Study on the ECONOMIC IMPACTS of RECYCLING

FINAL REPORT | JULY 2017

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Prepared by:

BURNS & McDONNELL

Prepared for:

Texas Commission on Environmental Quality

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APPENDICES

1.0 EXECUTIVE SUMMARY

1.1 THE STUDY ON THE ECONOMIC IMPACTS OF RECYCLING OVERVIEW

In 2015, the 84th Texas Legislature passed House Bill 2763, which directed the Texas Commission on Environmental Quality (TCEQ) to conduct a study on the economic impacts of recycling in Texas. This report titled the Study on the Economic Impacts of Recycling (Study) meets the requirements of the law by building on the efforts of prior recycling studies and providing information on the following topics:

- Current recycling efforts
- Methods to increase recycling, such as the development of new markets for recycled materials and new businesses that may result from increased recycling
- Funding methods to increase recycling
- Job creation from recycling, as well as potential job creation that will result from increased recycling
- Infrastructure needs and opportunities for rural and underserved areas

1.2 BUILDING ON PRIOR STUDIES

The methodology used to develop this Study was based on the efforts of prior recycling studies conducted in Texas. The Texas Recycling Data Initiative (TRDI), released in 2015, was developed by the State of Texas Alliance for Recycling (STAR), in partnership with the Lone Star Chapter of the Solid Waste Association of North America (TxSWANA). TRDI provided a snapshot of recycling activity in Texas that occurred in 2013, including establishing a methodology for measuring recycling and presenting limited economic and jobs information. Other similar, regional studies were completed by the North Central Texas Council of Governments and the Houston-Galveston Area Council.

1.3 POINTS TO CONSIDER WHEN COMPARING STATEWIDE RECYCLING RATE AND ECONOMIC DATA

A number of states report recycling quantities, rates, and economic data, but comparing this information across states is notoriously challenging and can be misleading. While methodologies vary between states, the Project Team employed a conservative approach to the Study, which should be kept in mind when reading this Study or comparing results to other states. Readers should keep the points in Table 1-1 in mind when comparing the Study's recycling measurement and economic impact analysis results to other studies. Table 1-1 was compiled based on the Project Team's experience and research. Specific to the economic impact analysis, the findings in this Study are based upon a number of assumptions about employees and payrolls, which relied upon information provided by responsive companies. Since participation in the Study was voluntary, past or future studies may be based on responses from different participants, which could lead to some variance in the results, even using an identical methodology.

1.4 PROJECT CONTRIBUTORS

Through a competitive bidding process, the TCEQ retained Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) to complete the Study. Burns & McDonnell led the TRDI effort in collaboration with STAR, and TRDI benefitted from the strong participation and support from the recycling industry in Texas. This collaborative, voluntary approach to gathering data for TRDI set the precedent for the current Study. The Project Team, led by Burns & McDonnell, has decades of experience addressing solid waste and recycling issues and was comprised of contributors from the TRDI Study: STAR, Boisson Consulting, and Wussow Consulting. In addition, Cox | McLain Environmental Consulting (CMEC), a Texas certified Historically Underutilized Business and Disadvantaged Business Enterprise firm, was brought in to utilize their abilities in econometric modeling. Project Team members included:

- Burns & McDonnell: Scott Pasternak, Haley Norman, Veronica Roof, Seth Cunningham, and Robert Craggs
- STAR: Sara Nichols
- Boisson Consulting: Ed Boisson
- Wussow Consulting: Katie Wussow
- CMEC: Ashley McLain, Michael Bomba, and Nathlie Booth

TABLE 1-1: POINTS TO CONSIDER WHEN COMPARING STATEWIDE RECYCLING RATE AND ECONOMIC DATA

Issue	*Study on the Economic Impacts of Recycling* Approach	Approach for Some Other Statewide Studies
Definition of Recycling	Developed a methodology based on collecting data on municipal solid waste (MSW) as defined in Texas statute. Though not defined in Texas statute, the study also excluded source reduction, energy recovery, and reuse.	Some states may include reuse, energy recovery, certain source reduction activities, other conversion technologies or non-MSW material.
Voluntary or Mandatory	Approach was strictly voluntary.	States that mandate local agencies and certain businesses to submit recycling data may have a higher response rate.
Double Counting	Systematically focused on specific points in the material value chain to minimize double counting.	While some states take a similar approach, other approaches may not address double counting.
Addressing Data Gaps/ Extrapolation	Did not extrapolate; employed conservative estimates only in a few key areas where essential to produce consistent results.	States may use any number of approaches to derive estimates where needed to address data gaps.
Accounting for Residuals	Did not count residuals at materials recovery facilities (MRFs) and end-use facilities.	Some states may not account for residuals disposed at MRFs and/or at end-use facilities.
Generators Included	Included all types of MSW generators, such as residential homes, commercial businesses and institutions.	Some states report only residentially generated material, and some include certain industrial generators.
Counting Certain High-Volume Industrial Materials	Intentionally excluded industrial material from MSW statistics, but separately reported data on select industrial streams (e.g., metals).	Some states count certain high-volume industrial materials such as metals, pre- consumer paper or plastic manufacturing scrap.

The Study utilized a targeted, voluntary approach to data gathering, and a key aspect to stakeholder involvement was interaction with the Recycling Industry Committee (RIC). The RIC was a diverse group comprised of trade group and governmental representatives that helped with targeted outreach to increase survey participation among respondents in their professional networks. More information on the RIC and a list of participating organizations is found in Section 2.

1.5 METHODOLOGY

Section 2 describes the Study's methodology, which followed important guiding principles intended to maximize participation and produce the highest quality results for the most recent measurement study in Texas. As was the case with TRDI, the Study was a collaborative, voluntary effort and its success depended on input, endorsement, and involvement from a broad range of recycling industry stakeholders. The Study was conducted using the methodology developed in other recycling studies such as the TRDI and other regional recycling studies conducted in Texas. The Study also incorporated feedback from the TCEQ stakeholder meeting held on September 10, 2015. Section 2 describes the many aspects considered when conducting this Study, including:

- Survey administration and outreach
- The definition of recycling
- Materials included in the study
- How double counting was prevented
- What facilities were targeted for participation
- How data from supplemental sources was used

While Section 2 gives a broad description of the methodology, Section 8 includes more detail regarding the methodology used for the economic analysis portion of this Study. For definitions of certain terms used throughout the Study, please refer to the definitions in Appendix A.

1.6 RECYCLED TONS AND RECYCLING RATE

Section 3 presents an overview of the recycled material value chain and how it was used for the purpose of this Study. The survey results are presented on individual material summaries (referred to as material summaries) with an explanation of how the Project Team arrived at these totals.

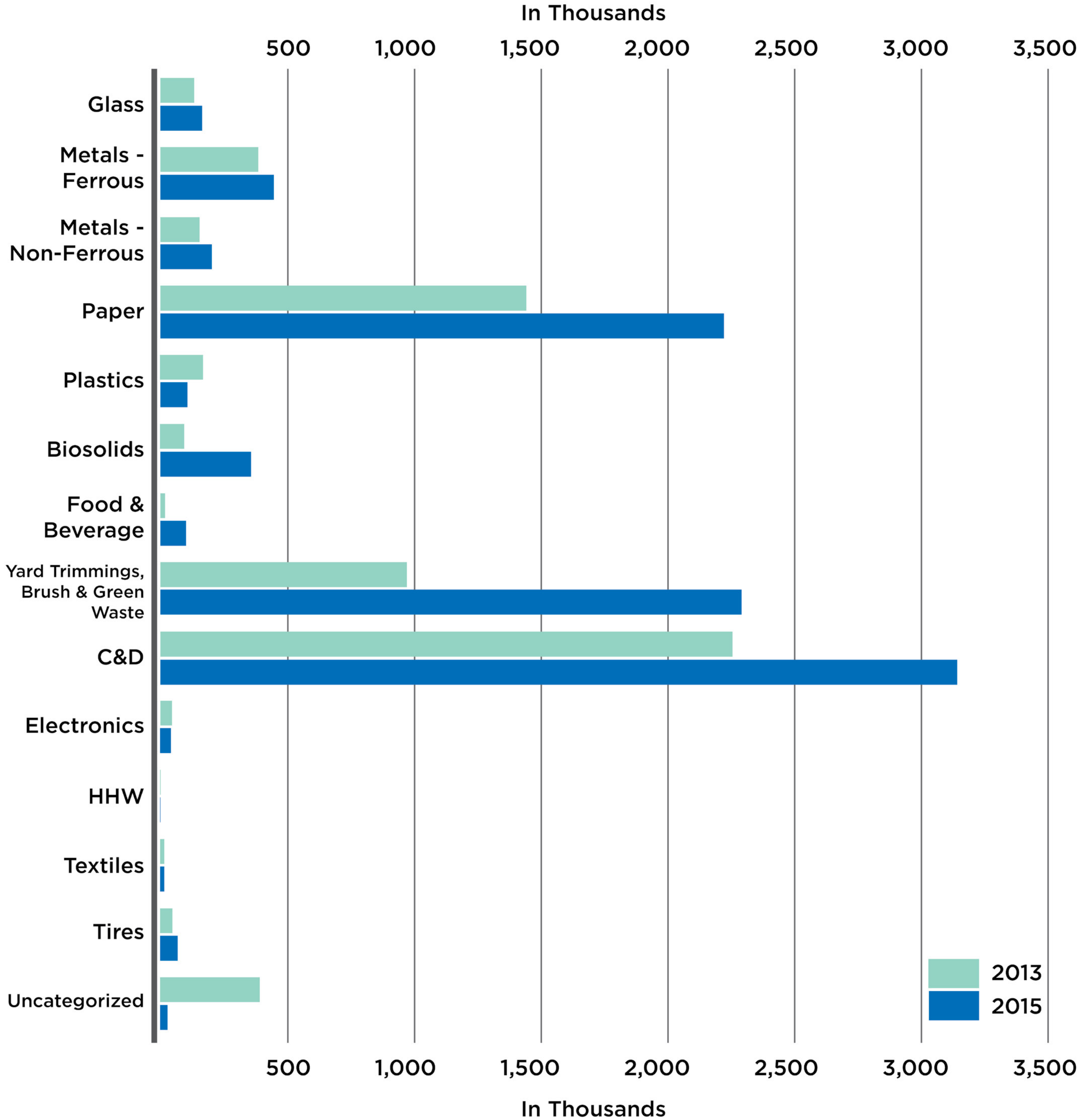
The survey showed approximately 9.2 million tons of recycled Texas MSW material in 2015, which represents a difference of 3.0 million tons of recycled MSW in comparison to the 2013 TRDI study results. The 9.2 million tons are based on data collected through the Study survey as well as supplemental data received from other sources. The data does not include any extrapolation of tons recycled, but only what was documented through the overall Study effort. Table 1-2 and Figure 1-1 provide a comparison between the results from this Study and the TRDI survey.

TABLE 1-2: MATERIAL RECYCLED FROM MSW SOURCES (TONS)

	Material	2013 Study (TRDI)	2015 Study
Typical Recyclables	Glass	137,222	165,527
	Metals – Ferrous[1]	386,876	447,207
	Metals – Non-Ferrous[1]	157,709	196,383
	Paper	1,444,632	2,212,562
	Plastics	169,216	107,851
Organic Materials	Biosolids	95,291	357,116
	Food and Beverage Materials	19,768	100,470
	Yard Trimmings, Brush, and Green Waste	970,233	2,289,542
Other Materials	Construction and Demolition Materials	2,253,598	3,136,727
	Electronic Materials	47,271	42,725
	Household Hazardous Waste	2,308	1,684
	Textiles	16,852	16,507
	Tires[2]	48,290	69,474
Uncategorized	Uncategorized[3]	393,527	27,932
	TOTAL	**6,143,393**	**9,171,707**

1. *The number shown in the table represents the portion of material that is MSW.*
2. *Quantity reflects a reduction of 600 tons to account for a typographical error in the TRDI study.*
3. *Includes all materials classified as "Other" by survey respondents. Respondents were required to provide a description. Respondents primarily reported commingled recyclables and commingled organic materials.*

FIGURE 1-1: MATERIAL RECYCLED FROM MSW SOURCES (TONS)



An objective of this Study was to not only measure recycling in Texas, but to also provide an update to the recycling rate measured during the TRDI study. A recycling rate indicates what percentage of waste generated is recycled and is typically calculated using the following formula:

Total Recycled / (Total Recycled + Total Disposed) = Percent Recycling Rate

To calculate a recycling rate, the Project Team determined the tons of MSW disposed for fiscal year (FY) 2015[1]. It should be noted that the disposal numbers reported by MSW landfills in Texas include non-hazardous industrial waste as well as tons imported from out of state, but the Project Team excluded these amounts from the estimate for FY 2015, which totaled 31,049,545 tons. The total disposed tonnage used in the recycling rate calculation represented FY 2015 while the total recycled tonnage used represents the calendar year 2015 total. It should also be noted that the recycling rate was based on the recycled tonnages reported in the survey and is, therefore, a conservative estimate. **Based on the tons of MSW recycling reported for this Study, the 2015 recycling rate for Texas was 22.7 percent, which is 3.8 percent more than the recycling rate from the TRDI study.** The TRDI study accounted for 26,380,522 tons of disposed MSW, which suggests that the disposal rate increased by 17.7 percent from 2013 to 2015. The individual material summaries in Section 3 provide an overview of the recycling process and explain reasons for increases and decreases for each material included in the Study. The reasons for an increase or decrease in quantities detailed in the summaries include:

- Change in end market demand
- Additional supplemental data obtained
- Increased emphasis on diverting materials from disposal
- Greater or lower response to survey
- Change in study methodology
- Enhanced scrutiny of supplemental data

1.7 RECYCLING COSTS, VALUE, AND QUALITY

Understanding the costs, value, and quality of recyclable materials is an essential component to understanding and potentially increasing recycling in Texas. Due to relatively large quantities of material recycled (as discussed in Section 3) and potential opportunities to increase recycling (as discussed in Section 6), Section 4 focuses on providing information on specific recyclable material categories that could yield the highest value or highest quantity. These categories include typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and construction and demolition (C&D) materials. Information in this section is based on a combination of survey responses, interviews, and the Project Team's collective industry experience.

Approximately 9.2 million tons of MSW designated material were recycled in Texas in 2015. Typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and C&D materials accounted for 8.7 million tons, or 94.4 percent of the total tons recycled materials in Texas. Based on an average commodity market for typical recyclables, organics, and C&D materials, $702 million in materials were recycled in Texas in 2015.

1.8 ESTIMATED AMOUNT OF RECYCLABLE MATERIALS THAT COULD BE RECYCLED, BUT ARE DISPOSED

Each year recyclable materials are disposed in MSW landfills. Section 5 estimates the composition of recyclable materials generated and disposed in Texas, followed by an estimate of the quantity and value of recyclable materials disposed.

In 2015, an estimated 31,049,545 tons of municipal solid waste, including recyclable material, was generated and disposed in Texas. MSW and C&D materials accounted for the majority of the material generated and disposed, 21.0 million and 6.4 million tons, respectively. Based on multiple composition studies, the Project Team estimated the quantities of materials that were disposed, but could have been recycled. In the analysis included in Section 5, there were 10,286,994 tons of MSW, 2,715,317 tons of C&D materials, and 427,989 tons of other waste that could have been recycled, but were disposed. These 13,430,300 tons equal 43 percent of the total tons generated and disposed in Texas.

1. While landfill data was provided on a fiscal year basis, the recycling data requested for the Study survey was primarily provided on a calendar year basis in order to streamline the reporting process for respondents.

Table 5-6 in Section 5 presents the estimated tonnage of material disposed that could be recycled and an estimate of the percentage of the materials by category that could have been recycled, recognizing that not all material could be diverted. The Project Team provided a range based on recycling 20, 40, and 60 percent of the disposed material. Even though a material can be recycled, the Project Team used a range to recognize that it may be impracticable (from a cost and/or environmental perspective) for all of a material to be recycled due to lack of recycling infrastructure, contamination of recyclable materials, access to end markets, and need for additional public education and outreach.

1.9 INCREASING RECYCLING THROUGH NEW MARKETS AND NEW BUSINESSES

Section 6 describes key trends in Texas recycling and identifies barriers and opportunities to expanding the industry and markets, as reported by survey respondents. This section also identifies market and business opportunities that are likely to have the largest impact or appear to be the most feasible based on the information available and the nature of the recycling industry in Texas. Based on survey respondents and interviews with key stakeholders, the Project Team also identified successes and challenges that occurred in the Texas recycling market.

1.10 GRANTS AND OTHER FUNDING SOURCES

Both government incentives and private funding sources can provide financial benefits for a variety of solid waste management and recycling projects. These grants and other funding sources are often provided on a competitive basis and are not always specific to the solid waste and recycling industry. If a project can secure additional funding, it will typically allow for a reduction in the capital or operating costs. Some of these funding sources may offset the start-up infrastructure costs for smaller projects, especially those in smaller, more rural communities. Section 7 provides an overview of potential governmental incentives that public and private solid waste and recycling entities could utilize or that have historically been used for solid waste management or recycling projects. Section 7 concludes with a discussion of public-private partnership options for structuring recycling projects.

1.11 ECONOMIC IMPACTS OF RECYCLING

The act of recycling incorporates a broad range of activities that have a positive impact on the Texas economy. After a consumer uses and discards a recyclable material, it is collected, sorted, processed, and sold to end markets. All of this is done with the intent of preparing it for use as a future feedstock for manufacturing. When recyclable materials are sufficiently processed to be used as feedstock, they are then transported from the processor to a manufacturer. The manufacturer, in turn, either feeds the recyclable material directly into the manufacturing process, further processes it before use, or mixes the recyclable material with virgin material before manufacturing. During each stage of this recycling process, from collection to manufacturing, economic activity is being generated in the form of employment, workers' wages, and public revenue that benefit the Texas economy.

Section 8 estimates the statewide economic, employment, and fiscal impacts that are derived from recycling MSW. This section demonstrates that the recycling of MSW creates economic benefits for the Texas economy, with more than 17,000 person years of direct, indirect, and induced employment supported during 2015, as shown in Table 1-3. The overall impact of recycling MSW on the Texas economy exceeded \$3.3 billion. Collection activities generated the largest employment impacts, followed closely by processing facilities and end users. The recycling industry was also responsible for generating nearly \$195 million of revenue for state and local governments in 2015, through sales taxes, property taxes, and other taxes and fees. Expanding recycling activities has the potential to generate greater economic impact and public revenue, although these benefits may not be experienced uniformly throughout the state, due to local conditions that affect operating costs. Lastly, another potential benefit from the recycling of MSW is the siting of manufacturing facilities near the source of recycled feedstocks. Texas manufacturers that use recycled feedstocks supported almost 9,500 person years of employment during 2015.

1.12 INFRASTRUCTURE NEEDS AND DEVELOPMENT OPPORTUNITIES

Access to adequate infrastructure is crucial to increasing recycling in Texas. Section 9 broadly assesses current recycling infrastructure and provides a discussion of current MRF activity in Texas. This section also assesses the needs of rural or remote areas of Texas and includes information on how regional approaches to recycling systems could help strengthen access to recycling services in these challenged areas. This section also examines four communities and regions of Texas that represent both challenges and successes associated with recycling in Texas, including the cities of El Paso, Booker, and Dallas, and the Lower Rio Grande Valley.

TABLE 1-3: SUMMARY OF TOTAL ECONOMIC IMPACT OF THE RECYCLING INDUSTRY ON THE TEXAS ECONOMY

Measure	Direct	Indirect	Induced	Total
Employment	7,868	5,040	4,129	**17,037**
Labor Income	$342,862,641	$314,883,480	$199,242,509	**$856,988,630**
Value Added	$793,557,644	$490,200,422	$343,903,017	**$1,627,661,083**
Output	$1,894,943,170	$875,280,989	$606,533,341	**$3,376,757,500**

2.0 METHODOLOGY

The Study methodology followed important guiding principles intended to maximize participation and produce the highest quality results for the most recent recycling measurement study in Texas. The Study was conducted using the methodology developed in studies such as the TRDI and other regional recycling studies conducted in Texas. The Study also incorporated feedback from the TCEQ stakeholder meeting held on September 10, 2015. While this section provides a broad description of the methodology, Section 8 gives more detail regarding the methodology used for the economic analysis portion of this Study.

2.1 CONFIDENTIALITY PLAN

A confidentiality plan protects the proprietary nature of individual responses. A copy of the confidentiality plan can be found in Appendix B.

2.2 STAKEHOLDER INVOLVEMENT

The Study utilized a targeted, voluntary approach to data gathering, and its success depended on input, endorsement, and involvement from a broad range of recycling industry stakeholders and other industry representatives. The Project Team coordinated with TCEQ to facilitate external communications and stakeholder input during the project. A key aspect to stakeholder involvement was interaction with the Recycling Industry Committee.

Recycling Industry Committee

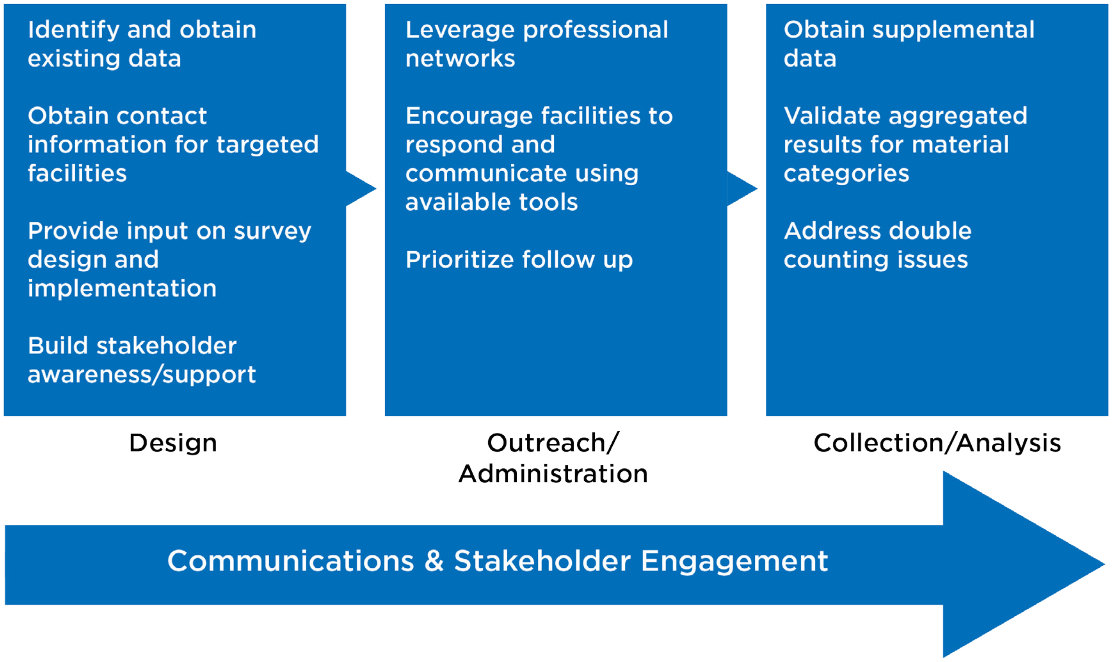
The Recycling Industry Committee (RIC) was a diverse consortium of governmental and trade group representatives working with the Project Team and TCEQ to help with targeted outreach to increase survey participation among respondents in their professional networks. The RIC was comprised of a select group of representatives and their respective organizations who participated on the TRDI Steering Committee, as well as new representatives. The purpose of the RIC was to (1) assist with efforts to communicate the survey launch and the importance of its completion and (2) serve as subject matter experts for the Project Team in regard to questions about the survey results. RIC membership included the following:

- American Forest and Paper Association (AF&PA)
- Carton Council
- Construction and Demolition Recycling Association (CDRA)
- Cooperative Teamwork and Recycling Assistance (CTRA)
- Glass Packaging Institute (GPI)
- Institute of Scrap Recycling Industries Inc. (ISRI)
- National Association for Polyethylene Terephthalate (PET) Container Resources (NAPCOR)
- National Waste and Recycling Association (NWRA)
- North American Hazardous Materials Management Association (NAHMMA)
- Recycling Council of Texas (RCOT)
- Society of the Plastics Industry (SPI)
- Solid Waste Association of North America – Lone Star Chapter (TxSWANA)
- STAR - Electronic Resource Recovery Council (ERRC)
- STAR - Texas Compost Council (TCC)
- STAR - Texas Product Stewardship Council (TxPSC)
- Texas Association of Business (TAB)
- Texas Association of Regional Councils (TARC)
- Texas Commission of Environmental Quality (TCEQ) Municipal Solid Waste Management and Resource Recovery Advisory Council (MSWRRAC)
- Texas Retailers Association (TRA)
- United States Environmental Protection Agency, Region 6 (U.S. EPA)
- Representative Ed Thompson (ex-officio)
- Senator José Rodriguez (ex-officio)

2.3 SURVEY APPROACH

As was the case with TRDI, this Study was a collaborative effort and its success depended on input, endorsement, and involvement from a broad range of recycling industry stakeholders. Figure 2-1 summarizes the approach for the survey.

FIGURE 2-1: SURVEY APPROACH



The Study measured the quantity of materials generated in Texas that are ultimately recycled, whether inside or outside of Texas. While some recyclables may be exported to processing facilities in neighboring states, the vast majority of Texas-generated recyclables are processed at facilities within the State. The survey also asked respondents to identify the percentage of their processed material that was imported from outside of Texas. In an effort to minimize double counting and to streamline the survey, generators and collectors/transporters were not surveyed. Section 3.1 provides further detail on the recycled material value chain. An important step in the data gathering process was to identify the recycling facilities/firms to survey. To a large extent, the specific entities to be surveyed were identified in the database Burns & McDonnell developed while completing TRDI. The Project Team updated this database based on new facilities that have started operations since the TRDI survey. The Project Team specifically completed this update by reviewing TCEQ information and third-party sources that publish lists of recycling facilities. Additionally, the Project Team requested that RIC members identify any new facilities.

Survey Design

The Project Team collaborated with TCEQ to refine and expand the survey instrument that was utilized during the TRDI process. This approach allowed the Project Team to build on the efforts from TRDI while also addressing the additional information required for this Study. Please refer to the "What Materials were Included?" portion of this section for the material types included in the Study. Additionally, the survey included questions on a range of economic issues (e.g. number of jobs, annual receipts, annual payroll), as well as the material cost, value, and quality of recycling materials and ideas to increase recycling via new markets and key market trends.

Survey Outreach

A variety of communication methods, including group email lists, organizational newsletters, press releases, phone calls, and in-person presentations and communication were used by the Project Team to promote the Study. The purpose of the external outreach was to:

- Communicate information regarding the survey and the purpose of the project among recycling stakeholders

- Leverage professional networks to communicate information about the project
- Encourage facilities to respond to the survey
- Secure buy-in on the confidentiality plan and support in communicating it to potential respondents

Key outreach efforts included the following:

- Individual RIC members communicated within their professional networks to increase awareness about the survey and encourage members of their respective organizations to respond.
- The Study was also the subject of a keynote presentation at the STAR Recycling Summit in October 2016.
- Presentations were given at the TCEQ MSWRRAC meetings, TCEQ Trade Fair, TARC meeting, NWRA annual Texas conference, CDRA meeting, Texas Compost Council Summit and Training, and the Lone Star Chapter of the NAHMMA quarterly meeting.
- Traditional media outlets were used to enhance communication and outreach efforts. A press release was distributed to several online and print journals, television, radio, and newspaper outlets throughout Texas and nationally. Social media networks were also used to promote the survey at key points during its administration.

Administration and Follow-Up

The survey was developed using the Re-TRAC Connect™ online platform, and the Project Team distributed the link to the survey via email[1]. All targeted respondents with valid email addresses received an initial survey notice, including the survey link, during the week of August 15, 2016. Many more respondents received emails after they were obtained as part of telephone outreach. The survey deadline was October 31, 2016. During the 11-week survey period, potential respondents received an average of three follow-up communications, by phone and/or email.

In order to facilitate open lines of communication with potential respondents, the Project Team maintained a dedicated phone number and email address for the Study, and had staff available to respond to inquiries Monday through Friday during business hours. In addition, representatives from Emerge Knowledge were available to provide technical support.

The Project Team also hosted a free, informational webinar on the WebEx platform on September 13, 2016 to engage and educate potential survey respondents about the survey. In certain cases, respondents expressed unwillingness or inability to log into Re-TRAC Connect to complete the survey. In those cases, Project Team members collected data over the phone or via a brief email questionnaire. When respondents submitted surveys, a lead Project Team member reviewed each submitted survey to verify and ask for clarification as needed on any reported information.

Additionally, several landfills, transfer stations, and processors were identified in TCEQ's annual municipal solid waste reports and facility lists. The Project Team surveyed these facilities by phone to determine whether the data reported could be included in the total volume for the Study.

What is Recycling?

The Study was required to use the assigned meaning of "recycling" in Texas Health and Safety Code Section 361.421(8), which is a "process by which materials that have served their intended use or are scrapped, discarded, used, surplus, or obsolete are collected, separated, or processed and returned to use in the form of raw materials in the production of new products. Recycling includes:

1. the composting process if the compost material is put to beneficial reuse as defined by the commission
2. the application to land, as organic fertilizer, of processed sludge or biosolids from municipal wastewater treatment plants and other organic matter resulting from poultry, dairy, livestock, or other agricultural operations"

To remain consistent with TRDI, the Study focused on MSW and post-consumer recyclables, and utilized the Texas Health and Safety Code definition of MSW found in Section 361.003(20). MSW is defined as "solid

1. Re-TRAC Connect is a waste reduction and recycling measurement system used by the public sector, developed by Emerge Knowledge Design Inc.

waste resulting from or incidental to municipal, community, commercial, institutional, and recreational activities, and includes garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and other solid waste other than industrial solid waste."

The Study did not cover other effective and commonly used methods to divert material from disposal, such as:

- Source reduction activities like purchasing products with less packaging or home composting
- Refurbishment or reuse of products for the originally intended use, such as consumer electronics or clothing
- Conversion or combustion of materials to fuel or energy
- Land reclamation or beneficial use projects using tire shreds or bales
- Disposal or on-site use of material at a landfill for road stabilization or alternative daily cover

What Materials Were Included?

The survey asked respondents to report on multiple types of materials that, if not recycled, would have been considered MSW, as opposed to non-MSW materials. According to Title 30, Texas Administrative Code, Chapter 330, material is considered MSW if it results from or is incidental to municipal, community, commercial, institutional, and recreational activities. MSW includes all other solid waste other than industrial solid waste[2]. Retailers, schools, hospitals, single-family homes, apartment buildings, public parks, and sports complexes are all examples of MSW generators. The survey asked respondents to omit material that is refurbished, reused, combusted or properly disposed in their reported recycling volumes. The survey also asked respondents to omit material that, if not recycled, would have been considered industrial solid waste, defined as the byproduct of industrial, manufacturing, or agricultural processes[3].

In addition, the survey asked the respondents for their percentage of incoming material tonnage that is ultimately disposed as residue (contamination rate) and the percentage of incoming recycled material tonnage that is ultimately used to produce new products (yield rate). This information was collected to assist in the evaluation of the quality of the materials being processed, as discussed in Section 4.

The survey requested information on broad, straightforward material categories, including some material subgrades. Table 2-1 lists the material categories for the survey. For definitions of these material categories, please refer to Appendix A.

