/27/2025)

Data from surveys, RDRS, and WISERTrade are provided by material grade or a high-level material category, not CMC end market group. Therefore, various composition studies were used including:

- Recycling and Disposal Reporting System (RDRS) for 2024 tonnage: An electronic data system where businesses, facilities, and operations submit information related to recycling and disposal quarterly. It includes information from disposal facilities, transfer facilities, material recovery facilities, organics processing facilities (OPF), brokers, and haulers.
- SB 343 Material Characterization Study Final Findings Report (SB 343 Report): Prohibits a person from claiming in advertising or labelling that a consumer good is recyclable unless the person demonstrates compliance with specific recyclability criteria. In 2023 and 2024, CalRecycle completed a statewide material characterization study of materials collected and sorted by large volume transfer and processors.
- PET Recycling Corporation of California PET Bale Composition Analysis for 2024[45] to match the material grades and material categories that end markets handled to CMC end market groups.

This methodology has two main caveats. One, available data were not always specific to covered material. Two, the contractor did not solicit information from international end markets, and information on specific international end market facilities receiving covered material from California was not otherwise available. WISERTrade provides data on the amount of material from California received by importing countries but does not provide further information on whether that is the final country of import or whether that material ends up recovered. Estimates of covered material reaching international end markets likely overestimate the amount that actually ends up accepted. Further, WISERTrade may overestimate the amount of material from California, since WISERTrade will include any tonnage shipped from California ports, including tons exported from other states for onward transport from California ports.

For further details on the methodology used to calculate tons sent to end markets in California, shipped from California to other states, and shipped from California to other countries, and CMC end market groups considered to be contamination at end markets in California, see Appendix A, Model Development.

2) Estimating CMC End Market Groups considered to be contamination at end market facilities in California.

CMC end market groups considered contamination at end markets were identified through survey responses, secondary research and the contractor knowledge regarding materials that are considered contaminants at end market facilities.

For further details on the methodology used to determine which CMC end market groups considered to be contamination at end markets in California, see Appendix A, Model Development.

3) Estimating Recovery of CMC end market groups at end market facilities in California

The contractor received survey data on the quantity of material produced at end market facilities and the loss rates for different processes used to recycle material. This information was used to estimate the rate at which CMC groups were converted to recovered products, referred to as the CMC conversion rate throughout this report. Where survey data were not provided, conversion rates were gathered through secondary research. Recovered material outputs from end market facilities were calculated by multiplying the total tonnage of each CMC end market group entering end market facilities (excluding contamination) by these CMC conversion rates.

For further details on the methodology used to estimate recovery, see the Appendix A, Model Development.

4) Estimating the costs and viability of end markets for CMCs, including CMC with limited end market facilities.

The costs and viability of end markets for CMCs, including CMCs with limited end markets was derived through survey response and secondary research and these results are detailed in Section 3.7, Section 4.5, Section 5.6, Section 6.4, Section 7.5, and Section 8.3.

Model outputs are provided in each section of the findings, by material class. The following tables are provided in each section where data are available:

- **Material Grades Accepted by or Sent to End Markets in 2024 (tons):** Includes three main columns estimating amount of covered and noncovered material accepted at end markets in California (using survey data supplemented with quantitative data, interviews and secondary data), the amount sent to other states in the United States (using RDRS data), and the amount sent to other countries (using WISERTrade data).
- **CMC End Market Groups Accepted by or Sent to End Markets in 2024 (tons):** Includes same three columns as Material Grades table, but with the amounts specific to covered material (CMC end market groups). CalRecycle's SB 343 Report's data were used to estimate the amount of covered material in each material grade.
- **Estimated Weight of Contamination Accepted by or Sent to End Markets in 2024:** Includes the estimated amount CMC end market groups and all other contaminants considered contamination that is accepted by or sent to end markets based on end market surveys.
- **CMC End Market Groups Recovered by End Markets in 2024 (tons):** Includes the weight of material accepted by or sent to all end markets (California, domestic, and international) excluding the weight of contamination to only include the weight of the target material sent to end markets. The table also includes the estimated CMC conversion rate, estimated from survey responses and the estimated amount of recovered material produced from feedstock derived from

covered material. For organics end markets, this is the estimated amount integrated into the recovery process. If a CMC end market group is not found in the table, it indicates they have limited to no end markets identified.

- **CMC End Market Groups with Limited End Markets in 2024 (tons):** Includes the CMC end market groups (specifically two material classes: plastic, and paper and fiber) where no end markets were identified and estimates for those groups with limited end markets. For many of these groups, sufficient information was not available to estimate the amount accepted by or sent to end markets (excluding contamination) and tons of recovered material produced.

2.4 Engagement with Community Based Organizations, Environmental Justice Groups, and California Native American Tribes

The contractor engaged with interested parties representing priority populations, including California Native American Tribes (Tribes), community based organizations (CBOs), and environmental justice (EJ) groups through introductory meetings, virtual listening sessions, and an online survey over a four month time frame. The primary objective was to have these communities share their experiences and provide their expertise related to their waste practices, as well as understand communities' concerns and suggestions on the impacts of end market facilities, facility development or expansion, and the siting of new facilities near existing ones. Concerns shared by CBOs, EJ groups, and Tribes who participated in the study regarding future expansion of these facilities will be discussed in the needed state report.

The contractor collaborated with CalRecycle to develop a list of 43 CBOs and EJ groups and 20 Tribes to contact for engagement. The contractor sought participation from priority populations from the five regions of California defined by CalRecycle's Statewide Waste Characterization Studies. More information on how the CBOs, EJ groups, and Tribes were selected for participation in the study can be found in Appendix A-5 of the Current State of Processing Report.

The Community Recycling and Composting Survey was designed to assess the impacts of activities associated with recycling and composting, barriers and opportunities to access and participate in these programs, and unique challenges and underlying needs related to waste management activities for the communities represented by the CBOs, EJ groups, and Tribes. This survey was translated into Spanish and simplified Chinese, and a version of the survey was adapted for Tribal communities. Results from the surveys are included throughout this report, as appropriate.

Virtual introductory meetings and listening sessions were held to introduce participants to the project and its objectives, and to offer a space for participants to share some of their lived experiences. These listening sessions provided a forum for community members to voice their experiences and provide more narrative discussion on the information captured in the survey. These included experiences related to opportunities and barriers to recycling and providing input for shaping solutions that work for their communities.

Appendix A contains additional details regarding engagement with CBOs, EJ groups, and Tribes.

Appendix G of the Current State of Processing Report contains the responses from the introductory meetings and listening sessions.

3.0 Plastic

3.1 Introduction

For the purposes of this work, plastic end markets were defined as the entity that first produces material, such as pellet, that meets the quality standards necessary to be used in lieu of virgin material in new or reconstituted products (see Figure 3-1 for further information on this process). All of the end market facilities identified utilize technologies to sort, grind, flake, and wash plastic feedstock to produce pellets or flake.

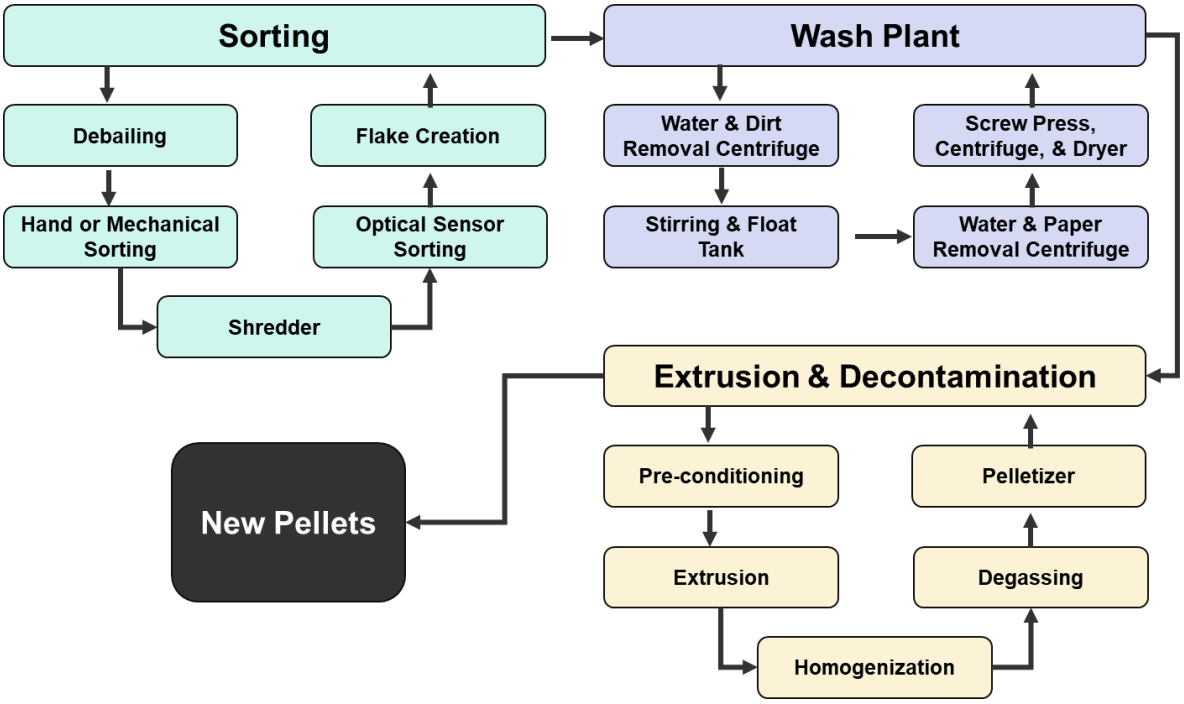

Figure 3-1: Example of a Recycling Process (Adapted from CEC, 2024[6])

3.2 Method and Survey Responses

This section provides additional information on the survey responses received from plastic end market facilities and the strategies that these facilities use to produce material to be used in lieu of virgin material in new or reconstituted products.

In total, the contractor identified 17 end market facilities that currently manage plastic covered material from California. Thirteen are located in California and four are located outside the state, but still in the U.S. This list is not exhaustive and there are likely end markets outside of the U.S. that manage covered materials from California, but for the purpose of this report, survey engagement focused on domestic end markets.

The contractor sent a survey to all 17 end market facilities identified and received eight responses: three managing polyethylene terephthalate (PET #1), three managing high density polyethylene (HDPE #2) and polypropylene (PP #5), and two managing polyethylene (PE) film. One response from each of these three plastic groups was

incomplete but included priority information. Appendix B provides more details on responses.

Of the 17 end market facilities, 15 were operational in 2024. Of these 15 end market facilities, seven provided feedstock and output data in the surveys. Six end market facilities did not respond to the surveys and for those facilities, data from RDRS on tons sent to these end market facilities from processing facilities was used to gather feedstock data, and for the remaining two end market facilities feedstock and output data were estimated through secondary research. Export data were used from WISERTrade to understand the volume of material exported internationally.

The contractor developed a list of common material grades for feedstock used by plastic end markets. These were included in the survey and end market facilities reported feedstock tonnages by these material grades, for example PET Grade A. Material categories in RDRS did not align with the project material grades; therefore, the contractor mapped RDRS materials to the project survey grades. Appendix A, Table A-3 gives more information on how the RDRS grades were mapped to survey grades. Composition studies were used to estimate the CMC end market groups within each material grade. For PET, the contractor used composition studies from the PET Recycling Corporation of California (PRCC), and for all other plastics material grades, composition estimates from the SB 343 Report were used.[7] [8] For each composition study, the team assigned material names to CMC end market groups. These mappings are provided in Appendix A, Table A-6 and Table A-7.

3.3 PET (#1) Rigid

Polyethylene terephthalate (PET, #1), is a common material used to produce bottles, food trays, clamshell packaging, and food service ware.

This section of the report presents findings on the weight of PET CMC end market groups estimated to be accepted by or sent to end markets as feedstock, challenges with contamination, and how much of the relevant CMC end market groups were converted into output product. In 2024, six end market facilities were identified as potentially recycling PET in California: Evergreen, Global Plastics Recycling, Indorama Ventures, Peninsula Plastics Recycling Inc., RePet Inc, and rPlanet Earth. However, in 2025 Evergreen announced the closure of their recycling operation[9] and industry news sources reported that rPlanet Earth closed their operation.[10] Outside of California, the Republic Services Polymer Center in Las Vegas was also identified as handling PET.

PET beverage containers are not covered material under the Act if they are covered by the California Beverage Container Recycling Program (BCRP). In this report, containers covered under BCRP are referred to as CRV (California Redemption Value) material. CRV material makes up a large portion of overall PET sent for recycling in California and is managed by the same end market facilities as PET CMCs, so it is included in this analysis as part of material grade totals for informational purposes. Further analysis was done to estimate the weight of CMC end market groups only.

3.3.1 Acceptance of Materials (Covered and Noncovered Materials)

PET is typically sorted and sold to end markets based on four different material grades.[11]

- PET Grade A is primarily made of CRV PET bottles collected through BCRP. This is primarily material that is not covered by the Act.
- PET Grade B are PET bottles collected through curbside and drop-off programs and processed at recycling processing facilities. To be considered Grade B, PET thermoforms cannot exceed 2% of the total weight.
- PET Grade B with Thermoforms are PET bottles and thermoforms collected through curbside and drop off programs and processed at recycling processing facilities.
- PET Thermoform Only grade excludes bottles; it only includes thermoforms collected through curbside and drop off programs and processed at recycling processing facilities.

Table 3-1 summarizes the estimated weight of the PET material grades that enter end markets as feedstock in and outside California. Together, they make up approximately 269,100 tons. These material grades include covered material made of PET, noncovered material (CRV PET), and contamination. Approximately 74% by weight comprises PET Grade A, which primarily constitutes the 8 billion CRV PET beverage containers returned through recycling centers each year. Four of the six end market facilities in California only take Grade A. The remaining materials (Grade B, Grade B with Thermoforms, and Thermoform Only) are collected and managed through California's recycling processing facilities system. These include approximately 1 billion CRV PET beverage containers. Facilities reported in the survey that they typically source the material they purchase from within 50 miles.

Table 3-1: PET Material Grades (including Covered and Noncovered Material) Accepted by or Sent to End Markets in 2024 (tons)

Material Grade	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
PET Grade A (Redemption Center)	164,200	None identified	32,100	**196,300**
PET Grade B (Recycling Processing Facility)	33,500	1,900	8,000	**43,400**
PET Grade B With Thermoforms	12,700	5,000	10,600	**28,300**
PET Thermoforms Only	1,100	None Identified	None identified	**1,100**
Total	**211,500**	**6,900**	**50,700**	**269,100**

Table 3-2 summarizes the PET CMC end market groups and PET CRV material typically targeted by PET end markets.

Table 3-2: PET CMC End Market Groups and CRV Material Accepted at PET End Markets

CMC End Market Groups and CRV Material	Acceptability
PET Clear Beverage Bottles – CRV	Always a target material and recovered by end market facilities.
PET Pigmented Beverage Bottles – CRV	Some end market facilities target this material and recover it, but some sort it to be sold to other end markets, as the price of colored recovered material may not cover the cost to produce it.
Plastic #1 – PET Clear Bottles, Jugs, Jars – Non-CRV	Always a target material and recovered by end market facilities.
Plastic #1 – PET Pigmented Bottles, Jugs, Jars – Non-CRV	Some end market facilities target this material and recover it, but some sort it to be sold to other end markets, as the price of colored recovered material may not cover the cost to produce it.
Plastic #1 – Other PET Rigid	Some end market facilities do not recover non-bottle PET packaging, and this material would be sorted and sold to other end markets or disposed of.

Of the different material grades, PET Grade A is considered the highest quality for plastic recyclers as it is made up of 95% PET bottles that are returned through CRV redemption centers. Although PET Grade A is only from redemption centers, this grade still includes approximately 2% PET Bottles that are likely to be covered under the Act and are not CRV PET.[12]

PET Grade B is processed at recycling processing facilities but is still mostly CRV bottles. It was estimated that PET Grade B with Thermoforms comprises 52% PET CRV beverage containers. This grade contains approximately 21% Other PET Rigid, which are mostly PET Thermoforms. The Thermoform Only grade contains 90% other PET rigid and small amounts of other small format plastics.[13] Appendix B provides more details on the composition of each material grade.

Approximately 269,100 tons of PET material grades from California are accepted by or sent to end markets globally, but only a portion of those grades are covered material. Table 3-3 summarizes the weight of PET CMC end market groups accepted by or sent to end markets both in and outside California, excluding contamination, as calculated through the contractor's modelling which is described in Appendix A. The contractor's modeling results showed that 31,300 tons of PET covered material were accepted by or sent to end markets in 2024.[14]

Table 3-3: PET CMC End Market Groups Accepted by or Sent to PET End Markets in 2024 (tons)

CMC End Market Group	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
Plastic #1 – PET Clear Bottles, Jugs, Jars – Non-CRV	12,500	1,300	3,700	**17,500**
Plastic #1 – PET Pigmented Bottles, Jugs, Jars – Non-CRV	700	100	1,400	**2,200**
Plastic #1 – PET Rigid	7,400	1,200	3,000	**11,600**
Total	**20,600**	**2,600**	**8,100**	**31,300**

3.3.1.1 Covered Material Exports

Approximately 50,000 tons of PET material grades from California, representing nearly 20% of all PET material, are exported internationally. For covered material specifically, 24% of rigid PET covered material is estimated to be exported internationally.[15]

According to WISERTrade data, the top four countries that receive PET covered material are Mexico, Vietnam, Malaysia, and El Salvador. These four countries represent 95% of international PET exports from California in 2024 and no other country received more than 1,000 tons. Figure 3-2 shows how in 2017, a greater share of exports went to Asian markets such as Vietnam and Malaysia, but in the past several years exports to Mexico have increased sharply, rising from less than 5,000 tons in 2019 to over 35,000 tons in 2024. Figure 3-2 shows exports for PET only for Mexico, while other countries showed combined tonnages for PET and HDPE, as this is how the WISERTrade data are organized. End market facilities reported that the growing demand from Mexican markets impacts the ability of California end market facilities to source quality PET and remain operational.

Appendix B further explores the economic impacts of reduced availability for PET material grades on survey respondents. The contractor was unable to verify how material was managed by international end markets.

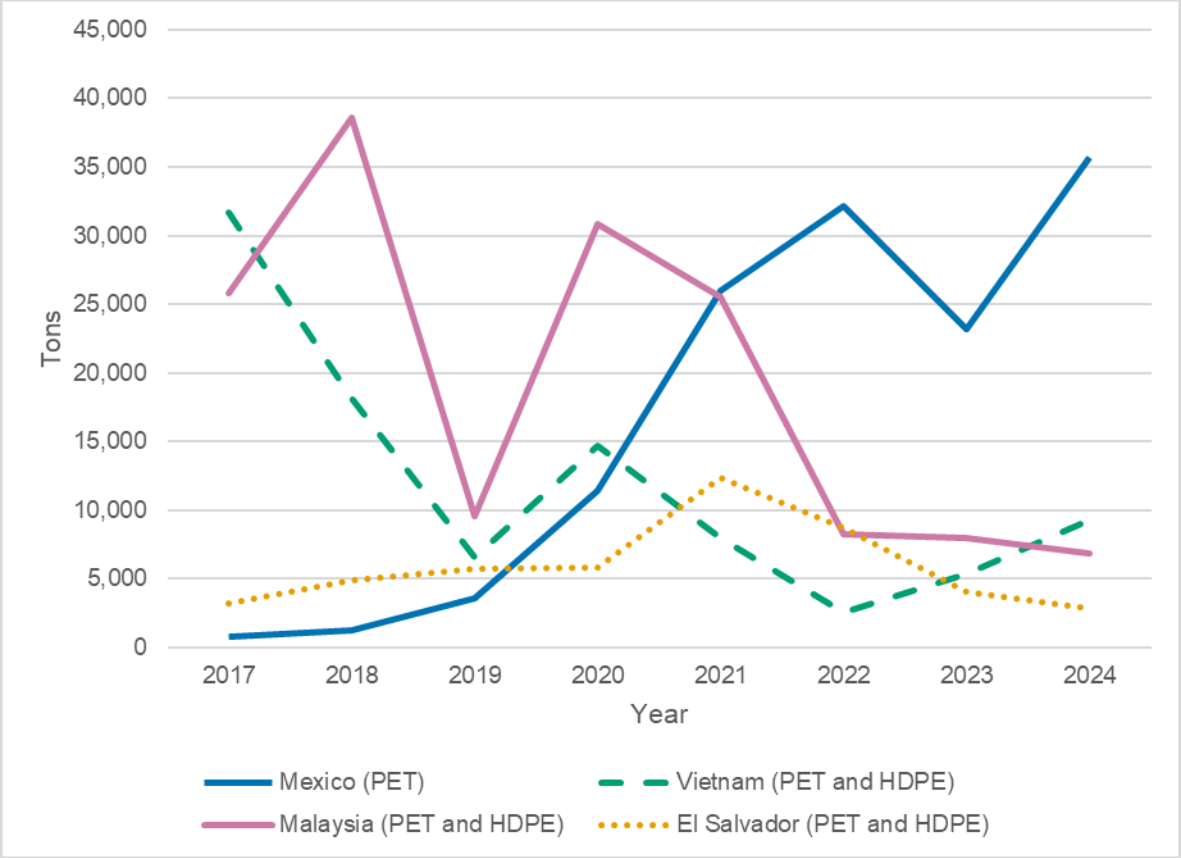

Figure 3-2: PET International Exports of Covered and Noncovered Materials from California 2017 - 2024 (tons)

3.3.2 Contamination

3.3.2.1 Types of Contamination and Weight Derived

Two end market facilities provided information on contamination; they reported contamination from items missorted into PET grades at processing plants, such as glass, paper, and metals. One end market facility also reported receiving contamination from nonpackaging materials such as medical waste and batteries. They also reported some forms of contamination based on the design of PET packaging. Survey respondents reported labels, shrink sleeve labels, and metal closures as forms of contamination from the design of PET packaging.

Colored PET bottles and PET Thermoforms may be accepted as part of the input material grade but sorted and sent to another end market facility. One end market facility reported that they sort colored PET bottles and send them to other end market facilities, as managing these containers would not be profitable at their end market facility. Similarly, some end market facilities recover PET thermoforms and do not consider them a problem as long as they do not have characteristics that limit their recovery. The example the survey respondents provided was a PET bottle that contains a PVC layer (a contaminant).

Table 3-4 summarizes the weight of contamination that enters PET end markets from CMC end market groups and whether this material is disposed of or sorted and sent to another plant. Some material may be sorted or disposed of depending on the end market facility and quantity of material.

Noncovered material (labelled other contaminants) makes up the largest share of contamination followed by small format plastics and PP rigid items. Other contaminants consist of moisture, food, dirt, and other material types that are not covered material.

Table 3-4: Estimated Weight of Contamination Which Were Accepted by or Sent to PET End Markets in 2024

CMC End Market Group	Tons Per Year	Sorted or Disposed of
Mixed Papers	390	Disposed of
Plastic #2 – HDPE (pigmented and natural) Bottles, Jugs, Jars – Non-CRV	360	Sorted or Disposed of
Plastic #2 – Other HDPE Rigid	130	Sorted or Disposed of
Plastic #5 – PP Rigid Items	890	Sorted or Disposed of
Plastic #6 – PS Rigid Items	130	Disposed of
Small Format – Plastics	2,000	Sorted or Disposed of
Plastic – #7 Other Flexible and Films	130	Disposed of
All Other Wood and Organics	130	Disposed of
Other contaminants (noncovered material)	6,930	Disposed of

3.3.2.2 Systems to Monitor Contamination

All the survey respondents reported that they use similar technologies to remove contamination, as these are reasonably standardized in PET recycling processes. They are summarized in Table 3-5.

Table 3-5: Technologies Used to Remove Contamination at PET End Markets

Technology	Examples of Contamination Removal
Manual and sensor-based sorting of feedstock	Unwanted color materials, incorrect polymers, other items
Eddy currents and magnets	Metals
Washing technologies	Dirt, grease, food and beverage residues
Float/Sink	Polyolefins, styrene
Flake Sort	Out of specification plastic flakes, e.g., wrong color or wrong polymer
Extrusion Filtration	Fine filtration will remove all materials that do not melt into a liquid phase

3.3.3 Recovery of Covered Material

The end market facilities surveyed reported producing post-consumer flake and pellets. Some of these end market facilities are vertically integrated with a converter, where the pellets and/or flakes produced are used as material feedstock to manufacture new PET bottle and non-bottle packaging. For those not vertically integrated, the pellet and flake are shipped to converters, some reported to be 250 miles from the end market. One end market facility, which sorted colored PET and resold it to a broker, reported that they believe this material was used in products such as strapping.

End markets use processes such as sorting, grinding, and washing to produce material free from contaminants; however, these processes can result in the loss of some target materials. End markets seek to refine these processes to maximize the quality of the material while minimizing loss. The estimated CMC conversion rate of the accepted covered material is 60-70% for different PET material (Table 3-6). The CMC conversion rate presented in Table 3-6 is for the CMC end market groups only. These tonnage feedstocks have already considered and removed the contamination arising from other covered and noncovered material.