TABLE 2-1: MATERIAL CATEGORIES

Typical Recyclables	Organic Materials	Other Materials
Glass (Containers, Other Glass)	**Biosolids (i.e. sludge)**	**Construction and Demolition (C&D) Materials**
Metals (Ferrous, Non-Ferrous)	**Food and Beverage Materials**	**Electronic Materials**
Paper (Mixed, Old Corrugated Containers, Other Paper)	**Yard Trimmings, Brush and Green Waste**	**Household Hazardous Waste (HHW)**
Plastics (PET #1, HDPE #2, Plastics #3-7)		**Textiles**
		Tires
		Other (respondent must specify)

2. 30 TAC, Chapter 330, Subchapter A
3. 30 TAC, Chapter 335, Subchapter A

What Facilities Participated?

The survey asked respondents to identify whether their facility is a processor and/or an end user of recyclable material. The survey also asked respondents to identify the types of processing and end-use activities that occur at their facility, selecting from the processing activities and end-use activities listed in Table 2-2. In some cases, facilities reported more than one processing or end-use activity. For definitions of these recycling activities, please refer to Appendix A.

TABLE 2-2: RECYCLING ACTIVITIES

Processing Activities	End-Use Activities
C&D Debris Processing Electronics Processing Household Hazardous Waste Collection Material Recovery Scrap Metal Processing Textile Processing Tire Processing	Compost/Mulch Production Glass Beneficiation Glass Containers Manufacture Fiberglass Manufacture Plastics Reclamation Plastics Product Manufacture Pulp, Paper, or Paperboard Secondary Metals Smelter, Melter or Product Fabrication Textiles End-Use Construction & Demolition Debris End-Use Recycled Tire Product Manufacture/End-Use Other Manufacturer or End-Use

How Was Double Counting Prevented?

With any effort to collect recycling information, it is critical to avoid double counting material. Double counting can occur when material flows from one respondent to another and is reported by multiple entities. The Project Team employed the following rigorous process to eliminate double counting:

- **Confirmed understanding of the flow of materials in Texas.** The Project Team included staff familiar with recycling markets who, during the stakeholder engagement process, confirmed their understanding of Texas-specific flows for each material included in the survey.
- **Focused analysis on select points in the recycling value chain.** Understanding the flow of materials allowed the Project Team to pinpoint specific facility types in the recycling value chain for each material. For instance, to collect data on recycled paper, the Project Team targeted material recovery facilities (MRFs), as well as paper mills, suppliers, and brokers to capture material that does not go through MRFs (i.e. direct-to-mill material). The Project Team focused on large, commercial MRFs rather than smaller, local MRFs because the recycled materials from the smaller MRFs are generally shipped to other processors and end users, so their volumes were largely accounted for in the results from those facilities.
- **Asked respondents to report material shipped to other Texas-based processors rather than an end user.** If a respondent indicated that they shipped material to other processors, the survey required the respondent to list the processors. After the close of data collection, the Project Team conducted a comprehensive double-counting review using this information and removed all material that was reported by multiple entities.

What Was the Reporting Period?

The Study survey asked respondents to provide data for January 1 through December 31, 2015. In the event that data for this reporting period was not available for a particular facility, respondents provided data for an alternate 12-month period. Some respondents provided data for the State's fiscal year of September 1, 2014, through August 31, 2015[4] (FY 2015). Disposal data was provided on the State fiscal year basis.

4. Fiscal year data responses were considered representative of a full year of data and used in their entirety.

How Were Imports and Exports Taken into Account?

The intent of the survey was to capture recycled materials generated in Texas. To account for material generated in Texas that is transported outside of Texas for processing or end use (i.e., exported), the Project Team identified key facilities outside of Texas to include in the survey. These facilities are primarily in surrounding states, including Oklahoma, Arkansas, and Louisiana, plus a small number of facilities in other states. The Project Team did not target facilities outside of the United States to participate in the survey, but it did review export and import data available through the U.S. Census Bureau, specifically for ferrous and non-ferrous metals.

To account for material generated outside of Texas that is transported to Texas for processing or end use (i.e., imported), the Project Team asked respondents to indicate on the survey the percentage of reported materials generated outside of Texas. These materials were excluded from the survey data.

What Were the Reporting Units?

In completing the survey, respondents could select from the following available reporting units: tons (preferred), pounds, compacted cubic yards, uncompacted cubic yards, gallons, tires, or other (must specify). The Project Team converted all reported units to tons.

2.4 IDENTIFYING TARGETED FACILITIES

TCEQ and the Project Team gathered information from a variety of sources to compile the list of facilities targeted for the survey. Primary sources included Burns & McDonnell's database from TRDI, as well as composting, recycling, and other processing facility databases from TCEQ.

Certain recycling facilities are not required to obtain a permit or registration but must only provide notification of intent to operate a recycling or composting facility. TCEQ provided a list of these facilities to include in the survey.

It is important to note that, while TCEQ maintains records of permitted and registered recycling facilities and requires certain facilities to submit notification, these records cannot be considered a comprehensive list of recycling facilities in Texas. There are factors that allow certain facilities to be exempt from permitting, registration, and notification. To compile a comprehensive list of targeted facilities, as well as to obtain contact information for facilities identified through regulatory sources, the Project Team relied on industry experience, the RIC, and the supplementary sources of data described below.

Data from Supplemental Sources

Rather than "reinvent the wheel," the Project Team utilized data from specific supplemental sources. Data from the U.S. EPA and the ISRI were used as well as the sources identified in Table 2-3.

TABLE 2-3: SUPPLEMENTAL DATA SOURCES

Material	Data Source
Biosolids	TCEQ annual reports for Class B biosolids and water treatment plant sludge
Diverted Material – MSW Landfills	TCEQ annual reports for material diverted at landfills. The Project Team focused on landfills that reported more than 100 tons of diverted material.
Diverted Material – MSW Processors	TCEQ annual reports for material diverted at transfer facilities and other processors. The Project Team focused on facilities that reported more than 100 tons of diverted material.
Paper	American Forest and Paper Association
Plastics	Association of Postconsumer Plastic Recyclers, National Association for PET Container Resources
Glass	Glass Packaging Institute
Ferrous Metals	U.S. Geological Survey, U.S. Census Bureau (export data as compiled by Argus Metals Prices)
Electronics	Texas Recycles Computer Program, Texas Recycles TVs Program
Tires	TCEQ Scrap Tire Annual Report
Household Hazardous Waste (HHW)	TCEQ annual HHW reports

3.0 RECYCLED TONS AND RECYCLING RATE

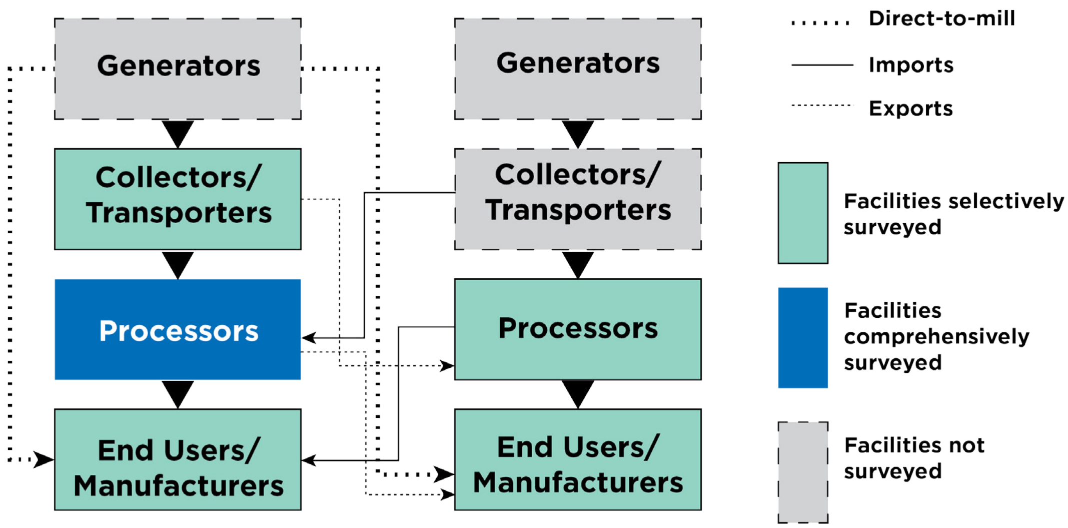
This section presents an overview of the recycled material value chain and how it was used for the purpose of this Study. The survey results are presented in individual material summaries with an explanation of how the Project Team arrived at these totals.

The survey showed approximately 9.2 million tons of recycled Texas material in 2015, which represents a difference of 3.0 million tons of recycled MSW in comparison to the 2013 TRDI study results. The 9.2 million Texas-recycled tons are based on data collected through the Study survey as well as supplemental data received from other sources. The data does not include any extrapolation of tons recycled, but only what was documented through the overall Study effort. Section 3.4 provides a detailed comparison between the results from this Study and the TRDI survey.

3.1 RECYCLED MATERIAL VALUE CHAIN

Figure 3-1 is a conceptual illustration of the recycled material flows analyzed for the Study based on TRDI and describes the approach and anticipated degree of surveying with each point in the recycled material value chain.

FIGURE 3-1: RECYCLED MATERIAL CHAIN



The Project Team's intent was to measure the quantity of material generated in Texas that ultimately is recycled, whether inside or outside of Texas. To measure these quantities, the survey focused primarily on Texas-based processors and end users/manufacturers. In addition, the Project Team collected data on recycled household hazardous waste (HHW) from HHW collection facilities. Last, the Project Team identified key out-of-state processors and end users to participate in the survey to capture material that is transported out of Texas that would have otherwise been missed.

Generators

Generators of MSW recyclables include residential homes (such as single-family dwellings and apartment buildings), commercial (businesses such as restaurants, office parks, and retail stores), and institutions (such as hospitals, universities, and government facilities). As indicated in Figure 3.1, MSW generators were not surveyed for this Study. In addition, as discussed in Section 2.3, a goal of the Study was to collect data on materials that, if not recycled, would have been considered MSW. Therefore, non-MSW materials, such as industrially generated waste, were not included in the survey.

Collectors/Transporters

The recycling industry in Texas has a dynamic collection infrastructure that includes hundreds of private and public enterprises providing collection and transport services, such as residential recyclables from municipal curbside and drop-off recycling programs, paper from office buildings, and metals from auto shops and commercial facilities. It also includes large retailers and grocery stores that bale material, mostly cardboard, and transport it directly to end users. For efficiency and to prevent double counting in measuring Texas recycling, the Project Team primarily focused on gathering data from processors, not collectors/transporters.

Texas-Based Processors

As reflected in Figure 3-1, Texas-based processors were a key focus of the Study survey effort. Processors of recyclables (such as MRFs, C&D MRFs, electronics processing facilities, textile processing facilities, and tire processing facilities) focus on disassembling, sorting, shredding, baling and/or otherwise preparing recycled materials to be sold to end users. While some recyclables may be exported to processing facilities in neighboring states, the vast majority of Texas-generated recyclables are shipped to facilities within the state. In an effort to focus on material generated in Texas, the survey asked respondents to identify the percentage of their processed material that was imported from outside of Texas. Any materials originating from outside of the State were excluded from the reported results.

MRFs processing typical recyclables — glass, metals, paper, and plastic — were a significant source of data for this Study. The Project Team identified and targeted 28 MRFs to participate in the survey. These facilities process large quantities of material through long-term processing agreements with municipalities as well as commercial accounts. Of these 28 MRFs, 25 responded to the survey or data was available from supplemental sources. The three unresponsive facilities are thought to be smaller than the MRFs that responded to the survey. Therefore, the data presented in this report includes data for almost all of the MRFs in Texas.

Texas-Based End Users

Although large quantities of Texas-generated recyclables are shipped to other states or countries for use in manufacturing, the State is home to several end users that consume recycled feedstocks to make new products. There are two glass container manufacturing plants and two fiberglass insulation plants. Other end users include: five paper or paperboard mills, five steel mills, several small foundries and smelters consuming ferrous or non-ferrous scrap metal, and a variety of plastics converters.

Texas is also home to two glass beneficiation facilities, several plastics reclamation facilities, and a large number of compost and mulch production facilities that were considered recycled material end users in this Study. These three categories are sometimes classified as processors in recycling studies, but were defined as end users in the survey because it helped to simplify responses in the online form. End users were included in the survey primarily to capture material that does not flow through a processing facility but comes in directly from generators. In some cases, end-user responses also helped to validate recycling quantities based on processor responses alone.

Out-of-State Processors

A relatively small quantity of material that is generated in Texas is transported outside of Texas to be processed. Therefore, the Project Team, in coordination with stakeholders, identified key out-of-state processing facilities to participate in the survey.

Out-of-State End Users

There are several key end users outside of Texas that source recyclables generated in Texas. Therefore, the Project Team, in coordination with stakeholders, identified key out-of-state end users and manufacturers to participate in the survey.

3.2 RECYCLING RATE

An objective of this Study was to not only measure recycling in Texas, but to also provide an update to the recycling rate measured during the TRDI study. A recycling rate indicates what percentage of waste generated is recycled and is typically calculated using the following formula:

Total Recycled / (Total Recycled + Total Disposed) = Percent Recycling Rate

To calculate a recycling rate, the Project Team determined the tons of MSW disposed for FY 2015[1]. It should be noted that the disposal numbers reported by MSW landfills in Texas include non-hazardous industrial waste as well as tons imported from out of state, but the Project Team excluded these amounts from the estimate for FY 2015, which totaled 31,049,545 tons. The total disposed tonnage used in the recycling rate calculation represented FY2015 while the total recycled tonnage used represents the calendar year 2015 total. It should also be noted that the recycling rate was based on the recycled tonnages reported in the survey and is, therefore, a conservative estimate. **Based on the tons of MSW recycling reported for this Study, the 2015 recycling rate for Texas was 22.7 percent, which is 3.8 percent more than the recycling rate from the TRDI study.** The TRDI study accounted for 26,380,522 tons of disposed MSW, which suggests that the disposal rate increased by 17.7 percent from 2013 to 2015. While not evaluated in detail for this Study, this increase in disposal tonnages may be attributed to the growing population and economy in Texas. Figure 3-2 shows the quantities by material type.

In evaluating the recycling rate, it is important to note that a number of other states report recycling quantities and rates, but comparing this information across states is notoriously challenging and can be misleading. Table 1-1 in the Executive Summary identifies multiple points to consider when seeking to understand the reported recycling rate for Texas and when making comparisons to other states or national numbers provided by U.S. EPA. Key points to consider include the varying definitions of recycling, whether a survey is voluntary or mandatory, addressing double counting, addressing data gaps/extrapolation, accounting for residuals, generators included, and counting industrial materials. For each of these points, this Study erred on the side of being conservative, which likely means that this reported recycling rate for Texas is understated.

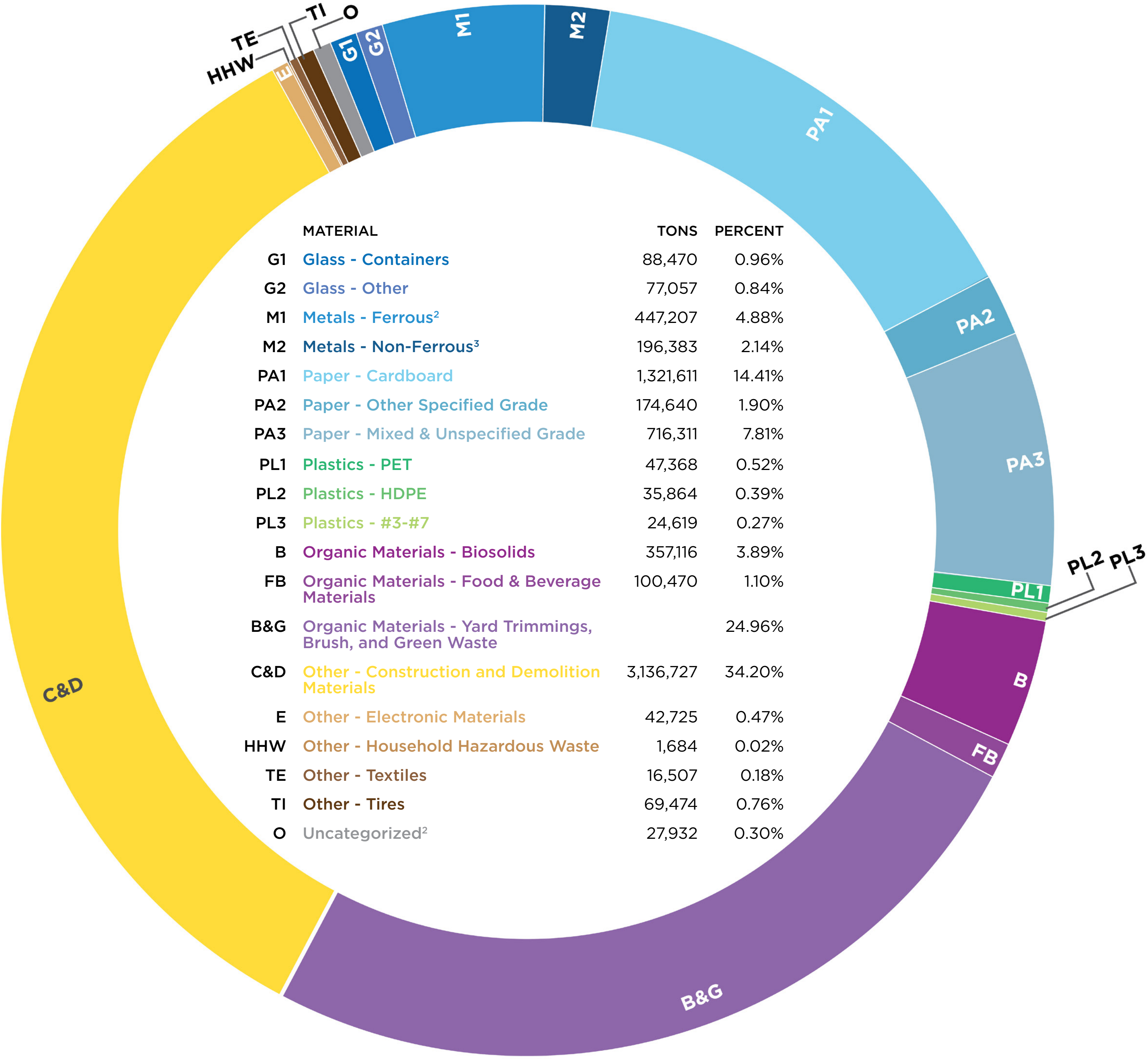
3.3 MATERIAL SUMMARIES

The following sections provide a material-by-material summary of the tons documented through the Study and the relative quality of data received. For each material, the Project Team has included:

- **Total Tons:** Includes the tons reported through the survey and from supplemental data sources
- **Confidence:** Addresses the degree of comprehensive responses to the survey
    - **Strong:** Tonnages reflect a substantial percentage of the Texas facilities that process this material.
    - **Moderate +:**
        - As applicable to ferrous and non-ferrous metals: Tonnages reflect estimated MSW portion of total tonnage from all sources, which includes the estimated scrap metal tonnage from C&D materials.
        - As applicable to yard trimmings, brush, and green waste; paper; and C&D: Tonnages reflect a greater level of response in comparison to the TRDI study, yet represent a lower percentage of the Texas facilities than those categorized under the Strong confidence level.
    - **Moderate:** While significant tonnages were reported, there were multiple facilities that did not respond to the survey.
- **The Story:** Summarizes a description of the material with examples, the major material sources and how they flow through the recycling industry even as they move in and out of Texas and the types of facilities targeted in the survey
- **Survey Data:** Includes the number of tons reported through the survey, the number and types of facilities represented, and a discussion of quality of data received and potential remaining data gaps
- **Supplemental Data:** Includes the number of tons documented through supplemental data sources and the number of facilities represented
- **Tonnage Comparison to TRDI:** Documents the 2013 TRDI recycled material tonnage versus the recycled material tonnage resulting from this Study. If the tonnages are significantly different, this section includes an explanation as to the difference.

1. While landfill data was provided on a fiscal year basis, the recycling data requested for the Study survey was primarily provided on a calendar year basis in order to streamline the reporting process for respondents.

FIGURE 3-2 MATERIAL RECYCLED IN 2015

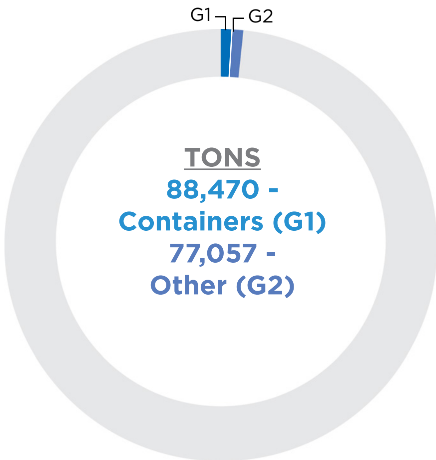


	MATERIAL	TONS	PERCENT
G1	Glass - Containers	88,470	0.96%
G2	Glass - Other	77,057	0.84%
M1	Metals - Ferrous[2]	447,207	4.88%
M2	Metals - Non-Ferrous[3]	196,383	2.14%
PA1	Paper - Cardboard	1,321,611	14.41%
PA2	Paper - Other Specified Grade	174,640	1.90%
PA3	Paper - Mixed & Unspecified Grade	716,311	7.81%
PL1	Plastics - PET	47,368	0.52%
PL2	Plastics - HDPE	35,864	0.39%
PL3	Plastics - #3-#7	24,619	0.27%
B	Organic Materials - Biosolids	357,116	3.89%
FB	Organic Materials - Food & Beverage Materials	100,470	1.10%
B&G	Organic Materials - Yard Trimmings, Brush, and Green Waste		24.96%
C&D	Other - Construction and Demolition Materials	3,136,727	34.20%
E	Other - Electronic Materials	42,725	0.47%
HHW	Other - Household Hazardous Waste	1,684	0.02%
TE	Other - Textiles	16,507	0.18%
TI	Other - Tires	69,474	0.76%
O	Uncategorized[2]	27,932	0.30%

TOTAL: 9,171,707 TONS

2. The number shown in the table represents the portion of material that is MSW.
3. Includes all materials classified as “Other” by survey respondents. Respondents were required to provide a description. Respondents primarily reported commingled recyclables and commingled organic materials.

GLASS



confidence: strong

The Story

Much of the recycled glass in Texas flows through MRFs to a small number of glass beneficiation facilities, which provide secondary processing to further prepare the material for end users. While most recycled glass containers in Texas flows through MRFs, some (mainly commercial window and plate glass) flows directly from generators to beneficiation facilities. To obtain a complete understanding of the quantity of glass recycled in Texas, the Project Team surveyed MRFs, glass beneficiation facilities (secondary processors), and end product manufacturing facilities (including two container and two fiberglass insulation plants that consume recycled glass cullet). The team also analyzed the data in detail to eliminate double counting while being as complete as possible.

Survey Data: 165,527 tons

Facilities Responding

38 total facilities

- 22 MRFs
- 11 landfills and transfer/collection stations
- 5 end-use facilities, including glass beneficiation and end product manufacturing facilities

The Project Team obtained data from 22 MRFs in Texas (as not all of the MRFs surveyed accept glass). Large commercial MRFs process material via long-term processing agreements with municipalities as well as commercial accounts. Therefore, they handle a large portion of Texas recycled glass. Additional quantities may also be recovered directly from auto shops and contractors. The Project Team believes the glass survey data presented above, which has been adjusted to eliminate double counting and residuals left over after processing, represents the vast majority of Texas glass that was recycled through MRFs in 2015. Of the 165,527 total tons, 88,470 tons are glass containers and the remaining 77,057 tons are other glass.

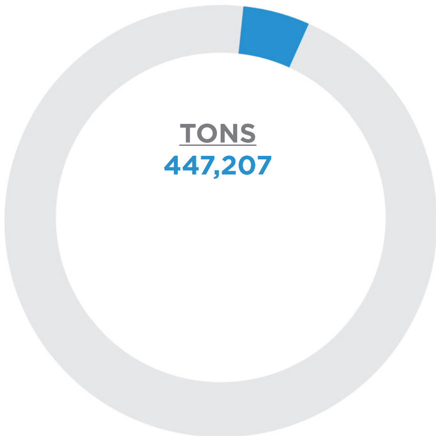
Supplemental Data

The Project Team relied on the survey to collect all data related to glass and did not identify available supplemental sources of statewide data covering Texas. However, information from the Glass Packaging Institute was used to confirm the list of Texas-based recycled glass end-use facilities.

Tonnage Comparison to TRDI

The 2015 estimate Study result for recycled glass is 21 percent higher than the 2013 estimate study result of 137,222 tons. The Project Team believes this is probably a result of a more complete survey response rather than an actual increase in Texas glass recycling.

METALS - FERROUS



confidence: moderate +

The Story

Ferrous scrap is generated from a wide variety of sources and includes auto bodies, appliances, industrial equipment, and other discarded parts and products, as well as relatively small quantities of steel cans that are used as packaging. While steel cans are likely to be processed at MRFs, most other ferrous scrap is collected by one of the over 600 scrap metal processors. Many of these processors are small and may sell their material to a small number of larger processors. Ferrous scrap flows to one of five steel mills in Texas or to one of several small foundries in the State. Significant quantities are also shipped to consumers in other states or countries.

Due to the availability of existing government data sources, the complexity of material flows, and the significant confidentiality concerns in the scrap metal industry, the Project Team used a combination of Study survey data and supplemental data to estimate

Survey Data: 67,376 tons from MSW sources

Facilities Responding

97 total facilities

- 25 MRFs
- 32 landfills
- 20 transfer stations
- 15 C&D processing facilities
- 4 electronics processors
- 1 HHW collection facility

Most of the ferrous metals reported through the survey came from responsive C&D processing facilities, with lower quantities of materials reported by other facility types. The Project Team obtained data from 25 MRFs in Texas. However, most ferrous metals are processed by scrap metal processing facilities, which the Project Team determined were not feasible to comprehensively survey. Consequently, supplemental data was used in addition to the survey data.

Supplemental Data: 379,931 tons from MSW sources

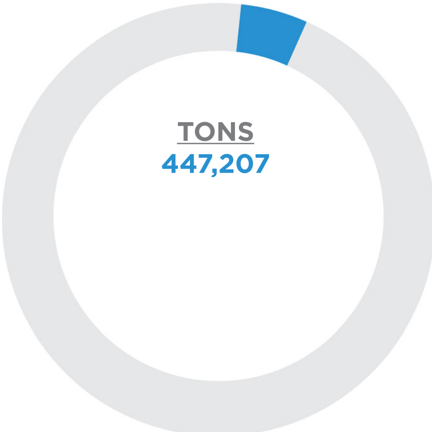
Facilities Responding

- 5 steel mills
- Over 600 registered scrap metal processing facilities and steel foundries

Based on analysis of existing data obtained by the Project Team from the U.S. Geological Survey (USGS), the U.S. Census Bureau (as compiled by Argus Metal Prices), and interviews with numerous ferrous metal processors, steel mills, and other industry representatives, the total quantity of Texas-generated ferrous scrap metal recycled in 2015 was estimated to be 4,885,375 tons. However, this estimate includes material that does not meet the definition of MSW used in this Study. The Project Team calculated the portion of this total that should be considered MSW, based on the State of Texas definition, through a two-step process. First, the Project Team estimated that on average about 7.9 percent of all recovered ferrous scrap metal was generated by residential and commercial generators, which is how U.S. EPA defines MSW. This percentage was calculated by dividing the U.S. EPA's most recent estimate for ferrous metal MSW recycled (5.8 million tons[4]) by ISRI's most recent estimate for all ferrous scrap metal processed (73.9 million tons[5]). Multiplying total recycled ferrous scrap metal (4,885,375 tons) by 7.9[6] percent, the Project Team estimated that 386,307 tons were generated by residences and commercial businesses. Second, because Texas includes C&D from non-industrial sources in its definition of MSW but U.S. EPA does not, the Project Team added 60,900 tons, a conservative estimate of recycled ferrous scrap that was sourced from C&D activities, resulting in 447,207 tons as the estimate for ferrous scrap recovery meeting the Texas definition of MSW. Therefore, the MSW tonnage derived from supplemental data sources is equal to the

4. "Municipal Solid Waste in the United States: Facts and Figures (2014)." U.S. Environmental Protection Agency. Available online at https://www.epa.gov/sites/production/files/2016-11/documents/2014_smm_tablesfigures_508.pdf.
5. "The ISRI Scrap Yearbook 2016." Institute for Scrap Recycling Industries Inc. 2016. Available at: http://www.isri.org/recycling-industry/commodities-specifications#.V__kWiQXTcD
6. Percentage rounded. Actual = 7.90741754727119%

METALS - FERROUS (CONT.)



confidence: moderate +

The Story (cont.)

the total amount of ferrous metal recycled.

An estimated total of 4,885,375 tons of ferrous scrap from all sources (includes industrial and MSW) was recovered, and the MSW portion of this amount is estimated at 447,207 tons.

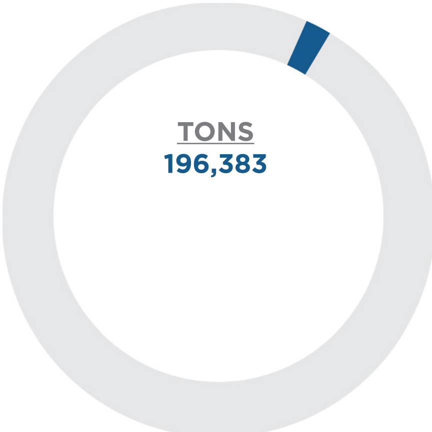
total estimated MSW ferrous scrap metal recovered (447,207 tons) minus the amount derived from the survey data shown above (67,276 tons), or 379,931 tons.

Tonnage Comparison to TRDI

The Study showed Texas recycled ferrous metals from all sources at an estimated 4.9 million tons. This is 17 percent less than the 2013 TRDI result of 5.9 million tons. This is likely due to the strong decline in scrap metal demand and prices over the past two years, and is similar to the 13 percent decline reported by ISRI.

On the other hand, the Study's estimate for Texas recycled ferrous metals from MSW sources was 16 percent higher than the 2013 TRDI estimate of 386,876 tons. This increase is mainly a result of the methodology change to include C&D sourced ferrous scrap metal. Without this change, the MSW estimate would have been 386,307 tons, almost exactly the same as the 2013 TRDI estimate. This flat trend for MSW ferrous metal (excluding C&D as defined by U.S. EPA), even as industrially-sourced ferrous metal declined, is not unexpected since residential recovery is far less sensitive to changes in markets and pricing than industrial generated scrap.

METALS - NON-FERROUS



confidence: moderate +

The Story

Non-ferrous scrap metal is generated from a wide variety of sources, including industrial equipment, miscellaneous parts and products, aluminum cans and other packaging. While aluminum cans are likely to be processed at MRFs, most other non-ferrous scrap metal is collected by one of over 600 scrap metal processors. Most of these processors are small and may sell their material to larger processors. Small amounts of non-ferrous scrap metal are consumed by processors in Texas, but the majority is shipped to consumers in other states or countries.

Due to the complexity of material flows and the significant confidentiality concerns in the scrap metal industry, the Project Team developed an alternative approach involving detailed analysis of information on Texas non-ferrous scrap metal flows. Data was gathered confidentially with support from the RIC representatives from large scrap metal processors, end users, and others involved in the Texas scrap metal

Survey Data: 18,060 tons from MSW sources

Facilities Responding

97 total facilities

- 25 MRFs
- 32 landfills
- 20 transfer stations
- 15 C&D processing facilities
- 4 electronics processors
- 1 HHW collection facility

Based on online surveys, the Project Team was able to document 18,060 unique tons of non-ferrous metal recycled by responding companies (i.e., tons that were not sent to other Texas-based processors).

Supplemental Data: 178,323 tons from MSW sources

Facilities Responding

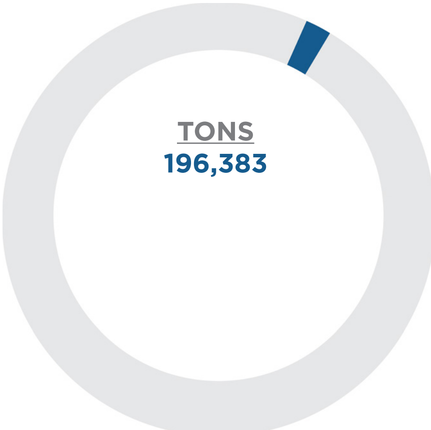
- 23 Texas-based shredders
- 88 large Texas scrap metal processing facilities

The Project Team relied heavily on information provided by several large processors, shredder operators, and other industry representatives, as well as data collected through the survey. Similar to the ferrous metals methodology, the Project Team also considered data on nonferrous metal exports and imports from the U.S. Census Bureau, but no other third party existing data sources covering Texas were available. Most non-ferrous metal not captured in this survey flows through over 600 scrap metal processors, but most of these processors ship materials to 88 of the largest processing facilities. To estimate this tonnage, the Project Team worked closely with RIC members who were able to estimate tonnages for 88 facilities operated by 22 companies, either through direct communications with the facilities or through third party sources and their personal experience working with these firms.

In a similar manner, the Project Team also estimated the flow of non-ferrous scrap metal from 23 Texas-based shredders. Although shredders primarily handle ferrous metals from scrap automobiles, approximately 85 pounds per ton of shredder output is considered "zorba," an industry term for the portion of shredder residue comprised mainly of aluminum and other nonferrous metals. Based on this information, the Project Team estimated that 706,052 tons of Texas-generated non-ferrous scrap metal was recycled by these facilities in 2015, including copper, nickel, aluminum, lead, zinc, tin, and stainless steel. However, this number includes non-MSW scrap metal. Of this amount, the Project Team estimated that 23.1 percent, or 163,098 tons, can be considered recycled MSW as defined by U.S. EPA.

To calculate this percentage, the Project Team first divided the U.S EPA's most recent estimate for non-ferrous metal MSW recycled (2.1 million tons) by ISRI's most recent estimate for all non-ferrous scrap

METALS - NON-FERROUS (CONT.)



confidence: moderate +

The Story (cont.)

recycling industry. An estimated total of 724,112 tons of non-ferrous scrap metal from all sources was recovered, with the MSW portion of this amount estimated at 196,383 tons.

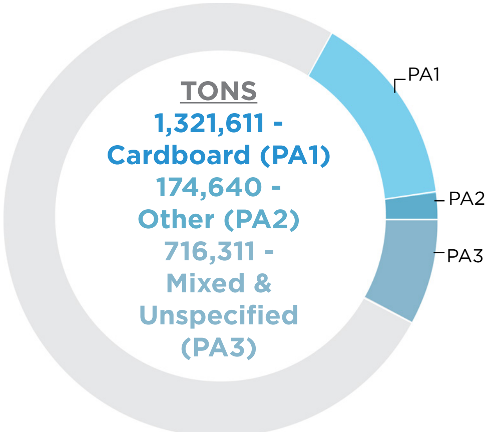
metal processed (8.9 million tons). Because Texas includes C&D from non-industrial sources in its definition of MSW, but U.S. EPA does not, the Project Team also added 15,225 tons as a conservative estimate of the quantity of nonferrous scrap metal sourced from C&D activities. This estimate assumes that the quantity of nonferrous scrap metal sourced from C&D activities is about 25 percent of the amount of ferrous scrap metal sourced from C&D activities, as described above.

These tonnages are in addition to the 18,060 tons documented in the survey data. Therefore, a total of 196,383 tons of nonferrous metals from the MSW stream was estimated to have been recycled in Texas in 2015, with 178,323 tons documented through supplemental sources, as opposed to online survey responses.

Tonnage Comparison to TRDI

The Study result for Texas recycled non-ferrous metals from all sources is 18 percent higher than the 2013 TRDI result of 616,054 tons. The Study result for Texas recycled nonferrous metals from MSW sources is 25 percent higher than the 2013 TRDI result of 157,709 tons. These increases, even in the face of a down market, are due to refinements to the 2013 TRDI study methodology that allowed for more robust estimates of all flows. In particular, the Project Team obtained more detailed information through industry interviews conducted through RIC members on the recovered quantities of stainless steel, a nonferrous material, and zorba, the nonferrous shredder residue described above.

PAPER



confidence: moderate +

The Story

Post-consumer recycled paper – including newspaper, cardboard, office paper, and food cartons – is generated from residences through curbside and drop-off recycling programs, and from commercial paper recycling service providers. Much of it is processed at MRFs and/or paper stock dealers in Texas. But significant amounts (mainly cardboard) are also recovered and baled at large retailers and grocery stores, which are often shipped directly to mills or brokers, by-passing MRFs. Recovered paper flows are complex. Paper and paperboard mills located in Texas consume recovered paper that they receive from both in-state and out-of-state suppliers. Significant quantities of recovered paper are sent from Texas to other states or exported from ports in Texas and California to other countries, including Mexico and overseas. An unknown portion of paper exported from Texas ports originated in other states. Many paper manufacturers operate collection and/or processing activities in Texas, while many others rely on brokers to procure supply.

To collect data on recycled paper in Texas, the Project Team first considered MRFs and incidental amounts of paper reported by other facility types. The Project Team then added significant quantities of direct-to-mill material reported by paper mills and supply companies in Texas and nearby states.

Survey Data: 2,212,562 tons

Facilities Responding

70 total facilities

- 25 MRFs
- 34 landfills and transfer/collection stations
- 11 paper mills and mill-affiliated supply operations in Texas, Oklahoma, and Louisiana

The Project Team obtained data from 25 MRFs in Texas. Large commercial MRFs process material via long-term processing agreements with municipalities, as well as commercial accounts. Therefore, the results represent a comprehensive understanding of the quantity of paper flowing through MRFs in the State. There was also a strong response from several mills and affiliated recovered paper supply operations in Texas and surrounding states. However, there were at least two companies that operate mills or that may source supply from Texas that were unresponsive. Moreover, significant quantities of recovered paper may be handled by brokers or other firms that were not identified as specifically operating in Texas. Therefore, the reported tons for paper are likely understated. Of the total 2,212,562 tons of paper reported, 1,321,611 tons were cardboard, 174,640 tons were other specified grades of paper, and 716,311 tons were mixed and unspecified grades of paper.

The Project Team believes that the volume of paper that was reported in the other specified grades category is largely office paper, but was not able to determine this with certainty.

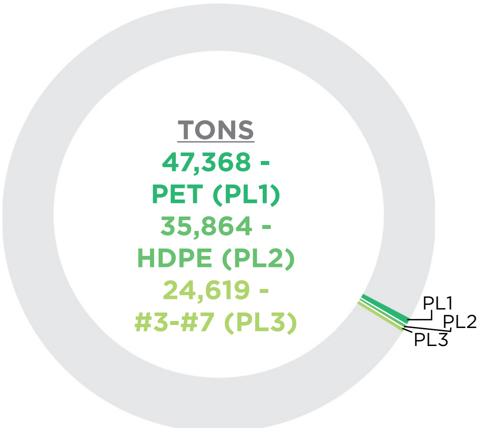
Supplemental Data

The Project Team relied on the survey to collect all data related to paper and did not identify available supplemental sources of statewide data covering Texas.

Tonnage Comparison to TRDI

The Study result for recycled paper is 53 percent higher than the 2013 TRDI result of 1,444,632 tons. The Project Team believes this is probably a result of a more complete survey response rather than an actual increase in Texas paper recycling.

PLASTICS



confidence: strong

The Story

Much of the recycled post-consumer plastic in Texas flows through MRFs. In addition, there are a small number of plastic reclamation facilities, which provide secondary processing for a small portion of Texas recycled plastic to further prepare the material for end users. Recycled plastic flows are very complex. Many reclaimers handle a mix of pre- and post-consumer material, and significant quantities of material flow into and out of Texas, including flows between reclaimers, which often also act as converters (i.e., manufacturers). Therefore, to collect data on the amount of Texas plastic recycled, the Project Team focused on the MRF survey responses.

Survey Data: 107,851 tons

Facilities Responding

57 total facilities

- 25 MRFs
- 20 landfills and transfer stations
- 12 plastics reclamation facilities

The Project Team obtained data from 25 MRFs in Texas. Large commercial MRFs process material via long-term processing agreements with municipalities, as well as commercial accounts. Therefore, the plastic data presented in this report represents the majority of the plastic that is recycled through MRFs in the State. The Project Team did survey plastic reclamation facilities; however, lower priority was placed on these facilities since the Project Team determined these facilities primarily process pre-consumer material with a large portion imported from out-of-state. The majority of post-consumer plastic recovered in Texas is shipped to reclaimers in other states. Of the total 107,851 tons reported, 47,368 tons were PET, 35,864 tons were HDPE, and 24,619 tons were plastics #3-7.

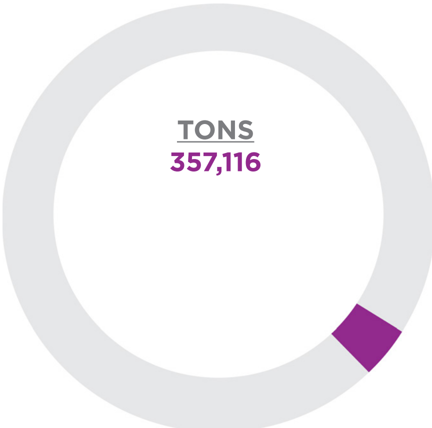
Supplemental Data

The Project Team relied on the survey to collect all data related to plastic and did not identify available supplemental sources of statewide data covering Texas.

Tonnage Comparison to TRDI

The Study result for recycled plastic is 36 percent lower than the 2013 TRDI result of 169,216 tons. In 2013, multiple facilities were recovering low grade plastic film used in packaging that was no longer financially viable for recovery in 2015 due to a lack of end market demand, which may be the reason for this decrease. Another reason for the decrease may be due to manufacturers utilizing less material in their products.

ORGANIC MATERIAL - BIOSOLIDS



confidence: strong

The Story

Wastewater biosolids are managed in a variety of ways in Texas, including landfill disposal, land application, and composting. Biosolids may be combined with yard trimmings, brush, green waste or other bulking agents to produce nutrient-rich compost. To collect data for biosolids, the Project Team focused on surveying compost/mulch production facilities and contacting landfills. Some facilities may have included biosolids in their total volume of organics, which also includes green waste and food and beverage material.

Survey Data: 260,116 tons

Facilities Responding

5 total facilities
- 2 landfills
- 3 compost/mulch production facilities

The five responsive facilities are among the largest municipal composters of biosolids in Texas. Conducting a comprehensive survey of compost/mulch production facilities in Texas is a significant challenge. There is a large number of relatively small facilities, many of which are exempt from regulatory authorizations (e.g., notification, registration or permit). Of the 41 compost/mulch production facilities that responded to the survey, three accept biosolids. There were 84 known and/or registered compost/mulch production facilities that did not respond to the Study survey. The Project Team expects that very few of these facilities, if any, process biosolids.

Supplemental Data: 97,000 tons

Facilities Represented in Data

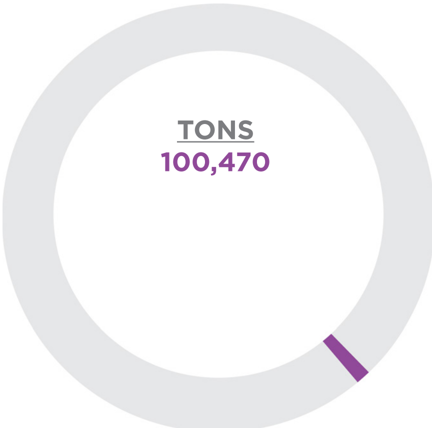
- 58 Class B biosolid treatment sites
- Several water treatment sites

The Project Team incorporated data from TCEQ regarding biosolids that were collected at landfills, as well as biosolids that were land applied in Texas in fiscal year 2015. This data only included Class B biosolids and water treatment plant sludge. The volume of sludge used for land application is reported by the land applicator and not the treatment plant. TCEQ does not have a database in place for the applicator to track the treatment plants that are the source of the sludge, so the number of facilities is unknown. Class A and Class AB biosolids used beneficially for marketing and distribution purposes do not require a fee so TCEQ does not track their tonnage information.

Tonnage Comparison to TRDI

The Study result is 275 percent higher than the 2013 TRDI result of 95,291 tons. This was due to receiving data from one or more facilities that have a relatively large quantity of biosolids, as well as the inclusion of land-applied biosolids, which was not included in the 2013 TRDI survey.

ORGANIC MATERIAL - FOOD & BEVERAGE



confidence: strong

The Story

The primary method to divert discarded food and beverage materials from disposal is through composting. Select municipalities in Texas have developed curbside programs to divert food scraps generated from households. In addition, select food service establishments have developed programs to divert this material. In some cases, agricultural operations and food product manufacturers may divert pre-consumer food and beverage materials via composting. The Project Team asked that compost/ mulch production facilities report this material separately in order to distinguish between MSW and non-MSW material. However, many compost/ mulch production facilities were not able to separately report non-MSW materials; therefore, the total number of food and beverage materials reported does include some non-MSW material.

Survey Data: 100,470 tons

Facilities Responding

19 compost/mulch production facilities

The responsive facilities represent most of the major compost/ mulch production facilities in Texas that compost food and beverage materials.

As previously discussed under "Biosolids," conducting a comprehensive survey of compost/mulch production facilities in Texas is a significant challenge. Of the 41 compost/mulch production facilities that responded to the survey, 19 accept food and beverage materials. There were 84 known and/or registered compost/mulch production facilities that did not respond to the survey. However, the Project Team expects that very few of these facilities, if any, compost food and beverage materials. Therefore, the 19 facilities that responded to the survey were assumed to represent the majority of facilities that accept food and beverage materials for composting.

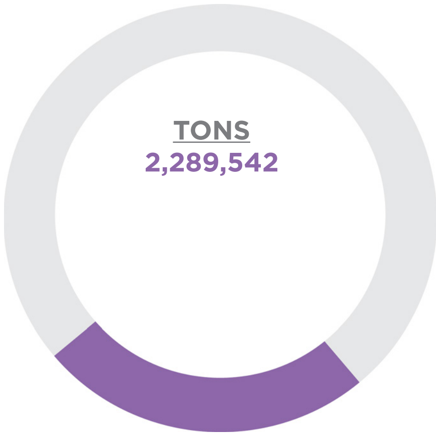
Supplemental Data

The Project Team relied on the survey to collect all data related to food and beverage materials and did not identify any available supplemental sources of statewide data covering Texas.

Tonnage Comparison to TRDI

The Study result is 408 percent higher than the 2013 TRDI result of 19,768 tons. This may be due to a continued emphasis to divert commercial and residential food and beverage materials away from disposal.

YARD TRIMMINGS, BRUSH & GREEN WASTE



confidence: moderate +

The Story

Municipal curbside collection programs, landscape companies, land clearing operations, and other entities are generators of yard trimmings, brush, and green waste. The primary means of recycling these materials is the production of mulch and compost. Therefore, the Project Team surveyed compost/mulch production facilities, landfills, transfer stations, and MRFs to collect data for this material type.

Survey Data: 2,289,542 tons

Facilities Responding

106 total facilities

- 2 MRFs
- 42 landfill-based compost/mulch production facilities
- 23 transfer station-based compost/mulch production facilities
- 39 compost/mulch production facilities

The 39 responsive compost/mulch production facilities are among the largest facilities in Texas. Conducting a comprehensive survey of compost/mulch production facilities in Texas is a significant challenge. There is a large number of relatively small facilities, many of which are exempt from regulatory authorizations (e.g., notification, registration or permit). Obtaining the cooperation of these very small facilities, which may have limited knowledge of the Study, is very difficult. There were 84 known and/or registered compost/mulch production facilities that did not respond to the survey. However, many of these are generally considered to be relatively small operations. Therefore, the 39 facilities that responded to the survey were assumed to represent the majority of facilities that accept yard trimmings, brush, and green waste for composting.

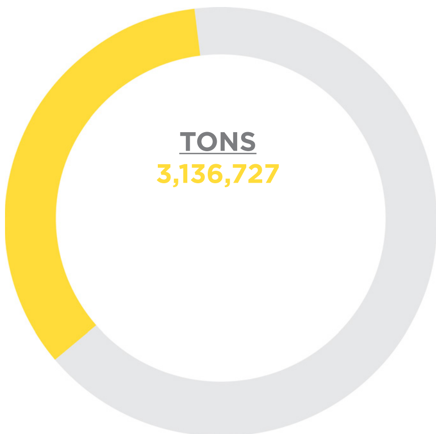
Supplemental Data

The Project Team relied on the survey to collect all data related to yard trimmings, brush, and green waste and did not identify available supplemental sources of statewide data covering Texas.

Tonnage Comparison to TRDI

The Study result is 136 percent higher than the 2013 TRDI result of 970,233 tons. This may be due to obtaining data from a greater number of facilities than those that responded to the 2013 TRDI survey. Also, several facilities that responded to the 2013 TRDI survey have significantly increased their quantities.

CONSTRUCTION & DEMOLITION



confidence: moderate +

The Story

Construction and demolition (C&D) materials are generated by new construction, demolition, and renovation of residential and commercial buildings. C&D material is primarily processed at facilities that specialize in handling commingled materials generated from these projects. Metal re-bar is separated from the concrete received and recycled as metal, not C&D material. In addition, some landfills have developed on-site recycling operations for this material. To collect data for C&D recycling, the Project Team focused on surveying C&D processing facilities and landfills.

Survey Data: 3,136,727 tons

Facilities Responding

40 total facilities

- 10 landfills
- 8 transfer stations
- 22 C&D processing facilities

The 40 responsive facilities include many of the larger C&D processing facilities in Texas, as well as recycling activity across different geographic regions. There were 18 unresponsive companies that did not respond to the survey, some of which are known by the Project Team to process significant tonnage. Because of the number of key facilities outstanding for this material type, the reported tons for C&D materials is likely understated.

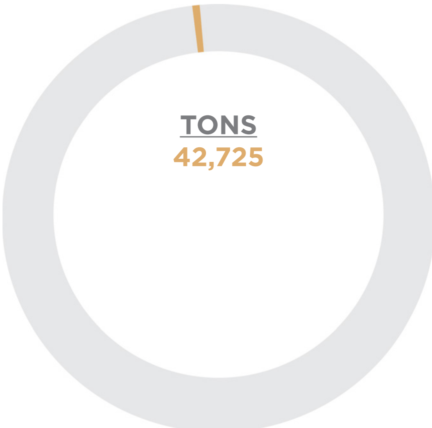
Supplemental Data

The Project Team relied on the survey to collect all data related to construction and demolition materials and did not identify available supplemental sources of statewide data covering Texas.

Tonnage Comparison to TRDI

The Study result is 39 percent higher than the 2013 TRDI result of 2,253,598 tons. This may be due to obtaining data from a greater number of facilities than those that responded to the 2013 TRDI survey. Also, several facilities that responded to the 2013 TRDI survey have significantly increased their quantities.

ELECTRONIC MATERIALS



confidence: moderate

The Story

Electronics materials are processed by facilities that deconstruct, shred, sort, bale and/or otherwise prepare electronics materials to be sold to end users, brokers or exporters. While there are many facilities that actively process electronic materials for recycling, many electronics are refurbished or reused (which was not covered by the Study). In addition, electronics processors will frequently buy from and sell materials to other electronics processors or other processors (such as plastics reclaimers or scrap metal processing facilities). The Project Team focused on surveying electronics processors and was vigilant to prevent double counting for this material. In addition, the Project Team identified available supplemental data available through TCEQ. All tons for this category were reported in aggregate and not broken down into constituent commodities, such as plastic and metal.

Survey Data: 21,107 tons

Facilities Responding

16 total facilities

- 8 landfills and transfer stations
- 8 electronics processing facilities

There were 16 large electronics processing facilities that responded to the Study survey, although the total number of electronics processing facilities in Texas was relatively large. There were 40 unresponsive electronics processors. There were inherent challenges to collecting data from electronics processors. For instance, many electronics processing facilities in Texas are part of national or multinational corporations that require corporate-level approval for the release of any data, so many companies were not able to participate because they were unable to obtain corporate approval. It should be noted that many of these facilities may focus significant efforts on reuse/refurbishment and have minimal recycling data to report.

Supplemental Data: 21,618 tons

Facilities Represented in Data

65 total facilities

- 35 computer manufacturers
- 30 television manufacturers

The Project Team incorporated data from the Texas Recycles Computers Program, which requires manufacturers of computers (including desktop and notebook computers, as well as monitors) to provide free and convenient recycling options for the products they sell in and into Texas. Manufacturers reported recycling 8,238 tons of electronics in 2015[7]. The program also reported a total of 3,714 tons of other electronic equipment was collected, but did not specify what amount was recycled. The Project Team assumed that all 3,714 tons were recycled.

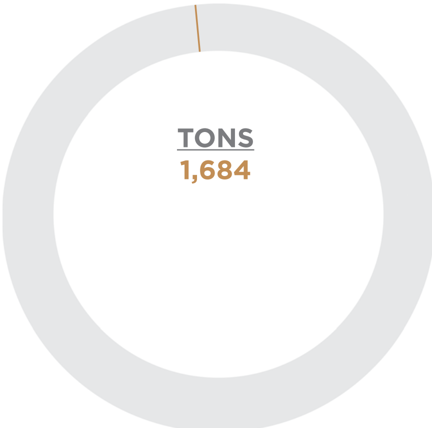
The Project Team also incorporated data from the Texas Recycles TVs Program, which is generally similar to the Texas Recycles Computers Program in that it requires manufacturers of televisions to provide recycling options for the products they sell in or into Texas. Manufacturers and retailers reported recycling 9,666 tons of electronics in 2015. For the purpose of this Study, the total tonnages of computers, other electronic equipment, and TVs were combined to represent the total of electronic materials recycled in 2015.

Tonnage Comparison to TRDI

The Study result is 9.6 percent less than the 2013 TRDI result of 47,271 tons. This may be due to a slight decrease in the number of facilities that responded to this Study survey, as compared to the 2013 TRDI survey. While there was an overall decrease in the total tonnage reported in comparison to the 2013 TRDI study, the supplemental tonnage from computer and television manufacturers increased. Also, the downward trend in the weight per unit of electronics may have also contributed to the decrease in the tonnage of electronics reported as recycled.

7. *Program Report on Texas Recycles Computers and Texas Recycles Television:* 2015 Report to the Legislature. Texas Commission on Environmental Quality. March 2016.

HOUSEHOLD HAZARDOUS WASTE



confidence: strong

The Story

Management of household hazardous waste (HHW) in Texas is primarily handled by local governments. To collect HHW data, the Project Team focused on surveying HHW collection facilities, most of which are owned and operated by local governments. It should be noted that a significant amount of material collected through HHW collection facilities is reused or appropriately disposed. Combined with the relatively low quantities of material generated, this is a reason that the quantity of material recycled in this category is relatively low compared to other categories.

Survey Data: 1,683 tons

Facilities Responding

11 total facilities

- 1 MRF
- 10 HHW collection facilities

The Project Team did not obtain a strong survey response from HHW processing facilities. However, the Project Team was able to develop a statewide estimate based on supplemental data. Survey results were not used because the data was considered redundant to the supplemental data obtained from the TCEQ.

Supplemental Data: 1,684 tons

Facilities Represented in Data

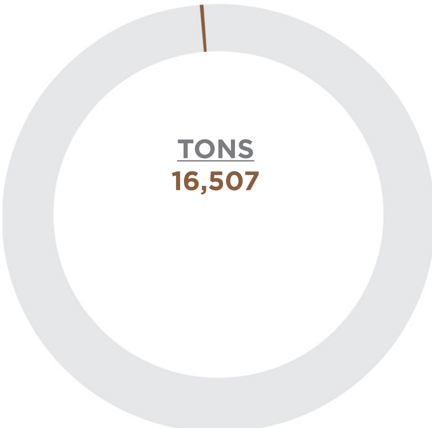
74 HHW collection programs

Under the TCEQ's HHW Program, authorized HHW facilities and processors must submit an annual report to TCEQ with the total volume of HHW that they recycle. While there are many responsible ways to manage HHW, this Study focused only on the processes that meet the Study's definition of recycling, which excludes energy recovery. Based on information provided in TCEQ's report, a total of approximately 8,089 tons were managed in Texas in 2015, of which an estimated total of 1,684 tons were recycled. Because this amount was nearly identical to the amount reported by survey respondents, the Project Team relied on TCEQ's total to represent HHW recycling in Texas. The survey results were considered redundant and were not counted.

Tonnage Comparison to TRDI

The Study result is 27 percent less than the 2013 TRDI result of 2,308 tons. This may be due to a greater level of scrutiny of the TCEQ supplemental data regarding the material that was actually recycled in comparison to another type of management, such as reuse or disposal. While more material was handled in 2015 than 2013, less of it was actually recycled.

TEXTILES



confidence: moderate

Survey Data: 9,257 tons

Facilities Responding

2 textile recyclers

Data was provided by two entities that recycle used clothing.

Supplemental Data: 7,250 tons

Facilities Represented in Data

80% of carpet collectors in Texas

Carpet America Recovery Effort (CARE) collects data from carpet recyclers in Texas and provided information collected from companies that represent a reported 80 percent of the companies in Texas.

Tonnage Comparison to TRDI

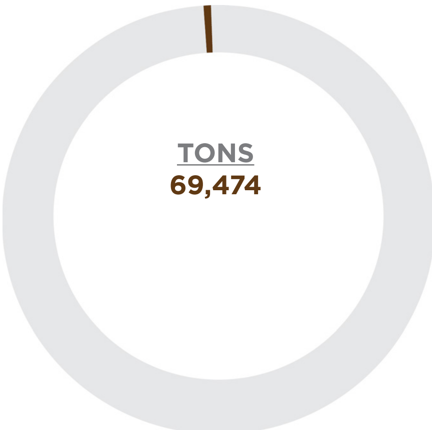
The Study result is two percent less than the 2013 TRDI result of 16,852 tons. This may be due to challenges associated with carpet recycling due to decreased oil pricing, as carpet is often recycled in place of incurring costs associated with purchasing new-oil based product. However, while the amount of carpet recycled decreased between 2013 and 2015, the amount of clothing recycled increased.

The Story

Textile recycling includes materials such as clothing, footwear, linens and carpet. According to Project Team research, the vast majority of discarded clothing, footwear, and linens is donated or otherwise reused. Multiple facilities did provide data on clothing recycling. In addition, a key material recycled in this category is carpet.

Recycled carpet is recovered directly by a collector that specializes in recycling carpet. Carpet cannot be mixed with other C&D materials and sorted at C&D processing facility. To collect data on recycled carpet, the Project Team worked with CARE, a carpet recycling trade organization that aggregates data from carpet collectors in Texas.

TIRES



confidence: strong

The Story

TCEQ regulates the collection, processing, storage, recycling and disposal of approximately 32 million scrap tires annually, in addition to tires stored in stockpiles which may enter the stream at irregular rates. There are many options to divert scrap tires from disposal, including land reclamation projects using tires, beneficial use projects, and production and use of tire-derived fuel. Although these are acceptable forms of tire management and diversion, they are not considered recycling for the purposes of this Study.

The Project Team focused on surveying tire processing facilities to gather information on tire recycling in Texas, along with supplemental information from TCEQ.

Survey Data: 5,483 tons

Facilities Responding

34 total facilities

- 30 landfills and transfer/collection stations
- 4 tire processing facilities

The Project Team did not obtain a strong survey response from tire processing facilities. However, the Project Team was able to develop a statewide amount based on supplemental data.

Supplemental Data: 63,991 tons

Facilities Represented in Data

62 scrap tire processors/facilities

Under the TCEQ's Scrap Tire Program, registered scrap tire facilities must submit an annual report to TCEQ with the total number of tires that they dispose, recycle or beneficially reuse. Based on information provided in this report, there were an estimated total of 69,474 tons of tires recycled in Texas in 2015, primarily into crumb rubber which, in turn, was used to produce a variety of products. Therefore, approximately 63,991 tons of tires were unaccounted for in the survey.

Tonnage Comparison to TRDI

The Study result is 44 percent higher than the 2013 TRDI result of 48,290 tons. This increase may be due to the number of scrap tire facilities reporting, which increased from 53 in 2013 to 62 in 2015. According to TCEQ's Scrap Tire Reports for years 2011 through 2015, the year 2013 had the lowest total volume of scrap tires managed in Texas, which may explain the increase in recycled scrap tires between 2013 and 2015.

Also, while the recycled tire tonnage increased, it was still congruent with the overall percentage of tires recycled versus tires managed. The 2015 recycled tonnage represented approximately 21 percent of the total of 323,996 tons of scrap tires managed in Texas, compared to 2013, when approximately 22 percent of the 224,042 tons managed were recycled.

3.4 TOTAL RECYCLED FROM MSW SOURCES IN 2015

Approximately 9.2 million tons of Texas sourced material was recycled in 2015. Table 3-1 compares totals from the 2015 study to the 2013 TRDI study, a difference of 3.0 million tons of recycled MSW in 2015.

TABLE 3-1: MATERIAL RECYCLED FROM MSW SOURCES (TONS)

	Material	2013 Study (TRDI)	2015 Study
Typical Recyclables	Glass	137,222	165,527
	Metals – Ferrous [1]	386,876	447,207
	Metals – Non-Ferrous [1]	157,709	196,383
	Paper	1,444,632	2,212,562
	Plastics	169,216	107,851
Organic Materials	Biosolids	95,291	357,116
	Food and Beverage Materials	19,768	100,470
	Yard Trimmings, Brush, and Green Waste	970,233	2,289,542
Other Materials	Construction and Demolition Materials	2,253,598	3,136,727
	Electronic Materials	47,271	42,725
	Household Hazardous Waste	2,308	1,684
	Textiles	16,852	16,507
	Tires[2]	48,290	69,474
Uncategorized	Uncategorized[3]	393,527	27,932
TOTAL		**6,143,393**	**9,171,707**

1. *The number shown in the table represents the portion of material that is MSW.*
2. *Quantity reflects a reduction of 600 tons to account for a typographical error in the TRDI study.*
3. *Includes all materials classified as "Other" by survey respondents. Respondents were required to provide a description. Respondents primarily reported commingled recyclables and commingled organic materials.*

4.0 RECYCLING COSTS, VALUE, AND QUALITY

Understanding the costs, value, and quality of recyclable materials is an essential component to understanding and potentially increasing recycling in Texas. Due to relatively large quantities of material recycled (as discussed in Section 3) and potential opportunities to increase recycling (as discussed in Section 6), this section focuses on providing information on specific recyclable material categories that could yield the highest value or highest quantity. These categories include typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and C&D materials. Information in this section is based on a combination of survey responses, interviews, and the Project Team's collective industry experience.