Of the recycled material produced, some end market facilities report the ability to produce near virgin quality pellets that meet FDA nonobjection criteria for food contact applications, from both Grade A and Grade B feedstock. Conversely, one end market facility reported the challenge in creating near virgin quality material is due to the contamination in Grade A and B feedstock. It was not explicit from the survey responses, but this challenge may be due to a more limited set of processes and technologies employed in this particular facility.

PET Grade B has relatively high levels of contamination in addition to significant amounts of target covered materials such as PET bottles and PET thermoforms. PET resin used in thermoforms is similar but not identical to that used in bottles. To maximize the quality of recycled resin resulting from recycling Grade B covered materials that can be used as an effective replacement for virgin PET used in bottles, PET end market facilities could be upgraded to separately recycle PET bottles from other material such as PET thermoforms.

Table 3-6: PET CMC End Market Groups Recovered by End Markets in 2024 (tons)

CMC End Market Group	Weight Sent to End Markets, Excluding Contamination	Recovered Material Produced	Estimated Loss at End Markets	Estimated CMC Conversion Rate (%)
Plastic #1 – PET Clear Bottles, Jugs, Jars – Non-CRV	17,500	11,700	5,800	67%
Plastic #1 – PET Pigmented Bottles, Jugs, Jars – Non-CRV	2,200	1,300	900	59%
Plastic #1 – Other PET Rigid	11,600	7,800	3,800	67%

3.4 HDPE (#2) and PP (#5) Rigid

High density polyethylene (HDPE, #2) and polypropylene (PP, #5) rigid plastics are two of the most common plastic resin types used in consumer packaging, after PET. According to the U.S. Plastics Pact recent annual report, approximately 25% of their members' consumer plastic packaging was either HDPE or PP rigid material.[16] HDPE is commonly used in milk jugs, shampoo bottles, and detergent containers. PP is commonly used in yogurt cups and as caps for bottles.

This section of the report presents findings on HDPE and PP CMC end market groups estimated to be accepted by or sent to end markets as feedstock, challenges with contamination, and how much of the relevant CMC end market groups were converted into output product. HDPE and PP rigid plastics are presented together, as several end market facilities manage both materials.

The three HDPE and PP plants identified in California as being operational in 2024 are Envision Plastics, Epic Plastics, and Talco Plastics. The contractor also identified two additional end market facilities that were not fully operational in 2024, one in California and one in a nearby state. Both said that they planned to manage California HDPE and PP in the near future. These include LyondellBasell, which recently acquired the PreZero plant in California, and Blue Polymers in Arizona. Information from these end

market facilities is not included in this report, but it will be used in the end markets needed state report. Of the end market facilities currently active in California, two completed the survey.

3.4.1 Acceptance of Covered Materials

HDPE and PP rigid material is typically sorted into five material grades before being sold to end markets. The five material grades are described as follows:

- HDPE Natural includes mainly HDPE bottles that do not have any color.
- HDPE Colored includes mainly HDPE bottles that have color.
- Other HDPE Packaging includes HDPE bottles in addition to other types of HDPE packaging.
- PP Rigid includes all types of PP rigids.
- Plastic #3-7 includes a mix of rigid plastics that include PP packaging but also other types of plastic packaging.

Table 3-7 summarizes the estimated weight of the HDPE and PP relevant material grades that end markets accepted in and outside California. In total, approximately 87,000 tons of these material grades are sorted and sold to end markets.

HDPE Natural material has the highest value[17] and is typically a material that end markets seek to acquire, which could explain why this material stays in California. HDPE Colored packaging is nearly evenly split between end markets in California, domestic end markets outside California, and international end markets. Plastics #3-7, which goes mainly to end markets outside the U.S., comprises many different materials and is typically of lower economic value,[18] which could be the reason it is sent to overseas end markets.

Table 3-7: HDPE and PP Material Grades Accepted by or Sent to End Markets in 2024 (tons)

Material Grade	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
HDPE Natural	15,700	Limited	Limited	**15,700**
HDPE Colored	12,200	8,600	11,900	**32,700**
Other HDPE Packaging	8,000	100	1,700	**9,800**
PP Rigid	500	2,000	2,000	**4,500**
Plastics #3-7	300	4,400	19,600	**24,300**
Total	**36,700**	**15,100**	**35,200**	**87,000**

Table 3-8 summarizes the HDPE and PP CMC end market groups and HDPE CRV material typically targeted by HDPE and PP end markets.

Table 3-8: HDPE and PP CMC End Market Groups and CRV Material Accepted by or Sent to HDPE and PP End Markets

CMC End Market Groups and CRV Material	Acceptability
Plastic #2 - HDPE Natural Beverage Bottles – CRV	Always a target material if the end market facility recovers HDPE material.
Plastic #2 – HDPE (pigmented and natural) Bottles, Jugs, Jars – Non-CRV	Always a target material if the end market facility recovers HDPE material but natural and pigmented are recovered separately.
Plastic #2 – HDPE Pails and Buckets	Some end market facilities target this material; if not, it is disposed of.
Plastic #2 – Other HDPE Rigid	Some end market facilities target this material; if not, it is disposed of.
Plastic #5 – PP Rigid Items	Target material if the end market facility recovers PP.
Plastic #5 – Other PP	Some end market facilities target this material; if not, it is disposed of.

The HDPE Natural material grade contains approximately 42% HDPE bottles that are CRV material and not covered by the Act and approximately 46% HDPE bottles that are likely to be covered material. The HDPE Colored material grade contains approximately 80% HDPE bottles likely to be covered material and 10% is other HDPE rigid. The PP Rigid material grade contains 50% PP rigid items and 17% containers designed as multi use. For this analysis, multi-use items were not considered covered by the Act. Finally,

the Plastic #3-7 material grade contains approximately 60% PP rigid items.[19] Appendix B provides more detail on the composition of each material grade.

Table 3-9 isolates the HDPE and PP CMC end market groups in the relevant material grades and presents the weight of each CMC end market group estimated to be sent to end markets in California, domestically but outside California, and internationally. HDPE bottles, jugs, and jars make up the largest share of the material and are the predominant driver for end markets for these material types.

Table 3-9: HDPE and PP CMCs Accepted by or Sent to HDPE and PP End Markets in 2024 (tons)

CMC End Market Group	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
Plastic #2 – HDPE (pigmented and natural) Bottles, Jugs, Jars – Non-CRV	24,050	6,830	10,840	**41,720**
Plastic #2 – HDPE Pails and Buckets	200	None identified	None identified	**200**
Plastic #2 – Other HDPE Rigid	1,660	1,060	1,480	**4,200**
Plastic #5 – PP Rigid Items	490	3,710	13,000	**17,200**
Plastic #5 – Other PP	None identified	None identified	None identified	None identified
Total	**26,400**	**11,600**	**25,320**	**63,320**

3.4.1.1 Covered Material Exports

According to WISERTrade, in 2024, approximately 35,200 tons of HDPE and PP material grades were exported internationally, of which approximately 13,420 tons were covered material.[20] Data on material exports were organized into three categories: HDPE only, PET and HDPE, and plastics #3-7. For HDPE only material grade, data were only obtained for Mexico. Mexico imported approximately 5,600 tons of HDPE material grades. For the PET and HDPE material category, the top importing countries were Vietnam (9,300 tons), Malaysia (6,800 tons), and El Salvador (2,800 tons). For the plastics #3-7 material category, the top importing countries were Mexico (15,500 tons), Malaysia (2,000 tons), and Canada (1,100 tons). No other countries imported more than 1,000 tons of any material category. The contractor was unable to verify how this material was managed by international end markets.

3.4.2 Contamination

3.4.2.1 Types of Contamination and Weight Derived

This section summarizes the weight of contamination derived from covered material. Facilities encounter various types of packaging and nonpackaging contamination, such as paper, other plastic resins, and metals. Survey responses indicated that other plastic polymers, flexible packaging, rigid plastics, glass, and metals all are known contaminants for HDPE and PP end markets. Respondents reported that most contamination in input material likely occurs due to mis-sorting at the processing plant. One facility reported that multi-material containers create challenges in the recycling process. Others responded that labels and residue from the good the packaging contained can contribute significantly to contamination and a loss of target material, which leads to a lower recycling rate.

Table 3-10 summarizes the weight of contamination that enters HDPE and PP end markets from CMC end market groups and whether this material is disposed of or sorted and sent to another facility. Some material may be sorted or disposed of depending on the facility and/or quantity of material. Noncovered material (labelled other contaminants) makes up the largest share of contamination followed by other PET rigid and mixed papers. Other contaminants may include dirt, moisture, or material types that are not covered by the Act. The PP Rigid and Plastic #3-7 material grades contain a greater share of contamination compared to the HDPE material grades.[21] Appendix B includes detailed compositions of each material grade.

Table 3-10: Estimated Weight of Contamination that was Accepted by or Sent to HDPE and PP End Markets in 2024

CMC End Market Groups and Other Contaminants	Tons Per Year	Sorted or Disposed of
All CMC Glass	30	Sorted or Disposed of
Aluminum Containers – Non-CRV	50	Sorted or Disposed of
Other Aluminum	90	Disposed of
Other Nonferrous	10	Sorted or Disposed of
Tin/Steel/Bimetal – Non-CRV	170	Sorted or Disposed of
Other Ferrous	80	Sorted or Disposed of
Kraft Paper	400	Disposed of
Aseptic Cartons	240	Disposed of
Gable Top Cartons	120	Disposed of
Paperboard	350	Disposed of
OCC	290	Disposed of
Mixed Papers	890	Disposed of
Small Format – Paper	130	Disposed of

CMC End Market Groups and Other Contaminants	Tons Per Year	Sorted or Disposed of
Plastic #1 – PET Clear Bottles, Jugs, Jars – Non-CRV	280	Sorted or Disposed of
Plastic #1 – PET Pigmented Bottles, Jugs, Jars – Non-CRV	320	Disposed of
Plastic #1 – Other PET Rigid	1,330	Disposed of
Plastic #2 – HDPE Flexible and Films	30	Disposed of
Plastic #4 – Other LDPE Rigid	160	Disposed of
Plastic #6 – Other PS	150	Disposed of
Plastic #6 – PS Rigid Items	370	Disposed of
Plastic #6 – EPS Rigid Items	40	Disposed of
Plastic #7 – Other Rigid Plastics	690	Disposed of
Plastic – #7 Other Flexible and Films	610	Disposed of
All Other Wood and Organics	490	Disposed of
Other contaminants (noncovered material)†	5,640	Sorted or Disposed of

3.4.2.2 Systems to Monitor Contamination

Table 3-11 captures the processes that end markets reported having in place to manage and remove contamination. This includes, but is not limited to, visual material inspections, manual sorting, optical sorting, magnets, float sink tanks, and temperature-controlled extruders.

† Includes Aluminum Beverage Cans – CRV, Plastic # 1 - PET Clear and Pigmented Beverage Bottles – CRV

Table 3-11: Technologies Used to Remove Contamination at HDPE and PP End Markets

Technology	Examples of Contamination Removal
Manual and sensor-based sorting of feedstock	Unwanted color materials, incorrect polymers, other items
Eddy currents and magnets	Metals
Washing technologies	Dirt, grease, food and beverage residues
Float/Sink	Polyolefins, styrene
Flake Sort	Out of spec. plastic flakes, e.g., wrong color or wrong polymer
Extrusion Filtration	Fine filtration will remove all materials that do not melt into a liquid phase

3.4.3 Recovery of Covered Material

Based on the relevant CMC end market groups accepted by or sent to end markets, Table 3-12 details the estimated share of material that is recovered or not. Overall, HDPE bottles have the highest CMC conversion rate (90%), followed by HDPE pails and buckets (85%) and PP rigid items (56%) (based on the contractor's modeling detailed in Appendix A).[22] The estimates show that HDPE other rigid packaging is typically not targeted by facilities for recycling.

The conversion rate presented in Table 3-12 is for the CMC end market group only. These tonnage feedstocks have already considered and removed the contamination arising from other covered and noncovered material and were calculated through the contractor's modeling detailed in Appendix A.[23]

Of the three end markets identified in California and operational in 2024, two produce pellet and flake (Talco Plastics and Envision Plastics), which are sold to plastic converters. The end market facilities typically utilize similar technologies, including a grinding and washing phase, followed by sink float separation, and drying and extrusion. The pellet and flake produced in California is generally reported to be sold across the western U.S., but one facility reported exporting to longtime clients on the east coast. End markets reported that the quality of the pellet and flake produced depends on the client's standards and specification. Facilities reported that they can get close to virgin quality and can obtain FDA letters of No Objection, allowing the product to be used in food contact applications. The remaining end market facility in California produces HDPE flake and utilizes this material at their location to produce landscaping products. They use similar technology to other facilities to flake, wash and dry the plastic but, rather than producing pellets, they extrude the plastic into boards.[24]

Table 3-12: HDPE and PP CMCs Recovered by End Markets in 2024 (tons)

CMC End Market Group	Weight Accepted by or Sent to End Markets, Excluding Contamination	Recovered Material Produced	CMC End Market Groups Accepted by or Sent to End Markets but not Recovered	Estimated CMC Conversion Rate (%)
Plastic #2 – HDPE (pigmented and natural) Bottles, Jugs, Jars – Non-CRV	41,720	37,600	4,120	90%
Plastic #2 – HDPE Pails and Buckets	200	170	30	85%
Plastic #2 – Other HDPE Rigid	4,200	Unknown	4,200	<1%
Plastic #5 – PP Rigid Items	17,200	9,600	7,600	56%
Plastic #5 – Other PP	Unknown	Unknown	Unknown	Unknown

3.5 PE Film

Polyethylene (PE) film is a common resin used for flexible film material in packaging. PE film is used in some primary packaging material types, such as carrier bags and bread bags. It is also used for secondary and tertiary packaging (see Glossary) as shrink film, bubble wrap, air pillows, and stretch films. Although it is a common packaging material, end markets are still limited and only 9% of the U.S. plastic recycling capacity is dedicated to PE film.[25]

PE film end market development tends to vary widely between the sources of the PE material. Higher grades of PE, such as Grade A (5% contamination allowed) or Grade B (10% contamination allowed), tend to be derived from transport packaging, accumulated at locations like warehouses and retailer returns, and collected and baled separately from other materials. Clear and clean low density PE (LDPE) derived from these sources is readily recovered,[26] and bales of these grades typically command a relatively high value.[27] At the opposite end of the value scale, post-consumer PE film grades (PE recycling processing facility film, which sees up to 35% contamination) from primary and secondary packaging sources tend to include much higher levels of colors, inks, labels, and other contaminants as well as variable resin specifications in the mixture of items. This is more technically challenging to recycle, and the bales of these grades tend to command low values and may at times market at negative values.[28]

This section of the report presents findings on the weight of PE CMC end market groups accepted by or sent to end markets as feedstock, challenges with contamination, and how much of the relevant CMC end market groups were recovered. Data on whether the PE material grades were LDPE film or high-density PE (HDPE) film were limited; therefore, only one CMC end market group is provided for both LDPE and HDPE together and labelled as PE film. Two end market facilities that manage PE film responded to the survey.

3.5.1 Acceptance of Covered Materials

Table 3-13 summarizes the estimated weight of PE film material grades that are accepted by or sent to end markets in and outside California. An estimated 38,300 tons of covered PE film material was sent to end markets; approximately 70% is managed in California, with the remainder sent to end markets outside the state. End market facilities inside California that manage PE film include Ecowise, PPP, LLC, and Circulus; out of state end market facilities include Trex and Revolution. Survey respondents indicated that much of their material is collected from Bulk and Bale sources, but as they purchase material mainly from brokers the exact source could not be identified. Based on anecdotal information, the contractor concluded that material accepted by California markets is likely all source separated secondary and tertiary packaging films. In contrast, material sent out of state and exported internationally, as reported in RDRS, is PE recycling processing facility film. Approximately two thirds of the PE film material grades are sourced from tertiary packaging generated at commercial businesses and the remaining one third is post-consumer.

Table 3-13: PE Film Material Grades Accepted by or Sent to End Markets in 2024 (tons)

Material Grade	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
PE Film Mixed Grades	25,900	5,400	7,000	**38,300**

Detailed composition estimates of PE film are limited. The SB 343 Report only included a composition study for agricultural and commercial film, which was estimated to be 98% PE film and only 2% contamination. A detailed composition of post-consumer PE recycling processing facility film was not identified, and APR Model Bale Specifications for recycling processing facility PE film indicate that 35% contamination is the maximum specified.[29] Based on the maximum specified contamination, the contractor conservatively estimated that the recycling processing facility PE film contained 65% PE film. Subtracting this contamination (35% for PE film tons sent to end markets from recycling processing facilities, versus 2% for PE film tons sent to end markets directly from commercial consumers) from the total PE film tons sent to send markets yields the estimated amount of PE film accepted by or sent to end markets (33,730 tons; Table 3-14).

Table 3-14: PE Film CMCs Accepted by or Sent to PE Film End Markets in 2024 (tons)

CMC End Market Group	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
PE Film	25,700	3,480	4,550	**33,730**

3.5.1.1 Covered Material Exports

The contractor generally used WISERTrade data to estimate the weight of material exported to international end markets. However, WISERTrade did not include any estimates for PE film material grades. Therefore, RDRS data were accessed, which included domestic and international end markets for some material. State and country level locations are provided for domestic and international exports in RDRS for some tonnages, but for the few data points where the destination organization is provided, the organization is labelled as a broker. Consequently, the destination in RDRS may only be the first stop or office location of the broker.

For material in RDRS that did not indicate that it is sent to an out-of-state end market the contractor investigated the destination organizations, and based on company websites, concluded that these were likely international brokers who sent the material overseas. Therefore, any PE recycling processing facility film identified in RDRS is likely to be managed outside of California. The contractor was unable to verify how international facilities managed this material.

3.5.2 Contamination

3.5.2.1 Types of Contamination and Weight Derived

As limited composition estimates were identified for PE film, the weight of contamination by CMC end market group could not be estimated. Survey respondents did not report significant issues with contamination. This aligns with the SB 343 Report's material composition analysis, which indicated that the commercial grade PE film includes only 2% contamination. These end market facilities did report some issues, such as rigid plastic contamination due to a lack of proper sorting. PE recycling processing facility film has a higher concentration of contamination, up to 35%, but the exact makeup of the contamination that reaches end markets could not be estimated based on the limited availability of PE recycling processing facility film composition studies.

3.5.2.2 Systems to Monitor Contamination

Survey respondents indicated that they use hand sorting and label removing machines to monitor and reduce contamination.

3.5.3 Recovery of Covered Material

For the material sent to end market facilities in California, survey respondents reported that this material was converted into pellets. End market facilities reported that this material is not as clear as virgin material.

The technologies used to recycle PE film are similar to other plastic resins. Feedstock that enters the end market facilities goes through a manual screening and sorting process, after which labels are removed from the material, and it is cleaned. One of the main reported reasons for material losses during the recycling process is color film in the material grade. The material is then flaked and extruded into pellets. If the feedstock is very high quality, it could go straight to an extrusion process without being washed, but typically most plants will include a cold wash process. The types of technology used to manage PE recycling processing facility film could not be verified because no end market facilities that take the material could be identified. This material could be recovered using similar processes (i.e. screening, sorting, washing, flaking, and then extrusion). Recent studies on California film indicate that pellets recycled from noncommercial grades are likely to be used to produce durable goods, such as lumber or decking.[30]

Table 3-15 summarizes the weight of PE film that is accepted by or sent to end markets and recovered. The CMC conversion rates are based on survey responses for end markets in California. The conversion rate for covered material that is exported domestically or internationally could not be confirmed and may differ from what is presented in this report.

The conversion rate presented in Table 3-15 is for the CMC end market group only. These tonnage feedstocks have already considered and removed the contamination arising from other covered and noncovered material.

Table 3-15: PE Film CMCs Recovered by End Markets in 2024 (tons)

CMC End Market Group	Weight Accepted by or Sent to End Markets, Excluding Contamination	Recovered Material Produced	CMC End Market Groups Accepted or Sent to End Markets but not Recovered	Estimated CMC Conversion Rate (%)
PE Film	33,730	30,020	3,710	89%

3.6 Plastic Covered Material with Limited End Markets

For the remaining CMC end market groups within the plastic material class, limited to no end markets were identified. This means that an end market facility that takes this material from California was not identified nor was the material identified in RDRS or WISERTrade data for domestic or international end markets. Table 3-16 shows the quantity of these materials that enter end markets and how much of it is recovered. For

nearly all these groups except small plastics, all the material accepted by or sent to end markets was not recovered. This means the end market facilities accepted these materials as part of a different material grade type and then disposed of them as they were identified as contamination. Note that small plastics are recovered by some HDPE and PP plants, which reported accepting caps and closures from PET plants. As the caps are a detachable component, these were considered as part of the small format plastics CMC end market group. EPS transport packaging sent for recycling was not considered as part of this analysis.

Table 3-16: Plastic CMC End Market Groups with Limited End Markets in 2024 (tons)

CMC End Market Group	Weight Accepted by or Sent to End Markets, Excluding Contamination	Recovered Material Produced	CMC End Market Groups Accepted or Sent to End Markets but not Recovered
Plastic #1 – PET Flexibles and Films	Unknown	Unknown	Unknown
Plastic #3 – PVC Flexibles and Films	Unknown	Unknown	Unknown
Plastic #3 – PVC Rigid	Unknown	Unknown	Unknown
Plastic #4 – LDPE Bottles and Jugs	Uknown	Unknown	Unknown
Plastic #4 – Other LDPE Rigid	100	Unknown	100
Plastic #5 – Mono PP Flexibles and Films	Unknown	Unknown	Unknown
Plastic #6 – Other PS	3	Unknown	3
Plastic #6 – PS Rigid Items	200	Unknown	200
Plastic #6 – EPS Rigid Items	300	Unknown	300
Plastic #6 – PS Flexibles and Films	Unknown	Unknown	Unknown
Plastic #7 – Other Flexible and Films	200	Unknown	200

CMC End Market Group	Weight Accepted by or Sent to End Markets, Excluding Contamination	Recovered Material Produced	CMC End Market Groups Accepted or Sent to End Markets but not Recovered
Plastic #7 – Other Rigid Plastics	400	Unknown	400
Plastic Based Textiles	Unknown	Unknown	Unknown
Small Format – Plastics	4,000	1,100	2,900
Plastic – Multi Material Laminate	0	Unknown	0

3.7 Cost and Markets Related to Plastic End Markets

This section describes the current costs that plastic end markets face, factors that affect end market viability, and the strategies that end markets use to make recycling covered materials more viable.

3.7.1 Cost of Plastic End Markets

According to survey responses, the two biggest ongoing cost categories for end markets are the cost of feedstock material and the cost of labor. The next largest include utilities, transportation and logistics, maintenance, and building costs. Table 3-17 presents a summary of the average share of annual costs for plastic end markets as reported by the survey respondents.

Table 3-17: Average Share of Annual Cost for Plastic End Markets Based on Survey Responses

Cost Category	Share of Annual Costs
Feedstock Material Purchases	30-50%
Labor	20-30%
Utilities	5-10%
Transportation and Logistics	~5%
Maintenance	~5%
Land and Building	~3%
Education and Compliance	~1%
Other	5-10%

The largest cost category for plastic end markets is the cost of feedstock, which can vary. Feedstock prices change on a near daily basis due to the external market, so it can be a challenge for end markets to predict their yearly cost. Figure 3-3 illustrates this challenge; it shows the price of HDPE Natural feedstock material has varied between $0.20 per pound and $1.00 per pound over the last ten years.[31] Other material grades have also seen varying prices. For example, PET Grade B has varied between $0.05 and $0.25 per pound over the last ten years and PP Rigid has varied between $0.04 and $0.35 per pound over the same period.

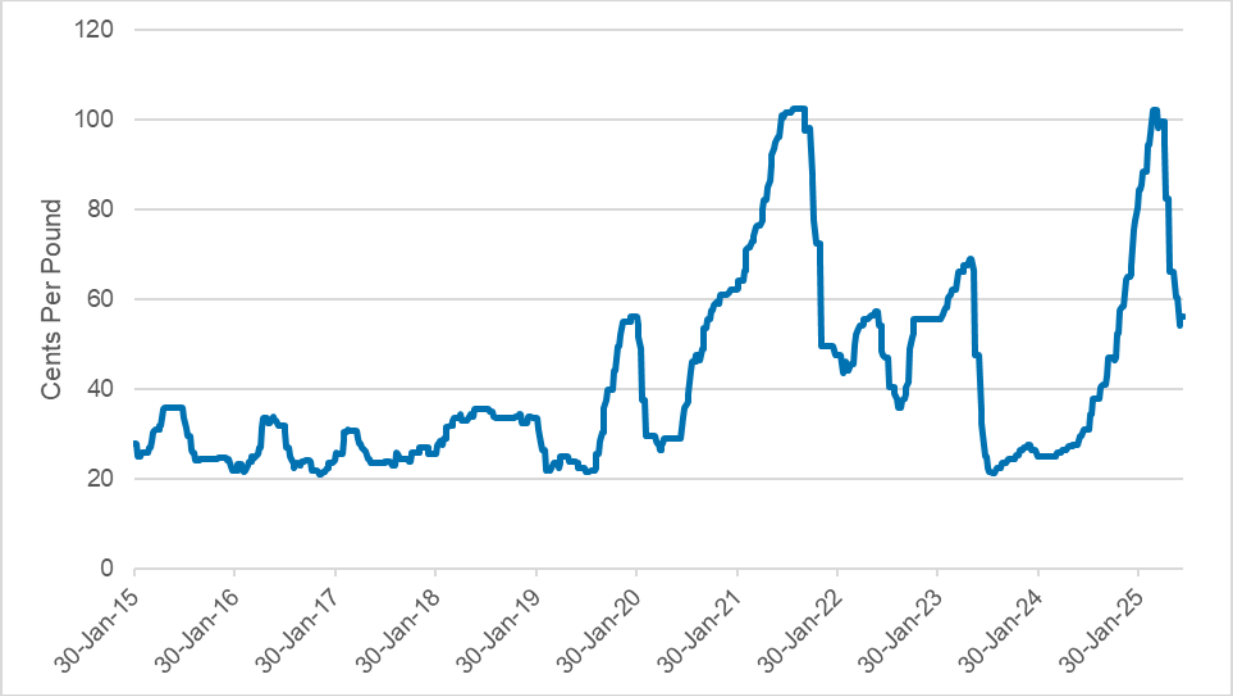

Figure 3-3: Historical Price of HDPE Natural Material Grade

The upfront cost of plastic recycling is variable as it depends on many factors, such as land costs, building costs, the types of technologies invested in, the resins intended to be produced, and the scale of the project. These investment costs are not always made public by companies, and many plastic end markets have operated for many years so their initial upfront costs may no longer be relevant. When Republic and Ravago announced their joint partnership with Blue Polymers, their $350 million joint venture was expected to build four plants across the country with the capacity to produce 300 million pounds of plastic annually.[32]

All the plastic end markets reported that sales were the primary or only source of revenue for their end market facility. CalRecycle has invested in various end market facilities to support plastics recycling in addition to ongoing payment programs. Not all these programs directly support the recycling of covered material, as some focus on CRV materials:

- The Plastic Market Development Program set aside $16 million to be used between 2023 and 2027 for reclaimers that recycle PET material, with higher payments for recycling from PET Grade A.[33]
- In 2017, CalRecycle awarded:
- $3 million to rPlanet Earth to process PET thermoform packaging and
- $3 million to Revolution to increase capacity for LDPE agricultural film processing.[34]
- In 2021, CalRecycle awarded Global Plastics Recycling $1.6 million to boost optical sorting capabilities and upgrade grinding and washing lines.[35]

In addition to grants from CalRecycle, one facility reported capital investment from private equity.

3.7.2 Factors That Affect End Market Viability

As reported by survey respondents, the main factors that impact end market viability are external – both on the supply (feedstock inputs) and the demand (product outputs) side.

As previously discussed, the largest ongoing cost of plastic end markets is the plastic feedstock, which has a variable price. When this price starts to go up it increases costs for facilities, limiting their viability. End markets reported facing feedstock supply challenges as more material is being exported internationally, especially to Mexico. End market facilities in Mexico can buy the material at a higher price compared to domestic markets due to their lower operational costs (specifically labor costs). These exports reduce the availability of quality input material for California facilities. Nearly all end market facilities surveyed reported operating below their capacity, and some have reported needing to shut down at several points in 2024 due to a lack of feedstock at a financially feasible price point.

End market facilities surveyed also reported that the demand for domestically produced recovered material had fallen due to increased imports of recovered resin. Recovered PET (rPET) imports to the U.S. rose by over 65% from 2022 to 2024, from 165,347 short tons in 2022 to more than 275,578 short tons in 2024.[36] This increased supply creates price pressure for domestically produced material, and if it leads to lower prices overall it can limit a facility's ability to compete financially. Therefore, developing demand for domestically recovered resin would help end market facilities within California and in the U.S. remain competitive and viable in an increasingly global supply chain system.

Overall, key comments from the survey highlight that plastic end markets face viability challenges on both sides of the cost equation. The increased demand for feedstock

through international exports can in turn increase annual costs and limit end markets' ability to produce enough recovered material at scale to cover their costs. Furthermore, imports of virgin and recovered resin can lower the price of recovered material outputs. These factors combined limit plastic end markets' ability to cover their costs. Surveyed respondents stated that they worry that if these conditions continue, some existing end markets may have to close. However, this is not a comprehensive assessment due to the limited number of end market facilities that provided responses to the survey.

3.7.3 Strategies to Support Viability

End market viability is mainly related to external factors, including the price of feedstock and the sale price of recovered products created. To increase their own viability, end markets reported investing in more efficient sorting, including both optical sorting and labor sorting, with the goal of more efficiently eliminating the contamination in feedstock material grades. No end market facility reported using artificial intelligence. The contamination section for each material form goes into additional detail on the technologies used to remove contamination.

4.0 Paper and Fiber

4.1 Introduction

For the purposes of this project, paper and fiber end markets are defined as beneficiation plants that repulps material into a pulp product.

Covered material made predominantly of paper and fiber includes items with plastic components and laminated paper packaging products, such as:

- Aseptic and gable top food and beverage cartons, used primarily for liquids (juice, milk, soup) and made up of layers of paper, plastic, and/or aluminum foil.
- Coffee cups with a plastic lining.
- Snack food packaged in laminated bags with layers of paper, plastic, and/or aluminum foil.
- Takeaway containers with plastic lining.
- Pet food bags comprising paper layers, plastic layers, and a metalized layer to keep food fresh.

There are many different grades of paper and fiber material aggregated for recycling. Table 4-1 lists those relevant to single-use packaging and single-use plastic food service ware.

Table 4-1: Grades Used for Paper and Fiber End Markets

Grade	Brief Description	Typical Use of Recovered Material derived from Grade
Old Corrugated Cardboard (OCC)	High quantities of corrugated cardboard with relatively low quantities of box board and other papers.	Typically used to manufacture components of corrugated cardboard and other packaging items requiring good fiber strength.
Mixed Paper	Can vary considerably in composition and has a variety of sub grades. The main variability is attributed to the proportion of deinked papers (such as newsprint, household letters, and pamphlets) and the proportion of box board and OCC. The lower the proportion of boards, the softer the grade; the higher the proportion of boards, the harder the grade.	Pulp use is influenced by how hard or soft the grade is. Softer grades might be typically used in tissue or molded fiber applications. Harder mixes are more likely to be used in board applications.
Aseptic and Gable Top Food and Beverage Cartons	These types of food and beverage packaging are both primarily made of Paperboard with polyethylene (PE) coatings, but with different structures. Aseptic cartons, like those for shelf stable items such as juice and broth, also include a layer of aluminum foil. Gable top cartons, often used for refrigerated products like milk, lack the aluminum layer.	Both are recovered in a specialized pulping process to produce fibers. Also, in some cases the whole package is recycled into insulation and construction materials.

Paper and fiber are widely used in pulp form to manufacture a range of products, including covered material. It provides a substitute for virgin wood and other plant-based fibers extracted for the paper making industry. As a result, this waste stream has significant economic value and is traded internationally.

To produce paper, mills utilize paper and fiber waste, virgin pulp, or a combination of both as their raw materials. In 2021, approximately 30 million tons of recovered paper were used by U.S. paper mills, and 80% of paper mills use some recovered paper fiber.[37] The most prevalent products as outputs from the mills are packaging paper and board, printing and writing paper, and tissue paper.

4.2 Method and Survey Responses

This section provides additional information on the outreach and survey responses received from paper end market facilities. Information related to paper and fiber accepted at end market facilities that generate recycled organic products can be found in Section 8.0.

Through secondary research, 19 facilities in California were identified as potential paper end market facilities. To verify eligibility, the contractor contacted individual end market facilities and consulted two national industry associations, the American Forest & Paper Association (AF&PA) and the Carton Council of North America. AF&PA was provided with a preliminary list of potential paper and fiber end markets in California and asked to review and refine the list and add any end market facilities not already on it. Through this outreach and AF&PA's input, the list was revised down to three relevant paper and fiber plants. The contractor was informed of an end market facility based in Mexico that may be receiving California material, but the operator did not respond to requests for contact.

Data on California end markets are derived from the two survey responses received and supplemented with SB 343 Report data. Table C-2 details which datasets were used by material. Table 4-2 sets out the key characteristics of the three end markets. The third end market facility did not want to participate. Of the two survey responses received, only one provided compositional data.

Table 4-2: Coverage of Grade Compositions from Survey Responses

Respondent	Grades Accepted and Source	Composition Provided
1	OCC – 96% of material is sourced using community collectors and some business collections; 4% from brokers. No material is sourced from material recovery facilities.	No
1	Mixed Paper – 96% of material is sourced using community collectors and some business collections; 4% from brokers. No material is sourced from material recovery facilities.	No
2	OCC – Either sourced from material recovery facilities (20%) or unspecified/outside CA (80%).	Yes
2	Mixed Paper – 100% sourced from material recovery facilities.	Yes
3	OCC	No data
3	Mixed Paper	No data

RDRS data were used to derive the tonnage of material exported outside California but domestically within the U.S., whereas WISERTrade data were used to derive the tonnage of material exported internationally. Note that RDRS data cannot easily be matched with grades of exported paper and fiber. Categories of Mixed Paper and OCC were identified, but it is unclear whether grades such as Aseptic Cartons were exported but included in categories such as Mixed Paper or not exported at all. WISERTrade also may overestimate tons from California that are accepted at international end markets (see discussion of limitations in Section 2.3).

Secondly, there are significant limitations in using WISERTrade for export statistics. This is because the tonnages reflect point of exit shipments for seaborne exports, which will include any tonnage shipped from other states for onward transport from California ports.

4.3 Paper and Fiber End Markets

4.3.1 Acceptance of Covered Materials

Table 4-3 presents the weight of paper and fiber material grades that are accepted by or sent to end markets in California, outside California but within the U.S., and exported from the U.S. Surveyed end market facility operators use two material grades: OCC and Mixed Paper. Survey respondents did not report using a carton grade in their end market facilities. Some recycling processing facilities do produce separate grades of cartons. However, available data from RDRS and surveys did not identify any specific

amounts of carton grades. While an estimate is provided for the amount of cartons sent to end markets in Mixed Paper, it was not possible to estimate the amount of carton-specific outbound bales.

Table 4-3 includes covered material, noncovered material, and contaminants.

Overall, the quantity of paper and fiber material, including noncovered material, sent to end markets was just under 5.8 million tons in 2024. Less than 10% of paper and fiber grades are accepted into Californian end markets (i.e., most paper and fiber tons from California are exported).

Of the tons sent to Californian end markets, the majority are OCC grades (480,400 tons). In contrast, a relatively small quantity of cartons and other composite material reaches end market facilities in the state, with less than 10,000 tons being sent to facilities in California.

Table 4-3: Paper Material Grades Accepted by or Sent to End Markets in 2024 (tons)

Material Grade	Accepted by End Markets in CA	Domestic Exports	International Exports	Total
OCC	480,400	327,500	4,093,900	**4,901,800**
Mixed Paper	20,700	148,800	719,500	**889,000**
Total	**501,100**	**476,300**	**4,813,400**	**5,790,800**

Based on survey responses and RDRS, of the two material grades, OCC is the higher quality grade, as it is made up of approximately 91% OCC. This grade also contains approximately 2.5% paperboard, 1.4% kraft paper, and 1.8% mixed paper. In comparison, the Mixed Paper grade contains approximately 43% mixed paper, 29% OCC, 10% paperboard, and 7% kraft paper. Appendix C Table C-3 and C-4 include these modelled compositional data for each material grade.

Approximately 5.8 million tons of paper and fiber material grades from California are accepted by or sent to end markets with approximately 5.6 million of these tons being covered material. Table 4-4 summarizes the weight of paper and fiber CMC end market groups accepted by or sent to end markets both within and outside of California.

Table 4-4: Paper and Fiber CMC End Market Groups Accepted by or Sent to End Markets in 2024 (tons)

CMC End Market Group	Accepted by End Markets in California	Domestic Exports	International Exports	Total
Kraft Paper	8,100	14,800	106,100	**129,000**
Aseptic Cartons	100	500	2,500	**3,100**
Gable Top Cartons	200	300	2,000	**2,500**
Paperboard	14,200	23,300	175,900	**213,400**
OCC	442,300	340,800	3,927,500	**4,710,600**
Mixed Paper	17,600	68,900	379,400	**465,900**
Molded Pulp	600	1,000	**8,300**	**9,900**
Small Format – Paper	3,300	5,200	39,900	**48,400**
Total	**486,400**	**454,800**	**4,641,600**	**5,582,800**

4.3.1.1 Covered Material Exports

According to WISERTrade (Table 4-4) over 4.6 million tons of paper and fiber covered materials were exported internationally in 2024, representing just under half of all covered material international exports. In 2024, OCC accounted for a little under 4 million tons (over 80% of all paper and fiber international exports). This trend has been consistent throughout recent years, with OCC maintaining the dominant share of paper and fiber exports from 2022 through 2024.

Both OCC and Mixed Paper grades are predominantly exported, with an estimated 83% sent to destinations outside the U.S. The primary destinations of OCC exports were all in East Asia: Thailand, Vietnam, Malaysia, Taiwan, China, South Korea, and Indonesia. Other countries receiving OCC are mostly based in Central and South America but are handling much smaller volumes and represented only 1% of the export total for OCC by weight in 2024. As China's imports dropped, the overall volume of paper and fiber exports remained relatively stable during the decade before 2024, because other East Asian countries increased their volumes. Evidence was not available to determine what destinations and processing occurred after exports took place.

4.3.2 Contamination

4.3.2.1 Types of Contamination and Weight Derived

Two end market facilities provided information on the contamination of OCC and mixed paper feedstocks. They reported that the most significant contaminants entering their end market facilities were plastic film or flexible packaging, glass, metals (e.g., aluminum, cans, staples, wires), wax coated or heavily laminated paper, and pressure sensitive adhesives. Specific materials such as tapes, pressure sensitive adhesives, staples, wet strength board/paper, book bindings, and wood were identified as problematic as either they do not contain fiber or the plant's equipment cannot recover the fiber from them.

Building from the information provided by the surveyed end market facilities that processed OCC and Mixed Paper only, Table 4-5 summarizes the weight of contamination that enters OCC end markets from CMC end market groups and other contamination.

Table 4-6 provides the equivalent data for Mixed Paper end markets. For OCC end markets, Mixed Paper constitutes the largest share of nontarget material, but Mixed Paper is still accepted and incorporated into the final end product as long as it does not exceed an end market facility's tolerance. When discounting Mixed Paper, other contaminants (noncovered material) make up the largest share of contamination into OCC end markets at 57,200 tons. However, it should be noted that these 57,200 tons of other contaminants represent approximately 1% of all materials accepted by OCC end markets in 2024. For Mixed Paper, while other contaminants make up the greatest share of contaminants at 34,400 tons, it is less than 4% of all materials accepted by Mixed Paper end markets in 2024. The second highest contaminant for Mixed Paper was flexible film plastics (11,200 tons), representing approximately 1% of all materials accepted by Mixed Paper end markets in 2024.

Table 4-5: Estimated Weight of Contamination Which Was Accepted by or Sent to OCC End Markets in 2024

CMC End Market Group	Tons
All CMC Glass	620
Aluminum Containers - Non-CRV	310
Other Aluminum	200
Other Nonferrous	10,010
Tin/Steel/Bimetal - Non-CRV	1,530
Other Ferrous	1,230
Small Format - Metal	200
Gable Top Cartons	1,530
Mixed Papers	89,840
Molded Pulp	6,540
Small Format - Paper	28,900
Plastic #1 - PET Clear Bottles, Jugs, Jars – Non-CRV	820
Plastic #1 - PET Pigmented Bottles, Jugs, Jars – Non-CRV	310
Plastic #1 - Other PET Rigid	3,270
Plastic #2 – HDPE (pigmented and natural) Bottles, Jugs, Jars – Non-CRV	7,550
Plastic #2 - Other HDPE Rigid	3,980
Plastic #4 - Other LDPE Rigid	200

CMC End Market Group	Tons
Plastic #4 - Mono LDPE Flexibles and Films	5,310
Plastic #5 - PP Rigid Items	3,980
Plastic #6 - PS Rigid Items	2,450
Plastic #7 - Other Rigid Plastics	100
Plastic - #7 Other Flexible and Films	15,310
Multi Material Laminate	200
Small Format - Plastics	7,960
Wood - Treated	3,980
All Other Wood and Organics	2,040
Other Contaminants (noncovered material)	58,510

Table 4-6: Estimated Weight of Contamination Which Was Accepted by or Sent to Mixed Paper End Markets in 2024

CMC End Market Group	Tons
All CMC Glass	430
Other Aluminum	430
Other Nonferrous	430
Tin/Steel/Bimetal - Non-CRV	860
Other Ferrous	430
Small Format - Metal	860
Aseptic Cartons	3,110
Gable-Top Cartons	960
Plastic #1 - PET Clear Bottles, Jugs, Jars – Non-CRV	430
Plastic #1 - Other PET Rigid	5,160
Plastic #2 – HDPE (pigmented and natural) Bottles, Jugs, Jars – Non-CRV	1,720
Plastic #2 - Other HDPE Rigid	430
Plastic #4 - Mono LDPE Flexibles and Films	430
Plastic #5 - PP Rigid Items	3,010
Plastic #6 - Other PS	430
Plastic #6 - PS Rigid Items	2,150
Plastic #6 - EPS Rigid Items	430
Plastic #7 - Other Rigid Plastics	430
Plastic - #7 Other Flexible and Films	11,180
Multi-Material Laminate	430
Small Format - Plastics	3,440
Wood - Treated	1,300
All Other Wood and Organics	3,010
Other Contaminants (noncovered material)	36,520

4.3.2.2 Systems to Monitor Contamination

The primary methods for monitoring contamination are periodic bale inspection and various types of screens. The process for removing contaminants is to:

- Presort: visual load inspection by yard personnel at a macro level. The scale operator then segregates material into sections of the yard with similar material. If large contaminants are identified, the supplier's load will be rejected, or the supplier will be asked to separate bad and good before or during the unloading process.
- Pulping: a beater operator observes what is loaded onto a conveyor in loose format and can detect large pieces of contaminants at this point. Other screens and cleaners are utilized.
- Pulp cleaning: the process involves removing impurities, residual lignin, and other chemicals from the pulp using various methods.
- Recovery of pulp lost through screening: process screening – Scavenger, V200 screen, V100 screen, float purger, and ultrasorter (see Glossary of Terms), in that order – to remove contaminants.

Respondents did not cite any deinking processes. The cost impacts of the processes stated, include additional staff time (wages) and energy consumption. They reported sending rejected material to landfill.

4.3.3 Recovery of Covered Material

Based on the modelling of relevant CMC end market groups accepted by or sent to end markets, Table 4-7 provides the CMC conversion rate for end markets. This table presents the conversion rates for the CMC end market group only. These tonnage feedstocks have already considered and removed the contamination arising from other covered and noncovered material. Overall, kraft paper, OCC, and paperboard have high conversion rates (96%), while mixed papers, molded pulp, and small format paper have much smaller conversion rates (<50%). The contractor did not identify any material recovered from aseptic and gable-top cartons.

Table 4-7: Paper and Fiber CMC End Market Groups Recovered by End Markets in 2024 (tons)

CMC End Market Group	Accepted by or Sent to End Markets, Excluding Contamination	Recovered Material Produced	Accepted by or Sent to End Markets but not Recovered	Estimated CMC Conversion Rate (%)
Kraft Paper	129,000	123,600	5,400	96%
Aseptic Cartons	3,100	Unknown	3,100	Unknown
Gable Top Cartons	2,500	Unknown	2,500	Unknown
Paperboard	213,400	204,400	9,000	96%
OCC	4,710,600	4,512,800	197,800	96%
Mixed Papers	465,900	224,200	241,700	48%
Molded Pulp	9,900	Unknown	9,900	Unknown
Small Format - Paper	48,400	6,400	42,000	13%

Survey respondents reported loss of fiber at screening and pulp cleaning stages. This is mainly due to the presence of unpulpable materials, such as fiber items with high wet strength (i.e. with sufficient structural integrity, even when wet, to resist mechanical means of breaking down the material). The solutions to reduce contamination include installing more screening equipment, introducing additional stages such as heat injection, and using solvents, acids, bases, or similar approaches to break down high wet strength material.

4.4 Paper and Fiber Covered Materials with Limited End Markets

The survey provides evidence that a number of paper and fiber CMC end market groups have limited to no end markets (see Section 8.1.2 for organics end markets for some of these materials). These CMC end market groups may have been identified by the operator as part of a material grade composition but were not targeted by the end market facility. Table 4-8 shows the quantity of these materials that enter end markets, none of which were found to be recovered. This means the end market facilities accepted these materials as part of a different material grade, then disposed of these materials.

Table 4-8: Paper and Fiber CMC End Market Groups with Limited End Markets in 2024 (tons)

CMC End Market Group	Accepted by or Sent to End Markets, excluding Contamination	Recovered Material Produced	Accepted by or Sent to End Markets but not Recovered
Other Lined Paper	Unknown	Unknown	Unknown
Aseptic Cartons	3,100	Unknown	3,100
Gable Top Cartons	2,500	Unknown	2,500
Waxed OCC	Unknown	Unknown	Unknown
Molded Pulp	9,900	Unknown	9,900

4.5 Cost and Markets Related to Paper and Fiber End Markets

Survey responses provided limited but insightful information about the economic dynamics in the end market sector for paper and fiber.

4.5.1 Cost of Paper and Fiber End Markets

Paper mills and recyclers face financial barriers to increasing output and improving conversion rates. Many mills are designed to use virgin fiber as their feedstock and retrofitting to use 100% recycled content is expensive. Circular economy consultancy Circular Ventures estimates conversion costs at between $250-450 million USD per mill in the U.S. and Canada. Even though mills are capable of using waste paper and fiber as a feedstock, they may choose not to do so where virgin raw material is cheaper or where it is required for specific characteristics, such as color and brightness, and food contact products. The volatility of material feedstock prices is likely to inhibit investment; although some mills have purchased their own forest lands as a solution to this. There are only a few mills in the U.S. that were able to provide a business case for processing cartons, based on the cost to process them relative to the return. Parameters such as agitation time, pH levels, and water temperature need to be adapted to specific grades. Finally, contamination has a direct operating cost impact; a number of contaminants can slow down the process such as flexible films (which need to be manually extracted from equipment) and laminates (which require additional processing steps to remove non paper elements). [38]

According to one of the survey respondents, the two biggest ongoing cost categories for end markets are the cost of feedstock material and maintenance. The next largest includes labor and utilities. Table 4-9 presents a summary of the average share of annual costs for paper and fiber end markets as reported by this survey respondent.

Table 4-9: Share of Annual Cost for Paper and Fiber End Markets

Cost Category	Share of Annual Costs
Feedstock Purchase	37%
Labor	14%
Land and buildings	2%
Equipment Capital Expenditures	3%
Maintenance	18%
Transportation and Logistics	8%
Utilities	17%
Education and Compliance	1%

Source: Survey Findings

Labor, maintenance, and energy consumption were cited as the main cost impact of operations, with estimated capital costs, if operators were to expand, in a relatively wide range ($143 up to $1,027 per ton). Given the respondent citing the higher estimate was a multi-site business, this may have included the cost of setting up a new site. Return on investment in the additional measures needed to improve yield loss, such as more screening and cleaning equipment, was estimated at three years.

One respondent noted the quality of recycled material as typically lower than virgin pulp, which means it typically commands a lower price. Conversely, another respondent maintained that its products could meet the same specifications as virgin material.

4.5.2 Factors That Affect End Market Viability

Prices for recycled paper fluctuate considerably. The paper and fiber market is particularly internationally focused, with a large proportion of waste paper being exported. Hence global market dynamics influence prices. The relative prices of grades are fairly consistent, however, with sorted paper commanding the highest prices, followed by OCC, then mixed paper.

Some key comments from the survey highlight potential challenges to further development of end markets in California, including lack of strong markets to accept recycled pulp and difficulty obtaining investments. However, this is not a comprehensive assessment due to the limited number of facilities that provided responses to the survey.

Transport costs are sensitive to the distances required to sell products. While inbound distances reported in the survey are relatively short (30 miles or less), one end market facility had customers who were up to 300 miles away, which they argued added significant operating costs for transport.

4.5.3 Strategies to Support Viability

To support end market viability, paper and fiber end markets seek to create the most material they can from the feedstock they receive. They seek to reject or remove the maximum amount of contamination as well as difficult to recycle paper and fiber grades, which will allow them to improve the conversion rate for each CMC end market group. Facilities could improve the quality of products and increase their value by investing in more efficient presorting and screening, which allows them to more efficiently eliminate nontarget input material grades. The contamination section goes into additional detail on the technologies used to remove contamination.