4.1 COSTS OF RECYCLING

The primary costs of recycling are collection (collection at place of generation and transportation to processing facility), processing (processing recyclable materials at a processing facility to end market specifications), and public education and outreach about the recycling program. Specific to collection and public education and outreach costs, this section primarily focuses on the costs associated with providing services to residents, expressed on a per household basis. Given the number of variables associated with providing collection services to commercial establishments, this section excludes details on the costs of collecting commercial recyclable materials.

Paying for the costs of recycling services typically comes from a combination of service fees and revenue offsets from the sale of commodities (as discussed in Section 4.2). Often the costs of recycling can exceed the value of the recyclable material itself. Recycled materials are commodities that are strongly impacted by market fluctuations.

Costs of Recycling Typical Recyclables

Residential collection costs for typical recyclables are incurred per household per month, and range from \$2 to \$5. Processing costs for typical recyclables are generally incurred per ton and range from \$60 to \$90. Public education and outreach costs range from \$0.15 to \$0.50 per household per month for typical recyclables. Table 4-1 shows the estimated recycling costs for typical recyclables in Texas.

TABLE 4-1: AVERAGE COSTS OF RECYCLING FOR TYPICAL RECYCLABLES IN MUNICIPAL COLLECTION PROGRAMS[1]

Recyclable Material	Collection (per household per month)	Processing (per ton)	Public Education & Outreach (per household per month)
Typical Recyclables[2]			
Glass, Metals, Paper, and Plastics	\$2 - \$5	\$60 - \$90 with 50% – 90% revenue share	\$0.15 - \$0.50

1. *Based on a combination of financial studies and recycling contract projects conducted in Texas by the Project Team.*
2. *Based on single stream materials collection (commingled collection of paper, plastics, metal, and glass). This is the most common approach to collecting typical recyclables in Texas.*

Costs of Recycling Organics

The cost for organics collection and processing varies based on type of organic material. For the evaluation of the costs of organics recycling, yard trimmings includes grass, leaves, and other green waste that is collected and containerized in compostable bags or cans. Brush includes tree branches and other green waste that is collected in loose piles rather than containers due to size. Like typical recyclables, residential collection costs and processing costs for organics are incurred per household per month and per ton respectively. Residential collection costs for organics range from \$1 to \$5 per household per month.

Processing costs for organics range from $0 to $25 per ton. Public education and outreach costs are generally included in the public education and outreach costs for typical recyclables. Table 4-2 shows the estimated recycling costs for organics in Texas.

TABLE 4-2: AVERAGE COSTS OF RECYCLING ORGANICS IN MUNICIPAL COLLECTION PROGRAMS[1]

Recyclable Material	Collection (per household per month)	Processing (per ton)	Public Education & Outreach (per household per month)
Organics			
Yard Trimmings[2]	$1 - $3	$0 - $25	Included in Table 4-1
Brush[2]	$2 - $5	$5 - $25	
Food and Beverage Materials[3]	$3 - $5	$6 - $25	

1. *Based on a combination of financial studies and recycling contract projects conducted in Texas by the Project Team.*
2. *For the evaluation of the costs of recycling organics, yard trimmings includes grass, leaves, and other green waste that is collected and containerized in compostable bags or cans. Brush includes tree branches and other green waste that is collected in loose piles rather than in containers due to size.*
3. *Food and beverage materials can be commingled with yard trimmings.*

Costs of Recycling C&D Materials

Like typical recyclables and organics, C&D materials processing costs are incurred per ton. However, estimating a per ton processing fee for C&D materials is challenging due to the diversity of materials processed, lack of contracted pricing between a C&D MRF and governmental entities, and the relative small number of C&D MRFs in the State. In 2007, the North Central Texas Council of Governments developed a C&D MRF Feasibility Study that estimated a processing cost of approximately $30 to $40 per ton, based on a facility that would process a wide array of C&D material[1]. A C&D facility that would process material such as concrete, aggregate, and cement would have a significantly lower cost on a per ton basis (and no cost in some cases[2]).

4.2 FACTORS THAT IMPACT THE COST OF RECYCLING

Various factors can impact the costs of recycling. This section provides a discussion of each of the primary costs of recycling and factors that can increase and decrease these costs.

Factors that Impact Collection Costs

Collection frequency is the primary factor increasing recyclable material collection costs. Single stream materials (commingled collection of paper, plastics, metal, and glass) are generally collected weekly or every other week. Yard trimmings, brush, and green waste collection frequencies vary greatly, ranging from weekly to semi-annually. Food and beverage materials are generally collected at least weekly due to nuisance concerns. C&D materials are generally collected upon request of the entity. Other factors that can increase collection costs include separate collections of yard trimmings and food and beverage materials, longer drive time, unlimited or larger set-out limits, and uncontainerized or unbundled set-outs[3]. Conversely, factors that decrease collection costs include decreased collection frequency, commingled collection of yard trimmings and food and beverage materials, shorter drive time, smaller set-out limits, and containerized or bundled set-outs. Table 4-3 presents factors impacting collection costs.

1. *Construction and Demolition Material Recovery Facility Feasibility Study.* North Central Texas Council of Governments. August 2007. Available on-line at http://www.nctcog.org/envir/SEELT/reduction/RWBeckCDMRFFeasibilityStudy_Final.pdf
2. Processors may process clean/unpainted concrete delivered to facility at no cost.
3. Set-out means the materials placed by the generator for collection by a hauler.

TABLE 4-3: FACTORS IMPACTING COLLECTION COSTS FOR RECYCLABLE MATERIALS

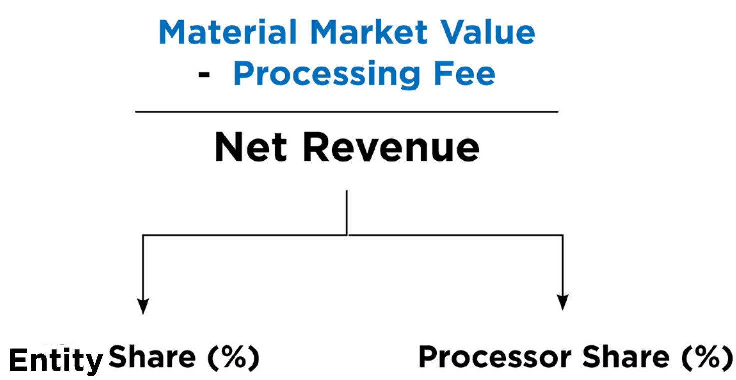
Factors that Increase Costs	Factors that Decrease Costs
Increased collection frequency	Decreased collection frequency
Separate collections of yard trimmings and food and beverage materials[1]	Commingled collection of yard trimmings and food and beverage materials[1]
Longer drive time[2]	Shorter drive time[2]
Unlimited or larger set-out limits	Smaller set-out limits
Uncontainerized/unbundled set-outs	Containerized/bundled set-outs

1. *For the evaluation of the costs of recycling organics, yard trimmings includes grass, leaves, and other green waste that is collected and containerized in compostable bags or cans. Brush includes tree branches and other green waste that is collected in loose piles rather than containers due to size.*
2. *Drive time includes distance from yard to route, distance between collections, and distance from route to processing facility, and impacts the number of customers that can be serviced.*

Factors that Impact Processing Costs

Processing costs are generally embedded into the collection costs for entities that generate small quantities of recyclable materials. Entities such as municipalities that generate large quantities of recyclable materials may contract directly with a facility for processing services. Single stream materials are processed at a MRF, which utilizes labor and specialized equipment to sort recyclable materials to end market specifications. For entities that contract directly with a MRF, the entity typically pays a per ton processing fee. Since recyclable materials have value (see Section 4.3), the entity may receive a portion of the revenue from the sale of the recyclable materials (revenue sharing). Figure 4-1 illustrates the typical processing fee and recyclable materials revenue share calculation.

FIGURE 4-1: SINGLE STREAM MATERIALS PROCESSING FEE AND RECYCLABLE MATERIALS REVENUE SHARE CALCULATION



During the recession that began in 2008, the value of recyclable materials decreased from record highs to record lows over the course of weeks. Prior to the recession, MRFs typically offered processing fees in the range of $30 to $40 per ton with a recyclable materials revenue share to the entity of 40 to 70 percent of net revenue. The business model for MRF operators assumed that any costs in excess of the processing fee would be recovered by the processor's share of recyclable materials revenues. Toward the end of 2008, several MRF operators started to experience negative cash flows as the revenue from the sale of commodities was no longer sufficient to offset the portion of the processing fees that were being recovered from the sale of recyclable materials. Facing shortfalls, MRF operators began increasing processing fees to amounts ranging from $60 to $90 per ton to allow the processing fees to fully recover the costs. In cases where a municipality had an existing processing agreement in place with a MRF, there may have been a lag (until its next contract started) before the municipality incurred an increase in processing costs, unless the MRF operator requested a price increase. Since MRFs were recovering costs via higher processing fees, the MRFs were typically willing to offer entities a greater recyclable materials revenue share, often in the range of 50 to 90 percent of net revenues. Table 4-4 presents the average single stream materials processing fees and recyclable materials revenue shares in Texas before and after the 2008 recession.

TABLE 4-4: AVERAGE SINGLE STREAM MATERIALS PROCESSING FEES AND RECYCLABLE MATERIALS REVENUE SHARE

Fee/Revenue	Before 2008	2008 - 2016
Single Stream Materials		
Processing Fee	$30 - $40 per ton	$60 - $90 per ton
Recyclable Revenue Share to Entity	40% - 70%	50% - 90%

TABLE 4-5: FACTORS IMPACTING PROCESSING COSTS FOR RECYCLABLE MATERIALS

Factors that Increase Costs	Factors that Decrease Costs
Low market value of recovered materials	High market value of recovered material
Increased contamination	Decreased contamination
Composting of yard trimmings, brush, green waste, and food and beverage materials	Mulching of yard trimmings, brush, and green waste

Organics processing costs vary based on the type of recyclable material (i.e. yard trimmings, brush, and green waste and food and beverage materials). The processing fees for yard trimmings, brush, and green waste are typically less than the processing fees for food and beverage materials. The costs of labor and equipment to process yard trimmings, brush, and green waste into mulch is typically lower than the cost to process organics, including food and beverage materials, into compost. Table 4-5 presents factors impacting processing costs for recyclable materials, including single stream materials, organics, and C&D materials.

Factors that Impact Public Education and Outreach Costs

Quality public education and outreach is important to a successful recycling program. A well designed and implemented recycling public education and outreach program will increase participation and decrease contamination (a key factor in processing costs). The cost of public education and outreach varies based on the scope of the recycling program (single stream materials, yard trimmings, brush, green waste, or food and beverage materials), the length of time the program has been in place, and other factors. Table 4-6 presents factors impacting public education and outreach costs for recycling.

TABLE 4-6: FACTORS IMPACTING PUBLIC EDUCATION AND OUTREACH COSTS FOR RECYCLABLE MATERIALS

Factors that Increase Costs	Factors that Decrease Costs
Broader scope of recycling program	Narrower scope of recycling program
New recycling program to community	Existing recycling program in community
High number of renter occupied residences	High number of owner occupied residences

4.3 VALUE OF RECYCLABLE MATERIALS

The value of recyclable materials is dependent on the commodity markets. This section provides a discussion of value of typical recyclables, organics, and C&D materials.

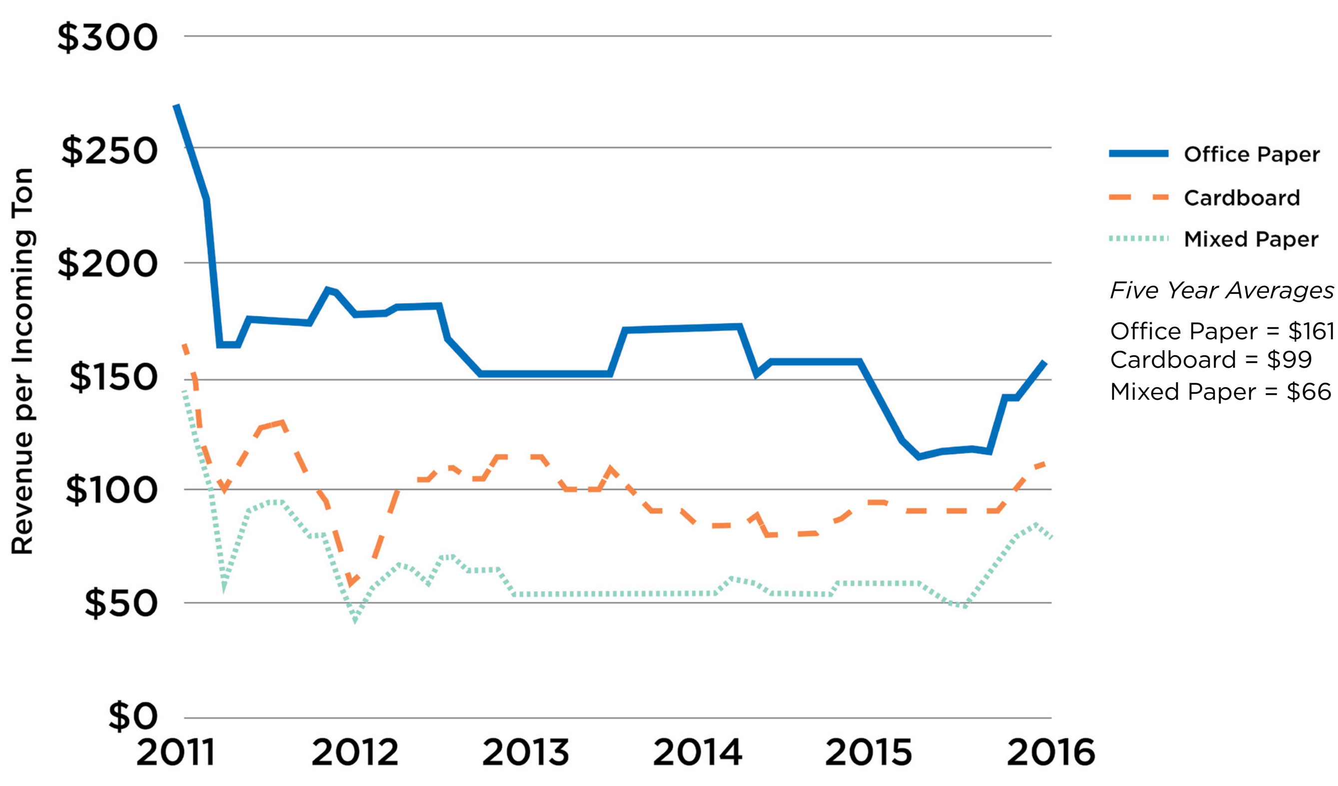
Value of Typical Recyclables

As a commodity, the value of paper, plastics, metal, and glass recyclables changes daily. The value of typical recyclables is tracked on a national and regional basis by RecyclingMarkets.net. Figures 4-2, 4-3, and 4-4 illustrate the changes in the value of paper, plastic, and metal in Texas over the past five years based on applicable market indices, as provided by RecyclingMarkets.net (a subscription based, recycling data provider). Discussion regarding the value of glass is also included, but does not include the same types of graphs as for the other commodities due to other issues that affect the value of glass (as discussed in the glass section). Given that many typical recyclable materials are collected single stream, this section also discusses the average pricing of single stream materials.

The value of glass depends on the quality of the glass and where the glass is generated. Glass collected single stream is processed at a MRF and then at a secondary processing facility. The level of secondary processing will depend on the amount of contamination (often shredded paper and other small items) that is mixed with the glass. The value of glass going from a MRF to a secondary processor can range from plus $20 to minus $45 per ton depending on contamination and transportation costs. Since secondary processing facilities are located in the Dallas/Fort Worth area, transportation costs are dependent on the proximity to this area. The value of glass going from a secondary processor to an end market can range from $40 to $90 per ton depending on transportation costs.

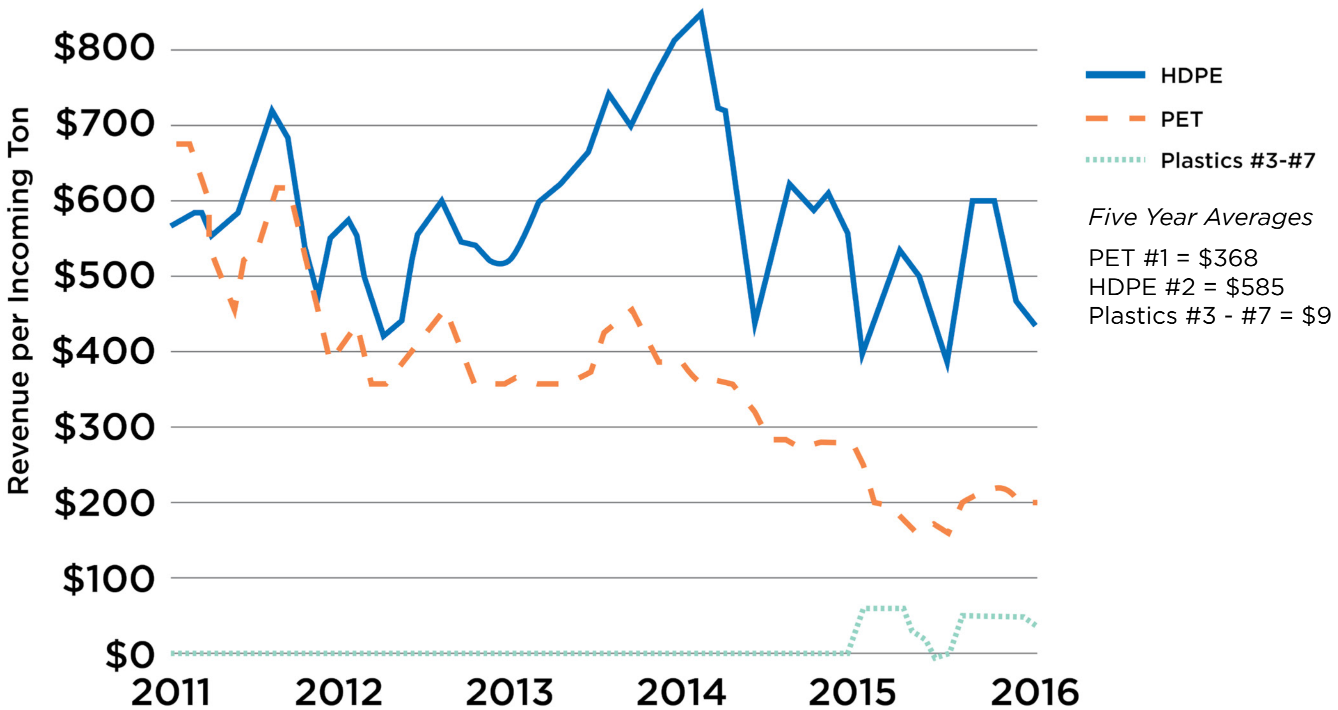
Based on commodity pricing and material composition for paper, plastics, metal, and glass, the average value of processed recyclable materials collected single stream from municipal collection programs in Texas over the past five years was $89 per ton. In addition to commodity values, the value of single stream materials varies based on the composition of the materials (i.e. quantity of paper, plastics, metal, and glass) and quality of the materials (see Section 4.4). Figure 4-5 illustrates the changes in the average value of single stream materials in Texas over the past five years.

FIGURE 4-2: PAPER RECYCLABLE MATERIAL REVENUE (PER TON)[1]



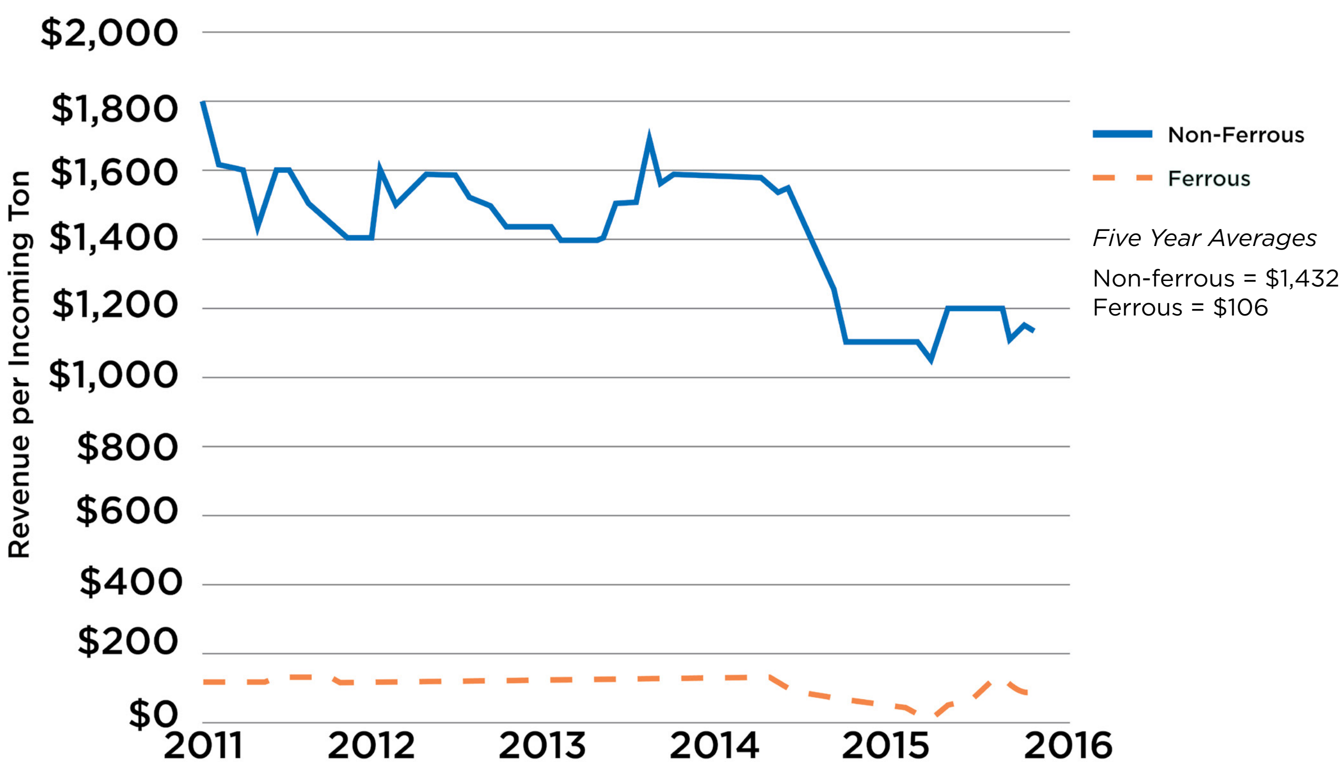
1. *Values are based on Houston (Southcentral USA) Region as reported on RecyclingMarkets.net.*

FIGURE 4-3: PLASTICS RECYCLABLE MATERIAL REVENUE (PER TON) [1,2]



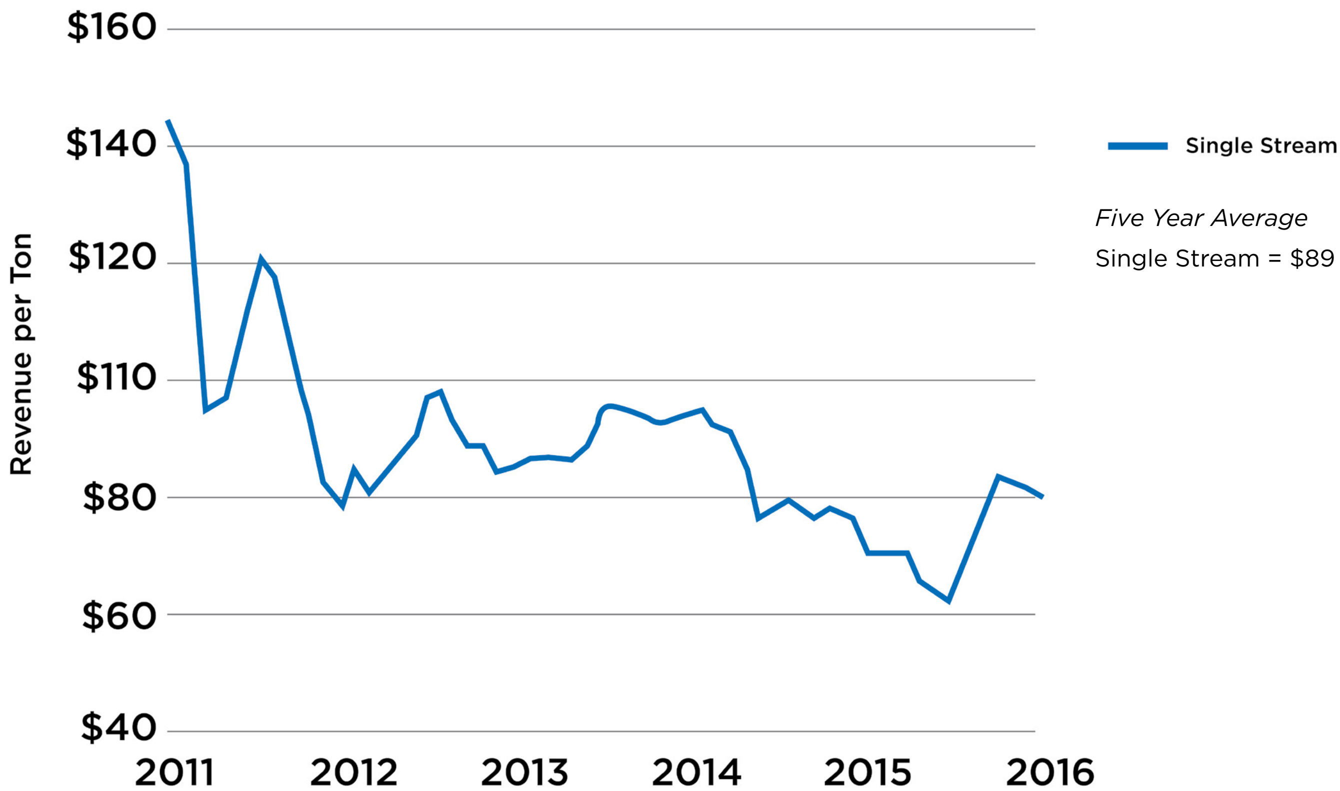
1. *Values are based on Houston (Southcentral USA) Region as reported on RecyclingMarkets.net*
2. *Value of HDPE #1 is based on a combination of pricing for colored and natural HDPE. The figure assumes 57.1% colored HDPE and 42.9% natural HDPE based on recent MRF audits conducted in Texas by the Project Team.*

FIGURE 4-4: METAL RECYCLABLE MATERIAL REVENUE (PER TON)[1]



1. *Values are based on Houston (Southcentral USA) Region as reported on RecyclingMarkets.net*

FIGURE 4-5: SINGLE STREAM MATERIAL REVENUE (PER TON) [1]



1. *Assumes 35.5% Mixed Paper, 12.0% Cardboard, 4.5% PET #2, 1.5% Natural HDPE, 2.0% Colored HDPE, 1.0% Plastics #3 - #7, 2.0% Ferrous Metal, 1.0% Non-ferrous Metal, and 19.0% Glass based on recent single stream MRF audits in Texas conducted by the Project Team.*

Value of Organics

The value of organics depends on the end product (mulch or compost) and is regionally driven based on local markets. Many areas within Texas have developed high quality mulch and compost product, generating extensive demand. Other regions of the State struggle with creating demand for this material. The value of mulch and compost is based on price per cubic yard, which varies from typical recyclables that are based on price per ton. For regions of Texas with developed markets, the value of mulch and compost can be as high as $25 to $50 and $30 to $70 per cubic yard, respectively. Even though the value per cubic yard of mulch is lower than compost, producing mulch typically requires less material as compared to compost. Therefore, the value depends on not only the price per cubic yard, but also the amount of material needed for production.

Value of C&D Materials

The value of C&D materials depends on the material. Concrete, aggregate, and cement represent a significant amount of the C&D materials stream. Values for other materials that are often a part of the C&D materials stream, such as ferrous metal and cardboard, are established by the market indices discussed in this section. However, the value of concrete, aggregate, and cement was proprietary to the C&D facilities in Texas. The North Central Texas Council of Governments C&D MRF Feasibility Study estimated the value of concrete as $4 to $8 per ton[4]. Other out-of-state sources have valued concrete as $6 to $14 and $8 to $13 per ton. The Project Team used the median value of recycled concrete, aggregate, and cement as reported by the North Central Texas Council of Governments C&D MRF Feasibility Study to provide a conservative estimate of the value of C&D materials recycled in Texas.

4. *Construction and Demolition Material Recovery Facility Feasibility Study*. North Central Texas Council of Governments. August 2007. Available on-line at http://www.nctcog.org/envir/SEELT/reduction/RWBeckCDMRFFeasibilityStudy_Final.pdf

Estimated Annual Value of Recycled Material in Texas

Approximately 9.2 million tons of material were recycled in Texas in 2015 (as discussed in Section 3.4). Typical recyclables (paper, plastics, metal, and glass), organics (yard trimmings, brush, green waste, and food and beverage materials), and C&D materials accounted for 8.7 million tons, or 94.4 percent of the total tons recycled materials in Texas. Based on an average commodity market for typical recyclables, organics, and C&D materials, $702 million in materials were recycled in Texas in 2015. Table 4-7 summarizes the value of typical recyclables, organics, and C&D materials recycled in Texas in 2015 based on average market pricing discussed in this section. Table 4-7 communicates the gross values, as collection, processing, and public education and outreach costs would offset these values.

TABLE 4-7: ESTIMATED ANNUAL GROSS VALUE OF RECYCLED MATERIAL IN TEXAS (FY 2015)[1]

Recycled Material		Annual Tonnage[2]	Rounded Value[3]	Basis
Typical Recyclables	Glass	165,527	$10,760,000	$65/ton[4]
	Metals – Ferrous	447,207	$47,400,000	$106/ton[5]
	Metals – Non-Ferrous	196,383	$281,220,000	$1,432/ton[5]
	Paper	2,212,562	$196,920,000	$89/ton[5, 6]
	Plastics	107,851	$38,610,000	$358/ton[5, 7]
Organics		2,390,012	$108,270,000	$30/CY for compost[4, 8, 9]
C&D Materials		3,136,727	$18,820,000	$6/ton[4]
TOTAL		**8,656,269**	**$702,000,000**	

1. *Value excludes costs of collection, processing, and public education and outreach.*
2. *Annual tonnage is based on the tons of recycled material in Texas in FY 2015 discussed in Section 3.*
3. *Values are rounded to the nearest $10,000.*
4. *Values are based on interviews with local processors and industry reports and research.*
5. *Values are based on the five-year averages discussed in Section 4.3.*
6. *Includes 1,321,611 tons of cardboard and 174,640 tons of other paper valued at $99/ton and 716,311 tons of mixed paper valued at $66/ton.*
7. *Includes 47,368 tons of PET #1 valued at $368/ton, 35,864 tons of HDPE #2 valued at $585/ton and 24,619 tons of Plastics #3-7 valued at $9/ton.*
8. *Includes food and beverage materials and yard trimmings, brush, and green waste. Excludes biosolids.*
9. *CY - cubic yard. The industry value of compost and mulch is based on price per cubic yard. Due to the diversity of organics materials, the Project Team assumed a conservative value of $30/CY for compost or approximately $16/CY for mulch. The assumed value for mulch is lower than compost because mulch has a higher yield rate (i.e. producing mulch requires less material than producing compost). Organics includes 100,470 tons of food and beverage materials and 2,289,542 tons of yard trimmings, brush, and green waste for a total of 2,390,012 tons of organics. For a conservative estimate, assumes producing 1.51 CY of compost per ton of organics (i.e. 1.51 multiplied by 2,390,012 tons of organics) for a total of 3.6 million CY of compost valued at $30/CY. The above estimate is equivalent to producing 2.88 CY of mulch per ton of yard trimmings, brush, and green waste (i.e. 2.88 multiplied by 2,289,542 tons of yard trimmings, brush, and green waste) for a total of 6.6 million CY of mulch valued at approximately $16/CY.*

4.4 QUALITY OF RECYCLED MATERIALS

The value of recycled materials can be impacted by the quality of material, as measured by contamination levels. Contamination reflects the inclusion of non-recyclable materials in recyclable materials. This section focuses on the quality of recycled materials for single stream materials and organics, as these materials can be significantly impacted by contamination levels. The Project Team provided a weighted average contamination rate and ranges for contamination rates based on survey responses. The weighted average provides an understanding the average contamination rate based on the total tonnage of recycled materials in Texas. The range provides an understanding of the varying contamination rates reported among the facilities.