5.0 Metal

5.1 Introduction

For the purposes of this project, metal end markets are defined as entities that smelt metal to produce ingots, sheets, or coils. Both aluminum and steel materials can be recycled indefinitely, so increasing the volume of recycled metals can help reduce the demand for virgin materials and the carbon emissions associated with their extraction. Recycling aluminum saves an estimated 95% of the energy needed to make new aluminum.[39] The aluminum and steel recycling processes at end market facilities are detailed as follows:

- Shredding: Material received at end market facilities is shredded into smaller pieces to reduce volume.
- Cleaning: Mechanical and chemical processes clean the metals in preparation for melting.
- Melting: Scrap is loaded into high temperature furnaces and melted down at temperatures that reach or exceed 750 degrees Celsius for aluminum and 1300 degrees Celsius for steel.
- Removal of byproducts (aluminum only): Waste products created during the melting process are removed either mechanically or using chlorine and nitrogen gas.
- Creation of alloys (aluminum only): Alloys are created by adding metals such as copper, zinc, magnesium, or silicon, depending on the planned use for the recovered metals.
- Refining and purification (steel only): Impurities are removed through electrolysis or magnetism.
- Compounding: Molten metal is poured out and formed into ingots, sheets, or coils, depending on their planned use.

Both aluminum and steel materials can be recycled in closed loop and open loop systems – in other words, can to can sheet recycling or cans to ingots or coils.

5.2 Method and Survey Responses

This section provides additional information on the survey responses received from metal end market facilities and additional strategies used to produce report outputs.

The contractor did not identify any end market facilities in California that manage covered metal material but did identify seven elsewhere in the U.S. Four of these recycle used beverage can (UBC) material, one recycles aluminum foil, and the remaining two recycle steel.

The contractor interviewed and sent a survey to four of the aluminum facilities. Two partially completed the survey. The remaining aluminum end market facilities and the

steel end market facilities did not respond to any outreach and no interview was conducted or survey response received. Due to the limited survey responses, some quantities of metal covered material sent to end markets could not be estimated, while others are likely underestimated.

RDRS and WISERTrade data provided domestic and international material grades tons sent to metal end markets.

RDRS tonnage information is associated with a material type. The categories of tin/steel/bimetal containers, cans, foil, mixed aluminum, and aluminum beverage cans were included in the totals of metals entering end markets. The contractor acknowledges that the overall totals look relatively low and there may be additional metal covered materials entering end markets that have not been accounted for. To address this issue, other RDRS categories labelled as 'Scrap Metal' and 'Mixed Metal' were considered. However, it is not possible to establish whether they included any covered materials and if so in what quantities, so they were not included in the totals discussed throughout Section 5.3 and 5.4.

5.3 Aluminum

Aluminum is a common packaging material used to produce cans, trays, foil sheets, and foil containers for beverage containers, aerosol products, other liquids, pharmaceutical products, and food products.

This section of the report summarizes the modelled outputs related to the recovery of aluminum packaging material at end markets inside and outside the U.S. As previously mentioned, no end market facilities processing aluminum packaging in California were identified. The state is exporting this material to both domestic and international end markets. The aluminum market is also largely dominated by beverage cans covered under the BCRP; therefore, aluminum end market facilities largely focus on recycling aluminum beverage containers.

End market interviews with Used Beverage Cans (UBC) aluminum recyclers identified that material grades sometimes contain non-UBC aluminum material, such as aluminum foils and pet food cans, which are covered under the Act. End markets that purchase aluminum UBC grades tolerate aluminum covered material to an extent; however, end market facilities purchase aluminum UBC grades with non-UBC aluminum at a lower price than 100% UBC material grades.

5.3.1 Acceptance of Covered Materials

Post-consumer aluminum packaging is typically sorted and sold to end markets based on three different material grades:

- Post-consumer aluminum can stock consists of aluminum cans collected through curbside and drop off programs, processed at recycling processing facilities, and collected through the California BCRP.
- Aluminum, tin, and steel containers is a mixed metal grade made up of aluminum, tin, and steel containers collected through curbside and drop-off programs and processed at recycling processing facilities.

- Post-consumer aluminum foil grades consist of old household aluminum foil and foil molded containers, collected through curbside and drop-off programs and processed at recycling processing facilities.

Table 5-1 summarizes the estimated weight of identified aluminum material grades that enter end markets as feedstock in and outside California. Together they make up just under 196,000 tons. These material grades include covered aluminum packaging, noncovered packaging (CRV aluminum), and contamination. Approximately 99% by weight of the identified aluminum material grades leaving California are Post-Consumer Aluminum Can stock, which primarily consists of aluminum beverage containers covered under the BCRP. Four of the five end market facilities identified only take Post-Consumer Aluminum Can stock. The remaining material (Post-Consumer Aluminum Foil) makes up less than 1% of the total aluminum material grades sent for recycling from California.

Table 5-1: Aluminum Material Grades Accepted by or Sent to End Markets in 2024 (tons)

Material Grade	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
Post-Consumer Aluminum Can Stock	0	101,300	94,200	**195,500**
Post-Consumer Aluminum Foil	0	100	None identified	**100**
Total	**0**	**101,400**	**94,200**	**195,600**

Aluminum end markets primarily target aluminum beverage cans as they are typically cleaner than other aluminum packaging such as food cans and foils. The acceptability and usage of target material at aluminum end market facilities is summarized in Table 5-2.

Table 5-2: Aluminum CMC End Market Groups and CRV Material Accepted at Aluminum End Markets

CMC End Market Groups and CRV Material	Acceptability
Aluminum Beverage Cans – CRV	Always target material and recovered by aluminum end markets.
Other Aluminum	Some end markets target this material and recover it, and some tolerate it in small quantities.
Other Nonferrous	Not targeted by most aluminum end markets and not recovered unless aluminum and in small quantities.
Small Format – Metals	Not targeted by most aluminum end markets and not recovered unless aluminum and in small quantities.

Table 5-3 summarizes the weight of aluminum CMC end market groups identified as accepted by end markets both in and outside California.

Table 5-3: Aluminum CMC End Market Groups Accepted by Aluminum End Markets in 2024 (tons)

CMC End Market Group	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
Other Aluminum	0	200	200	**400**
Aluminum Containers – Non-CRV	0	Limited	Limited	**Limited**
Total	**0**	**200**	**200**	**400**

5.3.2 Contamination

5.3.2.1 Types of Contamination and Weight Derived

No aluminum end market facilities provided composition information on contamination at their facilities and therefore the following tons are based on CalRecycle's SB 343 Report[40]. It is unknown whether aluminum end markets disposed of or sorted nontarget CMC materials.

Table 5-4-4 summarizes the weight of contamination that enters aluminum end markets from CMC end market groups in post-consumer aluminum can material grades. Some material may be sorted or disposed of depending on the facility and quantity of material. PS rigid items makes up the largest share of contamination followed by other ferrous and tin/steel/bimetal – non-CRV.

Table 5-4: Estimated Weight of Contamination Which Were Accepted by or Sent to Aluminum End Markets in 2024

CMC End Market Group	Tons per year	Sorted or Disposed of
Mixed Papers	600	Unknown
Tin/Steel/Bimetal – Non-CRV	780	Unknown
Other Aluminum	390	Unknown
Other Ferrous	400	Unknown
Kraft Paper	160	Unknown
Plastic #1 – PET Clear Bottles, Jugs, Jars – Non-CRV	160	Unknown
Plastic #1 – Other PET Rigid	200	Unknown
Plastic #5 – PP Rigid Items	230	Unknown
Plastic #6 – PS Rigid Items	6,700	Unknown
Plastic – #7 Other Flexible and Films	100	Unknown
Small Format – Plastics	390	Unknown
All Other Wood and Organics	230	Unknown

In 2021, the Aluminum Association released an aluminum container design guide which discussed the difficulties that nonmetal materials on aluminum containers cause at recycling facilities.[41] The guide specifically mentions design elements, such as plastic labels or shrink sleeves and plastic tops and lids, that reduce the value of aluminum bales and also create environmental and safety control issues at end market facilities. For example, plastic materials in the aluminum recycling stream can increase chlorine emissions during the delacquering and remelting processes, and excessive amounts of carbon based residues from plastics can produce tar like deposits in emission control systems, which can increase the risk of fires.[42]

5.3.3 Systems to Monitor Contamination

No end markets provided information on how they deal with contamination at their facility; however, secondary research showed that aluminum end markets employ various sorting and separation techniques to address this. These techniques and the contaminants they remove are shown in Table 5-5.

Table 5-5: Technologies Used to Monitor Contamination at Aluminum End Markets

Technology	Contaminant Removed
Magnets and eddy currents	Separates out ferrous and nonferrous metals.
Air separation	Separates out lightweight materials such as plastic, rubber, and foam.
Sink-Float	Separates nonferrous metals with differing densities.
Color Sorting	Separates other metals from aluminum.

5.3.4 Recovery of Covered Material

Based on the CMC end market groups accepted by or sent to end markets, Table 5-6 shows the estimated share of material that is recovered or not. The conversion rate for aluminum containers is 95% based on a 2023 Ball Corporation report that looked at U.S. packaging recycling rates.[43] Limited information was available on conversion rates for other aluminum packaging.

The conversion rate presented in Table 5-6 is for the CMC end market group only. These tonnage feedstocks have already considered and removed the contamination arising from other covered and noncovered material.

Table 5-6: Aluminum CMC End Market Groups Recovered by End Markets in 2024

CMC End Market Group	Weight Accepted by or Sent to End Markets, Excluding Contamination	Recovered Material Produced	CMC End Market Groups Accepted by or Sent to End Markets but not Recovered	Estimated CMC Conversion Rate (%)
Other Aluminum	400	Limited	Limited	Limited
Aluminum Containers – Non–CRV	Limited	Limited	Limited	95%

5.4 Steel End Markets

Steel is a common material used to produce cans, tins, and other container types. Steel is used as a packaging material for beverage containers, aerosol products, other liquid containers, medical and pharmaceutical products, and food products.

This section of the report summarizes the modelled outputs related to the recovery of steel packaging material at end markets in and outside the U.S. No end market facilities processing steel packaging in California were identified. Steel packaging in California is exported to both domestic and international end markets for recovery. Steel end markets outside of California did not respond to survey and interview requests and therefore data in this section came from RDRS and WISERTrade.

5.4.1 Acceptance of Covered Materials

Post-consumer steel packaging is typically sorted and sold to end markets under two material grade categories: Steel Can Bundles; and Aluminum, Tin, and Steel Product Containers. These material grades are typically collected through curbside and drop off programs and processed at recycling processing facilities.

Table 5-7 summarizes the weight of the approximate material grade from California that enters steel end markets in the U.S. and internationally. These material grades include covered material, noncovered material, and contamination. Approximately 11,500 tons of Steel Can Bundles from California were accepted into end markets throughout the U.S. Approximately 4,400 tons of steel packaging materials were exported outside the U.S. for recycling. Approximately 2,000 tons of Aluminum, Tin, and Steel Product Containers material grades were identified as exported domestically and internationally from California in 2024.

Table 5-7: Steel Material Grades Accepted by or Sent to End Markets in 2024 (tons)

Material Grade	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
Steel Can Bundles	0	11,500	4,400	**15,900**
Aluminum, Tin, and Steel Product Containers	0	1,300	700	**2,000**
Total	**0**	**12,800**	**5,100**	**17,900**

Steel Can Bundles and Aluminum, Tin, and Steel Product Container material grades comprise both covered and noncovered material. Steel end markets target all forms of steel material, and the acceptability and usage of target material is summarized in Table 5-8.

Table 5-8: Steel CMC End Market Groups and CRV Material Accepted at Steel End Markets

CMC End Market Groups and CRV Material	Acceptability
Tin/Steel/Bimetal – Non-CRV	Always target material and recovered by end markets.
Tin/Steel/Bimetal – CRV	Always target material and recovered by end markets.
Other Ferrous Metals	Always target material and recovered by end markets.
Small Format – Metals	Sometimes targeted by end markets and recycled if ferrous metal.

Table 5-9 summarizes the weight of steel CMC end market groups accepted by or sent to end markets both in and outside California.

Table 5-9: Steel CMC End Market Groups Accepted by or Sent to Steel End Markets in 2024 (tons)

CMC End Market Group	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
Tin/Steel/Bimetal – Non-CRV	0	8,200	3,100	**11,300**
Other Ferrous	0	1,700	600	**2,300**
Small Format – Metal	0	500	200	**700**
Other Nonferrous	0	100	50	**150**
Total	**0**	**10,500**	**3,950**	**14,450**

5.4.1.1 Covered Material Exports

Of the 11,500 tons of domestic steel can material grade exports (including covered material, noncovered material, and contamination, Table 5-7), approximately 8,400 were sent to Oregon, with the remaining 3,100 going to other states throughout the U.S., with no other state receiving more than 1,000 tons.

Table 5-10 shows the domestic Aluminum, Tin, and Steel Product material grade exports in 2024. Of the 1,300 tons exported domestically, between 200 and 300 tons were sent to Kentucky, Pennsylvania, South Carolina, and Michigan, with the remainder sent to other states throughout the U.S. Table D-5 in Appendix D shows these export tons in detail.

Table 5-10: Aluminum, Tin, and Steel Product Material Grade Domestic Exports identified in 2024 (tons)

State	Tons Sent to End Markets
Kentucky	290
Pennsylvania	230
South Carolina	200
Michigan	200
All Other States	380
Total	**1,300**

All international steel can material grade exports (4,400 tons, Table 5-7) identified by the contractor in 2024 were sent to Taiwan.

Table 5-11 shows the international Aluminum, Tin, and Steel Product material grade exports identified in 2024. The figures in this table come from RDRS data as WISERTrade data did not provide information on steel material grade exports containing covered material.

Table 5-11: Aluminum, Tin, and Steel Product Material Grade International Exports identified in 2024 (tons)

Country	Tons Sent to End Markets
Malaysia	550
Canada	130
South Korea	20
Total	**700**

5.4.2 Contamination

5.4.2.1 Types of Contamination and Weight Derived

As no steel end market facilities provided information on contamination at their facilities, the tons listed are based on SB 343 Report material composition data. It is unknown whether steel end markets disposed of or sorted nontarget CMC materials.

Table 5-12 summarizes the weight of contamination that enters steel end markets from CMC end market groups in Steel Can Bundle material grades. Some material may be sorted or disposed of depending on the facility and quantity of material. Small format – metal makes up the largest share of contamination, followed by all other wood and organics, other nonferrous, and aluminum containers – non-CRV.

Table 5-12: Estimated Weight of Contamination that was Accepted by or Sent to Steel End Markets in 2024

CMC End Market Group	Tons per year	Sorted or Disposed of
Aluminum Containers – Non-CRV	130	Unknown
Other Aluminum	40	Unknown
Other Nonferrous	180	Unknown
Small Format – Metal	730	Unknown
Mixed Papers	30	Unknown
OCC	30	Unknown
Paperboard	20	Unknown

CMC End Market Group	Tons per year	Sorted or Disposed of
Kraft Paper	10	Unknown
Small Format – Paper	40	Unknown
Plastic #1 – PET Clear Bottles, Jugs, Jars – Non-CRV	10	Unknown
Plastic #1 – Other PET Rigid	10	Unknown
Plastic #2 – HDPE (pigmented and natural) Bottles, Jugs, Jars – Non-CRV	20	Unknown
Plastic – #7 Other Flexible and Films	20	Unknown
Small Format – Plastics	40	Unknown
All Other Wood and Organics	180	Unknown
Other Contaminants (noncovered materials)‡	840	Unknown

5.4.2.2 Systems to Monitor Contamination

No steel end markets provided information on how they deal with contamination at their facility. Secondary research shows that they employ similar processes as aluminum end markets for dealing with contamination, which are detailed in Section 5.3.3; however, steel mills have more tolerance for labels, coatings, and small plastic parts. Steel is melted at much higher temperatures than aluminum, so nonmetal contamination typically burns off or forms part of the slag which floats on top of the molten steel and is skimmed off in the steel recycling process. Slag can be recovered and used as a substitute for natural aggregates in roads, railways, asphalt, and concrete. In 2024, U.S. Steel reported that they recovered approximately 3.2 million metric tons of blast furnace slag and 284,080 metric tons of steel slag, which were used in place of natural aggregates in construction applications.[44]

5.4.3 Recovery of Covered Material

Based on the CMC end market groups accepted by or sent to end markets, Table 5-13 shows the estimated share of material that is recovered or not. The conversion rate for tin/steel/bimetal – non-CRV and other ferrous metals is 97% based on a 2023 Ball Corporation report that looked at U.S. packaging recycling rates.[45] Limited information was available on conversion rates for small format metals.

‡ Includes Aluminum Beverage Cans – CRV

The conversion rate presented in Table 5-13 is for the CMC end market groups only. These tonnage feedstocks have already considered and removed the contamination arising from other covered and noncovered material.

Table 5-13: Steel CMC End Market Groups Recovered by End Markets in 2024

CMC End Market Group	Weight Accepted by or Sent to End Markets, Excluding Contamination	Recovered Material Produced	CMC End Market Groups Accepted by or Sent to End Markets but not Recovered	Estimated CMC Conversion Rate (%)
Tin/Steel/Bimetal – Non-CRV	11,300	11,000	300	97%
Other Ferrous	2,300	2,200	100	97%
Small Format Metal	700	Unknown	Unknown	Unknown
Other Nonferrous	150	Unknown	Unknown	Unknown

5.5 Metal Covered Materials with Limited End Markets

Metal aerosol covered materials have limited end markets both domestically and internationally. All four domestic aluminum end markets interviewed mentioned that aluminum aerosol containers are an issue in the aluminum can recycling process due to explosion hazards. Aerosol cans that are not thoroughly crushed and emptied can explode when added to the shredder, which can cause significant equipment damage and safety hazards. One aluminum end market also mentioned that the top ring of aerosol containers often contains high lead and iron content; this can affect the chemistry of recycled aluminum products, making processing aerosol cans problematic.

For these reasons, aluminum end markets interviewed typically avoid processing aluminum aerosol cans. Both steel and aluminum aerosol cans are also considered hazardous waste in California when they are not empty and will no longer be used.[46]

5.6 Cost and Markets Related to Metal

5.6.1 Cost of Metal End Markets

Since no metal end market facilities in California were identified, information on costs and revenues is limited. Upfront costs for metal end market facilities include equipment capital expenditure and land and buildings costs, while ongoing costs include input material purchases, labor, maintenance, transportation and logistics, utilities, and education and compliance costs.

One new aluminum UBC end market facility in the U.S., expected to begin operating in 2026, reported equipment capital expenditure costs of $120 million in 2024. This facility also reported that, on average, inbound material will travel 500 miles to the facility and outbound recycled material will travel 1,453 miles to locations where it is used in a new product. A separate facility reported that both their inbound material and outbound material go to and come from all over North America.

The primary source of funding for metal end market facilities is the sale of recovered material – in the form of slabs, sheets, ingots, or coils – to metal product manufacturers. Two aluminum end market facilities surveyed and interviewed are also aluminum packaging manufacturers, so the material they recover goes to their manufacturing facilities. One end market facility reported that their primary source of funding is selling slabs to a sister company.

5.6.2 Factors That Affect End Market Viability

As reported by survey respondents, factors affecting end market viability for recycled metal across the U.S. include the price of virgin material, the price of the recovered material, recovered material demand, and manufacturers' willingness to pay for recovered material.

There is demand for recovered aluminum and steel materials. In 2023, the average recovered content of U.S. made aluminum cans was 71%, 53% of which was post-consumer scrap (largely from UBCs) and 18% of which was post-industrial scrap.[47] The energy savings are also considerable; the Aluminum Association estimates that recovered aluminum is approximately 95% less energy intensive to produce than new aluminum.[48] Survey responses provided limited information on willingness to pay for recovered material. However, one facility reported that recovered materials are sold at a discounted price compared to virgin materials, as the quality of virgin materials is better.

5.6.3 Strategies to Support Viability

All aluminum end markets surveyed and interviewed mentioned that they generally purchase aluminum based on ISRI Specifications.[49] As previously mentioned, all aluminum end markets surveyed purchase UBC aluminum material grades in which materials covered under the Act are not the target. However, they all accept some non-UBC aluminum within their UBC material grades, with one end market facility reporting that they have accepted up to 25% non-UBC aluminum in a UBC aluminum material grade. While the non-UBC aluminum material is still recovered at end market facilities, end markets purchase material grades with higher non-UBC aluminum content at a discounted price compared to UBC aluminum grades that are free from non-UBC aluminum.

The aluminum end market facilities interviewed reported that, typically, aluminum UBC material grades coming from California are free from contaminants that could not be used in their recycling processes; therefore, they rarely need to use strategies or technologies for removing contamination.

6.0 Glass and Ceramics

6.1 Introduction

For the purposes of this work, glass end markets are defined as beneficiation plants that produce products, such as cullet (see Glossary). Glass can be recycled indefinitely, and approximately 95% of post-consumer glass can be a substitute for virgin materials.[50] This means that increasing the volume of post-consumer glass used in manufacturing can help reduce the need for virgin materials and the carbon emissions associated with their extraction.

Ceramic end markets are entities that return ceramic material to the marketplace. No specific end markets for ceramics were identified. Any ceramics in the recycling stream are most likely to be received by glass end markets. Thus, although ceramics are a separate material class, this assessment evaluates them with glass.

The end of life management for glass has various routes. Glass sent for recovery is usually converted into two types of material: fine grind glass or glass cullet. Fine grind glass is typically used to replace sand in various sand markets, such as in construction projects, and cullet is typically used in fiberglass or glass container manufacturing.

Converting glass into quality cullet or fine grind at end markets involves the following steps:

- Presorting: to remove large contaminants.
- Magnetic sorting: employed at the first stage of sortation to remove ferrous metals.
- Hand sorting: to remove hazardous contamination such as batteries, lighters, and ammunition.
- Air separation: to remove paper and dust.
- Optical/sensor sorting: to reject any remaining non-glass items and sort the reaming glass by color.
- Shaker tables: to separate glass materials into cullet and fine grind, by size.

The end of life management of ceramics involves crushing and grinding ceramic materials into small particles for use as aggregate materials in construction.

6.2 Method and Survey Responses

This section provides additional information on the survey responses received from glass end market facilities and additional strategies to produce report outputs.

In total, seven plants were identified that manage glass covered material from California. All seven are located in California.

The contractor sent a survey to all seven facilities and received survey responses from all of them. Six of these responses were only partially complete, but they still included

key information used in the analysis. Appendix E provides more details on the survey responses.

All seven of the end market facilities were operational in 2024 and provided feedstock data in the surveys, with one facility providing both feedstock data and output data. Output data for the remaining six were identified in RDRS data. Export data from WISERTrade were also used to understand the volume of material exported internationally.

The contractor developed a list of common material grades used by glass end markets. These were included in the survey, and facilities reported tonnages by these material grades – for example, Material Recovery Facility derived 3 Color Mixed Container Glass (recycling processing facility glass). As previously mentioned, material categories in RDRS did not align with the project material grades; therefore, the contractor mapped RDRS material to project survey grades. Appendix E provides more information on how the RDRS grades were mapped to survey grades. Survey responses and composition estimates from the SB 343 Report[51] were used to estimate the CMC end market groups within each material grade.

6.3 Glass End Markets

Glass is a common packaging material, used to produce bottles, jars, and vials by multiple industries, including sectors covering food and beverages, pharmaceuticals, cosmetic and personal care, and household and cleaning products. It is widely used in packaging applications due to its durability, impermeability, and inert chemical properties.

This section of the report summarizes the modelled outputs related to the recovery of glass material at end markets both in and outside California. In 2024, seven end market facilities recovered glass in California. Only a small percentage of glass was exported to international end markets. Five of the Californian end market facilities are owned by Sibelco (Strategic Materials Inc), with the other two owned by Potential Industries Inc and Halo Glass Recycling. CRV glass is a large share of the overall glass material sent for recycling in California and managed by the same plants as glass packaging covered under the Act. CRV glass is included in this analysis and segregated where relevant.

6.3.1 Acceptance of Covered Materials

Glass is typically sorted and sent to end markets based on five different material grades:

- Material Recovery Facility derived 3 Color Mixed Container Glass (recycling processing facility glass), collected through curbside and drop off programs and processed at recycling processing facilities.
- Redemption Center 3 Color Mixed Container Glass, collected through the redemption centers for beverage containers subject to BCRP.
- Unprocessed Green Container Glass Cullet, commonly collected pre-consumer as breakage at manufacturing facilities; it is assumed, for this report, that it is not covered under the Act.

- Unprocessed Amber Container Glass Cullet, commonly collected pre-consumer as breakage at manufacturing facilities; it is assumed, for this report, that it is not covered under the Act.
- Unprocessed Clear/Flint Container Glass Cullet, commonly collected pre-consumer as breakage at manufacturing facilities; it is assumed, for this report, that it is not covered under the Act.

Table 6-1 summarizes the estimated weight of glass material grades (including covered and noncovered material) that enter end markets as feedstock in and outside California. Together, they make up approximately 762,000 tons. These material grades include covered glass material, noncovered material (CRV glass), and contamination. Approximately 60%, by weight, of glass material being sent to end markets is recycling processing facility glass, with approximately 99% of this sent to end markets in California and 1% exported to end markets outside the U.S. Approximately 17% of the total glass material accepted by end markets is collected and managed through California's BCRP (Redemption Center 3 Color Mixed Container Glass), with 100% of that portion staying in California for recovery. This includes approximately 1.9 billion glass beverage containers.[52] Unprocessed Green, Amber, and Clear/Flint Container Glass Cullet, commonly collected for pre-consumer use as breakage at manufacturing facilities, made up the remaining 23% of glass material accepted by end markets in California in 2024.