Specific to single stream materials, the TRDI study reported an average contamination rate of 13.0 percent for MRFs that responded to the survey. For this Study, survey respondents reported an average contamination rate of 18.3 percent for single stream MRFs, a 40.7 percent increase over a two-year period. The contamination rates for organics and C&D materials are lower than single stream materials. Organics and C&D materials processing requires low contamination to meet end market specifications. Survey

TABLE 4-8: AVERAGE CONTAMINATION RATE BY RECYCLABLE MATERIAL

	Contamination Rate	
Material	Weighted Average	Range
Single Stream Materials	18.3%	10% - 25%
Organics	8.8%	5% - 10%
C&D Materials	3.9%	1% - 17%

respondents reported an average contamination rate of 8.8 percent for organics and 3.9 percent for C&D materials. Table 4-8 summarizes the contamination rates by recyclable material.

As discussed in Section 6, survey respondents stated that contamination was a key barrier to increasing recycling in Texas. When questioned about the top barriers to increasing recycling, the “high contamination / low quality” category was chosen most often. This category also received the third highest overall number of responses. Based on industry interviews, MRF operators stated that one reason why contamination rates have increased is due to end markets becoming more particular and requiring a greater focus on quality, which has driven MRF operators to remove more contamination prior to sending recycled material to end markets. Additional factors affecting contamination included the need for enhanced public education and outreach and clarification for the types of material accepted for the program. MRF operators reported that their facilities may receive materials that the public thinks can be recycled but are not acceptable recyclable materials. MRF and organics processors stated that contamination levels directly impact their processing costs. For example, one organics processor stated that its facility has significantly decreased the accepted quantities of food and beverage materials from commercial sources due to very high contamination levels.

5.0 ESTIMATED AMOUNT OF RECYCLABLE MATERIALS THAT COULD BE RECYCLED, BUT ARE DISPOSED

Each year recyclable materials are disposed in MSW landfills. This section estimates the composition of recyclable materials generated and disposed in Texas, followed by an estimate of the quantity and value of recyclable materials disposed.

5.1 COMPOSITION OF RECYCLABLE MATERIALS DISPOSED IN MSW LANDFILLS

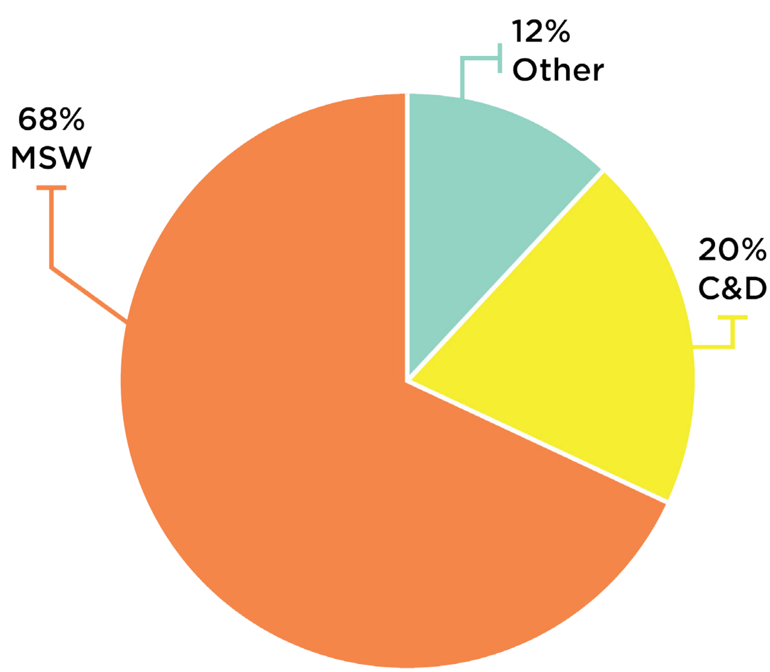
In 2015, an estimated 31,049,545 tons of solid waste, including recyclable material, was generated and disposed in Texas. MSW and C&D materials accounted for the majority of the material generated and disposed in Texas, 21.0 million and 6.4 million tons, respectively. Table 5-1 and Figure 5-1 present the estimated tonnage and composition of solid waste generated and disposed in Texas by waste type. The following sections provide additional composition information for each waste type.

TABLE 5-1: TONNAGE DISPOSED BY WASTE TYPE (2015)

Waste Type	Percentage	Tonnage Disposed
MSW	67.7%	21,026,466
C&D Materials	20.5%	6,359,055
Other[1]	11.8%	3,664,024
TOTAL	**100.0%**	**31,049,545**

1. *Other includes solid waste other than MSW and C&D materials such as brush, sludge, septage, contaminated soil, regulated and non-regulated asbestos-containing material, tires, and medical waste.*

FIGURE 5-1: DISPOSAL COMPOSITION BY WASTE TYPE (2015)

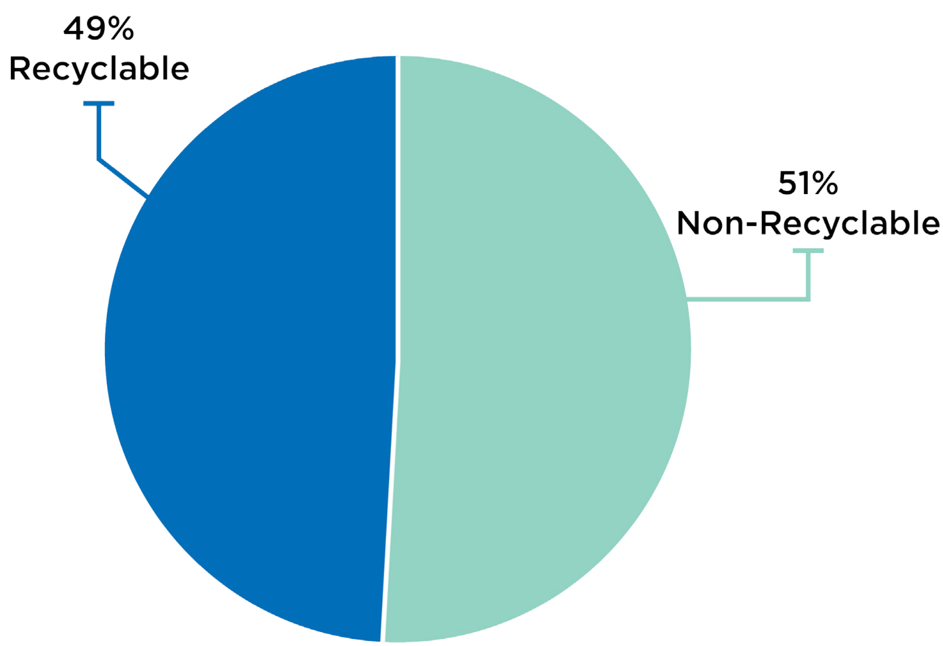


Composition of MSW Disposed

MSW composition varies from region to region based on various factors, such as percentages of residential versus commercial sectors, access to recycling programs, and vegetative growth. Multiple large cities in Texas, including, but not limited to Austin, Dallas, and Fort Worth, have completed solid waste characterization studies over the past five years. After reviewing these studies, the Project Team developed an estimate of MSW composition. First, the Project Team estimated the quantity of MSW generated by residences versus commercial establishments. Then, the Project Team based the composition of residential MSW on the residential waste characterization studies in Texas[1]. For commercial MSW, the Project Team based the composition on the Dallas waste characterization study, since it was the only study to separately evaluate the composition of commercial MSW.

Table 5-2 and Figure 5-2 present the estimated composition and tonnage of MSW disposed in Texas by material category and whether it was recyclable. As indicated by the rows shaded in Table 5-2, there are substantial types of MSW disposed in Texas that could potentially be recycled. While there is an understanding that not all of the material in the shaded rows could be recycled, it represents a total of 10,286,994 tons, or 48.9 percent, of the total 21,026,466 tons.

FIGURE 5-2: COMPOSITION OF MSW DISPOSED BY RECYCLABLE OR NON-RECYCLABLE (2015)



1. Composition based on waste characterization studies for other cities in Texas, including, but not limited to, Austin, Dallas, and Fort Worth.

TABLE 5-2: COMPOSITION OF MSW DISPOSED BY MATERIAL CATEGORY (2015)

Material Group	Material Category[1]	Percentage[2]	Tonnage Disposed[3]
Paper	Cardboard	9.5%	1,997,315
	Mixed (Other recyclable)	9.9%	2,088,333
	Other (Non-recyclable)	9.2%	1,932,044
	Subtotal	**28.6%**	**6,017,692**
Plastics	PET #1	1.6%	331,148
	HDPE #2	1.3%	274,493
	Plastics #3-7	1.0%	205,261
	Plastic Bags & Film Wrap	5.2%	1,100,830
	Other Plastic	5.3%	1,115,717
	Subtotal	**14.4%**	**3,027,449**
Metals	Ferrous	1.6%	338,010
	Non-Ferrous	1.4%	285,869
	Subtotal	**3.0%**	**623,879**
Glass	Glass	3.1%	657,577
	Subtotal	**3.1%**	**657,577**
Organics	Yard Trimmings, Brush, and Green Waste	4.6%	970,875
	Food and Beverage Materials	14.9%	3,125,350
	Textiles[4]	4.6%	959,217
	Diapers	1.7%	359,581
	Other Organics	2.2%	469,419
	Subtotal	**28.0%**	**5,884,442**
C&D Materials	Clean/Unpainted C&D Aggregates	0.1%	12,763
	Clean/Unpainted C&D Wood[4]	6.4%	1,342,444
	Other C&D Materials	7.0%	1,464,794
	Subtotal	**13.4%**	**2,820,001**
Other	Other	**9.5%**	**1,995,426**
	Subtotal	9.5%	1,995,426
Subtotal Recyclable		48.9%	10,286,994
Subtotal Non-recyclable		51.1%	10,739,472
TOTAL		**100.0%**	**21,026,466**

1. *Shaded rows represent materials that could potentially be recycled.*
2. *Percentages based on material category tonnage divided by total tonnage. Percentages rounded for ease of presentation.*
3. *Composition based on waste characterization studies for other cities in Texas, including, but not limited to Austin, Dallas, and Fort Worth.*
4. *These materials are recyclable, but have not been a point of emphasis in recycling programs. For a conservative estimate, the Project Team decided against including these materials in the estimated tonnage of materials that could potentially be recycled.*

The Project Team compared the MSW composition for Texas to the national composition of MSW disposed as reported by U.S. EPA[2]. Paper accounted for a higher percentage of MSW disposed in Texas; 28.6 percent in Texas versus 14.3 percent nationally. Food and beverage materials and metal accounted for a lesser percentage of MSW disposed in Texas; 14.9 percent in Texas versus 21.6 percent nationally for food and beverage materials, and 3.0 percent in Texas versus 9.4 percent nationally for metal. In addition, plastics, glass, and yard trimmings, brush, and green waste accounted for a lesser percentage of the MSW disposed in Texas in comparison to average composition of MSW disposed nationally. Table 5-3 compares the composition of MSW disposed post diversion in Texas to the national composition.

TABLE 5-3: COMPOSITION OF MSW DISPOSED BY MATERIAL GROUP/CATEGORY IN TEXAS VERSUS UNITED STATES (2015)

Material Group/Category[1]	Texas	National	Difference
Paper	28.6%	14.3%	14.3%
Plastics	14.4%	18.5%	(4.1%)
Metals	3.0%	9.4%	(6.4%)
Glass	3.1%	5.2%	(2.1%)
Food and Beverage Materials	14.9%	21.6%	(6.7%)
Yard Trimmings, Brush, and Green Waste	4.6%	7.9%	(3.3%)
Other	31.4%	23.1%	8.3%
TOTAL	**100.0%**	**100.0%**	

1. *Material groups and categories revised to allow comparison of Texas and national composition of MSW disposed. Material groups and categories not listed above are included in Other. Texas composition based on previously cited studies. National data based on previously cited data from the U.S. EPA.*

Composition of C&D Materials Disposed

Like MSW, the composition of C&D materials varies from region to region. Therefore, the Project Team developed an estimate of C&D materials composition based on the C&D waste characterization completed by R.W. Beck for the North Central Texas Council of Governments as part of a C&D MRF Feasibility Study[5-3]. The C&D MRF Feasibility Study included waste characterization data from more than 600 loads of C&D material. This study is the only publicly available C&D waste characterization study in Texas that the Project Team is aware of. Table 5-4 and Figure 5-3 present the estimated composition and tonnage of C&D material disposed in Texas by material category and whether it was recyclable. The tonnage of C&D materials reported in Section 3 is generally consistent with the material group C&D materials in Table 5-4. Concrete/cement was the largest C&D material currently disposed that could potentially be recycled, as shown in Table 5-4. C&D material also contains materials found in MSW. As indicated by the rows shaded, cardboard, ferrous metal, and brush are other types of materials contained in C&D being disposed that could be recycled and generally an emphasis of recycling programs. In total, 2,715,317 tons, or 42.7 percent of the total 6,359,055 tons of C&D materials being disposed could potentially be recycled.

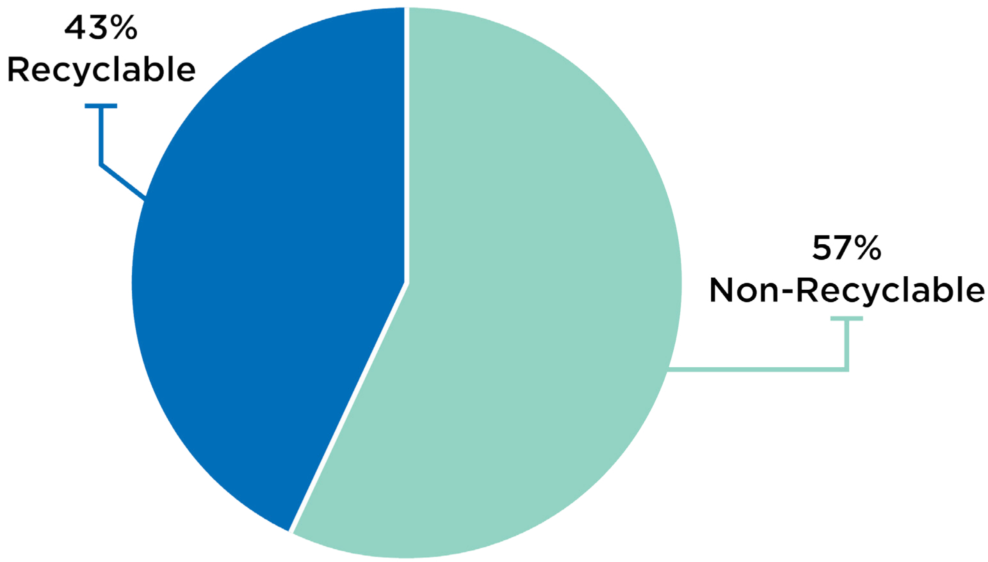
2. *Advancing Sustainable Materials Management:* 2014 Fact Sheet. U. S. Environmental Protection Agency. November 2016.

TABLE 5-4: COMPOSITION OF C&D MATERIALS DISPOSED BY MATERIAL CATEGORY (2015)

Material Group	Material Category[1]	Percentage[2]	Tonnage Disposed[3]
C&D Materials	Concrete/Cement	28.5%	1,812,331
	Bricks/Cinder Blocks	6.5%	413,339
	Asphalt	5.4%	343,389
	Drywall/ Gypsum	3.9%	248,003
	Subtotal	**44.3%**	**2,817,062**
Paper	Cardboard	5.9%	375,184
	Other	1.3%	82,668
	Subtotal	**7.2%**	**457,852**
Metals	Ferrous	5.0%	317,953
	Subtotal	**5.0%**	**317,953**
Organics	Yard Trimmings, Brush, and Green[3, 4]	3.3%	209,849
	Wood Packaging[5]	2.7%	171,694
	Scrap Lumber[5]	7.4%	470,570
	Soil - Contaminated	21.1%	1,341,761
	Subtotal	**34.5%**	**2,193,874**
Other	Refuse	1.6%	101,745
	Other	7.4%	470,570
	Subtotal	**9.0%**	**572,315**
Subtotal Recyclable		42.7%	2,715,317
Subtotal Non-recyclable		57.3%	3,643,739
TOTAL		**100.0%**	**6,359,056**

1. *Shaded rows represent materials that are recyclable and generally an emphasis of recycling programs.*
2. *Percentages rounded for ease of presentation.*
3. *Includes estimated quantity of brush disposed as C&D based on tonnage of C&D disposed reported in Municipal Solid Waste in Texas: A Year in Review FY 2015 Data Summary and Analysis by Texas Commission on Environmental Quality, 2016. Excludes brush disposed as MSW or Brush.*
4. *Yard trimmings, brush, and green waste in C&D is generally brush. The Project Team used the category Yard Trimmings, Brush, and Green Waste to be consistent with the Study definitions.*
5. *These materials are recyclable, but have not been a point of emphasis in recycling programs. For a conservative estimate, the Project Team decided against including these materials in the estimated tonnage of materials that could potentially be recycled.*

FIGURE 5-3: COMPOSITION OF C&D DISPOSED BY RECYCLABLE OR NON-RECYCLABLE (2015)



Composition of Other Waste Disposed

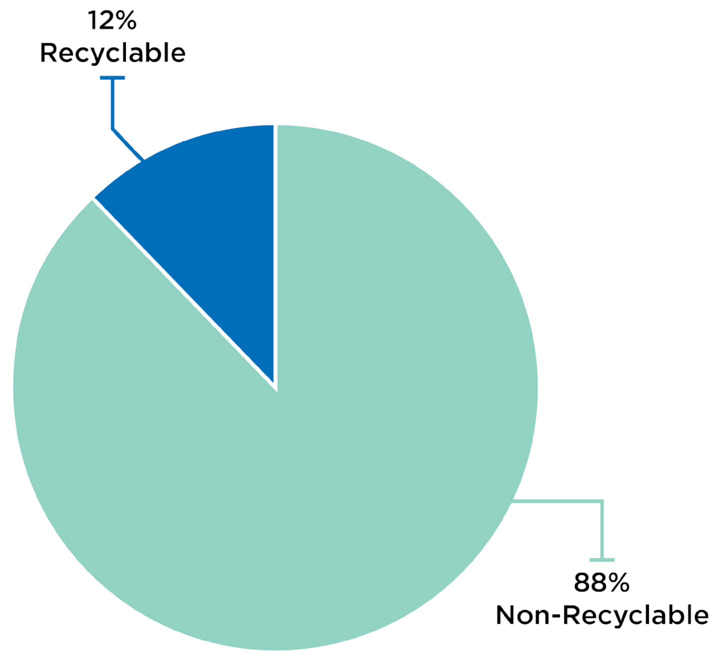
The composition of other waste is based on the waste types specified in the *Municipal Solid Waste in Texas: A Year in Review FY 2015 Data Summary and Analysis*. Table 5-5 and Figure 5-4 present the composition and tonnage of other waste disposed in Texas by material category and whether it was recyclable. As indicated by the shaded row (brush), 427,989 tons, or 11.7 percent of the total 3,664,024 tons of other waste being disposed could potentially be recycled.

TABLE 5-5: COMPOSITION OF OTHER WASTE DISPOSED BY MATERIAL CATEGORY (2015)

Material Category[1]	Percentage[2]	Tonnage Disposed
Brush[3]	11.7%	427,989
Sludge[4]	41.5%	1,521,187
Septage	6.4%	235,832
Contaminated Soil	22.9%	839,413
Other	17.5%	639,603
Subtotal Recyclable	**11.7%**	**427,989**
Subtotal Non-recyclable	**88.3%**	**3,236,035**
TOTAL	**100.0%**	**3,664,024**

1. *Shaded rows represent materials that could potentially be recycled.*
2. *Percentages rounded for ease of presentation.*
3. *Includes quantity of brush disposed reported in Municipal Solid Waste in Texas: A Year in Review FY 2015 Data Summary and Analysis by Texas Commission on Environmental Quality, 2016. Excludes estimated quantity of brush disposed as MSW or C&D.*
4. *These materials are recyclable, but have not been a point of emphasis in recycling programs. For a conservative estimate, the Project Team decided against including these materials in the estimated tonnage of materials that could potentially be recycled.*

FIGURE 5-4: OTHER WASTE COMPOSITION BY RECYCLABLE OR NON-RECYCLABLE (2015)



5.2 AGGREGATE COMPOSITION OF RECYCLABLE MATERIALS DISPOSED

Based on the preceding tables in this section, there were 10,286,994 tons of MSW, 2,715,317 tons of C&D materials, and 427,989 tons of other waste that could have been recycled, but were disposed. As shown in Figure 5-5, these 13,430,300 tons equal 43 percent of the total tons generated and disposed in Texas.

FIGURE 5-5: AGGREGATE COMPOSITION BY WASTE TYPE BY RECYCLABLE OR NON-RECYCLABLE (2015)

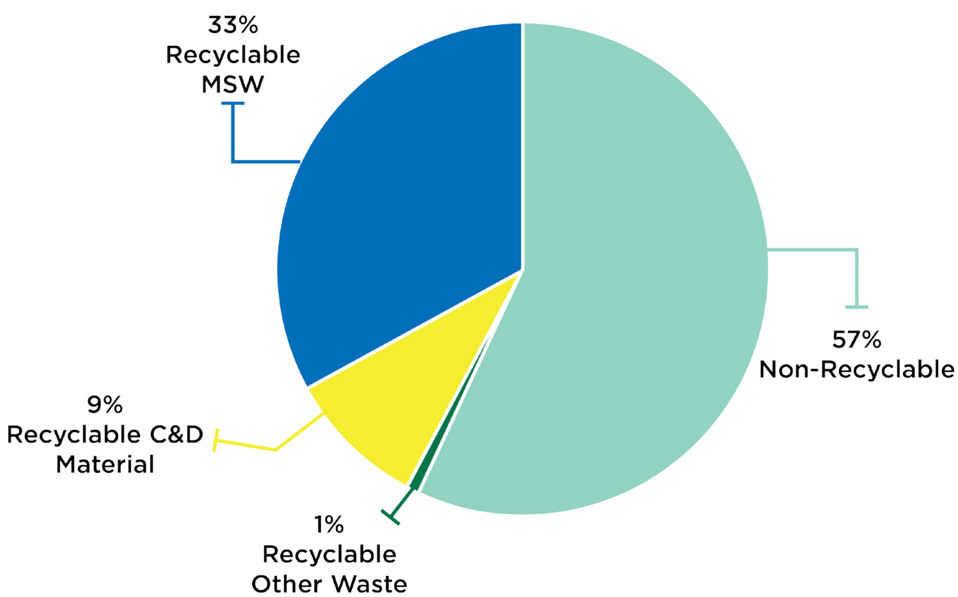


Table 5-6 presents the estimated tonnage of material disposed that could be recycled and an estimate of the percentage of the materials by category that could have been recycled, recognizing that not all material could be diverted. The Project Team provided a range based on recycling 20, 40, and 60 percent of the disposed material. Even though a material can be recycled, the Project Team used a range to recognize that it may be impracticable (from a cost and/or environmental perspective) for all of a material to be recycled due to lack of recycling infrastructure, contamination of recyclable materials, access to end markets, and need for additional public education and outreach.

TABLE 5-6: AGGREGATE COMPOSITION OF DISPOSED MATERIAL BY WASTE TYPE BY RECYCLABLE MATERIAL CATEGORY (2015)

			Assumed Recovery Rate		
Waste Type	Recyclable Material Category	Total Tonnage Disposed[1]	20%	40%	60%
MSW	Glass	657,577	131,515	263,031	394,546
	Metals –Ferrous	338,010	67,602	135,204	202,806
	Metals –Non-Ferrous	285,869	57,174	114,348	171,521
	Paper	4,085,648	817,130	1,634,259	2,451,389
	Plastics	810,902	162,180	324,361	486,541
	Organic Materials[2]	4,096,225	819,245	1,638,490	2,457,735
	Clean/Unpainted C&D Aggregates	12,763	2,553	5,105	7,658
	Subtotal	10,286,994	2,057,399	4,114,798	6,172,196
C&D Materials	Concrete/Cement	1,812,331	362,466	724,932	1,087,399
	Paper	375,184	75,037	150,074	225,110
	Ferrous	317,953	63,591	127,181	190,772
	Brush	209,849	41,970	83,940	125,909
	Subtotal	2,715,317	543,063	1,086,127	1,629,190
Other	Brush	427,989	85,598	171,196	256,793
	Subtotal	427,989	85,598	171,196	256,793
TOTAL		**13,430,300**	**2,686,060**	**5,372,120**	**8,058,180**

1. *Tonnages are based on Tables 5-2, 5-4, and 5-5.*
2. *Includes food and beverage materials and yard trimmings, brush, and green waste*

6.0 METHODS TO INCREASE RECYCLING VIA THE DEVELOPMENT OF NEW MARKETS AND NEW BUSINESSES

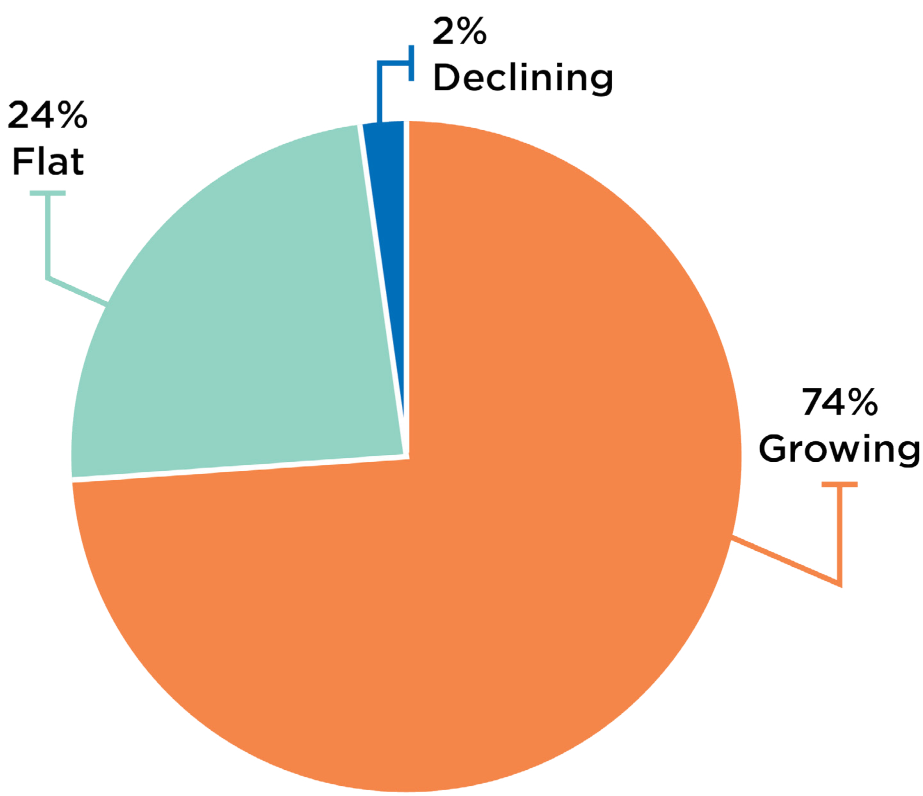
This section describes key trends in Texas recycling and identifies barriers and opportunities to expanding the industry and markets, as reported by survey respondents. This section also identifies market and business opportunities that are likely to have the largest impact or appear to be the most feasible based on the information available and the nature of the recycling industry in Texas. Based on survey respondents and interviews with key stakeholders, the Project Team also identified successes and challenges that occurred in the Texas recycling market.

6.1 TRENDS

Recyclable Material Quantities Expected to Grow

Texas companies and public agencies surveyed were optimistic about their future recycling business operations. As shown in Figure 6-1, 74 percent of respondents said they expect the amount of recyclable materials their business handles to grow over the next one to three years, while 24 percent said they expect the amount to stay flat, and only 2 percent expect a decline. Public organizations were somewhat more optimistic with 88 percent expecting growth, while 67 percent of private companies expect growth. At opposite ends of the spectrum, 80 percent of respondents involved in glass recycling said they expect volumes to remain flat, while 90 percent of organizations involved with organics recycling said they expect growth.

FIGURE 6-1: RESPONDENT EXPECTATIONS FOR THE AMOUNT OF RECYCLABLE MATERIALS THEIR OPERATIONS WILL HANDLE OVER THE NEXT ONE TO THREE YEARS



Uneven Recycling Growth

Municipal recycling in many large Texas cities is growing, while many rural, remote municipalities continue to face challenges. As the state's population grows, especially in urban areas, more material is produced by Texas residents and this is likely increasing expectations and demand for recycling services. Multiple Texas cities have presented solid waste plans with high diversion benchmarks and other ambitious goals, including San Antonio, Austin, Denton, and Dallas. Generally, as in many regions of the country, there is a trend toward single stream, cart-based collection programs accepting a wide range of materials. Many cities also include organics collection, accepting brush waste in large paper bags (e.g. Kraft bags) or carts alongside typical recyclables. Some municipalities, particularly Austin and San Antonio, are at different stages related to including residential food materials with their organics collection. Some rural areas maintain drop-off recycling programs and some have curbside programs, but recycling generally is much less established. Some rural municipalities do not provide recycling services. See Section 9 for more on rural recycling infrastructure in Texas.

Evolving Waste Stream Increases Costs

The types of products and packaging that are produced and enter the waste and recycling stream are rapidly changing and evolving. This presents challenges in handling this material, which leads to increased recycling processing costs and reduced revenues for recycling companies. Generation of lightweight, flexible, plastic, and multi-material packaging (e.g. plastic pouches and flexible film containers) is increasing. Generation of newspaper and other printed paper is decreasing, although cardboard generated by homes is increasing due to expanded online purchasing. These changes tend to reduce MRF revenues, since lighter materials means less material to sell. These changes increase MRF costs, since the growing mix of new packaging types are increasingly harder to sort. Overall, this reduces MRF profitability and requires periodic investments in new equipment or reconfiguration.

New equipment or reconfiguration can provide MRFs with increased sorting capabilities and allow the MRF to recover more high quality material. These investments can be financially burdensome, but as the waste and recycling stream changes, they are necessary to bring increased profits to the recycling facility. See the Dallas case study in Section 9 for an example. This trend also complicates community education efforts, and is leading to even more diversity across programs in what is accepted and how this is communicated to residents. Furthermore, it complicates the way that communities measure the success of their recycling programs. Traditional weight-based measurements and standard recycling rate goals are now being called into question as materials become lighter, with some communities exploring other methods to measure recycling efforts. For example, Denton uses the participation rate of its residents in the recycling program as one of its measures of success.

Reduced Demand for Recyclable Materials

Historically, high demand for recyclable metals, paper, and plastics, especially in China, has helped to drive expansion of curbside recycling in the U.S. and worldwide for over two decades. In recent years, global demand has fallen while supplies remained relatively flat. Reduced demand for recyclable materials has led to lower pricing and stricter quality standards by manufacturers, exacerbating MRF profitability concerns. These market conditions allow manufacturers to pay lower per ton prices to MRFs, as described in Section 4, while requiring higher quality with lower contamination rates, which increases processing costs. Moreover, a strong U.S. dollar has reduced the value of foreign currency to U.S. companies. These trends further exacerbate the profitability crunch MRFs are experiencing, and has led many recycling industry observers to call for investment in new or expanded U.S. manufacturing facilities that utilize recycled content material as a feedstock to increase domestic demand for recyclable materials. Like all commodities markets, demand and pricing for recyclable materials is cyclical, but some fear it could be years before demand and prices return to the high levels of the past decade.

Although Reduced, Demand for Recyclable Materials is Still Sufficient

Despite weakened markets, there continues to be sufficient demand for high-quality recyclable materials collected in Texas. The situation varies somewhat by material type as summarized below.

Glass

Texas is home to two glass container and two fiberglass manufacturing plants, as well as two secondary processors that produce furnace-ready recycled glass cullet from the bottles and jars sorted at MRFs. With this infrastructure, Texas has one of the strongest glass recycling markets in the country. However, the demand for glass depends on the cleanliness of the material. Based on the Project Team's interviews with glass end users, Texas does not currently recover enough clean glass that meets specification requirements to feed these plants. In fact, secondary processors report that they import clean, source-separated recyclable glass from their facilities in neighboring states to meet demand by Texas manufacturers. Some single stream MRFs in Texas are adapting and investing in technology to be able to provide cleaner glass, which has more value.

Despite strong demand, glass recyclers in Texas are not particularly optimistic about increasing their volumes, with 80 percent of survey respondents involved in glass recycling saying they expect volumes to remain flat. As in other areas of the country, increasing Texas recyclable glass volumes is constrained by poor economics and sortation challenges. While demand for clean recyclable glass is high, prices are relatively low compared to other recyclables, largely because recyclable glass replaces very low cost raw materials like sand and soda ash. Prices are especially low for the highly contaminated, mixed-color recyclable glass often produced by MRFs serving single stream curbside programs, which secondary processors must clean and color sort using costly automated equipment. Since glass is heavy, shipping it long distances is expensive, and may not be justified due to its low value. To make matters worse, including glass in single stream curbside programs tends to increase contamination of paper bales with broken glass. This further impacts MRF profitability by increasing sortation costs and reducing the value of shipped paper bales.

These constraints have led some communities such as Houston to remove glass from their single stream curbside program. They have generally stymied expansion of glass collection statewide, especially in rural west Texas areas that are a long distance from the state's secondary processors and glass markets in eastern Texas.

MRFs can invest in automated color-sortation equipment, but this can be hard to justify given the poor economics of glass recycling. Understanding the composition of a community's waste stream can also be key to the success of collecting glass in a curbside program. The city of Austin, which has a higher percentage of glass in its recycling stream than the national average, contracts with a MRF that was designed and built with this in mind. The facility works to sort glass ahead of any other materials, which keeps the material clean and the equipment in better shape. Other communities, like the city of El Paso, are located far from secondary glass processors. In 2016, El Paso began a pilot program allowing residents to drop off color-separated glass at its collection sites, and the city offers crushed glass back to the community for free to use in landscape projects. Through this pilot, El Paso is able to divert this material from landfills despite its distance to a secondary glass market. Finally, collecting recyclable glass in drop-off programs or through deposit systems, as ten other states have, yields far cleaner material that is more valuable and does not require costly cleaning or color sortation. However, drop-off programs generate far less volume than curbside, and Texas does not have a beverage container deposit system.

Paper

Recyclable paper is a global commodity. Scrap paper recovered in Texas flows to one of four in-state mills, several mills in neighboring states, or to other countries. Even with recent market declines, there is strong demand and recently strengthened pricing for recyclable paper sourced in Texas. Paper industry representatives say quality is a concern for mixed paper grades and they are seeing increased contamination in paper loads that are sorted from other single stream recyclable materials at MRFs. However, much of Texas' current supply of recyclable paper is cardboard sourced from retail stores and other commercial businesses that is, by-and-large, separated and baled at the source, virtually eliminating quality concerns.

Plastics

Most plastic recovered in Texas is first sorted and baled at MRFs and then flows to secondary processors in the southeastern U.S. or overseas that further sort and clean the material to produce pellets that compete with virgin plastic as manufacturing feedstock. Texas, which is a producer of virgin plastic due to the presence of a significant petrochemical industry, does not currently have a large secondary processor for post-consumer plastics, although a few Texas facilities do handle small amounts of post-consumer plastics or pre-consumer plastics generated by manufacturing facilities. This may be because the recovery of recyclable plastics in Texas remains low and there are not many manufacturers in the state buying recycled plastic as feedstock. One national firm, however, is building a large bottle-to-bottle plant in Dallas, set to open in 2017. This facility will require a strong supply of material coming from MRFs in Texas and surrounding states. Another firm recently announced plans to invest $10 million in a new plastic film recycling facility in Houston. This plant will initially process only commercially generated plastic film because of the higher contamination found in plastic film (such as bags) from MRFs and grocery store collection programs.

Metals

Outside of the MSW stream, collection of recyclable ferrous and nonferrous scrap metals is dependent upon market pricing, and sustained low prices have led to about a 15 percent decline in metal tonnages over the past two years. However, much of the metals in the MSW stream are aluminum and steel cans generated by homes and commercial businesses, and collection is far less dependent upon market trends. Domestic and global demand remain ample for scrap metals recovered from Texas; although, pricing in recent years has been very low by historical standards.

Organics Growing

Diversion and recycling of organic material through composting and land application is slowly and steadily growing in many parts of Texas, but growth is constrained by economics and geographic distance, lack of processing facilities, low value markets, and challenges in collection efficiency. At the same time, some larger communities, as part of their solid waste plans, have started collecting organics from residents and in some cases, local businesses with food operations. San Antonio and Austin have implemented third-cart programs for brush and food waste collection from households, and Austin has put in place regulations that will eventually require all local food establishments to have an organics collection program. The professionals surveyed for this Study who work in the organics industry in Texas generally see this field growing over the next few years.

Texas C&D Materials Recycling Thriving

In Texas, recycling of C&D materials is strong and growing where markets or market drivers exist, particularly in the more sprawling metropolitan areas, like the north Texas and Houston regions. However, C&D materials recycling is weak in other areas lacking strong markets and where other factors play a limiting role, such as distance to processing facilities. For example, recycling of concrete for use as aggregate is economical in eastern Texas where poor availability of natural aggregate creates a market for recyclable materials. However, in West Texas where natural aggregate is plentiful, recycling concrete is more difficult. Therefore, C&D materials recycling in Texas is dependent on a regional approach to be successful, and companies have focused on select areas where populations are thriving and where the markets are strong, like Houston and north Texas.

Poor Markets for Recyclable Electronics

Electronics recycling has become more challenging in recent years. A significant portion of recyclable electronics by weight is comprised of cathode ray tube (CRT) devices (i.e., larger televisions and computer screens that are rapidly being replaced by newer flat screen devices). The main market for leaded glass from recyclable CRT devices has been in the production of new CRT devices, but production has declined and the market for recyclable CRT glass has nearly disappeared. Moreover, declining demand and prices for recyclable plastic and metals (as described above) further weakened the economics of electronics recycling. The net result of these trends has been a decline in the tonnage of recyclable electronics in Texas and nationwide as electronics recyclers reduce recycling activities and shift to a renewed focus on reuse and refurbishment. The range of electronic “gadgets” and technologies continues to evolve rapidly, with many electronics becoming lighter and more compact, and recyclers are looking for ways to successfully adapt and handle this material at the end of its life.

Industry Support for Recycling

A growing number of specific industry organizations are supporting recycling through voluntary stewardship programs. In recent years, a variety of industry sponsored organizations have emerged that aim to collaborate with government and private companies to help strengthen and expand recycling. The programs vary significantly in their goals, resources, and approach. In some cases, they have been, or potentially could be, valuable partners in expanding Texas recycling.

Shift to Sustainable Materials Management

Many recycling experts are working on a new policy framework called sustainable materials management (SMM). Recycling has historically been viewed as part of the solid waste management system, with goals measured in terms of diversion from landfill disposal. However, many recycling organizations are now focusing on broader environmental and sustainability goals. Numerous studies by a variety of government, industry, and academic organizations have all reached the same conclusion - producing new products using recyclable materials instead of "virgin" raw materials (i.e., from mines and forests) can significantly reduce air emissions and consumption of natural resources and energy. Organizations such as the U.S. EPA, Oregon Department of Environmental Quality, and the National Recycling Coalition have formally embraced SMM as a framework to identify the best method to minimize the overall environmental impacts of materials use across the entire life-cycle. In future years, the field of SMM will likely evolve and provide tools and concrete ideas for how government agencies can promote these goals and measure the success of their work.

6.2 BARRIERS TO EXPAND RECYCLING BUSINESS ACTIVITIES

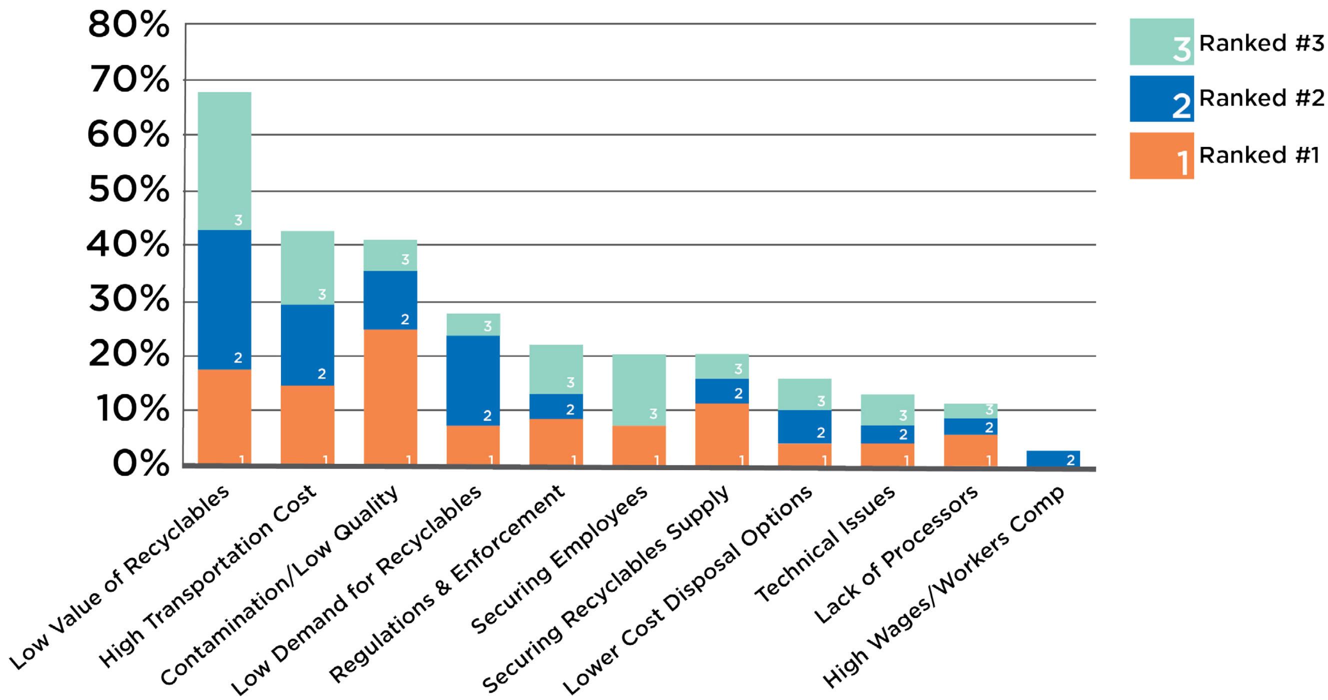
Figure 6-2 shows how survey respondents ranked barriers to expanding their recycling business activities. The top barrier by far, cited by 68 percent of respondents, is the low value of recyclable materials. The three next biggest barriers, cited by between 28 and 43 percent, are contamination/low quality materials, high transportation costs, and low demand for recyclable materials. These top barriers directly impact the economics of recycling collection and processing activities. The next six barriers, cited by 12 to 22 percent of respondents, can impact most any segment of the recycling chain. The lowest-ranked barrier, cited by only 3 percent of respondents, was high wages and worker compensation costs, which is more of a concern for recycling companies in some other states.

These barriers impact most types of recyclable materials to varying degrees. For curbside programs targeting household paper, plastics, metals, and glass, poor economics can often be addressed by strong municipal contracts and efficient operations. However, for private sector programs not directly supported by local governments, such as C&D materials recycling in many areas, poor economics often result in materials flowing to relatively low cost disposal rather than to recycling facilities. Texas has some of the lowest disposal costs in the country, so this is often a significant recycling barrier. Manufacturers using certain recyclable materials (especially glass) are more likely than collectors and MRFs to cite difficulty securing a consistent supply of recyclable materials as a barrier to growth, with most emphasizing the need for high-quality supply, not just quantity.

6.3 OPPORTUNITIES TO EXPAND RECYCLING BUSINESS ACTIVITIES

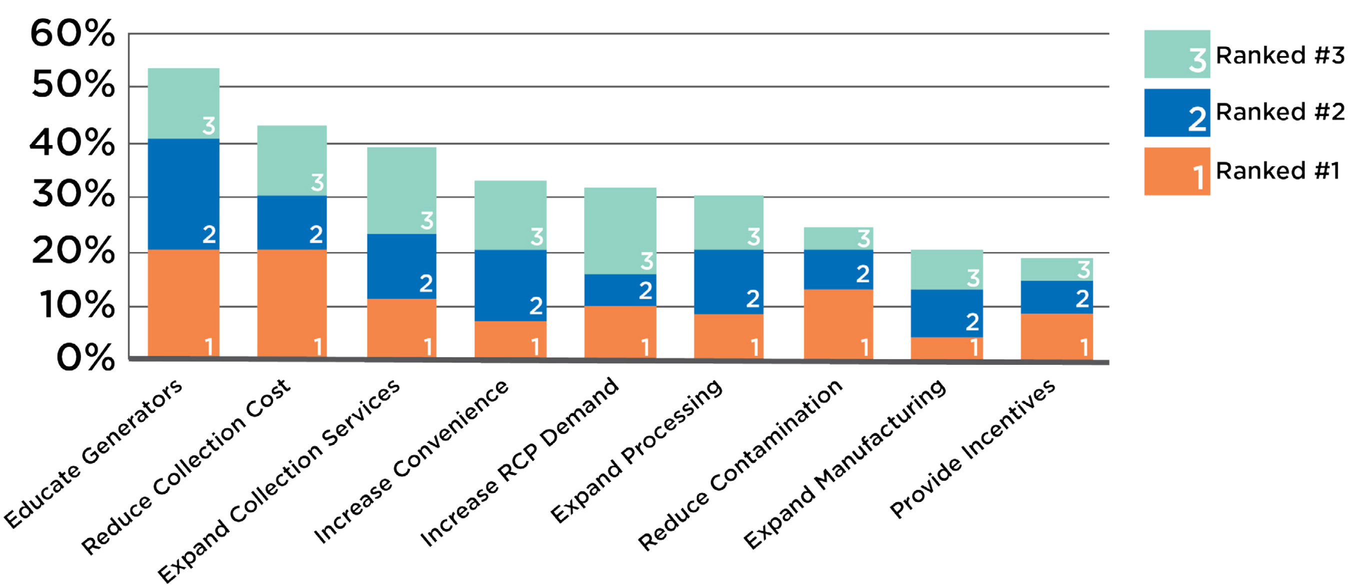
Figure 6-3 shows how survey respondents ranked opportunities to expand recycling volumes. Educating generators (i.e., residents and commercial businesses) was the most highly ranked opportunity, cited by over half of respondents. This is followed by reducing collection costs and expanding collection services (both cited by about 40 percent of respondents) and increasing convenience (33 percent of respondents). All of these top ranked opportunities involve strengthening local collection programs. The remaining five opportunities, cited by 20 to 30 percent of respondents, mainly involve strengthening processing operations and increasing demand for recyclable materials by manufacturers. Two of these last five opportunities – reducing contamination and providing incentives – could involve any stage of the recycling process.

FIGURE 6-2: BARRIERS CONSTRAINING EXPANSION OF RECYCLING BUSINESS ACTIVITIES AS REPORTED IN SURVEYS[1]



1. A #1 ranking indicates the strongest barrier.

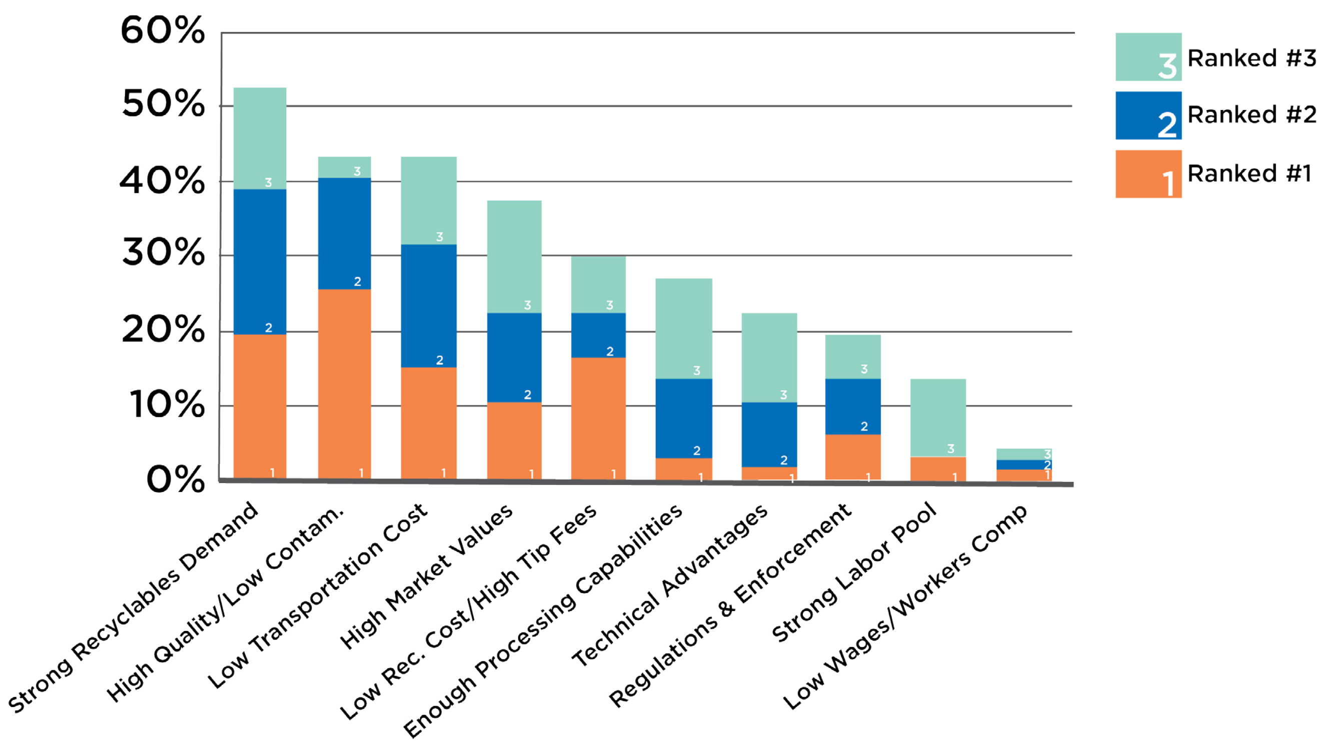
FIGURE 6-3: RECYCLING EXPANSION OPPORTUNITIES AS REPORTED IN SURVEYS[1]



1. A #1 ranking indicates the biggest opportunity.

Figure 6-4 shows how survey respondents ranked "enablers," that is, the types of conditions that will most effectively increase recycling. The top five enablers, cited by 30 to 52 percent of respondents, would directly strengthen the economics of collection and processing programs through both strengthened local programs (e.g., delivering higher quality materials with low contamination at a low cost) and through stronger markets (e.g., strong demand with high market values). The sixth strongest enabler—enough processing capacity, cited by 27 percent of respondents – is a significant issue for certain material streams (e.g., organics) and in certain regions (e.g., some rural, remote areas of the state). Many urban areas have ample processing capacity for curbside recyclable materials, although most processing facilities would benefit from improved technological advantages (cited as a top enabler by 22 percent of respondents). Section 9 addresses recycling infrastructure needs in more detail. The remaining enablers, each cited by less than 20 percent of respondents, could be important for operations involved with a wide variety of material streams or stages of recycling.

FIGURE 6-4: ENABLERS TO EXPANDED RECYCLING AS REPORTED IN SURVEYS[1]



1. *A #1 ranking indicates the strongest enabler.*

6.4 ADVANCING THE OPPORTUNITIES

The above findings regarding barriers and opportunities suggest there is strong interest in expanding Texas recycling by focusing on collection and processing programs. There are two broad ways to do this - strengthening existing programs and expanding access to recycling. Examples of methods to strengthen existing programs include:

- Adoption of strong municipal contracting practices that incentivize efficiency and diversion and that include appropriate revenue/risk sharing mechanisms to ensure continuity of service in both down and up markets. See Section 7 for more information on public-private partnerships and Section 9 for the Dallas case study that describes how one public-private partnership works.
- Adoption of sustainable local funding mechanisms that reliably provide revenue needed to operate effective recycling programs. For example, funding recycling through service fees, preferably structured to provide an incentive for increased recycling as in pay-as-you-throw programs, can provide a more reliable, dedicated revenue stream for recycling rather than using revenue from the local tax base.

- Improved and expanded education programs, including the harmonization of materials accepted and distribution of educational materials across the areas served by a given MRF. This can reduce consumer confusion about what and how to recycle, thereby increasing volumes collected and reducing contamination levels. Higher quality of material often yields higher pricing from end users and can improve the overall economics of recycling.
- Adoption of best management practices in collection and processing systems to ensure that all targeted materials are efficiently and effectively recovered, using the latest technology appropriately matched to the type and scale of local systems.

The Recycling Partnership is an example of an industry-funded program aiming to partner with local communities and private firms to strengthen their programs. The organization provides a variety of free tools and best practices on its website. See Table 6-1 and Section 7 for more information on the Recycling Partnership.

The second way to boost local collection is by expanding access to recycling, especially in communities where programs do not currently exist or are very limited. While Texas-specific statistics are not available, a recent study by the Sustainable Packaging Coalition[1] found that 70 percent of households have some type of access to curbside recycling services in the southern U.S. region, which includes Texas, 23 percent have access to drop-off programs, and 7 percent have no recycling access.

The study also found that the type of access to curbside programs varies widely. At the national level, 53 percent have automatic, universal access to curbside recycling (i.e., all households in covered neighborhoods are automatically provided with the service). Fourteen percent have subscription-based access to curbside recycling and 6 percent must opt-in. Statistics on type of curbside access were only available at the national level.

TABLE 6-1: FINDINGS FROM THE 2015-2016 CENTRALIZED STUDY ON AVAILABILITY OF RECYCLING ON TOP OPPORTUNITIES TO INCREASE RECOVERY FROM RESIDENCES[1]

Automatic Service	Providing bundled garbage and recycling services automatically to all homes
Consistent Information	Use available tools to better tell the public what to recycle at the curb
Consistent Messaging	Uniform communication of accepted materials across communities and regions is essential to robust public participation without confusion
MRF Shed Perspective	Collaborate with neighboring cities served by the same MRF to develop a common approach. See Section 9 for more information.
Collection in Carts	On average, cart-based systems yield 100 pounds (43 percent more) per year per household more than bins.
Hub & Spoke	Pooling and hauling of materials improves economics. Adapt existing transfer station infrastructure for consolidation of recyclable materials. See Section 9 for more information.
Multi-family Recycling	This is a largely underserved, if challenging, sector with lots of potential for innovation.

1. *State of Curbside Report. Recycling Partnership. 2016.*

Expanding recycling collection from commercial generators, including C&D materials, can be more challenging than residential recycling systems, especially where landfill tipping fees are low, which is the case in Texas, or where there are no local policies in place to drive activity (e.g. C&D recycling ordinances, landfill bans, etc.). However, business opportunities are available where market conditions are favorable. For example, multiple large C&D materials processing facilities have opened in the past few years in Texas.

1. *The 2015-2016 Centralized Study on Availability of Recycling.* Moore Recycling Associates, Inc. and RRS on behalf of the Sustainable Packaging Coalition. 2016.

Beyond strengthening and expanding collection, survey respondents also pointed to the need for higher demand and pricing for recyclable materials. Some recyclable materials, notably paper, metals, and plastics, are global commodities and U.S. manufacturing facilities must typically be relatively large and modern to successfully compete with firms from all over the world. For some other recyclable materials such as concrete/cement, organics, and glass, economics preclude long-distance shipping. Markets for such materials are largely local or regional, and in some cases, there may be more variability in the size and type of end use and manufacturing facilities.

Business development opportunities in and near Texas can be found across all recyclable commodities. For example, a plastics recycler with a well-established operation in California is actively pursuing development of a Texas facility to process bales of recyclable plastic bottles shipped from MRFs. A new, large steel pipe producer has invested over $1.5 billion in a new Texas manufacturing facility that expects to open in 2017. Also, in recent years a new paper manufacturing facility began operation in Louisiana, and another is planned in Arkansas.

Promoting investment in new recycled product manufacturing facilities, whether large or small, is a much different undertaking than expanding collection programs. Many states and private organizations have demonstrated a wide variety of successful approaches. A 1994 report for the Texas Natural Resource Conservation Commission provided an analysis of recycling markets at the time, along with a comprehensive strategic plan for expanding the Texas recycling industry and markets[2]. Examples of funding mechanisms that private companies can take advantage of to build new facilities or expand existing ones are included in Section 7. Some examples of recycling market development activities for public or private entities include:

- Sponsoring networking events and systems to match potential partners in new ventures.
- Organizing cooperative marketing campaigns to match locally produced recycled product producers with local consumers. For example, recycled tires in road paving projects, compost in parks and recreation projects, and recycled cement or pavement as aggregate in civil engineering projects.
- Collaborating with financing organizations with an interest in recycling, especially the Closed Loop Fund (described further in Section 7), an organization funded by the consumer product industry that is dedicated to expanding recycling market infrastructure and improving the economics of recycling.
- Regularly documenting industry trends and providing information on existing recycling companies to help companies identify and evaluate potential opportunities.

2. *Market Development for Texas Recyclables.* Mt. Auburn Associates and Hazen & Sawyer, P.C. for the Texas Natural Resource Conservation Commission. 1994.

7.0 GRANTS AND OTHER FUNDING SOURCES

Both government incentives and private funding sources can provide financial benefits for a variety of solid waste management and recycling projects. These grants and other funding sources are often provided on a competitive basis and are not always specific to the solid waste and recycling industry. If a project can secure additional funding, it will typically allow for a reduction in the capital or operating costs. Some of these funding sources may offset the start-up infrastructure costs for smaller projects, especially those in smaller, more rural communities. This section provides an overview of potential governmental incentives that public and private solid waste and recycling entities could utilize or that have historically been used for solid waste management or recycling projects. For each listed program, the Project Team included an example of its applicability and the website to contact for additional information[1]. This section concludes with a discussion of public-private partnership options for structuring recycling projects.

7.1 STATE OF TEXAS PROGRAMS

This section provides an overview of programs provided by the State of Texas.

Regional Solid Waste Grants Program

In Texas, grant funds are awarded to regional and local governments for MSW management projects through the state's Regional Solid Waste Grants Program. State law dedicates a portion of the revenue generated by state fees on MSW disposed at landfills to grants for regional and local MSW projects. Funding is allocated to Texas' 24 Councils of Government (COGs) based on a formula that takes into account population, area, solid waste fee generation, and public health needs. More information on the allocation of these funds can be found in Section 361.014 of the Texas Health and Safety Code.

Grant funds can be used for illegal dumping cleanup, source reduction and recycling projects, developing or updating local solid waste management plans, HHW management, educational and training projects, and other MSW projects. Eligible applicants include cities, counties, public schools and school districts, general and special law districts, and COGs. Projects should promote cooperation between public and private entities, although private and nonprofit entities are not eligible to receive direct grant funding from the COGs. However, the private and nonprofit entities could enter into a partnership with any of the eligible applications listed above.

During the 2014/2015 biennium, the 24 regional COGs funded 226 projects totaling more than $5 million. $2.2 million was granted to fund 71 recycling projects (41 percent of the total funding) and $279,138 was granted to fund ten organic waste management projects (5 percent of the total funding)[2].

Regional example: The Ark-Tex Council of Governments (ATCOG) was a solid waste grant recipient during the 2014/2015 funding period and was able to expand a regional recycling education program focused on educating residents about recycling opportunities in the nine-county area. The ATCOG formed partnerships with 11 different organizations (school districts, municipalities, and counties) and utilized $60,000 in grant funding for utility trailers to collect recyclables and to create and distribute educational material to participating partners. As a result, residents have diverted 537 tons of recyclable material from landfills and have generated more than $97,400 in revenue from the sale of recyclable material.

Community example: The City of Victoria Environmental Services Department (ESD) has been able to provide recycling services and education for residents not only in the city of Victoria, but also in surrounding areas. In 2006, ESD created Golden Crescent Recycling (GCR), which is a network of school recycling programs in seven different counties tailored to fit the needs of each participating community in the Golden Crescent Regional Planning Commission (GCRPC). As of 2012, the GCRPC has administered more

1. For the listed examples, the Project Team prioritized listing examples in Texas that were specific to recycling programs. In some cases, non-recycling and/or examples from outside of Texas are provided because Texas recycling examples were not available.
2. Information about the Texas solid waste grants was taken from the Texas Association of Regional Councils (TARC) Impacts and Results in Your Region report to the Texas Legislature, covering the funding period from 2014/2015. This report is available on TCEQ's website as well as on the TARC website: www.txregionalcouncil.org.

than $100,000 in regional solid waste grant funds for GCR communities, and the City of Victoria ESD has provided $45,000 in in-kind funds and services[3].

For more information: https://www.tceq.texas.gov/permitting/waste_permits/waste_planning/wp_grants.html

Composting Refund for MSW Facilities through TCEQ

In Texas, the operator of a publicly or privately owned MSW facility may be eligible for a refund of up to 20 percent of the solid waste fees collected by the facility. The operator of the facility must submit a composting plan to the TCEQ and receive written approval of the plan.

MSW facility permit holders that may apply for the compost refund are those with on- or off-site composting operations who demonstrate that the refunds are used to lease or purchase and operate equipment necessary to compost yard waste; that compost operations are actually performed; and that the finished compost material produced by the facility is returned to beneficial use.