Table 6-1: Glass Material Grades Accepted by or Sent to End Markets in 2024 (tons)

Material Grade	Accepted by End Markets in CA	Exported Domestically	Exported Internationally	Total
Material Recovery Facility Derived 3 Color Mixed Container Glass	454,800	None identified	2,350	**457,150**
Redemption Center 3 Color Mixed Container Glass	131,000	None identified	None identified	**131,000**
Unprocessed Green Container Glass Cullet	43,080	None identified	None identified	**43,080**

Material Grade	Accepted by End Markets in CA	Exported Domestically	Exported Internationally	Total
Unprocessed Amber Container Glass Cullet	43,800	None identified	None identified	**43,800**
Unprocessed Clear/Flint Container Glass Cullet	87,100	None identified	None identified	**87,100**
Total	**759,780**	None identified	**2,350**	**762,130**

Table 6-2 summarizes the glass CMC end market groups and glass CRV material typically targeted by glass end markets.

Table 6-2: Glass CMC End Market Groups and CRV Material Accepted at Glass End Markets

CMC End Market Groups and CRV	Acceptability
Mixed Glass Bottles and Jars – CRV	Always target material and recovered by end market.
Mixed Glass Bottles and Jars – Non-CRV	Always target material and recovered by end market.
Other Forms of Glass	Always target material and recovered by end market.
Small Format – Glass	Always target material and recovered by end market.

Of the different material grades, Redemption Center 3 Color Mixed Container Glass is the highest quality for glass recyclers, as it comprises approximately 54% glass bottles and jars that are returned through redemption centers and the material grade is less contaminated than other glass material grades. Although this grade is from redemption centers, it still includes approximately 1% of glass covered under the Act. Recycling processing facility glass contains approximately 11% mixed glass bottles and jars that are covered by the BCRP and 46% comprising other glass covered by the Act. Approximately 76% of Unprocessed Green Container Glass, 27% of Unprocessed Amber Container Glass, and 38% of Unprocessed Clear/Flint Container Glass is covered material.

Approximately 762,000 tons of glass material grades from California are sent to end markets globally, but only a portion of those grades are covered material (223,300 tons). Table 6-3 summarizes the weight of glass CMC end market groups accepted by end markets both in and outside California. All glass CMC end market groups were

grouped together for this analysis, as glass that enters end markets is typically broken down into smaller fragments, making it difficult for end markets to identify their original format.

Table 6-3: Glass CMC End Market Group Accepted by or Sent to Glass End Markets in 2024 (tons)

CMC End Market Group	Accepted by End Markets in California	Exported Domestically	Exported Internationally	Total
All Glass CMC end market groups	222,300	None identified	1,000	**223,300**

6.3.1.1 Covered Material Exports

According to WISERTrade data, approximately 1,000 tons of glass, representing less than 1% of the total glass material, was exported to end markets outside California and the U.S., with 33% of these exported to Mexico and the remaining 67% being seaborne exports to Asia. There were no domestic exports from California in 2024. Of the 2,400 tons exported internationally, only approximately 1,000 tons were estimated to be covered material.

Figure 6-1 shows how the exports of glass material have fluctuated since 2014, rarely reaching over 3,000 tons except for in 2023, which saw a spike in exports to Mexico. The top four countries that received glass material were South Korea, Japan, China, and Mexico. The contractor was unable to verify how this material was managed by international end markets.

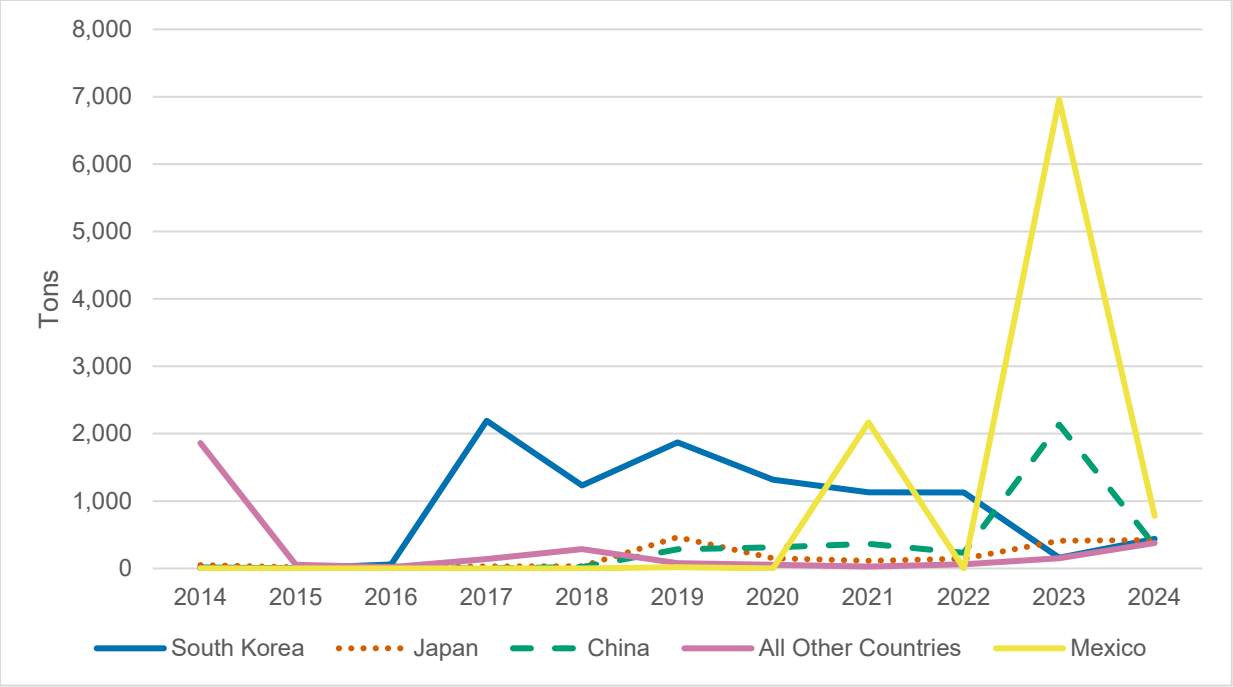

Figure 6-1: Glass Seaborne and Mexico Export from California from 2014-2024 (tons)

6.3.2 Contamination

6.3.2.1 Types of Contamination and Weight Derived

All seven facilities provided information on contamination. They reported contamination from missorted material in recycling processing facility glass, including ceramics, stone, porcelain, glass food storage containers, mirrors, shredded paper, plastic, small format packaging, batteries, and textiles/clothing. They also reported some forms of contamination based on the design of glass packaging, including labels, caps, and metal foil closures.

One facility mentioned that foil coatings on glass bottles were a particularly difficult contaminant to manage. They explained that metal foil is difficult to remove from glass and that their metal detection system ejects glass with metalized labels, which results in a lower capture rate.

Another facility mentioned that they crush ceramic, stone, and porcelain material they receive and have been storing this crushed material for potential future sales to the construction industry. Other end markets mentioned that ceramic materials are sent for landfill, but that they recover all other nontarget material they can capture.

Table 6-4 summarizes the weight of contamination that enters glass end markets from CMC end market groups, in addition to all other contamination, in all glass material grades and whether this material is disposed of or sorted and sent to another facility. Material may be sorted or disposed of depending on the facility and quantity of material. Noncovered material (labelled other contaminants) makes up the largest share of

contamination, followed by small format paper, mixed paper, and all other wood and organics.

Table 6-4: Estimated Weight of Contamination Which Were Accepted by or Sent to Glass End Markets in 2024

CMC End Market and CRV	Tons per year	Sorted or Disposed
Ceramic*	21,300	Sorted or Disposed of
Aluminum Containers - Non-CRV	500	Sorted or Disposed of
Other Aluminum	300	Sorted or Disposed of
Other Nonferrous	400	Sorted or Disposed of
Tin/Steel/Bimetal - Non-CRV	2,200	Sorted or Disposed of
Small Format - Metal	400	Sorted or Disposed of
Kraft Paper	3,600	Sorted or Disposed of
Aseptic Cartons	100	Sorted or Disposed of
Gable-Top Cartons	100	Sorted or Disposed of
Paperboard	2,800	Sorted or Disposed of
OCC	3,100	Sorted or Disposed of
Mixed Papers	30,500	Sorted or Disposed of
Molded Pulp	400	Sorted or Disposed of
Small Format - Paper	30,300	Sorted or Disposed of
Plastic #1 - Other PET Rigid	200	Sorted or Disposed of
Plastic #2 - Other HDPE Rigid	600	Sorted or Disposed of
Plastic #5 - PP Rigid Items	1,800	Sorted or Disposed of
Plastic #6 - Other PS	100	Sorted or Disposed of
Plastic #6 - PS Rigid Items	1,000	Sorted or Disposed of
Plastic #7 - Other Rigid Plastics	200	Sorted or Disposed of
Small Format - Plastics	8,700	Sorted or Disposed of
Plastic #6 - EPS Rigid Items	300	Sorted or Disposed of
Plastic - #7 Other Flexible and Films	5,600	Sorted or Disposed of
Wood - Treated	900	Sorted or Disposed of

CMC End Market and CRV	Tons per year	Sorted or Disposed
All Other Wood and Organics	21,800	Sorted or Disposed of
Other Contaminants (noncovered material)§	130,200	Sorted or Disposed of

**Ceramic figures shown are for all ceramic material and not just CMC ceramic material*

6.3.2.2 Systems to Monitor Contamination

All seven survey respondents reported the technologies they use to remove contamination at their facility. These are summarized in Table 6-5.

Table 6-5: Technologies Used to Remove Contamination at Glass End Markets

Technology	Contaminant Removed
Trommel screen	Large contaminants
Magnets and eddy currents	Ferrous and nonferrous metals
Hard sorting	Hazardous materials
Air separation	Paper and dust
Vacuum	Labels and caps

6.3.3 Recovery of Covered Material

Based on the CMC end market groups accepted by or sent to end markets, Table 6-6 shows the estimated share of material that is recovered or not. Overall, the conversion rate for glass CMC end market groups is approximately 97%.

All seven end market facilities in California produce cullet, which is sold to glass containers or fiberglass insulation manufacturers. Some glass material that does not meet cullet quality standards is sold as aggregate to the construction industry or is used in applications such as sand blasting or as sand in bunkers.

The CMC conversion rate presented in Table 6-6 is for CMC end market groups only. These tonnage feedstocks have already considered losses and removed contamination arising from other covered and noncovered materials. Of the final material produced, six end markets commented that the quality of their output material is of high quality but still contains contaminants that virgin materials do not.

§ Includes Aluminum Containers – CRV and Tin/Steel/Bimetal – CRV.

Table 6-6: Glass CMC End Market Groups Recovered by End Markets in 2024

CMC End Market Group	Weight Accepted by or Sent to End Markets, Excluding Contamination	Recovered Material Produced	CMC End Market Groups Accepted by or Sent to End Markets but not Recovered	Estimated CMC Conversion Rate (%)
All Glass CMC end market groups	223,300	216,600	6,700	97%

6.4 Cost and Markets Related to Glass End Markets

6.4.1 Cost of Glass End Markets

Two glass end markets' survey responses provided information on their facilities' funding sources. Both mentioned that their primary source of funding is the sale of glass cullet to glass container manufacturers. One of the two end market facilities also listed fiberglass manufacturers as a primary source of funding.

All seven end market facilities mentioned that demand for cullet in California is high. One noted that they cannot produce enough cullet to meet demand.

Despite high demand, only two end market facilities reported that they are operating at capacity. The remaining five reported that they operate at between 15% and 76% capacity. One end market facility mentioned that capacity could be increased by approximately 50,000 tons if it converted to whole bottle/redemption loads, assuming they could support the purchase price for this, because there is significantly less contamination in these loads. They also reported that a reduction of contamination in recycling processing facility glass loads by 20% could increase capacity by approximately 25,000 tons annually.

Five end market facilities also mentioned that improved redemption centers or redemption systems and the encouragement of domestic glass manufacturing could increase recovery capacities. One cited excess capacity in California for glass beneficiating processing as the reason their facility is not operating at capacity. Overall, glass end markets are operating below capacity because of both contamination in input material and over capacity in California end market facilities, so plants are competing for input material. If contamination were reduced, facilities would be able to dedicate more of their operations to processing target glass material rather than dealing with contamination.

CalRecycle's Recycled Glass Processing Incentive Grant Program is a significant funding source available to glass end market facilities in the state.[53] This program was announced in 2024 with the aim of increasing the use of glass cullet in the manufacture of new glass beverage containers in California. A minimum amount of $1 million and a

maximum of $4 million in funding is available to grantees, with two organizations awarded $2 million and $2.4 million respectively in March 2025. One end market facility reported that the program was a significant source of funding for them.

6.4.2 Factors That Affect End Market Viability

As reported by survey respondents, factors affecting glass end market viability for recovered cullet in California include the price of virgin material, the price of the recovered cullet, recovered material demand, recovered content requirements in the state, and glass manufacturers' willingness to pay premiums for recovered material.

The cost of processing glass material at end markets ranges from approximately $50-90 per ton of input material but does not include transportation costs. These figures are based on confidential conversations with industry experts and are general to the U.S., not specific to California. Due to its weight, glass material does not typically travel very far for recovery. One end market facility reported that, on average, inbound glass material travels 70 miles to their facility.

The price of virgin materials used in the manufacturing of glass varies. Silica sand and soda ash, two of the key raw materials, are currently valued at approximately $54[54] and $241[55] per ton in the U.S. respectively. Silicia sand makes up the largest share of raw materials used in the production of glass (approximately 70%).

The average price for recovered cullet varies by color and type in the U.S. Clear/flint glass cullet has the highest average price per ton at $125, followed by amber and green glass cullet at $85-100 per ton and lastly fine grind glass cullet at $65-80 per ton; these prices do not include transportation costs. One glass end market facility reported that, on average, outbound glass cullet travels 10 miles to reach glass manufacturing facilities from their end market facility.

Demand for glass cullet is high in California due to state laws that require glass bottle manufacturers to use at least 35% recovered content[56] and fiberglass insulation manufacturers to include at least 30% recovered glass[57]. There are more than six glass containers and fiberglass manufacturers in California that must adhere to these requirements, including: Ardagh Glass, Owens Illinois, Gallo Glass, Johns Manville, and Owens Corning. Glass containers and fiberglass manufacturers in California have had to import glass from out of state to meet these requirements. In 2023, the average recovered content of glass containers in California was 41%, made up of CRV and non-CRV cullet produced in California and imported from out of state.

Overall, the viability of glass end markets in California is strong and should remain this way so long as demand from glass containers and fiberglass manufacturers persists. Recovered content requirements for fiberglass and glass containers manufacturers in California are keeping cullet demand high. Reducing contamination in glass material grades at recycling processing facilities could improve the quality of input material into end market facilities and increase the processing capacity of glass end market facilities.

6.4.3 Strategies to Support Viability

As previously mentioned, contamination, particularly for recycling processing facility glass, is an issue for glass end market facilities. To achieve higher quality, cullet end markets must employ sorting techniques and technologies to remove contamination from inbound glass loads and increase the viability of end markets. All seven end markets provided details on processes used at their end market facility to remove contamination. These include:

- Trommel presorting: to remove any large contamination material.
- Magnets and eddy currents: employed at the first stage of sortation to remove ferrous and nonferrous metals.
- Hand sorting: to remove any hazardous contamination such as batteries, lighters, and ammunition.
- Air separation: to remove paper and dust.
- Optical/sensor sorting: to reject any remaining non-glass items.
- Shaker tables: to separate remaining glass materials by size.
- Vacuums: to remove labels and caps.

A survey respondent suggested that improving sortation – by upgrading glass sortation equipment and monitoring cleanup systems at recycling processing facilities prior to end markets – could reduce the need for extensive sorting and in turn reduce material losses and increase CMC conversion rates.

6.5 Glass and Ceramic Covered Materials with Limited End Markets

Ceramic covered material is a CMC end market group that has limited end markets in California, domestically, and internationally.

Ceramic is an inorganic, nonmetallic material that is sometimes used as packaging for high end products such as liquors, food, and personal care products. Raw materials used in the production of ceramics include mined materials such as clays, feldspar, and quartz or silica. Ceramic packaging can be crushed into aggregate, which can be repurposed in construction projects.

No ceramic end market facilities were identified. RDRS data does not have a material grade associated with ceramics, and the WISERTrade data did not include ceramic material. Missorted ceramics frequently end up at glass end market facilities. One facility reported that they crush any ceramic material they receive and have been stockpiling it for potential future sale to the construction industry; however, they have not begun selling this material yet and they reported that ceramic material is still a contaminant at their plant. Other end markets reported that ceramic material received at their facility is landfilled.

Based on the contractor's modelling calculations described in Appendix A, approximately 21,200 tons of ceramics entered end markets in 2024, with almost all of

these tons entering glass end markets.[58] Note that this tonnage estimate is not limited to just ceramic covered material, as end markets cannot differentiate between covered and uncovered ceramic materials. Of the 21,200 tons estimate, approximately 6,050 tons were sent to the glass end market that reported stockpiling ceramic material for potential future sale. The remaining ceramic material was not recovered, meaning that the end markets accepted it as part of a different material grade type and then disposed of it as they identified it as contamination.

7.0 Wood and Other Organic Material

7.1 Introduction

7.1.1 Wood

Wood packaging encompasses single-use pallets, crates, and other structural wood elements used for containing, protecting, or transporting goods in addition to smaller wood packaging items, such as wooden lids and tea boxes.

Across different types of wood packaging, wood pallets make up a significant portion of this category and likely comprise the largest share by weight, due to their widespread use in shipping and logistics. Nationally, pallets are often reused and repaired; however, data is not available on the characteristics and circumstances of this reuse. Under the Act, wooden pallets may be considered reuseable, and therefore not covered material, if the requirements of PRC section 42041(af) are met.

It is assumed that wooden pallets used for residential purposes are less likely to be reused compared to their counterparts that are used commercially for shipping and logistics. As sector specific recycling flow data are not available, the 2021 Disposal Facility Based Waste Characterization is used as a proxy to understand the relative breakdown of residential and commercial wood packaging entering the recycling stream. The 2021 waste characterization study found that approximately 1.2% of clean pallets and crates disposed of were attributed to the franchised residential sector (4,181 tons) compared to the franchised commercial sector (355,674 tons).

For the purposes of the material characterization study, it was not possible to differentiate between single-use and reused wooden pallets because that determination requires case-by-case consideration of facts outside the material characterization context. Due to this limitation, all wooden pallets were included in the analysis; given the study only considered wooden pallets that had been disposed of and could not possibly have been destined for additional uses.

Compared to untreated wood, treated or painted wood is not an acceptable material for recycling as it cannot be chipped, ground, or mulched.[59]

Depending on the condition of the material, wood packaging can follow different end of life pathways:

- **Repaired and reused,** a common practice in the U.S. pallet industry, where pallets are collected, repaired, and returned to circulation for reuse.
- **Disassembled for parts,** where usable components are salvaged to remanufacture pallets.
- **Chipped or ground** into wood chips or similar products, which are then supplied to downstream users, such as landscapers and manufacturers, for use in lieu of virgin material.
- **Accepted as feedstock at composting facilities:** where clean, untreated wood packaging may be processed alongside other organics to produce soil amendments.

7.1.2 Other Organic Material

Other organic material covered by the Act includes packaging made from nonsynthetic textiles such as cotton or hemp and other packaging made from organic material such as mushroom, coconut, or bamboo. No end markets were identified for these covered materials.

7.2 Method and Survey Responses

The information on end markets accepting wood covered material was collected using two surveys: the Wood End Markets Survey for those other than composting and in-vessel digestion (described in Section 7.2.1); and the Organics Materials End Markets Survey for composting and in-vessel digestion facilities (described in Section 8). Based on CalRecycle's discussions with organics processing facilities, it was assumed that all untreated wood covered material accepted by composting and in-vessel digestion facilities was chipped and ground and not integrated into the composting or in-vessel digestion process.

7.2.1 Wood End Markets Outreach and Survey

This section provides additional information on the outreach and survey responses received from wood packaging end market facilities through the Wood End Markets Survey.

Through secondary research, an initial list of 19 end market facilities in California were identified as potential wood end markets (Appendix F provides a list of plants). Outreach to the California facilities to verify that they met the definition of an end market did not produce any responses. To address this, the contractor engaged with two wood industry associations, the National Wooden Pallet and Container Association (NWPCA) and the Western Pallet Association (WPA), to help identify end market facilities that met the definition. While the industry associations were not able to confirm which members were end markets nor share their member lists, they agreed to distribute the project survey through emails and newsletters, which included a self-identification question regarding end market eligibility.

At the start of the survey, the self-identification question gave the definition of a wood end market and asked the respondent to confirm whether they met the definition before proceeding with the survey. The contractor received four responses: two end market facilities indicated that they did not meet the wood end market definition, while the other two submitted incomplete responses. The total number of end market facilities that received the survey through the industry associations' outreach is unknown and hence the survey response rate was not calculated. The partial survey responses were taken into consideration in the end market facility material flow model that the contractor developed.

7.2.2 Other Organic Materials End Markets Outreach and Survey

The methods and findings from site visits and surveys of composting and in-vessel digestion facilities are presented in Section 8 and in the Current State of Processing report, where it relates to the processing of material.

7.3 Wood End Markets

This section of the report summarizes the outputs from survey responses and insights from supplementary secondary research.

7.3.1 Acceptance of Covered Materials

Untreated wood is accepted at composting and in-vessel digestion facilities but assumed to generally be chipped and ground and not incorporated into composting or in-vessel digestion processes. Table 7-1 summarizes the weight of untreated wood that composting and in-vessel digestion facilities accept. Overall, 80,700 tons of untreated wood were included in inbound facility feedstock.

Table 7-1: Wood and Other Organic Material Accepted by Organics End Markets for Chipping and Grinding in 2024 (tons)

CMC End Market Group	Weight Accepted by Organics End Markets	Recovered Material Produced	CMC Conversion Rate (%)
Wood – Untreated*	80,700	Unknown	Unknown

*Wooden pallets make up a significant portion of the wood – untreated CMC end market group and likely represent the largest share by weight due to their widespread use in shipping and logistics. Nationally, pallets are often reused and repaired; however, data is not available on the characteristics and circumstances of this reuse. Under the Act, individual wooden pallets may be considered reusable, and therefore not covered material, if the requirements of PRC section 42041(af) are met.

As previously mentioned, two partial survey responses from wood end markets other than composting and in-vessel digestion facilities were received, but only one of these provided tonnage and composition data. This end market facility reported receiving a total of 66,410 tons of pallets and 230 tons of crates. Appendix F provides further detail from this survey response. RDRS data indicated 923 tons of pallets under the category of construction/demolition/inert (CDI) debris for domestic export; however, the contractor was unable to verify if the receiving end market facilities met the criteria of

wood end markets as defined in this report. Additionally, RDRS excludes reuse, so pallets that are repaired, reused, and resold may be underreported. It should be noted these tonnages are material grades and not confirmed CMC end market groups.

7.3.1.1 Covered Material Exports

Available domestic export data from RDRS is discussed in the previous section. International export data for wood and other organic covered material were not available in the RDRS or WISERTrade datasets and, as a result, this section does not contain further analysis.

7.3.2 Contamination

7.3.2.1 Types of Contamination and Weight Derived

There is no standardized grading system for wood packaging in the U.S. wood end market facilities may classify materials based on characteristics such as treatment type (e.g., untreated or pressure-treated), surface condition (e.g., painted or stained), and contamination. However, some potential wood end market facilities may follow the UK Wood Recyclers Association (WRA) grades of waste wood or have their own grading system for inbound material.[60] Pallets and crates that are contaminated, treated, or painted are less suitable for recycling and often disposed of in landfills. As reported by one end market facility, treated wood is considered unwanted or a contaminant in wooden pallets and crates bales; however, they did not provide further information on how they manage treated wood. No survey data were received regarding any other types of contamination managed at wood end market facilities.

Additional secondary research suggests that metal fasteners, such as nails, screws, or staples, are a common contaminant that must be removed during or after grinding into wood chips.[61,62] Other common contaminants may include paint or coatings and plastic, but not all end markets will accept wood with these contaminants.

One potential wood end market in San Jose, California specified on its website that it will accept clean wood with small amounts of metal, such as pallets with nails, but will not accept wood that contains plastic nor wood that is treated or stained.[63] Another potential wood end market in San Jose, California specified on its website that it will accept wood with nominal contamination such as plastics, painted lumber, and metals, but will not accept treated wood.[64]

For wood and other organic materials that organics end markets (such as composters and anaerobic digestion plants) receive, contaminants may include plastics designed for compostability and inert materials, such as glass.[65] While some inert contaminants may be processed into the final product, others that will adversely affect product quality (e.g., glass, metal, and plastic) will need to be removed before processing.[66,67]

7.3.2.2 Systems to Monitor Contamination

No survey data were received on systems used to monitor contamination at wood end market facilities. However, secondary research suggests that, since the most common contaminant is ferrous metal fasteners, end markets may use magnets to separate fragmented metal fasteners from wood chips.[68]

Pallets, crates, and other wood covered material may end up in construction and demolition (C&D) mulch feedstock. In this case, a visual inspection or visual load check is required to ensure that the physical contaminants in the feedstock are no greater than 1% of the total by weight.[69] According to California Code of Regulations Title 14, section 17383.3(c), a visual load check includes "both visual observation of incoming loads of feedstock and load sorting to quantify the percentage of contaminating materials" and a "minimum of 1% of daily incoming feedstock volume or at least one truckload per day, whichever is greater, shall be inspected visually."