Example: In FY 2016, more than $821,000 was credited to 11 facilities participating in the program, and 307,869 cubic yards of compost was reused. Compost material can be sold or given away to citizens or applied to landscaping in local parks, government buildings, or roadways.

For more information: Section 361.0135 of the Texas Health and Safety Code and Section 330.677 of the Texas Administrative Code or online at: https://www.tceq.texas.gov/permitting/waste_permits/msw_permits/msw_compost_credit.html

Defense Economic Adjustment Assistance Grant

The Defense Economic Adjustment Assistance Grant Program (DEAAG) is an infrastructure grant program administered by the Texas Military Preparedness Commission. The grant program is designed to assist defense communities whose defense contracts have been changed, reduced, or terminated. Grants are available to local municipalities, counties, defense base development authorities, junior college districts, Texas State Technical College campuses, and regional planning commissions representing these defense communities. Texas is comprised of 15 active duty military installations, many of which have active recycling programs.

Grant funding can be used for infrastructure projects, to purchase new property, to purchase or lease capital equipment, or for the construction or rehabilitation of facilities that support job creation and opportunities. Grants may range from $50,000 to $5 million per project. Since the program was started in 1997, the Texas Military Preparedness Commission has awarded $47 million in 44 grants.

Example: While the Project Team did not identify an example of these grant funds used for a recycling project, examples of past awards include infrastructure projects such as the reconstruction of water and wastewater systems.

For more information: http://gov.texas.gov/military/grants

Texas Nonpoint Source Management Grant Program

The Federal Clean Water Act requires states to develop a program to protect the quality of water resources from the adverse effects of nonpoint source (NPS) water pollution. NPS pollution is all water pollution that does not originate from regulated point sources and occurs when rainfall flows off the land, roads, buildings, and other features of the landscape. This runoff carries pollutants into drainage ditches, lakes, rivers, wetlands, bays, and aquifers. The Texas NPS Management Program is the state's comprehensive strategy for addressing NPS pollution, and the NPS Grant Program is administered by the Texas State Soil and Water Conservation Board (TSSWCB), in partnership with TCEQ, for the purpose of providing grants to cooperating entities for activities that address the goals and objectives of the Texas NPS Management Program. Proper materials management, particularly with hazardous materials, directly affects the quality

3. Information about the City of Victoria grant was taken from the Texas Association of Regional Councils (TARC) Impacts and Results in Your Region report to the Texas Legislature, covering the funding period from 2012/2013. This report is available on TCEQ's website, as well as on the TARC website: www.txregionalcouncil.org.

of water in a particular watershed, and projects that provide best management practices to increase water quality may qualify for funding through the NPS Grant Program.

Example: The Dairy Manure Export Support program, administered by the TSSWCB, provided financial support for the transport of raw manure from dairy farms to compost facilities in an effort to lower elevated phosphorus levels in the North Bosque and Leon River watersheds. The manure, which would have otherwise been land applied, was improved through a composting process and provided to governmental entities and the general public for beneficial reuse as compost. This also addressed water quality concerns associated with traditional on-farm land application of manure in the region.

For more information: http://www.tsswcb.texas.gov/en/managementprogram or https://www.tceq.texas.gov/waterquality/nonpoint-source/grants/grant-pgm.html

Texas Emissions Reduction Plan (TERP)

The TERP program, administered through TCEQ, provides financial incentives to eligible individuals, businesses, and local governments to reduce emissions from mobile sources and equipment. The TERP program is comprised of nine separate grant programs, and each program has its own eligibility requirements and may accept applications at different time periods of the year.

Example: Recycling companies could apply for a TERP Emissions Reduction Incentive Grant (ERIG) to upgrade or replace on-road vehicles, non-road equipment, stationary equipment, or other improvement projects that would result in a reduction of emissions of nitrogen oxides of at least 25 percent.

For more information: http://www.terpgrants.org

Supplemental Environmental Projects (SEPs)

A TCEQ respondent that is assessed a monetary-administrative penalty has the option to voluntarily participate in a project that enhances, protects, and improves the environment of the respondent's community. These projects are referred to as Supplemental Environmental Projects (SEPs). If approved, a respondent may offset a portion or the entirety of the assessed penalty, depending on the type of respondent, to implement a SEP or to contribute to an already existing SEP. SEPs can include a range of actions that protect or improve the environment in or near the community where an environmental violation took place. SEPs advance the goal of cleaner air, water, and soil throughout Texas and enhance the environment in communities affected by environmental violations. The Program offers three types of SEPs:

1. Pre-Approved SEP: whereby the respondent contributes a portion or the entirety of an assessed administrative penalty, depending on the type of respondent, to a Third-Party Administrator to implement an existing SEP;
2. Custom SEP: whereby the respondent can use a portion or the entirety of an assessed administrative penalty, depending on the type of respondent, to perform a custom project using its own resources; and
3. Compliance SEP: whereby local governments, as defined within TEX. WATER CODE § 7.067 who meet certain criteria, can use the entirety of the assessed administrative penalty to correct the violations alleged in the enforcement action or remediate environmental harm caused by the violations.

Angelina Beautiful Clean, Texoma Council of Governments, and Texas Association of Resource Conservation and Development Areas, Inc. have all received pre-approval of SEPs to conduct collection events.

Example: Respondents with waste violations could redirect funds from TCEQ administrative penalties to help communities and local governments run recycling collection events. A local government with municipal waste violations could propose to use its assessed penalty to perform a recycling project rather than deposit the penalty into the state's General Revenue Fund.

For more information: https://www.tceq.texas.gov/legal/sep/

7.2 FEDERAL PROGRAMS

This section provides an overview of programs provided by the Federal government. The Project Team also recommends utilizing grant search engines, such as www.grants.gov, which provide a centralized location for grant seekers to find and apply for Federal funding opportunities. Currently, the system houses information on more than 1,000 grant programs and vets grant applications for Federal grant-making agencies.

For more information: https://www.grants.gov

Federal Grants

Federal grants are available to better manage solid waste and to reduce the amount of solid waste going to landfills, particularly for low-income rural areas. Some examples of departments that provide grants for solid waste management projects are the U.S. Department of Agriculture (USDA) and the U.S. EPA.

The USDA Rural Development Solid Waste Management Grant program reduces or eliminates pollution of water resources by funding organizations that provide technical assistance or training to improve the planning and management of solid waste sites. Most state and local government entities, nonprofits, federally recognized tribes, and academic institutions can apply for projects serving rural areas and towns of less than 10,000 people. Funds may be used to provide technical assistance or training to help communities reduce the amount of solid waste coming into a landfill.

Example: In 2016, the West Central Texas Council of Governments was awarded $152,000 to provide training and technical assistance to elected officials and city and county staff for environmental enforcement of state laws and city and county codes, as well as community education and involvement in reducing the solid waste stream.

For more information: https://www.rd.usda.gov/programs-services/solid-waste-management-grants

U.S. EPA U.S.-Mexico Border 2020 is an environmental program that emphasizes regional, bottom-up approaches for decision making, priority setting, and project implementation to address the environmental and public health problems in the border region. One of the goals of the Border 2020 program is to promote materials management and waste management. One way this is accomplished is through a grant program with border communities.

Example: In 2014, the city of Alamo, which is located in the Lower Rio Grande Valley, was awarded $54,838 to implement the Alamo's Recycling TEAM Includes Everyone (ARTIE) Project, which enhanced the management of MSW and recycling in the city. The project was aimed at increasing recycling efforts, increasing the awareness of nonpoint pollution and solutions, and establishing partnerships that promoted environmental stewardship.

For more information: https://www.epa.gov/border2020

The U.S. EPA Environmental Workforce Development and Job Training (EWDJT) grant program funds eligible entities, including nonprofit organizations, to deliver training programs that recruit, train, and place local, unemployed, and under-employed residents with the skills needed to secure full-time employment in the environmental field. Although the program is mainly geared toward brownfields hazardous waste training and hazardous waste operations and emergency response training, the program is flexible.

Applicants can deliver solid waste management or cleanup training, including training intended for operators of MRFs and recycling centers, electronics and HHW collection and recycling program operators, and C&D material collection and recycling management.

Example: The Project Team is not aware of any programs that have been funded specifically for recycling training, but the Oklahoma Environmental Training Center at Rose State College in Midwest City, Oklahoma provides free water and wastewater operator training to the unemployed and underemployed with funds provided by the U.S. EPA.

For more information: https://www.epa.gov/grants/fy17-environmental-workforce-development-and-job-training-ewdjt-grants

New Market Tax Credit

The New Market Tax Credit (NMTC) Program is a Federal program operated by the Department of Treasury that provides investors with Federal tax credits for qualified development in low-income communities. The tax credit is provided to a specialized financial institution called a Community Development Entity who invests in the NMTC applicant. The tax credit provided to the investor is claimed over a seven-year credit period. In each of the first three years, the investor receives a tax credit equal to five percent of the total amount paid for the stock or capital interest at the time of purchase. For the next four years, the value of the tax credit is six percent annually. The tax credit can be applied for multiple times for the same project.

Example: The city of Albuquerque, through a public-private partnership with Friedman Recycling, utilized new market tax credits as a part of its efforts to build and operate a new single-stream MRF in 2013.

For more information: https://www.cdfifund.gov/programs-training/Programs/new-markets-tax-credit

Tax-Exempt Private Activity Bonds

Private activity bonds provide tax-exempt financing for the furtherance of governmental and qualified purposes, which may include the construction of solid waste disposal facilities. Solid waste disposal could include various types of recycling activities. Qualified private activity bonds are issued by a state or local government, and the proceeds are used for a defined qualified purpose by an entity other than the government issuing the bonds.

Qualified private activity bonds must be approved by the governmental entity issuing the bonds and, in some cases, each governmental entity having jurisdiction over the area in which the bond-financed facility is to be located. Public approval can be accomplished by either voter referendum or by an applicable elected representative of the governmental entity after a public hearing, following reasonable notice to the public.

Example: The Dallas City Council approved the issuance of private activity bonds for the landfill gas to energy project at the McCommas Bluff Landfill as required by the U.S. Internal Revenue Service regulations. The contractor, Dallas Clean Energy, used a conduit issuer, Mission Economic Development Corporation, to issue the private activity bonds.

For more information: http://www.irs.gov/pub/irs-pdf/p4078.pdf

Commodity-Specific Grants

Some trade organizations representing specific recycling commodities have set aside limited funding to help increase the recovery of those specific commodities. One example is grant funding provided by the Carton Council, an industry-funded nonprofit organization, with members representing major manufacturers of aseptic (shelf-steady cartons, such as non-dairy milk, soups, and broths) and gable top cartons (refrigerated containers for juice and milk). The Carton Council has provided grant funding to MRFs for retrofitted equipment upgrades that better sort, process, and market this material.

Another example is grant funding provided by the Foam Recycling Coalition, which is part of the Foodservice Packaging Institute, to support increased recycling of packaging made from foam polystyrene. Both public and private organizations managing residential curbside programs or MRFs are eligible to apply for funding to build recycling infrastructure for the collection, processing, and marketing of post-consumer products made from polystyrene.

Example: Carton Council provided a grant to a MRF in Fort Worth. The grant helped the MRF with the purchase of an optical sorter that allowed them to more efficiently sort post-consumer aseptic and gable top cartons.

For more information: http://www.cartonopportunities.org/ and http://www.fpi.org/

7.3 PRIVATE FUNDING SOURCES

While there are various private funding sources, this section describes the Recycling Partnership and the Closed Loop Fund. The Project Team would also like to note that the Foundation Center manages an online database comprised of more than 140,000 granters and private funders for nonprofit organizations.

For more information: http://www.foundationcenter.org

The Recycling Partnership

The Recycling Partnership (Partnership), formerly the Curbside Value Partnership, is an industry-funded national recycling nonprofit with the goal of improving curbside residential recycling in the U.S. The Partnership provides resources for communities (4,000 or more households) starting programs with recycling carts or switching from bins to carts. To accelerate the local level adoption of recycling best management practices, the Partnership uses highly leveraged grants coupled with technical assistance. For 2016, the Partnership grants offered were for:

- Cart purchase: $7.00 per cart delivered up to $500,000
- Education and outreach implementation: $1.00 per household up to $50,000
- Access to technical assistance and the CARTs campaign materials valued at $139,000

Example: In 2015, the Partnership awarded a grant for residential recycling carts to the city of Santa Fe, New Mexico. The grant funds will assist Santa Fe with purchasing new recycling carts. Additionally, the city will receive assistance with a customized public education campaign and technical planning to support the cart deliveries to its 29,000 households. Santa Fe anticipates that cart distribution will take place in 2017.

For more information: http://recyclingpartnership.org/

The Closed Loop Fund

The Closed Loop Fund (CLF) was created to increase recycling rates and is funded by consumer goods companies and retailers. The CLF provides zero interest loans to municipalities and low interest loans to private companies. The goal for CLF is to invest $100 million in recycling infrastructure between 2015 and 2019.

Example: The CLF is investing $1.5 million to upgrade existing MRF infrastructure at Lakeshore Recycling Systems in Chicago, Illinois, where an increase in residential, single stream recycling led to capacity issues. The upgrade will increase the MRF throughput, allowing Lakeshore to increase revenue through increased productivity.

For more information: http://www.closedloopfund.com/

7.4 PUBLIC-PRIVATE PARTNERSHIPS

Public-private partnership can be an effective model to increase recycling without the full financial risk falling on either the local government or the private business. Effective public-private partnerships exist when both local governments and the private industry collaborate to share resources, capital investment, risk, and revenue. When considering a public-private partnership, a local government should consider what it would like its role to be in recycling processing and how much it wants to be involved in the operations and capital investment of a facility.

An example of a public-private partnership in Texas is the city of Denton. Denton utilizes many public-private partnerships for its recycling processing, as well as many other waste management services provided by the city, such as methane gas capture from the Denton landfill. All waste management services (landfill, recycling, compost, etc.) are provided on the same tract of city-owned land, which minimizes transportation costs and allows for more consistency between services.

There are advantages and disadvantages to the different arrangements and which entity takes ownership of the land, capital investment, and operations. While the processing services agreement is the most common option in Texas, public-private partnerships are gaining more appeal as a means to share risk given recent market volatility. For example, the city of Dallas recently entered into a public-private partnership with a company to build and operate a MRF on city land. More information on this agreement can be found in Section 9 - Infrastructure Needs and Development Opportunities.

Table 7-1 provides an overview of the different public-private partnership options available to local governments and private businesses. Tables 7-2 through 7-4 identify who would be responsible for the capital investment and who would operate the facility based on different relationship/partnership scenarios, as well as the advantages and disadvantages of each type of partnership.

TABLE 7-1: EXAMPLES OF PUBLIC-PRIVATE PARTNERSHIP OPTIONS FOR RECYCLING OPERATIONS

	City-Owned and Operated	City-Owned with Private Operations[1]	Privately Owned and Operated on City Land[1]	Processing Services Agreement
Land Ownership	City	City	City	Private
Capital Investment	City	City	Private	Private
Operations	City	Private	Private	Private
Examples	McAllen, Lufkin, and Laredo, TX	No known examples in TX; Phoenix, AZ	Denton and Dallas, TX	Many cities in Texas

1. True public-private partnership arrangement

TABLE 7-2: EXAMPLES OF CITY VERSUS PRIVATE RECYCLING OPERATIONS

	Possible Advantages	Possible Disadvantages
City	• City receives 100 percent of revenue • Control over operations	• Limited single-stream experience • Sole responsibility for sourcing material • Limited in materials marketing capabilities, scale, and experience
Private	• Experience with single-stream • City and private company work together to source material • Potential to market a large volume of material from multiple facilities • Sophisticated materials marketing (e.g. hedging, derivatives)	• City must manage contractor and provide oversight • City likely to incur processing fee and must share revenue • Limited control over operations

TABLE 7-3: CITY VERSUS PRIVATE RECYCLING CAPITAL INVESTMENT

	Possible Advantages	Possible Disadvantages
City	• Municipal cost of capital lower • City does not have to earn a return on capital investment • Potentially longer depreciation period • High control of facility and overall site	• Large capital outlay for city • Potentially longer project schedule • Higher risk
Private	• No capital outlay required by city • Potential for some cost and/or schedule savings due to private-led procurement processes • Lower risk	• Higher cost of capital • Private will compress depreciation period to match contract term • Private must earn a return on capital investment • Lower control over facility and site

TABLE 7-4: CITY VERSUS PRIVATE RECYCLING LAND OWNERSHIP

	Possible Advantages	Possible Disadvantages
City	• Flexibility with public-private partnership structures • City already owns land • Existing permitted facility with infrastructure (e.g. scale house) • Can retain facility long-term • High control of facility and overall site (e.g. potential future expansion)	• Increased level of effort • Higher risk to the city
Private	• Lower level of effort for city • Lower risk to the city	• No city involvement • City will not retain facility in the long-term • Low control of facility and site

8.0 THE STATEWIDE ECONOMIC IMPACTS OF RECYCLING

The act of recycling incorporates a broad range of activities that have an impact on the Texas economy. After a consumer uses and discards a recyclable material, it is collected, sorted, processed, and sold to end markets. All of this is done with the intent of preparing it for use as a future feedstock for manufacturing. When recyclable materials are sufficiently processed to be used as feedstock, they are then transported from the processor to a manufacturer. The manufacturer, in turn, either feeds the recyclable material directly into the manufacturing process, further processes it before use, or mixes the recyclable material with virgin material before manufacturing. During each stage of this recycling process, from collection to manufacturing, economic activity is being generated in the form of employment, workers' wages, and public revenue. The purpose of this section is to estimate the statewide economic, employment, and fiscal impacts that are derived from recycling MSW.

8.1 OVERVIEW OF ECONOMIC IMPACT ANALYSIS

The traditional tool for estimating the economic impacts of an activity within a region is the input-output model. Input-output models replicate a region's economy by estimating "the movement of products and services between industries, households, and governments"[1]. Economic impacts are estimated by manipulating these flows and observing the changes. The linking of these changes to a region's economy are described as either direct, indirect, or induced impacts, as defined below:

- Direct Impacts – Direct impacts represent changes to the expenditures or production of an industry or industries experiencing the change.
- Indirect Impacts – Indirect impacts represent the purchase of goods and services by the industry experiencing the change from other businesses in the regional economy. The input-output model also accounts for successive, iterative, backward linking expenditures by local industries.
- Induced Impacts – Induced impacts reflect the spending (wages and salaries) of employees in the affected direct and indirect industries, assuming they live within Texas.

The input-output model also reports economic indicators for each type of impact:

- Employment – A "job" in the input-output model does not necessarily denote permanent, ongoing employment. Instead, it represents a "person-year" of employment or the equivalent of one person working full-time for one year.
- Labor Income – Labor income is the value of a workers' wages and benefits plus the profits earned by the self-employed. For this analysis, it was assumed that all employees worked for public agencies or firms as employees, so proprietor income was set to zero in the input-output model.
- Value Added – The equivalent of the gross domestic product (GDP) for a region. It is the sum of labor income, other property type income (e.g. corporate profits, interest income, and rental income), and indirect business taxes (taxes collected by business for government, like sales taxes, excise taxes, etc.).
- Output – The sum of the value added expenditures plus expenditures for intermediate goods and services of production.

8.2 ECONOMIC IMPACT ANALYSIS METHODOLOGY

The calculation of the economic impacts in this Study was performed using the Minnesota IMPLAN Group's (MIG) IMPLAN software. IMPLAN is a commonly employed tool for input-output analysis, which is used by governments, consultants, and academics. It estimates the economic impacts of an activity, according to the types of impacts and indicators described in Section 8.1. Through MIG, the Project Team obtained the 2015 dataset for the Texas economy and set up a statewide input-output model. The estimates of recycling activities assessed in this economic impact analysis were divided into three categories: collection, processing, and long-haul transportation. Additionally, and consistent with the analysis in Section 5.2, three expanded recycling scenarios were modeled to show how the economic impacts would change if the statewide volume of recycling increased by 20, 40, and 60 percent. Manufacturing related to the use of recyclable feedstock was calculated and reported separately, since including it with the other activities would likely overstate the actual economic impacts of recycling in Texas.

1. Francis Day. No date. *Principles of Impact Analysis & IMPLAN Applications*, First edition. Minnesota IMPLAN Group: Huntersville, NC.

Consistent with the discussion on evaluating recycling rates in Section 3.2, it is important to note that the economic impact analysis in this Study is not directly comparable to other studies on the economic impacts of recycling. The findings in this Study are based upon a number of assumptions about employees and payrolls, which relied upon information provided by responsive companies. Since participation in the Study was voluntary, past or future studies may be based on responses from different participants, which could lead to some variance in the results, even using an identical methodology. Another notable aspect of this analysis is its limitation to MSW. Commonly, other studies on this topic include estimates of recycling from industrial sources, which can increase the overall economic impact. Generally, this Study erred on the side of being conservative, which likely means that reported economic impacts from recycling in Texas are understated. Table 1-1 in the Executive Summary further details differences in this Study, as compared to other economic impact studies, which can influence the results.

Employment and Compensation Assumptions by Activity

Prior to estimating the economic impacts of MSW recycling on the Texas economy, it was necessary to collect a significant amount of data from facilities to develop the inputs needed for the IMPLAN model. A description of the extensive data collection process undertaken by the Project Team to obtain this information is outlined in Section 2. Since there is specialization within the recycling industry, data about recyclables collection was gathered by material. The categories included organics, C&D materials, electronics, tires, metals (ferrous and nonferrous), paper, plastics, and glass. MRFs offered another category that handled multiple material types such as paper, plastic, metal, and glass. Employment reported in this section is based on the tonnage quantities documented in Section 3 and is limited to employment specific to MSW recycling activities. For example, it does not include other recycling employment, such as jobs created by the recycling of metal from industrial sources. The wages and benefits reported are not only for the staff who work directly on processing materials, but also include personnel focused on management, marketing, and administrative tasks. Additionally, benefits like health insurance and retirement are a component of the overall cost of employees.

Collection

Employment estimates for recyclables collection are shown in Table 8-1 by material type. Employment estimates for each material type were made using the reported tonnage of recyclable material collected. The Project Team utilized a proprietary database developed by Burns & McDonnell, based on multiple studies of entities in the business of collecting recyclable materials, to estimate the number of workers required to collect the tonnage reported. To validate this source, the Project Team also reviewed U.S. Bureau of Labor Statistics employment data and ultimately determined that the proprietary dataset was more appropriate because it was directly focused on collecting the types of materials that were the focus of this Study. When quantifying the number of employees, the Project Team targeted collection activities where the gathering of the material is the direct focus of the job, as opposed to being incidental to the job. The Project Team also excluded some material categories from the number of collection jobs, since the waste generator may be responsible for collection activities or collection may be a minor task for the job[2]. Among the three divisions of activities (e.g. collection, processing and end users, and long-haul transportation), the collection of recyclable materials contributed the most direct jobs to the Texas economy in 2015, with statewide employment at 4,065 workers. The collection of organics contributed the most jobs with more than 2,000 workers across Texas. MRFs, which handle a wide array of recyclable materials from the residential and commercial waste stream, had an estimated 1,467 workers. The number of jobs created by the collection of C&D materials, non-ferrous metals, and ferrous metals categories were 366, 62, and 142, respectively. Utilizing information from the aforementioned Burns & McDonnell dataset, the average annual wages and benefits for workers engaged in collection activities were similar, ranging from $37,765 to $41,201. While these wages were below the statewide average wage of $54,281 (according to the U.S. Bureau of Labor Statistics), they still provide a good wage to a segment of Texas' workforce that might otherwise be relegated to lower-paying jobs. The Project Team assumed the lower range in order to be more conservative since the wages were directly based on the material types included in this Study. Statewide, the total payroll for workers in recyclables collection was estimated to be $160.4 million in 2015.

2. For example, HHW is typically collected by a resident bringing the material to a collection center or a drop-off event.

TABLE 8-1: ESTIMATED 2015 EMPLOYMENT, WAGES AND BENEFITS, AND TOTAL ANNUAL PAYROLL FOR RECYCLABLE MATERIALS COLLECTION IN TEXAS

Recyclable Material/ Facility	Employment	Estimated Average Wages and Benefits[1]	Estimated Total Payroll[2]
Organics	2,028	$37,765	$76,587,420
C&D Materials	366	$40,846	$14,949,636
MRF	1,467	$41,201	$60,441,867
Non-ferrous Metals	62	$41,200	$2,554,400
Ferrous Metals	142	$41,201	$5,850,542
TOTAL	**4,065**	**$39,455**	**$160,383,865**

1. Total average salary is weighted by the number of workers collecting each type of material.
2. Payroll is equal to material category employment multiplied by average wages and benefits.
Source: Burns & McDonnell, 2017. MIG, 2017. U.S. Bureau of Labor Statistics, 2017.

Processors and End Users

Following collection, recyclables are typically transported to facilities for sorting, processing, consolidation, and (if needed) cleaning, in preparation to become feedstock. Many of the facilities that responded to the survey provided information regarding the number of jobs and payroll associated with their operations. However, due to the availability of employment data from federal data sources and to avoid confidentiality concerns, estimates of employment at ferrous and non-ferrous metal processors and end users was based on statewide employment data from the U.S. Bureau of Labor Statistics for NAICS 423930 Recyclable Material Merchant Wholesalers. These employment figures were adjusted by the estimated share of recyclable ferrous and non-ferrous metal sourced from MSW, as described in Section 3.

During 2015, MSW recycling processing facilities employed approximately 3,688 workers in Texas. The largest share were employed at metal (ferrous and non-ferrous) processors and MRFs with an estimated 1,134 and 1,112 workers, respectively. The recycling of organic materials into compost generated 574 jobs and the estimated employment for the remaining materials can be found in Table 8-2. The wages for workers in processor and end user activities had a broader range than collection activities ranging from a low of $30,000 annually to a high of $55,956, based upon the earlier mentioned Burns & McDonnell dataset.

TABLE 8-2: ESTIMATED 2015 EMPLOYMENT, WAGES AND BENEFITS, AND TOTAL ANNUAL PAYROLL FOR PROCESSORS AND END USERS IN TEXAS

Recyclable Material/ Facility	Employment	Estimated Average Wages and Benefits[1]	Estimated Total Payroll[2]
Organics	574	$51,719	$29,686,706
C&D Material	327	$50,154	$16,400,358
Electronics	432	$30,000	$12,960,000
MRF	1,112	$42,399	$47,147,688
Tires	109	$29,792	$3,247,328
Metals (ferrous and non-ferrous)	1,134	$55,956	$63,454,104
TOTAL	**3,688**	**$46,881**	**$172,896,184**

1. Total average salary is weighted by the number of workers collecting each type of material.
2. Payroll is equal to material category employment multiplied by average wages and benefits.
Source: Burns & McDonnell, 2017. MIG, 2017. U.S. Bureau of Labor Statistics, 2017.

Long-Haul Transportation

The long-haul transportation of recyclable materials generates relatively modest statewide employment. The Project Team only included jobs where recyclable material was being hauled to an end-user or manufacturing facility in Texas, and the number of jobs were estimated based on haul distances and commercial vehicle payload capacities. As detailed in Table 8-3, the total estimated number of workers statewide was 115, with about two-thirds of those drivers hauling recyclable paper materials. The average wage and benefits for these jobs totaled $46,344, which is less than the typical long-haul driver, but most or all of these drivers were expected to work a home-based schedule, which does not require the driver to spend multiple days on the road and, subsequently, offers lower pay.

TABLE 8-3: ESTIMATED 2015 EMPLOYMENT, WAGES AND BENEFITS, AND TOTAL ANNUAL PAYROLL FOR RECYCLABLE MATERIALS LONG-HAUL TRANSPORTATION IN TEXAS

Material Transported	Employment	Estimated Average Wages and Benefits	Estimated Total Payroll[1]
Paper	78	$46,344	$3,614,832
Glass	18	$46,344	$834,192
Non-ferrous Metal	6	$46,344	$278,064
Ferrous Metal	13	$46,344	$602,472
TOTAL	**115**	**$46,344**	**$5,329,560**

1. Payroll is equal to material category employment multiplied by average wages and benefits.
Note: Conveyed plastics recyclables were not included in these transportation employment estimates because the volumes were judged to be negligible.

Assigning Recycling Activities to Industry Sectors in the IMPLAN Model

The next step of the economic impact analysis was to assign each recycling activity to a specific industry sector in the IMPLAN model. Within the IMPLAN software, the Texas economy is parsed into 536 sectors. However, the range of activities within each industry sector varies and some industry sectors in the IMPLAN software are very specific (e.g. 290 Elevator and Moving Stairway Manufacturing or 321 Irradiation Apparatus Manufacturing), while others sectors lump together and represent a much broader range (e.g. 395 Wholesale Trade or 440 Real Estate).

Collection

Under the North American Industry Classification System (NAICS), the collection of various types of recyclable materials falls within a single broad category of activities called 562 Waste Management and Remediation Services. As activities become more specialized, the NAICS categorization can become more detailed, in accordance with the recyclable materials being collected. For example, the NAICS describes “collecting and removing debris, such as brush or rubble, within a local area” as 562119 Other Waste Collection. This classification is appropriate for both the collection of organic materials and C&D materials for recycling. There is also a NAICS categorization for “the collecting and/or hauling [of] mixed recyclable materials within a local area” that includes the collection of recyclables associated with MSW. This activity is described as 562111 Solid Waste Collection and it is closely aligned with the collection of recyclables that occurs at MRFs. The NAICS does not differentiate between the collection of ferrous and non-ferrous metals, which are probably most closely aligned with 562111 Solid Waste Collection. However, according to the IMPLAN model’s documentation, which shows how the various NAICS categories correspond with the IMPLAN model’s 536 industry sectors, all of these activities fall within a single broad IMPLAN sector called 471 Waste Management and Remediation Services. Therefore, all assumptions about collection activities (i.e. employment and payroll) were entered into the IMPLAN model under Sector 471, as shown in Table 8-4.

TABLE 8-4: ASSIGNMENT OF COLLECTION ACTIVITIES TO IMPLAN SECTORS

Recyclable Material/ Facility	2017 NAICS	IMPLAN Sector
Organics	562119 Other Waste Collection	471 Waste Management and Remediation Services
C&D Materials	562119 Other Waste Collection	471 Waste Management and Remediation Services
MRF	562111 Solid Waste Collection	471 Waste Management and Remediation Services
Non-ferrous Metals	562111 Solid Waste Collection	471 Waste Management and Remediation Services
Ferrous Metals	562111 Solid Waste Collection	471 Waste Management and Remediation Services

Source: U.S Census Bureau, 2017. MIG, 2017.

Processors and End Users

The categorization of processors and end users offered slightly more differentiation in the IMPLAN model than did collection activities. The processing of organic materials was categorized under NAICS 562219 Other Nonhazardous Waste Treatment and Disposal and this category includes lawn waste disposal facilities (see Table 8-5). MRFs were categorized under NAICS 562920 Materials Recovery Facilities. Activities under this category, as described by the U.S. Census Bureau, include "1) operating facilities for separating and sorting recyclable materials from nonhazardous waste streams (i.e., garbage) and/or (2) operating facilities where commingled recyclable materials, such as paper, plastics, used beverage cans, and metals, are sorted into distinct categories." The remaining processor and end user activities most closely fit into a broad sector called 423930 Recyclable Merchant Wholesalers, which contains specific materials like electronics and tires, as well as more general descriptions of recyclable materials. Since there was not a NAICS category that closely aligned to the recycling of C&D materials, NAICS 423930 was judged to be the best fit. Again, the IMPLAN model did not provide much granularity with its sectors. Organics facilities and MRFs were included under Sector 471 Waste Management and Remediation Services and the remaining materials were classified as Sector 395 Wholesale Trade, after referencing IMPLAN's crosswalk between its industry sectors and the NAICS categories.