7.3.3 Recovery of Covered Material

7.3.3.1 Wood End Markets

Of the two incomplete survey responses, one respondent provided tonnage information for inbound grades. For the wooden pallet grade, it received 52,460 tons per year of untreated wood and 13,950 tons per year of treated or painted wood, which is indicated as a contaminant in the grade. It is possible that the respondent included the tonnage of heat-treated wood within the "treated or painted wood" category, which does not involve chemical preservatives. For the wooden crates grade, it received 50 tons of untreated wood and 30 tons of treated or painted wood; the remainder was assumed to be other wood packaging and/or non-wood contamination. The respondent identified both other wood packaging and non-wood contamination as contaminants in the wooden crate grade, but the proportion of these materials was reported as unknown. Appendix F discusses this further. The end market facility did not report how it managed contaminants or nontarget materials within each grade. Since only one survey respondent provided partial information, the contractor was unable to obtain reliable estimates of contamination from the Wood End Market Survey. Due to the low number of survey responses, it is not possible to accurately estimate the proportion of untreated versus treated or painted wood from this survey data. In the U.S., the majority of broken or used pallets were repaired and sold rather than ground into wood chip.[70] Between 2016 and 2021, pallet repairs increased from 65% to 78%, which is the largest annual increase in three decades.[71] This increase may be attributed to rising pallet demand driven by the increase in e-commerce and potentially by a decline in pallet quality.[72] Additionally, lumber prices have increased during this period and repaired pallets may have been a more cost-effective alternative for distributors.[73] By comparison, the percentage of broken or used pallets that are ground or chipped decreased from 11% to 5% from 2016 to 2021.[74] This information is presented in Table 7-2.

Table 7-2: Secondary Research Findings on End Uses for Broken or Used Pallets in the United States (1993 – 2021)[75]

Year	Reused Without Repair (%)	Repaired (%)	Disassembled (%)	Ground or Chipped (%)	Landfilled (%)	Other (%)
1993	13	61	15	8	0	2
1995	10	63	18	8	1	1
1999	8	70	16	5	1	<1
2006	10	67	16	6	<1	1
2011	11	69	16	3	<1	<1
2016	5	65	18	11	<1	1
2021	5	78	11	5	<1	1

7.4 Covered Material Categories with Limited End Markets

Chemically treated or painted wood packaging has limited to no end markets. As defined by the California Department of Toxic Substances Control, treated wood refers to “wood that has gone through a treatment process with chemical preservatives to protect it against pests and environmental conditions.”[76] Certain treated pallets and crates may fall under this definition. Depending on the chemicals used, treated wood waste can potentially be hazardous; the relevant alternative management standards (AMS) that apply are statutes Health and Safety Code 25230 – 25230.18.[77] The AMS has prohibited treated wood waste, which may include chemically treated pallets and crates, from being burned, chipped, ground, or mulched.[78]

Appendix F, Table F-2 and Table F-3 summarizes the inbound tonnages and composition of inbound material grades from the one survey respondent who provided this information. Due to the limited data available, the estimated quantity of treated and painted wood that enters California end markets and how much is recovered is not known.

Additionally, no end markets were identified for the following two CMC end market groups: (1) all other textiles and (2) all other wood and organics. It was identified that limited end markets for the following CMC end market group exists, but a specific amount was unable to be identified: small format – wood and organics.

7.5 Cost and Markets Related to Wood and Other Organic Material End Markets

7.5.1 Cost of Wood End Markets

Survey responses did not provide cost information specific to wood end markets in California. However, typical costs for wood end markets may include capital expenditure

on specialized equipment and facility space necessary for operations.[79] Ongoing costs generally consist of labor, equipment maintenance, utilities, transportation, and contamination management.

While some wood end market facilities may generate revenue from the sale of wood chips into markets such as mulch, compost, and animal bedding, the primary revenue stream is likely through the sale of pallets and crates. Often wooden pallets and crates can be repaired, remanufactured, and/or reused;[80] wood end market facilities may generate revenue from these processes. Activities, such as grinding pallets and crates into wood chips, may be a byproduct of the end market's business operations and strategy. It is likely that grinding wood packaging into wood chips is a more economical option than disposing of it, allowing end markets to reduce disposal costs while potentially generating some additional revenue. Additional costs that may impact end market viability are discussed in the following sections.

7.5.2 Factors That Affect End Market Viability

Survey responses did not provide information on factors influencing the viability of wood end markets. While partial responses were received, none addressed this specific topic.

Secondary research suggests that the share of untreated wood and regulatory compliance are key factors that affect end market viability because chemically treated wood cannot be chipped, ground, or mulched under California's AMS.[81] Therefore, a higher untreated share directly raises usable yield and reduces costs for segregating and disposing treated wood. It is important to note that heat treatment of wood packaging does not use chemical preservatives and the majority of pallets in the industry are untreated, as confirmed with the NWPCA. Similarly, while there are no standardized grading systems for wood grades, the quality and condition of the wood can directly affect the final product value and overall marketability. End market facilities that process mixed wood debris may incur additional sorting and disposal costs.

In addition to the inbound material quality and condition, other broader challenges that influence the viability of wood end markets include logistics and transportation costs and fluctuations in demand.[82] Wood packaging such as pallets and crates are bulky, which can reduce load efficiency and increase transportation and storage costs. Additionally, end market facilities may face inefficiencies when handling nonstandard pallet sizes. Market conditions are also subject to fluctuations in demand for recovered wood products such as mulch and animal bedding, which can impact sales volumes and pricing stability.

7.5.3 Strategies to Support Viability

Survey responses did not provide information on strategies to support the viability of wood end markets. While partial responses were received, none addressed this specific topic. However, based on the previous discussion of factors that affect end market viability, end markets can potentially forge stronger upstream partnerships to ensure a consistent supply or greater share of untreated wood material and invest in equipment that improves the efficiency of contaminant removal.

Furthermore, regulations such as Short-Lived Climate Pollutant Reduction Strategy (SB 1383, Lara, 2016), which outline procurement targets for recovered organic waste products such as compost and mulch for cities and counties in California, can support the demand for wood chips derived from pallets and crates.

8.0 End Markets for Organic Material and Material Designed for Compostability

End markets for organic materials can provide diverse functions in the recovery of covered material. These end markets include composting or in-vessel digestion for the creation of compost, digestate, or biogas.

While inorganic material and plastics are typically processed at a recycling processing facility or similar facility before being sent to an end market, end markets for organic materials typically handle both the processing stage and end market stage at one location. Therefore, much of the information and analysis on acceptance, contamination, and technology at composting and in-vessel digestion plants is outlined in the Current State of Processing Report. This report on end markets focuses on the stage at which each relevant CMC end market group is accepted by an organics end market and integrated into their process for conversion into the plant's final product, including compost, digestate, or biogas.

For this analysis, the contractor received responses through interviews, surveys, and site visits from 21 end market facilities, including four anaerobic digestion facilities, 14 compost facilities, and three facilities that handle both compost and anaerobic digestion.

The data were insufficient to determine the export volumes of organic material and plastics designed for compostability.

8.1 Acceptance and Recovery Covered Material

8.1.1 Acceptance and Recovery of Plastics Designed for Compostability

There are two plastic CMC end market groups which are accepted by some organic end markets and included in this analysis; plastics and polymers designed for compostability – rigid items and plastics and polymers designed for compostability – flexibles and films. Table 8-1: summarizes the weight of plastics designed for compostability that are accepted by organics end markets and whether or not the material is removed or integrated into the organics conversion process. Approximately 26,300 tons of covered material plastics designed for compostability were included in inbound plant feedstock. It is estimated that more than 90% of this material is removed and disposed of, resulting in 10% or less (2,630 tons or fewer) of this material entering the organics conversion process,[**] though many facilities noted that they screen out all plastic materials, regardless of whether they were designed for compostability.

[**] This 10% refers to an assumed recovery level, based on survey responses and the Contract team's experience working at organics sites in California. Additional information can be found in the Current State of Processing Report, Table 3-25 (Covered Material Quantities for Select CMC Processing Groups at OPFs).

Table 8-1: Plastics Designed for Compostability Accepted by or Sent to Organics End Markets in 2024 (tons)

CMC End Market Group	Accepted by or Sent to Organics End Markets	Maximum Weight Integrated into Organics Recovery Process	Minimum Weight Screened Out
Plastics and Polymers Designed for Compostability – - Rigid Items	25,100	2,510	22,590
Plastics and Polymers Designed for Compostability – - Flexibles and Films	1,200	120	1,080
Total	**26,300**	**2,630**	**23,670**

8.1.2 Acceptance and Recovery of Paper and Fiber

Uncoated paper and fiber materials are commonly accepted at organics end market facilities and can be incorporated into finished compost products, as supported by the Composter Survey conducted by CalRecycle in 2023.[83] Paper and fiber items that are not integrated into organics recovery processes include paper that is coated in a plastic material that will not break down in the composting process.[84] Some end market facilities noted that they screen out much of this material, especially if it cannot be distinguished as compostable or contains plastic.

Table 8-2 summarizes the weight that organics end markets are sent and whether or not the material is removed or integrated into the organics conversion process. Overall, 206,400 tons of paper and fiber were included in inbound facility feedstock. An estimated 30% of this material (61,920 tons) is assumed to be integrated into the organics process.[††]

[††] This 30% refers to an assumed recovery level, based on survey responses and the project team's experience working at organics sites in California. Additional information can be found in the Current State of Processing Report, Table 3-25 (Covered Material Quantities for Select CMC Processing Groups at OPFs).

Table 8-2: Paper and Fiber Accepted by or Sent to Organics End Markets in 2024 (tons)

CMC End Market Group	Weight Accepted by or Sent to Organics End Markets	Weight Integrated into Organics Recovery Process	Weight Screened out
OCC	77,400	23,220	54,180
Mixed Papers	73,600	22,080	51,520
Kraft Paper	13,400	4,020	9,380
Molded Pulp	42,000	12,600	29,400
Total	**206,400**	**61,920**	**144,480**

8.1.3 Acceptance and Recovery of Wood and Other Organic Materials

Wood covered material accepted by organics end markets was assumed to not go through the composting or in-vessel digestion process. See Section 7.0 for more information about wood covered material.

8.1.4 Acceptance and Recovery of Other Covered Material

Other covered material enters organic end markets, but much of this is screened out as contamination. Other organic packaging such as packaging made from coconuts or mushrooms typically is not identified in composition studies. Therefore, no estimates were available of the quantity of other organic packaging that enters composting and anaerobic digestion end markets. Regarding small format wood and organics (e.g., small pieces of wood), of the 15 survey respondents that manage this material, 11 of them reported that they accept and incorporate it into the finished product. However, the specific amounts of small format wood and organics that are processed and incorporated into the finished product were unable to be identified because the quantity integrated into the organics recovery process was estimated using the 2023/2024 Alameda County Waste Characterization Study, which did not include small format wood and organics as a distinct category. Further information can be found in the Current State of Processing Report.

8.2 Contamination at Organics End Markets

The covered materials identified in Section 8.1 are either designed for compostability or based on their characteristics, can be integrated into an organics recycling process. As shown in Table 8-1: and Table 8-2, a majority of this material is screened out. In addition to the material identified in these tables, all other covered materials (e.g., metal, glass) sent to organics end markets are screened out.

There are several reasons why organics end market facilities remove the vast majority of covered materials. Certification and listing programs such as the Organic Materials Review Institute (OMRI) and California's Organic Input Material (OIM) program, administered by the California Department of Food and Agriculture, play a critical role in

signaling compost quality. OMRI serves as a third-party verifier for inputs compliant with USDA National Organic Program (NOP) standards. To be OMRI Listed®, compost must be produced using allowable feedstocks and approved processes. While many compost buyers are not certified organic growers, OMRI listing is widely recognized as a mark of quality and feedstock transparency across both organic and conventional markets. Agriculture is the largest end user for finished compost in the U.S. According to a 2019 study prepared on behalf of CalRecycle,[85] a significant share of compost is applied to farms, ranging from row crops and vineyards to orchards and specialty operations. These applications rely on compost to improve soil structure, water retention, and organic matter. They also have a very low tolerance for physical contaminants, particularly plastics, which can damage equipment, harm plant health, and reduce overall product confidence.[86]

Organics end market facilities consistently report that covered material, especially food packaging, has a significant impact on the quality of their finished compost. Despite being labeled as “compostable,” many products, including plastics designed for compostability and food-soiled paper products, do not biodegrade within the typical 50- to 90-day processing windows used by most composting operations, according to end markets. This incomplete breakdown leads to visible fragments as well as smaller invisible microplastics and potential unseen chemical contaminants that remain in the final compost product.

Additionally, under current USDA National Organic Program regulations, plastics designed for compostability are not approved feedstocks for compost intended for organic use. Compost containing these materials cannot be OMRI Listed®, limiting its market access in organic agriculture and diminishing its value.

Contaminated compost undermines the fundamental benefits of composting. Plastic residues and other contaminants degrade soil health, disrupt beneficial microbial communities, and may introduce harmful substances to the food system.[87] Visible contamination also reduces marketability, weakens consumer trust, and slows the growth of compost markets.

With agriculture as the largest consumer of finished compost, maintaining feedstock purity and product quality is critical. OMRI listing remains a valuable marketing and quality assurance tool (even for conventional growers) and is only attainable through rigorous feedstock control and adherence to regulatory standards. Composters have expressed interest in only processing clean green waste and food scraps, which will result in a high quality, marketable product that can be sold for a high dollar value.

8.3 Cost and Markets Related to Organics End Markets

Detailed information on the cost of organics end markets is provided in Appendix E of the Current State of Processing Report, which also outlines the estimated capital costs, operating costs, commodity revenues, and tipping fee revenues of organics end markets. Fewer than 105,000 tons of covered material are estimated to be recovered at organic end markets; this is less than 34% of total material processed at these facilities. Therefore, after covered material is screened out, the costs associated with managing covered materials are a small share of total operating costs.

Organic end markets that accept covered material and integrate it into their end product may incur additional operating costs as they need to monitor their compost to ensure that the covered material is effectively composted and does not diminish the quality of the end product.

A pilot project currently underway by the contractor is examining the operational impacts of compost sites accepting poly-coated paper designed for compostability. Preliminary findings suggest that these covered materials tend to migrate to the edges of compost windrows and accumulate. These nuisance conditions require additional labor to manage. Specifically, covered materials require additional mixing to incorporate them back into the windrows and, if blown away by winds, they require labor to pick up blown debris from the compost site. Blown debris tends to impact compost sites' neighbors, which makes the siting and management of compost facilities challenging. These additional requirements may increase costs for a plant to accept covered material.

9.0 Public Health, Environmental, Community, and Worker Impact from End Markets

Recycling and composting have benefits for the environment and the wider community, but there are potential impacts to the environment, workers, and local communities from end market facilities and processes. This section reviews these impacts and how end markets in California are managing them.

9.1 Public Health and Environmental Impact

End market facilities have the potential to create negative externalities for the environment and public health. These adverse impacts arise through the transportation of materials, the technologies employed on-site, and the pollutants and hazardous waste released. No on-site inspections were conducted to verify if these impacts occur at California facilities, but instead potential impacts were identified based on studies in other jurisdictions. Furthermore, end markets must follow regulations both at the national and the state level to mitigate these impacts. These regulations are described within each section. End markets outside the U.S. may not have similar regulations in place, but these would vary by end market location.

9.1.1 Transportation Impacts

One pathway by which end markets affect public health and the environment is the transportation of feedstock material to the end market facilities and the outbound distribution of recovered products.

Medium and heavy-duty vehicles used to transport these materials are typically powered by diesel fuels and have higher emissions than passenger cars. However, California has regulations in place to manage and reduce the potential adverse environmental and public health impacts. For example, the Truck and Bus regulation requires all heavy-duty diesel-powered vehicles operating in California to have a 2010 or newer engine and emission systems to reduce toxic air contaminants (TACs) emissions, such as particulate matter and nitrogen oxide emissions, from their exhaust.[88] Beyond heavy-duty vehicle requirements, California's Low-Carbon Fuel Standard (LCFS) also aims to lower the lifecycle carbon intensity of transportation fuels, incentivizing cleaner alternatives.[89]

The characteristics of the material being transported also influence environmental impacts. For example, transporting high-density materials such as compost or glass can result in greater per-mile emissions, whereas transporting bulky materials such as wooden pallets or plastic film may result in inefficient load utilization, requiring more trips and leading to greater emissions per ton transported. The relationship between transportation-related impacts and material characteristics underscores the importance of using strategies such as sourcing materials locally, using rail travel where feasible, and optimizing routes and logistics. Additional measures reported by end market

facilities to reduce transportation-related environmental impacts are discussed in a subsequent section.

Responses from end market facilities stated that inbound feedstock typically travels 30-100 miles on average but outbound material travels longer, typically hundreds or thousands of miles. Facilities that are vertically integrated and recover feedstock and then use the recovered material to create a new product at the same location do not have related transportation emissions; however, transportation impacts may still occur when the finished product is sold and distributed.

9.1.2 Impacts from End Market Facility Operations

End market facilities can create pollution that affects the local environment and surrounding communities. Depending on the material, recycling activities may involve processes that have the potential to release air pollutants, contaminated wastewater, residues, and other by-products that can affect the local environment and communities. For example, plastic recycling processes can emit volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and nuisance odors.[90] In particular, the melting and powdering processes used to process plastic material could generate harmful and malodorous gas emissions that can adversely impact employees' health and that of nearby communities.[91]

Studies have also shown that pulp and paper mills, including paper and fiber end market facilities, emit air pollutants such as nitrogen oxides, sulfur oxides, lead, VOCs and carbon monoxide.[92] They can also emit other odorous compounds and toxic substances, such as lead, mercury, and polycyclic aromatic compounds.[93,94] Glass recycling requires furnaces that operate at very high temperatures and can also release hazardous pollutants in the form of nitrogen oxides, sulfur oxides from the refining agent and oil fuel (if used), and particulate matter from compounds volatilized from molten glass.[95] Nitrogen oxides, sulfur oxides, and particulate matter (PM2.5 and PM10) can be associated with respiratory illnesses.[96] These air pollutants can pose adverse environmental risks and contribute to negative health consequences for both employees of and local communities surrounding recycling operations for different materials.

Given the serious environmental and public health consequences, regulations are in place to manage and mitigate these risks. End market facilities therefore have to abide by these regulations and obtain the proper permits to continue operations. The U.S. Clean Air Act of 1970 (United States Code (USC) Title 42, Chapter 85) regulates air pollution from stationary and mobile sources and Title V of the Clean Air Act established a mandatory operating permit program for each state.[97] Major sources of air pollution, such as end markets with potential to emit significant amounts of air pollutants like VOCs, nitrogen oxide emissions, and particulate matter, are required to have a Title V permit. The U.S. EPA delegates authority to state and local air agencies, such as the California Air Resources Board and regional air districts, of which California has 35; each has specific rules for controlling air pollution to comply with state and federal laws.[98] End markets outside California may have different rules to comply with federal laws.

In addition to Clean Air Act permitting requirements, end market facilities with VOC emissions above certain thresholds are required to review for any new and modified sources of pollution under a New Source Review (NSR) or Prevention of Significant Deterioration (PSD). Existing end market facilities, depending on the location, may also be subject to Reasonably Available Control Technology (RACT) regulations.[99] Those that fail to comply with the Clean Air Act would face enforcement actions such as installing add-on controls and paying penalties.[100]

In addition to the aforementioned air pollutants, recycling processes can release microplastics and Per- and Polyfluoroalkyl Substances (PFAS) into the environment, which pose additional environmental and health risks. These are discussed further in the PFAS Contamination in End Markets Section. The potential impacts and relevant regulations put in place to manage the associated risks are discussed further in subsequent sections.

9.1.3 Mitigation Measures Reported by End Markets

End markets reported that they follow local and national regulatory requirements (described in the preceding sections) to mitigate their environmental impact. Through survey responses, end markets in California reported implementing additional measures aimed at reducing their environmental impact, including onsite and transportation processes. The contractor received responses to this survey question from plastic, glass, and paper and fiber end market facilities.

Plastic end markets reported measures such as aiming to recycle and sell products locally; recycling and manufacturing new packaging at the same facility to minimize transportation emissions; implementing onsite wastewater treatment; controlling spillage; and managing inbound loads of scrap material by offering contracts to local suppliers.

Glass end markets reported using rail travel for material transport where possible to reduce emissions. One glass end market facility also specified that it uses buggies to move materials on-site to reduce forklift use; stages incoming material near processing areas; leverages consolidation sites (similar to a “hub-and-spoke” model) to reduce the number of trucks on the road; uses rail travel where feasible; and requests sites (when safely possible) to break down whole bottle glass to minimize density on trucks and rail cars. This glass end market facility has also reported that it is working to co-locate a partner on-site to take ceramic, stone, and porcelain material to reduce trucking these materials.

One paper and fiber end market reported that the majority of its incoming material is sourced from within 30 miles and that it maintains a robust environmental management program. Another paper and fiber end market noted that its location helps to minimize transportation-related carbon impacts and that it incorporates recycled water into its operations.

9.1.4 Microplastics Generation in Plastics Recycling

The contractor received limited information on microplastics in California end markets from survey responses and engagement with other interested parties. This section

discusses the potential microplastic generation and release risks in recycling processes more broadly, outlining the possible environmental and health implications. This is intended to illustrate the potential impacts that may occur with respect to recycling processes and does not imply that these issues are presently occurring in California's end markets.

The most common plastic recycling process is mechanical recycling, which generally involves sorting, grinding, flaking, and washing plastic feedstock to produce pellets. An unintended consequence of this process is the generation of large amounts of microplastics, which accumulate in wastewater and sludge from plastic recycling end market facilities.[101,102] Factors such as polymer type and environmental exposure (some plastic recycling plants may use exterior storage compounds for waste plastics) can impact the generation of microplastics.[103] The microplastics found in the wastewater from the washing process are then discharged into the environment and may reach downstream waterbodies.

While California does not have direct wastewater regulations aimed specifically at limiting or mitigating microplastics in effluent, California has established wastewater permitting requirements under the broader Porter-Cologne Water Quality Control Act (California Water Code section 13000 et seq.). Under this act, plants that discharge industrial wastewater, which may include plastic end markets, are required to obtain Waste Discharge Requirements (WDRs) or National Pollutant Discharge Elimination System (NPDES) permits, depending on whether the discharge is to land, surface waters, or a municipal treatment system.[104,105,106] It is important to note that microplastics are not currently regulated as a specific pollutant in these permits. However, California has adopted other regulatory measures to manage microplastics exposure and pollution, such as the California Statewide Microplastics Strategy in 2022 and Health and Safety Code section 116376, related to microplastics in drinking water.[107,108]. Additionally, the Department of Toxic Substances Control is considering adding microplastics to its list of Candidate Chemicals under its Safer Consumer Products program that would require products containing them to be identified as Priority Products and manufacturers of such Priority Products to conduct an analysis exploring safer alternatives to the Candidate Chemical of concern.

9.1.5 PFAS Contamination in End Markets

Limited information was received on Per- and PFAS contamination in California end markets from survey responses and other engagement with interested parties. Therefore, this section discusses the potential PFAS contamination in recycling processes in general and the associated environmental and health risks and the regulations that California has put in place to manage these risks.

PFAS contamination in recycling streams is an emerging concern. For paper end markets, the EPA has identified PFAS-treated paper and paperboard products sent for recycling as a source of PFAS contamination in pulp, paper, and paperboard mills.[109] PFAS persist through recycling systems and can remain in the recycled outputs. While the pulp, paper, and paperboard industry has phased out the use of certain long-chain PFAS (e.g., perfluorooctanoic acid (PFOA) and perfluoro octane sulfonic acid (PFOS)), FDA-approved short-chain PFAS in food contact packaging may still be used in the

manufacture of pulp and paper products.[110] The PFAS present in paper products can therefore be transported within the recycling stream as non-intentionally added substance (NIAS) in recycled paper products.[111]

It should be noted that California AB 1200 (Ting, 2021) has prohibited, beginning January 1, 2023, the distribution and sale of any food packaging that contains regulated PFAS and would instead require the manufacturer to use the least toxic alternative replacement.[112] Additionally, California AB 347 (Ting, 2024) requires the Department of Toxic Substances Control to adopt the existing regulations to enforce the prohibitions on the use of PFAS on or before January 1, 2029 and to enforce and ensure compliance with the regulations on and after July 1, 2030.[113] The covered products within AB 347 include juvenile products, textile articles, and food packaging.[114]

A similar concern applies to recycled plastics. PFAS can be used in the production of polymers (e.g., fluoropolymers) and can persist at trace levels in plastic products, despite not being an intended component of final product.[115] When recycled, the PFAS can be carried into the recycling stream. The recycling process for plastics can result in accumulating hazardous chemicals, including PFAS, in the recovered plastics.[116] PFAS can be introduced during recycling processes as polymer processing agents (e.g., as extrusion aids).[117] This results in PFAS being present in recovered plastics. However, the enactment of AB 347 demonstrates California's efforts in managing PFAS use across consumer products and packaging, with direct implications for both environmental and public health.

PFAS are persistent in the environment and can be found in water, soil, air, and food.[118] As reported by the U.S. EPA, scientific studies have shown that exposure to PFAS may be associated with a range of adverse health outcomes, such as reproductive impacts (e.g., reduced fertility), developmental delays in children (e.g., low birth weight), increased risk of certain cancers, weakened immune system to fight infections, disruption of hormone regulation, increased cholesterol levels, and increased risk of obesity.[119] It should be noted that while these health effects have been observed in association with PFAS exposure, additional health impacts may be difficult to determine and the science continues to evolve as research is ongoing to understand the severity and risks.[120] A study conducted by the U.S. EPA assessing PFAS groundwater concentrations in 40 California counties – where at least 25% of the population's drinking water derived from groundwater – indicated an association between PFAS contaminated groundwater and chronic health conditions (e.g., hypertension, chronic kidney disease, and cataracts) among Medicare beneficiaries aged 65 and older.[121]

9.2 Worker Health and Safety Impacts

Recycling processes vary across end markets, but they generally require the use of heavy machinery and equipment, which can create health and safety risks for employees. The Department of Labor Occupational Safety and Health Administration (OSHA) states that "there are some hazards that are common across various types of recycling, such as traffic safety, moving machine parts, unexpected machine startup, lifting injuries, and slips, trips, and falls."[122] The severity of these risks may be influenced by several interrelated factors including, but not limited to: the complexity of the recycling processes; the technologies, equipment, and machinery used; the design

and composition of materials handled; and the adequacy of protective measures put in place to mitigate hazards.

The health and safety risks that workers in end market operations face are closely tied to the specific materials they handle, which in turn determines the recycling processes, technologies, and equipment needed. More complex recycling processes, such as those involving multiple stages of crushing, shredding, and sorting, can create additional points where workers may be exposed to hazards, especially if it requires manual sorting processes instead of machine-automated systems.

The technologies employed, such as high-temperature furnaces for glass recycling and mechanical shredders for plastic, wood, and metal recycling, can introduce risks ranging from microplastics exposures to burns and severe injuries. Additionally, equipment and machinery used in paper end markets, such as forklifts and balers, can expose workers to potentially fatal crushing hazards.[123]

The design and composition of materials also impact the severity of health and safety risks for workers because they differ in their physical and chemical properties. For example, OSHA has identified that common illnesses associated with metal recycling include poisoning (e.g., lead or cadmium poisoning) and respiratory conditions due to inhalation or contact with toxic agents.[124] As discussed in previous sections, PFAS exposures from recycling food contact paper packaging serves as another example illustrating how the design of a covered material can impact worker health and safety.

The adequacy of protective safety measures – such as regular safety training, provision and enforcement of appropriate PPE, effective hazard communication, and strong oversight through audits and site inspections – can influence whether these risks result in minor incidents or occupational health outcomes. For example, OSHA cited a glass recycling plant for failing to ensure that the employees sorting glass used appropriate hand protection, resulting in exposure to laceration hazards.[125]

In addition to following OSHA requirements and local laws, end markets reported several processes and procedures to support worker safety. These include:

- Conducting safety training every week.
- Having an in-house safety department and external consultant group to provide support.
- Tracking safety performance indicators.
- Having a dedicated Employee Health and Safety leader on-site.
- Debriefing with the team if incidents occur.
- Routine walks around the facility to address any safety concerns.

9.3 Community Impact

The contractor compiled information from the end market surveys and interviews, desktop research, engagement with regional and national trade associations (National Waste & Recycling Association 2025), results from the Community Recycling and

Composting Survey (Appendix F of the Current State of Processing Report), and introductory meetings and listening sessions with CBOs, EJ groups, and Tribes to evaluate environmental and public health impacts processing in California.

9.3.1 End Market Survey Responses

Survey responses from California end markets highlight a range of measures implemented to ensure the safety, health, and participation of the local community. End markets reported undertaking weekly safety training sessions, maintaining OSHA compliance programs, holding regular safety meetings, and providing personal protective equipment (PPE). One respondent also reported that they work closely with their municipal environmental department to ensure full compliance with regulations; this includes hosting site visits and reviewing applicable guidelines. Another respondent noted that community concerns are addressed promptly, with the view that protecting employee health and safety also extends to safeguarding the surrounding community. Similarly, a couple of respondents mentioned community engagement, such as encouraging the community to recycle more or listening and responding to feedback received from local communities.

One of the glass end market facilities reported keeping operations indoors to reduce impacts to local communities. Another glass end market facility provided a more detailed response, describing its operational practices designed to mitigate localized environmental impacts. These included leveraging water trucks to minimize dust, contracting groundskeepers to perform litter control, and installing slats in perimeter fencing to prevent trash and debris from leaving the site. This end market facility also installed netting near a recycling processing facility pre-processing areas and a second recycling processing facility processing bunker to further prevent paper and other lightweight materials being blown off-site or throughout the plant. These measures collectively demonstrate a concerted effort to minimize nuisance and pollution impacts, such as dust and litter, which can impact communities located near recycling operations.

Overall, the survey responses suggest that while end markets inevitably create localized impacts through their operations, they are focused on ensuring safety compliance while taking into consideration how they can reduce risks for the communities in which they operate.

9.3.2 End Market Location Analysis

To understand the potential impact of end markets on different communities, the contractor evaluated the locations of end markets in California. This analysis determined that end market facilities (see Figure 9-1) are primarily concentrated in the San Francisco Bay Area region, around Sacramento, and around Los Angeles. Figure 9-2 and Figure 9-3 provide additional detail on the location of end markets in specific areas, including the average household income of the census tract where the facility is located. Median household income is determined using 2023 American Community Survey U.S. Census data.

Figure 9-4, Figure 9-5, Figure 9-6, and Figure 9-7 use data from SB 535 List of Disadvantaged Communities Geodatabase (2024)[126] to identify these communities in relation to organics processing facility (OPF) locations and end market locations. GIS analysis shows that these census tracts within San Joaquin, Stanislaus and Kern counties are in the top 25th percentile of pollution burden and have the highest overlap with end market locations in the state, meaning end markets are located in areas with the highest pollution burden. Comparatively, the Bay Area region and city of Los Angeles have fewer end markets in disadvantaged communities.

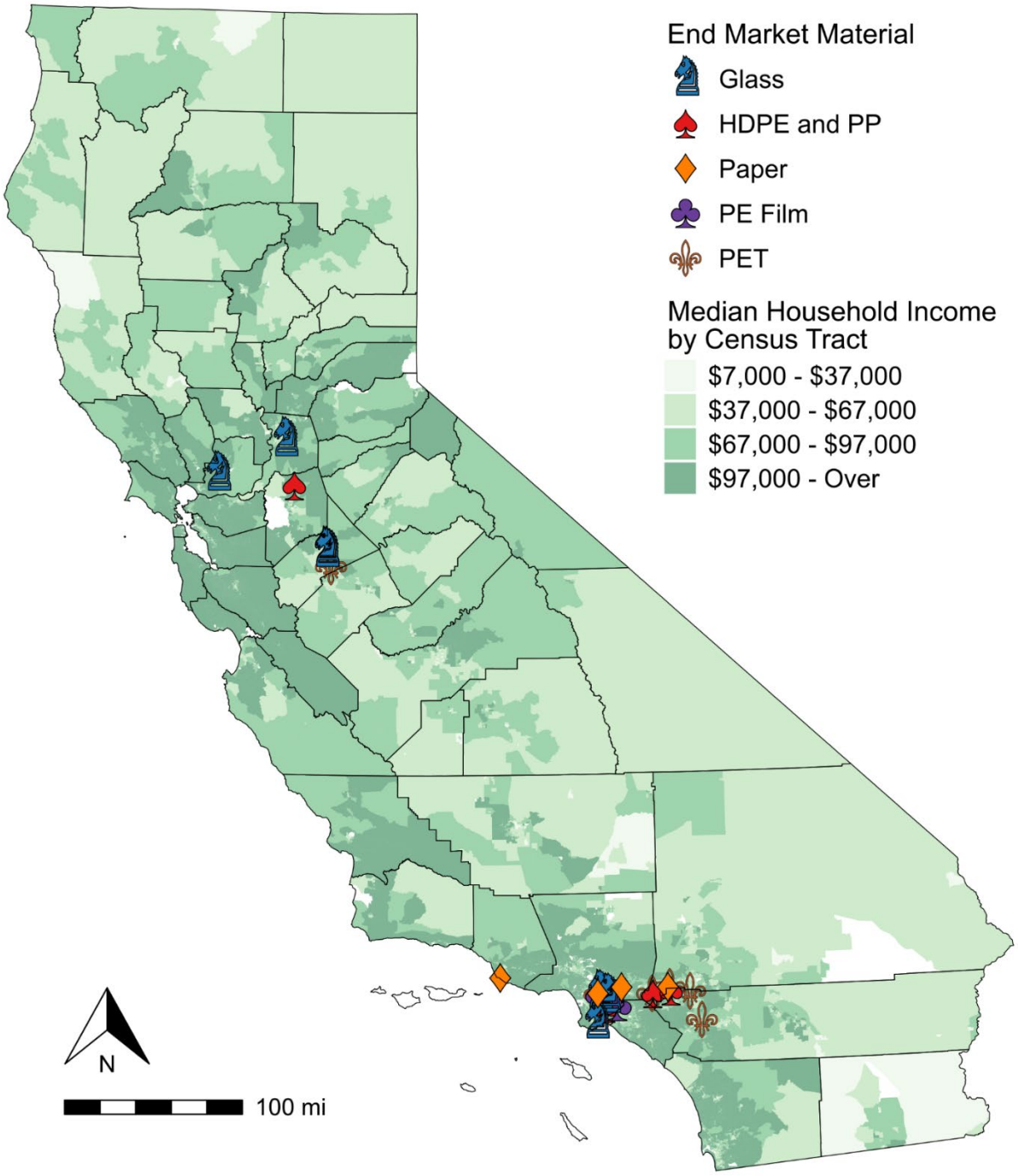

Figure 9-1: Location of End Markets in California

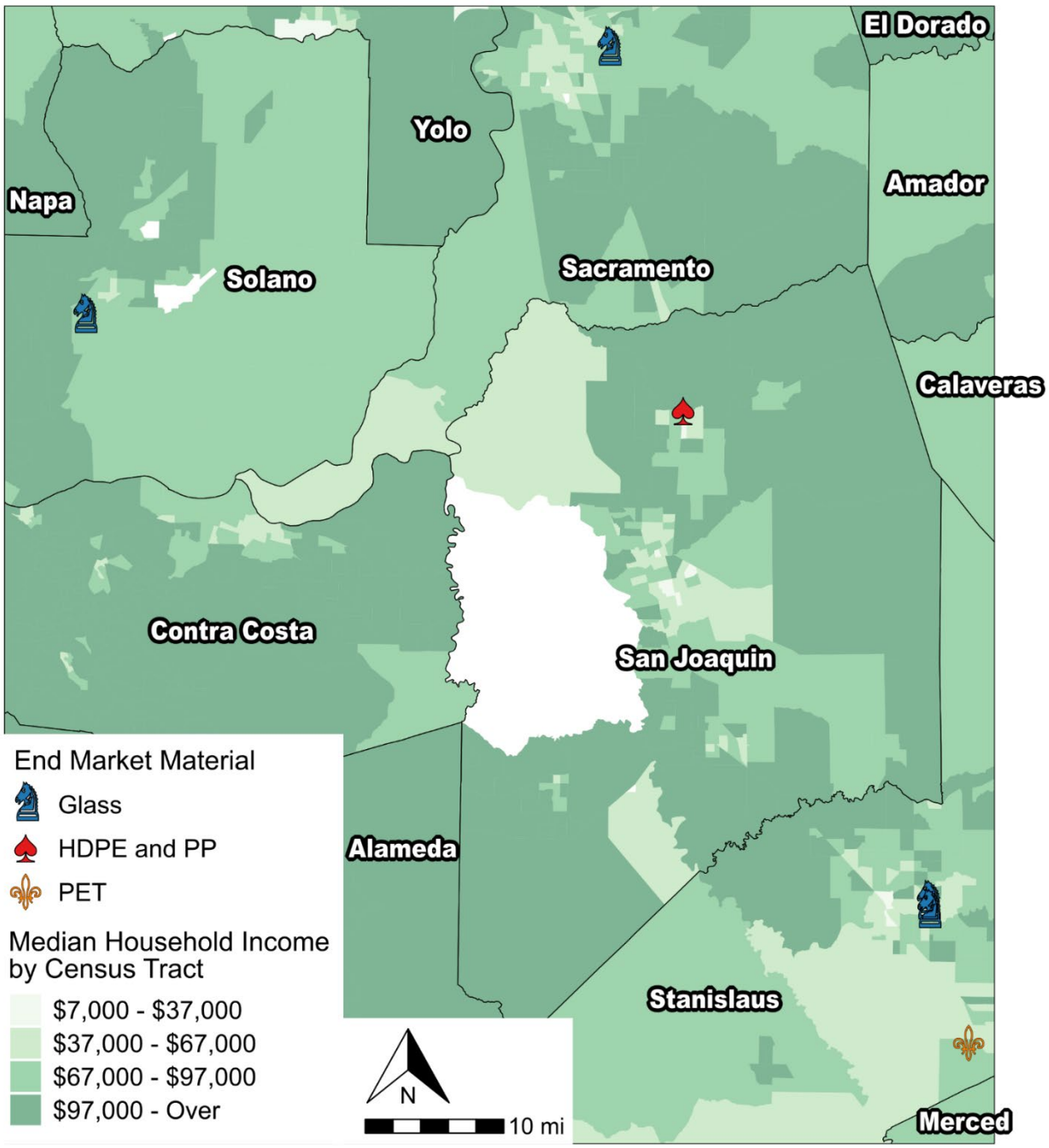

Figure 9-2: End Market Locations in Northern Central California

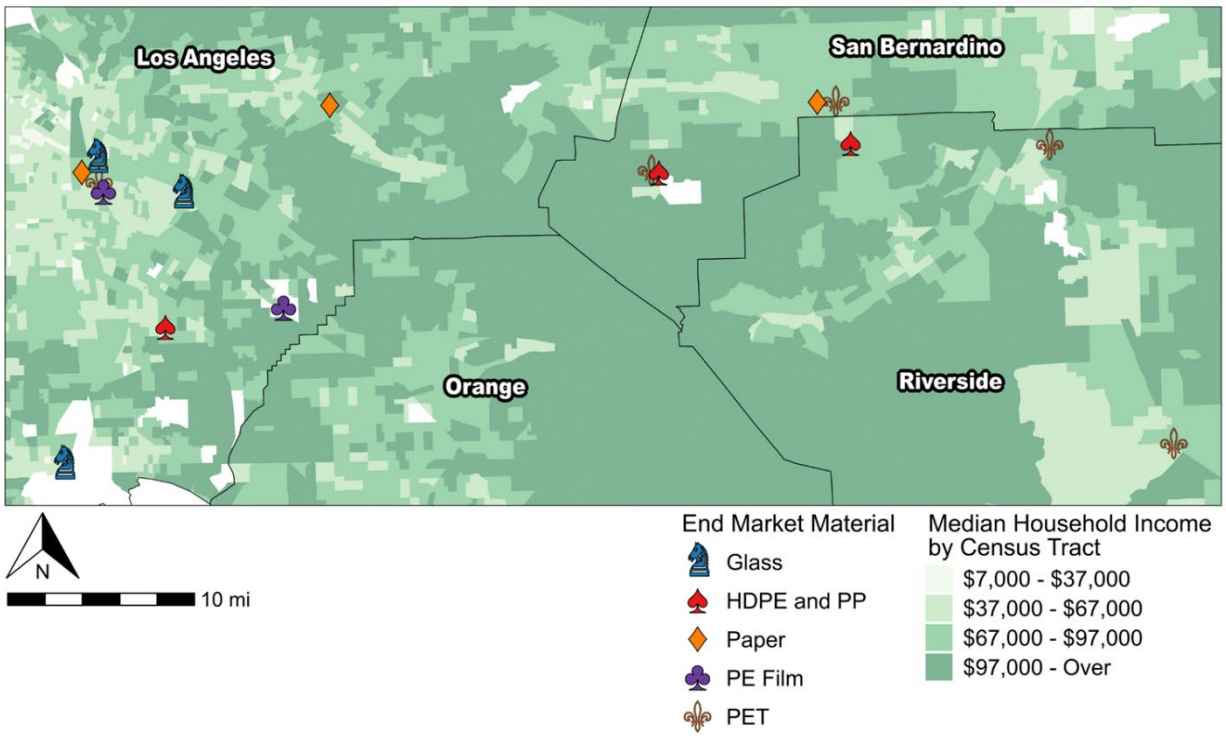

Figure 9-3: End Market Locations in Southern California

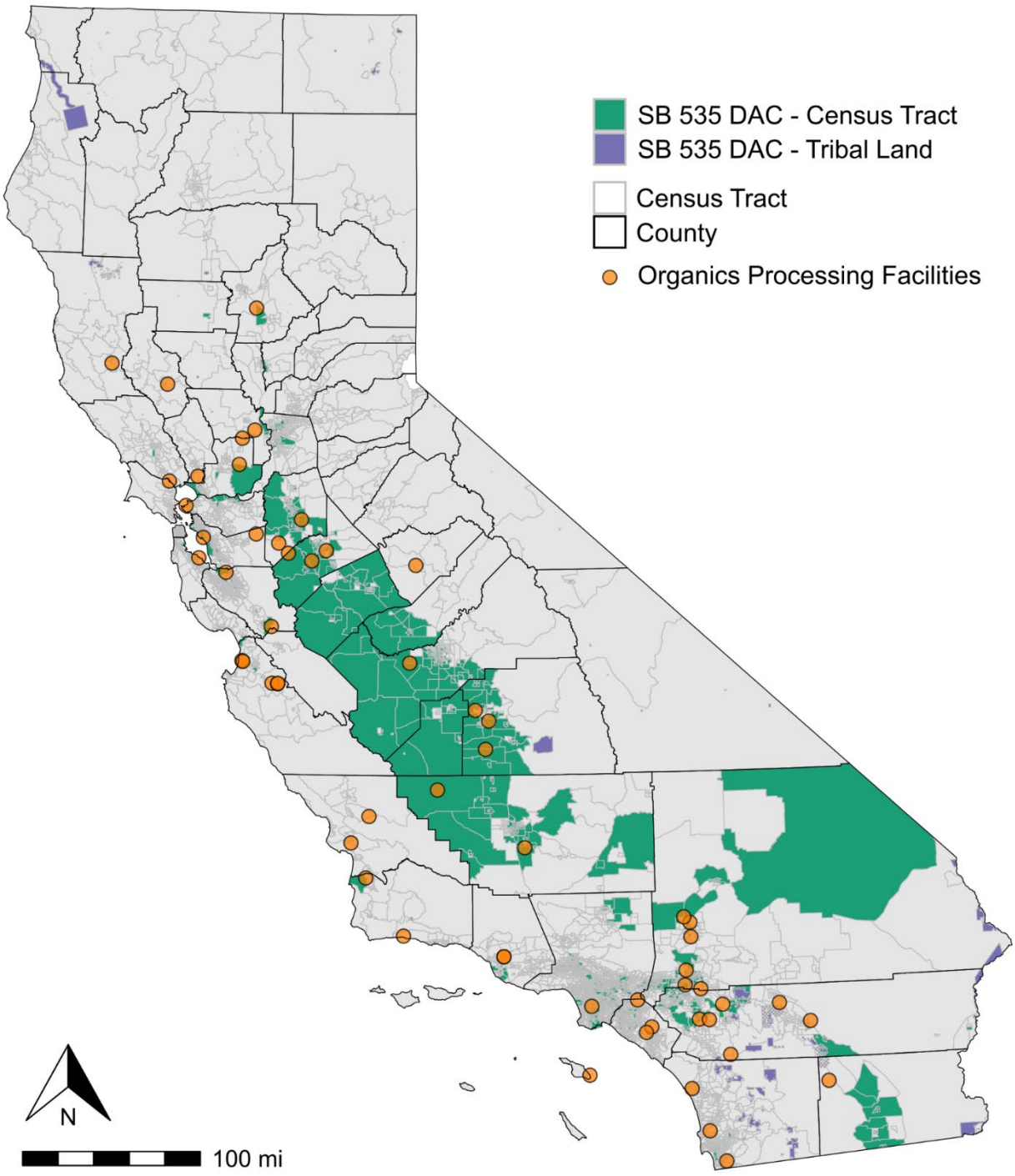

Figure 9-4: OPF Locations in Relation to SB 535 Disadvantaged Communities

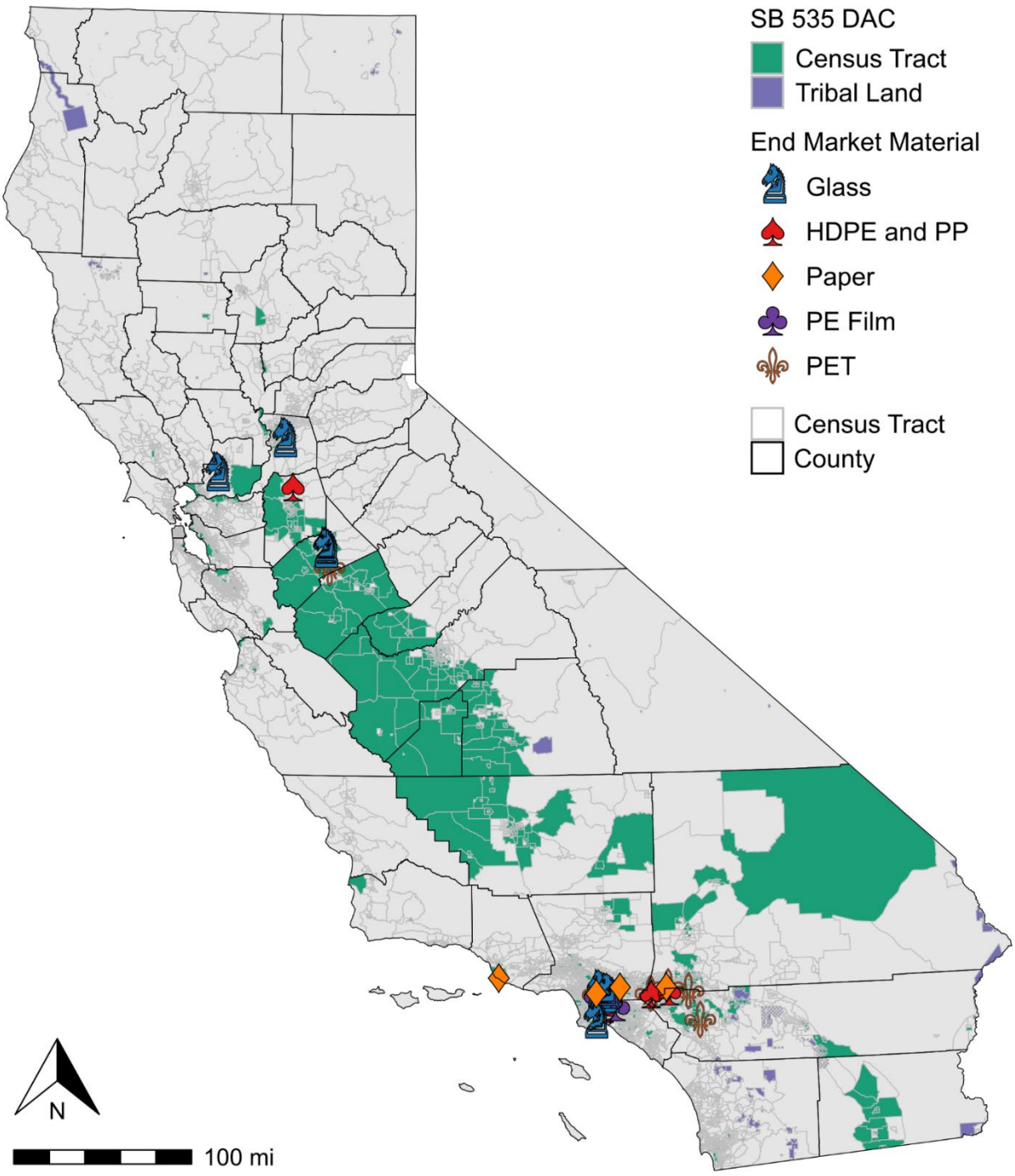

Figure 9-5: End Market Locations in Relation to SB 535 Disadvantaged Communities

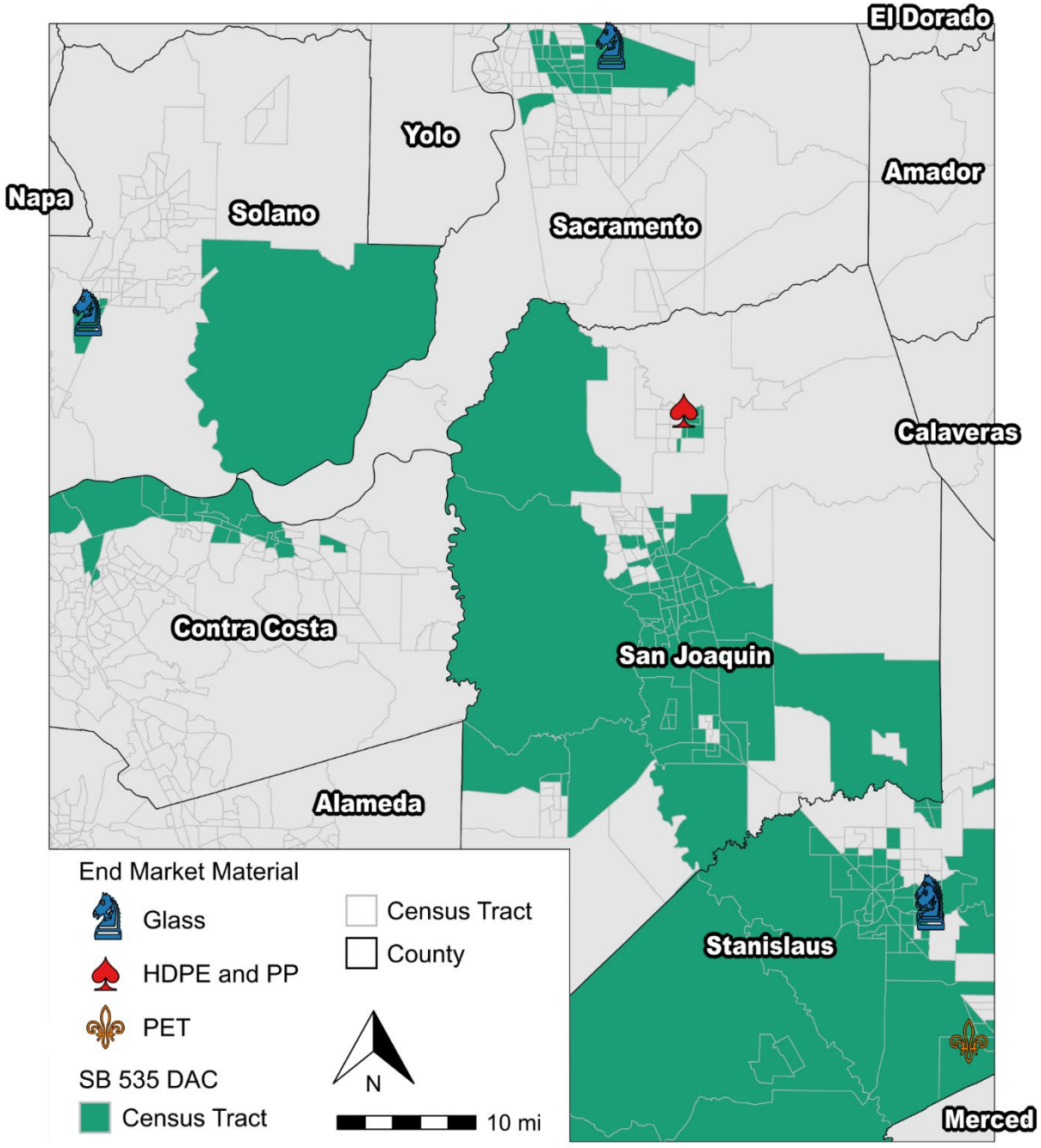

Figure 9-6: Northern-Central California End Market Locations in Relation to SB 535 Disadvantaged Communities

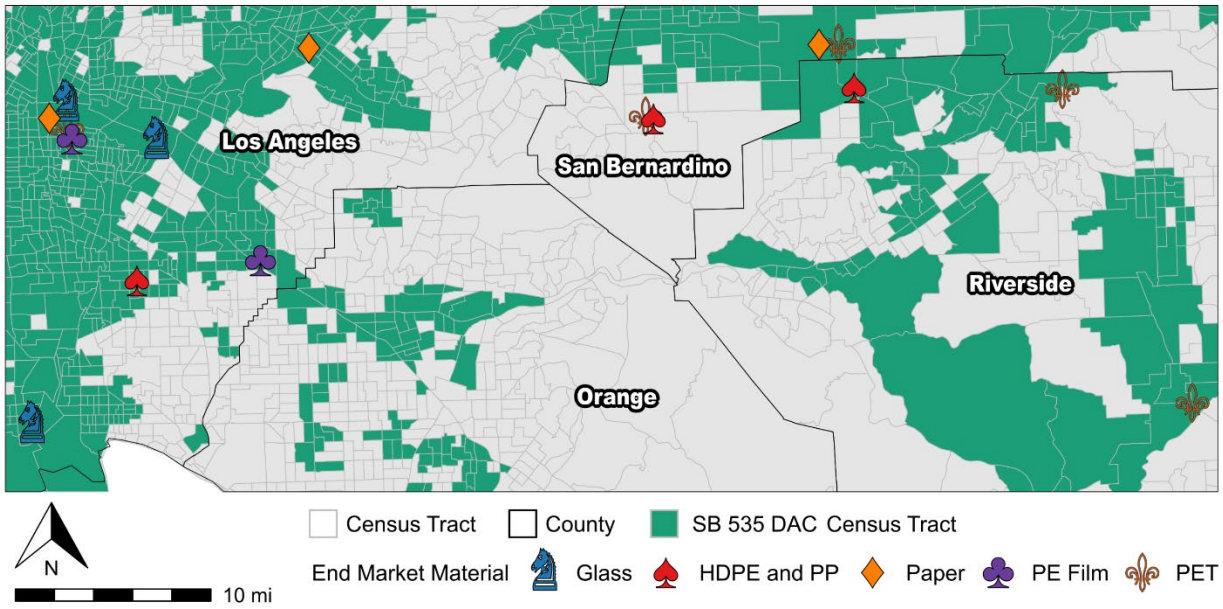

Figure 9-7: Southern California End Market Locations in Relation to SB 535 Disadvantaged Communities

The concentration of end market facilities in areas with lower median household income may indicate that these areas are more likely to experience localized environmental and public health impacts arising from recycling operations. Median household income is determined using 2020 U.S. Census data. Table 9-1 shows a breakdown of median household income in census tracts where end markets are located compared to the overall median household income in the surrounding region. End market locations are limited to areas that are zoned for industrial use, which could be one reason why many are found in similar locations.

Further analysis was conducted to analyze the characteristics of communities where end markets are located. As shown in the previous figures and in Table 9-1, most end market facilities are located in communities where median household income is lower than in surrounding regions. The only exception observed is PET end markets, where the median household income in census tracts with PET end markets is greater than the median household income for the broader regions. Among the different end markets, glass end markets exhibit the greatest disparities, particularly in the Bay Area, where the median household income in census tracts with glass end markets is more than $53,000 lower than the regional median. This observation aligns with research indicating that disadvantaged communities, identified in part by lower-income census tracts, may be frequently located near sources of pollution such as industrial and manufacturing plants.[127]

Table 9-1: Comparing Median Household Income in Census Tracts with End Markets vs. Regional Median (2024)‡‡[128]

Region	Median Household Income in Region	Median Household Income in Census Tracts with Glass End Market	Median Household Income in Census Tracts with Plastic End Market (HDPE and PP)	Median Household Income in Census Tracts with Plastic End Market (PET)	Median Household Income in Census Tracts with Plastic End Market (PE Film)	Median Household Income in Census Tracts with Paper and Fiber End Market
Bay Area	$129,297	$76,198				
Southern	$91,332	$58,284	$73,780	$94,461	$70,833	$88,309
Valley	$76,390	$66,879	$64,421	$82,361		

In addition to differences in median household income, further analysis examined the predominant languages[§§,129] spoken in census tracts with end markets, which provides further insight into the demographic characteristics of the communities surrounding these plants. While English is the predominant language in many (57% and 42% of census tracts with glass and plastic end markets, respectively), Spanish is also highly prevalent; it is the predominant language in 75% and 50% of the census tracts with paper and fiber and plastic end markets, respectively. Chinese is less common in comparison to English and Spanish, occurring as the predominant language in only 8% of census tracts with plastic end markets.[130]

‡‡ The demographic analysis is based on 2024 U.S. Census American Community Survey (ACS) data for median household income mapped at the census tract level.

§§ As defined by the U.S. Census, predominant language refers to the language spoken at home.

Table 9-2: Predominant Language in Census Tracts with End Markets (by End Market Material Type) (2024)[***][131]

End Market Material Type	Chinese as Predominant Language (% of census tracts)	English as Predominant Language (% of census tracts)	Spanish as Predominant Language (% of census tracts)
Glass	0%	57%	43%
Paper and Fiber	0%	25%	75%
Plastic	8%	42%	50%

9.3.3 Community-Based Organizations, Environmental Justice Groups and California Native American Tribe Engagement

The contractor engaged with CBOs, EJ groups, and Tribes to solicit these communities' expertise and experiences with recycling and composting in California through a 46-question survey, as well as through participation in listening sessions to provide this expertise and share their perspectives in a discussion format. The contractor received a total of 324 survey responses from CBOs and EJ groups and eight survey responses from Tribes. A total of 12 CBOs and EJ groups and two Tribes participated in four introductory meetings, and 12 CBOs and EJ groups, and three Tribes participated in ten listening sessions.

Of the CBOs and EJ groups surveyed, 20% (64 respondents) reported being located near a recycling or composting facility, while 13% (41 respondents) were unsure. The contractor reviewed the zip codes provided by survey respondents against the zip codes of end market locations. Three CBO and EJ group responses included a zip code that is the same as an end market location. Two of these three respondents indicated they did not live near a recycling or composting facility and the third was unsure. In general, respondents may not know whether they live near an end market or may live in a nearby but different zip code.

When CBO and EJ group survey respondents were asked if they felt that recycling or composting facilities impact their health and local environment, about one-third (34%, 22 respondents) of the 64 respondents reported a neutral perspective or no perceived impact. A smaller share (27%, 17 respondents) felt the facility had a positive impact, while 14% (9 respondents) reported a negative impact. The remaining 25% (16 respondents) were unsure of the perceived impact.

Three Tribes participated in the study and a total of eight survey responses were received from Tribal community members. Of these, six respondents (75%) reported not living near a recycling or composting facility, while the remaining two were unsure. As a

[***] The demographic analysis is based on 2024 U.S. Census American Community Survey (ACS) data for predominant language mapped at the census tract level.

result, the engagement generated limited insights on end markets and the perceived associated environmental and public health impacts on Tribal communities.

Survey respondents were asked whether they or their community were financially impacted by waste management. Of the 333 total responses including CBOs, EJ groups, and Tribes, half of all respondents said they were financially impacted or somewhat impacted by waste management challenges. The survey did not define or use examples as to what “financially impacted” means; this was left to each survey respondent to interpret individually.

Table 9-3: Number of Responses Indicating Respondent is Financially Impacted by Waste Management Challenges

Organization	Yes (% and # responses)	Somewhat (% and # responses)	No (% and # responses)	Unsure (% and # responses)
CBOs	22% (71)	23% (76)	33% (106)	22% (71)
Tribes	25% (2)	25% (2)	50% (4)	0% (0)

Of those respondents who indicated that waste management impacted them financially, impacts from illegal dumping and littering were the most common reasons cited, which were also discussed during listening sessions. Some feedback from the listening sessions also included comments from CBOs and EJ groups regarding the financial impact on the current state of recycling, which places the greatest plastic pollution burdens onto disadvantaged communities. Respondents' greatest concern with the Act is that these burdens will not be shifted away from communities and addressed by producers. Compensation is also a huge incentive for residents when it comes to recycling, especially for residents with barriers to access.

The Community Recycling and Composting Survey also asked respondents about their perception of their community's access to reliable environmental health information and community programs about health risks and pollution. While these questions were asked broadly at the community level (rather than being specific to end markets), the responses provide useful context about broader community perceptions of environmental and public health. Approximately one-quarter (25%, 81 respondents) of surveyed CBOs and EJ groups disagreed that their community had access to reliable environmental health information and almost half (45%, 146 respondents) felt they only "somewhat" had access. Only 18% (57 respondents) agreed that their community had access to reliable environmental health information. The remaining 13% (41 respondents) were unsure.

Responses displayed a similar breakdown for access to community programs about health risks and pollution, where 31% (100 respondents) of CBOs and EJ groups disagreed that they had access and 43% (140 respondents) felt they "somewhat" had access. Only 12% (38 respondents) agreed that their community had access to community programs about health risks and pollution and the remaining 14% (47 respondents) were unsure. These findings suggest that CBOs and EJ groups feel under-informed about environmental health, health risks, and pollution issues in general, which may potentially be more pronounced for communities located near end markets.

Findings were similar for Tribes. Two respondents (25%) from Tribes indicated they had access to reliable environmental health information and access to community programs about health risks and pollution. Three respondents (38%) either disagreed that they had access or somewhat agreed that they had access to information and community programs. No additional findings related to access to health information on end markets were gathered during listening sessions with Tribes.

Abbreviations and Acronyms

Abbreviation	Description
BCRP	Beverage Container Recycling Program
CMC	Covered Material Category
CRV	California Redemption Value
EPS	Expanded Polystyrene
HDPE	High-Density Polyethylene
ISRI	Institution of Scrap Recycling Industries
LDPE	Low-Density Polyethylene
OCC	Old Corrugated Cardboard
PET	Polyethylene Terephthalate
PET A	Polyethylene Terephthalate Grade A
PET B	Polyethylene Terephthalate Grade B
PFAS	Per- and polyfluoroalkyl substances
PP	Polypropylene
PRC	Public Resources Code (California Statute)
PRCC	PET Recycling Corporation of California
PS	Polystyrene
PVC	Polyvinyl Chloride
RDRS	Recycling and Disposal Reporting System
SB 54	Senate Bill 54 (Allen, 2022): Plastic Pollution Prevention and Packaging Producer Responsibility Act
UBC	Used Beverage Can

Glossary of Terms

Glossary of Terms are either referenced definitions from the Act or specifically used for the purposes of this study by CalRecycle or the contractor. If a referenced definition is from the Act, the Public Resources Code (PRC) is provided in the definition.

Term	Description
Beverage Container Recycling Program	CalRecycle administers the California Beverage Container Recycling & Litter Reduction Program (BCRP) in which consumers pay a refundable deposit every time they purchase an included beverage and then receive – California Refund Value (CRV) – when they return the empty container to a certified recycling center, registered dealer cooperative, or participating retail location. Californians may instead choose to forfeit their deposit by donating beverage containers to certified community service programs, or giving them to a registered curbside or certified drop-off or collection program for recycling.
Bimetal	An object that is composed of two separate metals joined together. Instead of being a mixture of two or more metals, like alloys, bimetallic objects consist of layers of different metals.
Bulk and Bale	Describes the collection method where a grade of material is collected separately from other materials, aggregated, and potentially baled, with no formal mechanical sorting before the material is received by end markets.
California Redemption Value (CRV)	A deposit consumers pay when purchasing certain beverages in California, which can be refunded when the containers are returned to a certified recycling center.
CMC Conversion Rate (%)	Total recycled output produced by an End Market facility divided by the total quantity of a CMC accepted by that specific End Market (excluding contamination).
CMC End Market Group	Groups of CMCs, approved by CalRecycle to be used in this project for analysis.

Term	Description
Collection Program	Refers to curbside single family, multifamily, and commercial, as well as noncurbside options such as residential and commercial drop off, take-back, public space collection, and other options for the collection of covered materials. Depending on the collection program, single family, multifamily, and commercial sources may be mixed (e.g., a single hauler route may pick up curbside recycling from both commercial and multifamily locations). The definitions of single family, multifamily, and commercial may also differ between collection programs.
Community-Based Organization (CBO)	Refers to a public or private nonprofit organization of demonstrated effectiveness that: 1. Has deployed projects and/or outreach efforts within the region of one or more impacted priority populations in California. 2. Has an official mission and vision statements that expressly identify serving priority populations (e.g., disadvantaged communities, low-income communities, and/or communities in rural areas). 3. Currently employs staff member(s) who specialize in and are dedicated to diversity, equity, or inclusion, or is a 501(c)(3) nonprofit.
Contamination	Contamination occurs when material that is not targeted by recycling facilities enters the recycling stream. This may include materials intentionally included in a product that are removed during the recycling process, and materials that incidentally or accidentally end up in the recycling stream (or in the incorrect recycling stream). It may also include materials that are deleterious to facilities or consumers. Contamination may encompass various situations and materials: • A material that a collection program does not accept. • A material that a receiving processing facility or end market does not accept or is not designed, permitted, or authorized to recycle. • A material that a receiving processing facility or end market accepts but that is destined for disposal.

Term	Description
Converter	A location that transforms plastic resin into finished products such as bottles, bags, and containers. Converters produce polymer-based, semi-finished and finished products for the full range of industrial and consumer markets. Converters primarily make use of several tried-and-tested plastics manufacturing processes, including injection molding, extrusion, blow molding, rotational molding, and vacuum forming.
Covered Material	The Act applies to "covered material," which PRC section 42041(e) defines as: Single-use packaging [PRC section 42041 (e)(1)(A)] that is routinely recycled, disposed of, or discarded after its contents have been used or unpackaged, and typically not refilled or otherwise reused by the producer. Plastic single-use food service ware [PRC section 420241 (e)(1)(B)], including, but not limited to, plastic-coated paper or plastic-coated paperboard, paper, or paperboard with plastic intentionally added during the manufacturing process, and multilayer flexible material.
Covered Material Category (CMC)	A category that includes covered material of a similar type and form, as determined by the department [PRC section 42041(f)]. This report uses the CMCs that CalRecycle published on July 1, 2024. The list and other supplementary material can be found at CalRecycle.ca.gov/packaging/packaging-epr/cmclist/.
Cullet	Glass that is processed and ready to be remelted into new glass products without further processing.
Disposal (of covered material)	Material landfilled, used for alternative daily cover (Title 27, California Code of Regulations (CCR), section 20690), used for alternative intermediate cover (Title 27, CCR, section 20700), combusted, incinerated, used for energy generation, or used for fuel production, except for anaerobic digestion of source-separated organic materials. Material that does not enter the managed disposal system or is lost from the recycling and waste management system through open burning, illegal dumping, or other forms of leakage.
Disposed of	Material sent to any activity meeting the definition of disposal, such as landfill or incineration.
Domestic Exports	Material exported to an end market in U.S. states other than California.

Term	Description
End Market	For material sent to a composting or in-vessel digestion facility for the creation of compost, digestate, or biogas, the end market is that facility. For other material, the end market is the entity that converts the material into feedstock to be used in lieu of virgin material to produce new or reconstituted products. Example end markets include: • Glass: a beneficiation plant that produces cullet. • Metal: an entity that smelts metal to produce ingots, sheets, or coils. • Paper: a beneficiation plant that repulps material into a pulp product. • Wood: an entity that chips and grinds wood material. • Plastic: an entity that creates pellet.
End market facility	A specific facility for an end market entity.
Feedstock	The materials entering an end market facility.
Float purger	Vertical pressurized machine which treats coarse screen rejects through a continuous pulping system.
Grade	Refers to a classification system used to categorize recyclable materials that form the feedstock for end markets. The system is based on the materials' quality, composition, and suitability for recycling processes. Materials can be defined by individual business to business description or, more formally, by industry associations and similar entities. A grade will typically have a grade specification associated with it, which will define the acceptable material proportion and the quantities and type of contamination that can be tolerated or whether it is prohibited.
Kraft paper	Stiff, sturdy paper derived from wood pulp, usually brown but can be white or colored.
Natural/Clear	Referring to glass or plastic without coloring.
Noncovered material	Material excluded from the Act pursuant to PRC section 42041(e)(2).
Nontarget material	Input material which is not wanted by the facility. This material can be considered a contaminant and is either sorted to be sent to a different plant or disposed of.

Term	Description
Packaging	PRC section 42041(s): means any separable and distinct material component used for the containment, protection, handling, delivery, or presentation of goods by the producer for the user or consumer, ranging from raw materials to processed goods. “Packaging” includes, but is not limited to, all of the following: (1) Sales packaging or primary packaging intended to provide the user or consumer the individual serving or unit of the product and most closely containing the product, food, or beverage. (2) Grouped packaging or secondary packaging intended to bundle, sell in bulk, brand, or display the product. (3) Transport packaging or tertiary packaging intended to protect the product during transport. (4) Packaging components and ancillary elements integrated into packaging, including ancillary elements directly hung onto or attached to a product and that perform a packaging function, except both of the following: (A) An element of the packaging or food service ware with a de minimis weight or volume, which is not an independent plastic component, as determined by the department. (B) A component or element that is an integral part of the product, if all components or elements of the product are intended to be consumed or disposed of together.
Paper	A material made from cellulose pulp derived mainly from wood, for the creation of consumer products.
Paperboard	A thicker paper material used for the production of packaging containers such as folding cartons, paper cups, and coated boards.

Term	Description
Plastic	PRC section 42041(t): means a synthetic or semisynthetic material chemically synthesized by the polymerization of organic substances…. “Plastic” includes, without limitation, polyethylene terephthalate (PET), high density polyethylene (HDPE), polyvinyl chloride (PVC), low density polyethylene (LDPE), polypropylene (PP), polystyrene (PS), polylactic acid (PLA), and aliphatic biopolyesters, such as polyhydroxyalkanoate (PHA) and polyhydroxybutyrate (PHB). “Plastic” does not include natural rubber or naturally occurring polymers such as proteins or starches.
Plastic Component	PRC section 42041(u): Plastic component means any single piece of covered material made partially or entirely of plastic. A plastic component may constitute the entirety of the covered material or a separate or separable piece of the covered material.
Plastic Covered Material	Plastic covered material includes any item of covered material with a plastic component.
Priority Populations	Disadvantaged communities, low-income communities, communities in rural areas, and Tribes.
Processing Facility	Any facility that engages in the statutory definition of processing (PRC section 42041(v)) – that is, to sort, segregate, break or flake, and clean material to prepare it to meet the specification for sale to an end market.
Recycled Organic Product	Digestate used for land application, biogas, and compost produced by a process that meets the definition of recycling.

Term	Description
Recycling	PRC section 42041(aa) defines recycle or recycling as the process of collecting, sorting, cleansing, treating, and reconstituting materials that would otherwise ultimately be disposed of onto land or into water or the atmosphere, and returning them to, or maintaining them within, the economic mainstream in the form of recovered material for new, reused, or reconstituted products, including compost, that meet the quality standards necessary to be used in the marketplace. Recycling does not include combustion, incineration, energy generation, fuel production (except for the anaerobic digestion of source-separated organic materials), or other forms of disposal. Recycling includes both traditional recycling processes (e.g., recycling steel cans) and organic recycling processes (e.g., composting organic materials). For material to be considered recycled, it must be sent to a responsible end market (PRC section 42041(aa)(3)).
Recycling Rate	Weight of material recycled / (weight of material recycled plus weight of material disposed of).
Redemption Center	Recycling centers that buy back empty California Redemption Value (CRV) beverage containers.
Rejects	Materials not accepted by processing facilities and/or end markets, for any reason, including physical contamination of the material or its inability to be processed due to its design.
Responsible End Market	A materials market in which the recycling and recovery of materials or the disposal of contaminants is conducted in a way that benefits the environment and minimizes risks to public health and worker health and safety (PRC 42041(ad)).
Scavenger	The Continuous Scavenger removes both lightweight contaminants and heavy trash from continuous pulpers. The Continuous Scavenger consists of a large-volume tub with a pumping rotor.
Secondary Packaging	Packaging that is intended to bundle, sell in bulk, brand, or display a product (See the definition of packaging).
Single-Use Packaging	Packaging that is routinely recycled, disposed of, or discarded after its contents have been used or unpackaged, and typically not refilled or otherwise reused by the producer (See the definition of covered material).

Term	Description
Target Material	Feedstock that an end market facility seeks to convert into recycled material.
Tertiary Packaging	Packaging that is intended to protect a product during transport (See the definition of packaging).
The Act	Refers to The Plastic Pollution Prevention and Packaging Producer Responsibility Act (The Act, Senate Bill 54, Allen, Chapter 75, Statutes of 2022).
Thermoform	A manufacturing process in which a plastic sheet is heated to a pliable forming temperature, formed to a specific shape in a mold, and trimmed to create a usable product. The sheet, or film when referring to thinner gauges and certain material types, is heated in an oven to a high enough temperature that it can be stretched into or onto a mold and cooled to a finished shape.
Ton	The short ton, a measurement unit equal to 2,000 pounds (907.18 kg).
Ultrasorter	Belt-driven system used in a paper machine approach system secondary fiber screening or in a pulp mill screening system.
V100/200 screen	Vertical rotor-based screening equipment.
Wet Strength	A measure of how well the web of fibers holding the paper together can resist a force of rupture when the paper is wet.

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