TABLE 8-5: ASSIGNMENT OF PROCESSING ACTIVITIES TO IMPLAN SECTORS

Recyclable Material/ Facility	2017 NAICS	IMPLAN Sector
Organics	562219 Other Nonhazardous Waste Treatment and Disposal	471 Waste Management and Remediation Services
C&D Materials	423930 Recyclable Merchant Wholesalers	395 Wholesale Trade
Electronics	423930 Recyclable Merchant Wholesalers	395 Wholesale Trade
MRFs	562920 Materials Recovery Facilities	471 Waste Management and Remediation Services
Tires	423930 Recyclable Merchant Wholesalers	395 Wholesale Trade
Metals (ferrous and non-ferrous)	423930 Recyclable Merchant Wholesalers	395 Wholesale Trade

Source: U.S Census Bureau, 2017. MIG, 2017.

Long-Haul Transportation

Transportation plays an essential role in the collection, consolidation, and delivery of recyclable materials to manufacturers for reuse. However, when accounting for the economic impacts of transportation, they are often integrated into the description of the primary activity. As a result, activities related to the local hauling of recyclables are considered part of the general NAICS category of *562 Waste Management and Remediation Services*. Therefore, transportation expenditures were captured under collection activities and was not necessary to enter local transportation into the IMPLAN model as a separate activity. However, the long-haul movement of recyclables, such as to a distant processor or end user or from a processor to a manufacturer would be a distinct economic activity and is categorized as NAICS *484230 Specialized Freight (except Used Goods) Trucking, Long-Distance*. In the IMPLAN model, long-haul trucking would be classified under *Sector 411 Truck Transportation*.

8.3 THE ECONOMIC IMPACTS OF RECYCLING ON THE TEXAS ECONOMY

Based upon the results in Tables 8-6 through 8-9, the total impact of Texas's 2015 recycling industry on the state's economy was estimated to be more than $3.3 billion of economic output and 17,037 person-years of employment[3]. While the total employment of the recycling industry only contributed 0.2 percent of the state's total employment, the sector was roughly similar in size to the state's paper manufacturing industry (16,843 workers), its pipeline transportation industry (18,831 workers), and its broadcasting industry (18,721 workers). Workers in the recycling industry earned estimated wages and benefits that were valued at almost $857.0 million. Collectively, these workers contributed more than $1.6 billion of value-added activities to Texas' economy in 2015. Employment directly related to the recycling industry totaled 7,868 person-years. These workers were responsible for the collection, processing, and transportation of recyclable materials in Texas. They earned an income valued at $342.9 million and they produced $793.6 million of value added activity. Indirect employment, which is generated from expenditures by local governments and firms that handle recycled materials, as well as subsequent rounds of spending by the firms that serve their suppliers, was equivalent to 5,040 person-years of employment, while income expenditures by recycling workers generated another 4,129 person-years of induced employment across the Texas economy.

TABLE 8-6: SUMMARY OF TOTAL ECONOMIC IMPACT OF THE RECYCLING ON THE TEXAS ECONOMY

Measure	Direct	Indirect	Induced	Total
Employment	7,868	5,040	4,129	**17,037**
Labor Income	$342,862,641	$314,883,480	$199,242,509	**$856,988,630**
Value Added	$793,557,644	$490,200,422	$343,903,017	**$1,627,661,083**
Output	$1,894,943,170	$875,280,989	$606,533,341	**$3,376,757,500**

Detailed estimates of the economic impacts of each component of recycling (i.e. separated by collection, processing, and transportation and by the material handled) are provided in Tables 8-7 through 8-9. This breakdown of estimated economic impacts shows that the collection of recyclable materials was responsible for a total of 8,648 person-years of employment in the Texas economy during 2015. These collection activities also created $421.9 million of income for workers. The processing of recyclable materials contributed 8,141 person-years of employment and $422.1 million of income, even though the direct employment (3,688 person-years of employment) was lower than the collection activities. The reason for this difference is the higher wages generated by workers in processing industries, which resulted in more indirect and induced employment. Finally, the 115 person-years of employment in long-haul trucking generated a total of 248 person-years of employment and $13.0 million of labor income, statewide.

Estimated Fiscal Impacts of Recycling

In addition to employment, workers' wages, and economic output, Texas's recycling industry also generates

3. A person-year of employment is the equivalent of one person working a full-time job for one-year. It does not necessarily imply the creation of a permanent job that lasts for multiple years.

revenue for state and local governments. In 2015, the IMPLAN model estimates that the recycling industry generated more than $194.3 million in public revenue. Within this total was almost $101.0 million in sales tax revenue and $72.0 million in property taxes. Other taxes, fines, and fees paid to local and state governments totaled $21.0 million.

TABLE 8-7: ECONOMIC IMPACT OF RECYCLABLES COLLECTION ON THE TEXAS ECONOMY

Material	Measure	Direct	Indirect	Induced	Total
Organics	Employment	2,028	1,272	992	**4,292**
	Labor Income	$77,549,380	$80,517,243	$47,876,468	**$205,943,091**
	Value Added	$164,096,312	$124,926,494	$82,638,106	**$371,660,912**
	Output	$456,808,502	$226,577,345	$145,745,361	**$829,131,208**
C&D Materials	Employment	366	230	186	**782**
	Labor Income	$15,137,408	$14,531,219	$8,987,750	**$38,656,377**
	Value Added	$30,756,825	$22,545,906	$15,513,314	**$68,816,045**
	Output	$82,441,772	$40,891,178	$27,360,471	**$150,693,421**
MRF	Employment	1,467	920	750	**3,137**
	Labor Income	$61,201,034	$58,243,988	$36,185,076	**$155,630,098**
	Value Added	$123,806,735	$90,368,434	$62,457,209	**$276,632,378**
	Output	$330,442,870	$163,899,900	$110,154,458	**$604,497,228**
Non-ferrous Metals	Employment	62	39	32	**133**
	Labor Income	$2,586,484	$2,461,572	$1,529,275	**$6,577,331**
	Value Added	$5,232,396	$3,819,252	$2,639,603	**$11,691,251**
	Output	$13,965,546	$6,926,921	$4,655,413	**$25,547,880**
Ferrous Metals	Employment	142	89	73	**304**
	Labor Income	$5,924,026	$5,637,795	$3,502,577	**$15,064,398**
	Value Ad ded	$11,984,019	$8,747,319	$6,045,619	**$26,776,957**
	Output	$31,985,605	$15,864,883	$10,662,530	**$58,513,018**
Total - Collection	Employment	4,065	2,550	2,033	**8,648**
	Labor Income	$162,398,332	$161,391,817	$98,081,146	**$421,871,295**
	Value Added	$335,876,287	$250,407,405	$169,293,851	**$755,577,543**
	Output	$915,644,295	$454,160,227	$298,578,233	**$1,668,382,755**

TABLE 8-8: ECONOMIC IMPACT OF RECYCLABLES PROCESSING ON THE TEXAS ECONOMY

Material	Measure	Direct	Indirect	Induced	Total
Organics	Employment	574	358	331	**1,263**
	Labor Income	$30,059,579	$22,670,289	$15,981,914	**$68,711,782**
	Value Added	$54,427,577	$35,174,078	$27,584,694	**$117,186,349**
	Output	$128,618,176	$63,794,708	$48,652,060	**$241,064,944**
C&D Materials	Employment	327	223	188	**738**
	Labor Income	$16,606,351	$13,404,498	$9,090,078	**$39,100,927**
	Value Added	$50,015,918	$21,015,329	$15,689,900	**$86,721,147**
	Output	$94,894,835	$35,892,529	$27,671,996	**$158,459,360**
Electronics	Employment	432	295	193	**920**
	Labor Income	$13,122,781	$17,708,695	$9,327,245	**$40,158,721**
	Value Added	$57,260,191	$27,763,371	$16,100,484	**$101,124,046**
	Output	$125,365,657	$47,417,655	$28,394,004	**$201,177,316**
MRF	Employment	1,112	697	577	**2,386**
	Labor Income	$47,739,876	$44,149,493	$27,838,950	**$119,728,319**
	Value Added	$95,195,590	$68,500,127	$48,051,200	**$211,746,917**
	Output	$250,478,818	$124,237,673	$84,747,213	**$459,463,704**
Tires	Employment	109	74	49	**232**
	Labor Income	$3,288,115	$4,468,166	$2,346,419	**$10,102,700**
	Value Added	$14,424,638	$7,005,110	$4,050,341	**$25,480,089**
	Output	$31,631,612	$11,964,177	$7,142,970	**$50,738,759**
Metals (ferrous and non-ferrous)	Employment	1,134	773	695	**2,602**
	Labor Income	$64,251,106	$46,485,321	$33,549,909	**$144,286,336**
	Value Added	$180,111,801	$72,878,845	$57,907,786	**$310,898,432**
	Output	$329,084,831	$124,471,338	$102,132,536	**$555,688,705**
Total - Processors	Employment	3,688	2,420	2,033	**8,141**
	Labor Income	175,067,808	148,886,462	98,134,515	**422,088,785**
	Value Added	451,435,715	232,336,860	169,384,405	**853,156,980**
	Output	960,073,929	407,778,080	298,740,779	**1,666,592,788**

TABLE 8-9: ECONOMIC IMPACT OF RECYCLABLES LONG-HAUL TRANSPORTATION ON THE TEXAS ECONOMY

Material	Measure	Direct	Indirect	Induced	Total
Paper	Employment	78	47	43	**168**
	Labor Income	$3,660,235	$3,123,528	$2,052,993	**$8,836,756**
	Value Added	$4,236,174	$5,057,219	$3,543,751	**$12,837,144**
	Output	$13,039,528	$9,049,819	$6,249,719	**$28,339,066**
Glass	Employment	18	11	10	**39**
	Labor Income	$844,670	$720,814	$473,768	**$2,039,252**
	Value Added	$977,579	$1,167,051	$817,789	**$2,962,419**
	Output	$3,009,122	$2,088,420	$1,442,243	**$6,539,785**
Non-ferrous Metals	Employment	6	4	3	**13**
	Labor Income	$281,557	$240,271	$157,922	**$679,750**
	Value Added	$325,860	$389,017	$272,596	**$987,473**
	Output	$1,003,041	$696,140	$480,747	**$2,179,928**
Ferrous Metals	Employment	13	8	7	**28**
	Labor Income	$610,039	$520,588	$342,165	**$1,472,792**
	Value Added	$706,029	$842,870	$590,625	**$2,139,524**
	Output	$2,173,255	$1,508,303	$1,041,620	**$4,723,178**
Total – Transportation	Employment	115	70	63	**248**
	Labor Income	$5,396,501	$4,605,201	$3,026,848	**$13,028,550**
	Value Added	$6,245,642	$7,456,157	$5,224,761	**$18,926,560**
	Output	$19,224,946	$13,342,682	$9,214,329	**$41,781,957**

8.4 ECONOMIC IMPACTS OF EXPANDED RECYCLING SCENARIOS

Expanding the volume of recycled materials from MSW in Texas could create additional economic activity in the state. This section provides a brief overview of the potential economic benefits that could accrue from expanded statewide recycling, providing estimates for three scenarios: a 20 percent increase of recycling from 2015 levels, a 40 percent increase from 2015 levels, and a 60 percent increase from 2015 levels, which is consistent with the analysis presented in Section 5.2. The changes to the employment assumptions of an input-output model generally increase the employment outputs in a linear fashion, when other assumptions are changed uniformly. However, the results for labor income, value added, and output are not necessarily linear, since the model accounts takes into account interactions with the remainder of the economy. It should also be noted that this analysis does not consider the incremental costs of additional recycling, which could make recycling programs profitable or unprofitable. For example, higher transportation costs to serve remote locations, diminishing returns from undersized sorting facilities and equipment, and lower market prices could all be factors that make local recycling activities less profitable or unprofitable. Ultimately, the potential profitability of a recycling program is dependent upon local and organizational conditions and circumstances that surround the recycler's operations and these must be considered on a case-by-case basis. The analysis also does not consider any incremental environmental impacts of recycling, which could make recycling program more or less environmentally-beneficial. For example, the analysis does not evaluate the environmental impacts of hauling more recyclables.

The results from modeling the three expanded recycling scenarios are provided in Table 8-10. The model results are shown for each division of activity (collection, processing, and transportation) and the estimates were prepared using 2015 dollars, so the results would be comparable to the base analysis. The results show that a 60 percent increase in statewide recycling could create more than 10,000 new person-years of employment in Texas, with about half of those jobs directly related the collection, processing, and transporting of recyclable materials and the remainder due to indirect and induced impacts. A less ambitious goal of 20 percent growth in statewide recycling could still increase statewide employment by more than 3,400 person-years, while a 40 percent increase could add almost 6,800 person-years of employment. This Study did not evaluate the increased costs to add these jobs.

TABLE 8-10: TOTAL POTENTIAL ECONOMIC IMPACT OF INCREASED RECYCLING ON THE TEXAS ECONOMY

Material	Measure	Direct	Indirect	Induced	Total
Base 2015	Employment	7,868	5,040	4,129	**17,037**
	Labor Income	$342,862,641	$314,883,480	$199,242,509	**$856,988,630**
	Value Added	$793,557,644	$490,200,422	$343,903,017	**$1,627,661,083**
	Output	$1,894,943,170	$875,280,989	$606,533,341	**$3,376,757,500**
20 Percent Growth Scenario	Employment	9,441	6,048	4,956	**20,445**
	Labor Income	$411,435,170	$377,979,094	$239,126,854	**$1,028,541,118**
	Value Added	$952,338,086	$588,427,452	$412,745,508	**$1,953,511,045**
	Output	$2,274,523,406	$1,050,677,400	$727,949,121	**$4,053,149,928**
40 Percent Growth Scenario	Employment	11,016	7,057	5,782	**23,855**
	Labor Income	$480,007,699	$441,036,592	$278,999,773	**$1,200,044,064**
	Value Added	$1,111,300,771	$686,588,561	$481,568,263	**$2,279,457,595**
	Output	$2,654,182,725	$1,225,945,361	$849,330,119	**$4,729,458,205**
60 Percent Growth Scenario	Employment	12,588	8,064	6,608	**27,260**
	Labor Income	$548,580,227	$503,971,176	$318,835,539	**$1,371,386,942**
	Value Added	$1,269,756,250	$784,567,116	$550,326,883	**$2,604,650,249**
	Output	$3,032,674,078	$1,400,903,140	$970,598,019	**$5,404,175,237**

8.5 ECONOMIC IMPACTS OF TEXAS MANUFACTURERS USING RECYCLABLE MATERIALS

Another economic impact from recycling is the contribution of recyclable materials as a feedstock for manufacturers. In many cases, the recyclable feedstock that goes into a manufacturing process is mixed with virgin material. Sometimes the content is mixed for technical reasons (e.g. product strength, appearance, etc.) and in other situations it is due to the cost of using recyclable materials (e.g. more complex manufacturing processes, etc.), their availability, or the reliability of sourcing them. Although it is common in similar economic impact studies to incorporate the economic activity related to manufacturing with recyclable materials into the total impact, the Project Team decided not to combine the numbers in this Study, but to show them separately. This is because it is difficult to precisely discern how much economic activity is generated by manufacturers' use of recyclable materials versus virgin material. In some cases, manufacturers using recyclable materials likely benefit monetarily from doing so, but could substitute virgin material, if it was necessary (e.g. glass, paper, and plastics). Other manufacturers may be more dependent upon the availability of recyclable materials to justify locating their facility in Texas (e.g. ferrous and non-ferrous metals) and could not as easily source a virgin feedstock. Again, these factors vary widely according to facility's function and circumstances, as well as market conditions. Therefore, since it would be very difficult, if not impossible, to accurately estimate these benefits, the analysis in this section was provided for informational purposes only and relied upon a separate set of inputs for the IMPLAN model, which are described below.

Assigning Manufacturing Activities to Industry Sectors

The Project Team received total payroll and employment information from manufacturing facilities that responded to the Study survey. The number of firms that responded by recycled material included:

- Plastics: 2 companies
- Paper: 3 companies
- Glass: 2 companies

For reasons previously discussed, estimates of employment at ferrous and non-ferrous metal manufacturers were based on statewide employment data from the U.S. Bureau of Labor Statistics. These figures were adjusted by the estimated share of recyclable materials from MSW. Estimated wages for ferrous and non-ferrous metal manufacturers were based upon data from the IMPLAN model. There are firms in Texas that did not respond to the data request from this Study, so this information does not constitute a comprehensive estimate of the economic impacts of firms that use recyclable materials as feedstock. Collectively, the analysis accounted for 2,226 employees of manufacturers who incorporated recyclable feedstock, and the average annual salary and benefits for these workers was estimated to be $72,955.

As with the analysis of the economic impacts for collecting, processing, and the long-haul transport of recyclable materials, it was necessary to assign each activity under an IMPLAN sector. Unlike the aforementioned activities, the manufacturing activities aligned very closely with NAICS and IMPLAN's sectors. The categorization of the model's inputs is shown below in Table 8-11.

TABLE 8-11: ASSIGNMENT OF MANUFACTURING ACTIVITIES TO IMPLAN SECTORS

Recyclable Material/ Facility	2017 NAICS	IMPLAN Sector
Plastic	3261 Plastic Products Manufacturing	195 Other Plastics Manufacturing
Paper	322110 Pulp Mills	146 Pulp Mills
Glass	327213 Glass Container Manufacturing	203 Glass Container Manufacturing
Glass	327993 Fiberglass Insulation Products Manufacturing	215 Mineral Wool Manufacturing
Non-ferrous Metal	331314 Refining Aluminum, Secondary	222 Secondary Smelting and Alloying of Aluminum
Ferrous Metal	331110 Steel Mills	217 Iron and Steel Mills and Ferroalloy Manufacturing

Source: U.S. Census Bureau, 2017. MIG, 2017.

Economic Impacts of Manufacturing Firms that Incorporate Recyclable Materials

Texas manufacturers that incorporate recyclable materials into their manufacturing processes included in this analysis were responsible for creating approximately 2,226 person-years of direct employment across Texas and more than 7,200 person-years of indirect and induced employment, as shown in Table 8-12. The total impact of these employers was 9,460 person-years of employment in 2015, with wages of $615.5 million and a total economic output of almost $3 billion.

TABLE 8-12: ECONOMIC IMPACT OF MANUFACTURERS USING RECYCLABLE FEEDSTOCK ON THE TEXAS ECONOMY

Measure	Direct	Indirect	Induced	Total
Employment	2,226	4,152	3,082	**9,460**
Labor Income	$164,423,334	$302,367,904	$148,704,616	**$615,495,854**
Value Added	$324,314,667	$504,644,116	$256,637,801	**$1,085,596,584**
Output	$1,526,001,195	$988,388,130	$452,613,636	**$2,967,002,961**

Fiscal Impacts of Manufacturing Firms that Incorporate Recyclable Materials

According to the IMPLAN model results, Texas manufacturing firms that incorporate recyclable materials and that were included in this analysis contributed more than $78 million to state and local governments through taxes, fees, and fines. Notably, manufacturers paid $39.3 million in sales taxes and $28.0 million in property taxes, while additional taxes and fees totaled $10.9 million.

9.0 INFRASTRUCTURE NEEDS AND DEVELOPMENT OPPORTUNITIES

Access to adequate infrastructure is crucial to increasing recycling in Texas. As stated in Section 6, many of the larger, more established metropolitan areas of Texas have access to transportation corridors and secondary processors or end users of recyclable materials, as well as a denser population. Therefore, many of the urban areas of the state contain a majority of the MRFs in Texas, as MRFs need to be located where the majority of the materials are generated for processing to remain economically viable.

According to The Recycling Partnership's 2016 *State of Curbside Report*[1], most of the top-performing recycling communities in the U.S. provide automatic, single stream, curbside recycling collection in carts for their residents. While this is a best practice to increase recycling in urban areas, many cities in Texas are widely spread and located too far from major metropolitan areas, and some small communities struggle to provide any recycling services for their residents.

This section broadly assesses current recycling infrastructure and provides a discussion of current MRF activity in Texas. This section also assesses the needs of rural or remote areas of Texas and includes information on how regional approaches to recycling systems could help strengthen access to recycling services in these challenged areas.

In Section 9.5, the Project Team provides case studies on four communities and regions of Texas that represent both challenges and successes associated with recycling in Texas, including the cities of El Paso, Booker in the Panhandle, Dallas, and the Lower Rio Grande Valley.

It is important to note that this section focuses mainly on typical recyclables, as these represent the majority of recyclable materials handled by municipal recycling infrastructure in Texas.

9.1 CURRENT MRF INFRASTRUCTURE IN TEXAS

Much of recycling is dependent on a system of MRFs throughout Texas that can source recyclable materials from surrounding communities. MRFs also have the ability to source materials based on the markets they can access. For instance, if a MRF is located far from a secondary glass processor, it may not accept glass, since the transportation to secondary processing would be economically prohibitive. In turn, this issue influences the list of recyclable materials the communities can accept in their local recycling program. A map of current MRFs in Texas and the population of Texas counties, is shown in Figure 9-1. This figure also indicates the locations of the case studies discussed in Section 9.5.

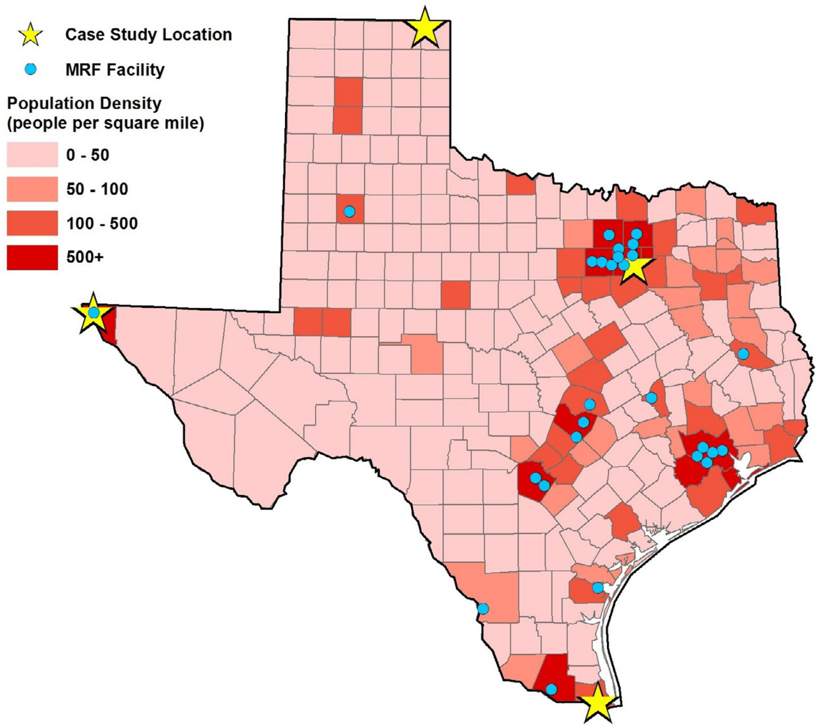
Most MRFs in Texas are privately owned and operated and provide processing for recyclable materials from the larger, more metropolitan areas, as the volume of material coming from these areas is high enough for the MRF to operate in an economically viable manner. Further information on the economics of MRFs is included in Section 4. There are a few MRFs owned or operated by cities in Texas, such as McAllen in the Rio Grande Valley. More detail is provided in a case study in Section 9.5.

Many of the MRFs in Texas accept single stream recyclable materials from residential sources, and many larger communities in established metropolitan areas have curbside recycling for single-family households (often considered up to four units). Recycling is typically collected from the curb in carts, but some cities use either bags or bins. Due to the convenience and ease of participation, programs with curbside collection services see a much higher tonnage of recyclable materials than communities with only a drop off program. At the same time, communities with single stream curbside recycling often see higher contamination rates, which occurs when residents place non-recyclable or dirty materials in the recycling bin.

MRFs also have the opportunity to provide recycling processing services to more than just the community in which they are located. The MRFs shown on the map in Figure 9-1 can source material from surrounding communities, providing an opportunity for more robust regional recycling systems with consistent education based on the materials that particular recycling facility has the ability to accept in its system. By sourcing material from other communities, the MRF is able to increase the volume of material coming into its facility and maintain control of what that material is, which is particularly helpful and less confusing as residents or companies may move within the same region served by the same MRF.

1. *Section 6: Methods to Increase Recycling via the Development of New Markets and New Businesses* provides a more comprehensive summary of the 2016 State of Curbside Report.

FIGURE 9-1: MAP OF TEXAS MRFS, COUNTY POPULATION DENSITY, AND CASE STUDY LOCATIONS



9.2 RURAL RECYCLING INFRASTRUCTURE NEEDS

Although most of the larger communities and more populous areas of Texas have access to a MRF and therefore, to curbside recycling, many areas of Texas are more remote and proximity to recycling infrastructure is a major issue hindering the growth of their recycling programs. For the purposes of this study, there is no set definition of a "rural" community, but researchers at the USDA define nonmetropolitan areas as: open countryside, rural towns with fewer than 2,500 people, and urban areas with populations ranging from 2,500 to 49,999 that are not part of larger labor market areas. There are also communities with populations greater than 49,000 that lack recycling infrastructure due to their remote location and distance from recycling processors or end users.

Many remote or isolated communities in Texas either have limited or no curbside recycling collection. These communities are often challenged by population density and the volume of recyclable materials, as well as the distance to recycling processors and end markets. For example, Figure 9-1 shows that the majority of MRFs exist in what is called the "Texas Triangle," an area of Texas containing the majority of the state's population. These are also located along some of Texas' major transportation corridors, I-35 and I-10, which allow MRFs to more easily transport and sell recyclable materials to end markets. Even within and around the "Texas Triangle" area, barriers to recycling infrastructure exist due to the distance to the major metropolitan areas.

Widespread populations, long distances, and low volume of recyclable materials can increase the costs of hauling recyclable materials and decrease potential profits for smaller, more rural communities, prohibiting the initiation or expansion of recycling programs. In lieu of providing curbside recycling, some rural or remote communities are able to provide recycling services to their residents by setting up drop off recycling centers. Many of these drop off centers require recyclable materials to be separated by commodity type. The number of materials accepted might be limited by the ability of the drop off center to market and sell that material. Drop off centers are also less convenient for residents than curbside programs are, so participation in these programs and the volume of material coming into drop off centers are often much lower than with curbside programs.

Figure 9-1 indicates where MRF infrastructure is lacking. Areas of west, south, and east Texas are underserved by recycling infrastructure despite containing communities and populations that could benefit from closer proximity to a MRF. This is particularly apparent in areas of east Texas, where populations of many of the counties range from 50 to 500 people per square mile, yet areas east of the Houston area and northeast Texas remain somewhat isolated from current MRF infrastructure. A lack of processing infrastructure is also seen in west central Texas, particularly around the cities of Midland and Odessa, where at least three counties with higher population densities have no access to MRF infrastructure within a reasonable distance. South Texas also remains underserved, with only one MRF serving the growing population at the most southern part of Texas. More information on the infrastructure needs and opportunities for South Texas can be found in Section 9.5.

9.3 OPPORTUNITIES FOR RURAL RECYCLING IN TEXAS

Rural and remote areas of Texas could benefit from regional recycling systems and partnerships with neighboring communities to increase the diversion of recyclable materials. Some examples of successful regional partnerships and rural recycling initiatives are found in this section and in the case studies in Section 9.5, although it should be noted that making regional recycling systems work successfully is a large undertaking and requires substantial work and collaboration from a number of different entities to ensure the long-term sustainability of the program.

Regional Planning via Council of Governments (COGs)

The COGs can be a resource for building stronger recycling systems within their region and may be able to facilitate dialogue that addresses what that region might be lacking in recycling infrastructure and education. Additionally, some of the funding sources described in Section 7 are geared toward communities with a population of fewer than 10,000. Section 7.1 describes the TCEQ Regional Solid Waste Grants Program, administered by the COGs, which provides funding to rural communities to build infrastructure through the purchase of equipment or buildings. An example of a community utilizing recycling equipment purchased with a COG grant is found in Section 9.5.

Cooperative Teamwork and Recycling Assistance (CTRA)

One way to enhance and support rural recycling programs is through a cooperative marketing program, which can help rural communities negotiate better pricing with recycling processors or end markets and can lessen the burden of transportation costs to get recyclable materials to these areas. Cooperative programs help communities in rural areas partner to reach the volume and supply of material needed by the processor or end use of the recyclable materials. For example, CTRA is an organization that manages a cooperative rural recycling program in Texas. CTRA's mission is to provide cooperative marketing of recyclable commodities, to promote the development of end markets for recyclable materials in Texas, and to promote education about recycling. CTRA consists of 60 rural recycling cooperatives representing more than 500 public, private, and nonprofit entities. CTRA provides technical assistance to communities or groups interested in recycling and serves as their liaison between the public and private sector by negotiating contracts with recycling haulers and end markets at competitive prices. CTRA helps community recycling programs effectively increase the amount and quality of recyclable materials by assisting in the development of new drop off recycling programs and maximizing existing recycling programs.

Hub and Spoke Recycling Systems

Successful recycling programs depend on efficient collection and processing of material, and hub and spoke recycling models offer a way for rural and remote areas to achieve this. Hub and spoke systems work when one larger community, or a "hub," invests in infrastructure to sort, bale, and store recyclable materials before it sends the materials to an end market. Smaller, surrounding communities, or "spokes," will then invest in recycling trailers or containers to transport material to the larger hubs. Hub and spoke systems can increase access to recycling for rural or remote regions, address transportation barriers, and consolidate recyclable materials so that ideal volumes are met. Depending on market conditions, the hub can generate enough revenue from the sale of recyclable materials to cover basic operation costs. Hub and spoke systems can be duplicated in other areas of Texas where there is little or no access to recycling, and other states have been able to fund the start-up of hub and spoke recycling systems through state and Federal grants. For example, in 2010, the New Mexico Recycling Coalition received a $2.8 million Federal grant to develop hub and spoke infrastructure throughout New Mexico, providing recycling opportunities to rural and underserved towns and tribal communities. An example of an area of Texas that could potentially benefit from a more robust hub and spoke recycling system is described in Section 9.5.

Milk Runs

Implementing recycling "milk runs" can also lower transportation costs and increase volume in certain areas that are located along a main transportation corridor, but may not have access to a larger recycling processing facility nearby. A recycling milk run involves one processor or end-user sending a single truck to make multiple stops at communities along the transportation corridor to collect material. CTRA makes use of milk runs for material that is generated at lower volumes in the communities they work with. By combining a particular material from a number of different communities within the same region, CTRA is able to transport full truckloads more often to the end users of the recyclable material.

9.4 RESOURCES FOR RURAL OR UNDERSERVED COMMUNITIES IN TEXAS

Despite the challenge that creating sustainable recycling systems in rural or remote areas creates, the Project Team identified resources, in addition to the funding sources documented in Section 7, which can help these communities. Each community is different, but strong champions or advocates – many of which are volunteers – can provide some of the much-needed manpower that will help support and complement current efforts already taking place within that community. Table 9-1 describes resources, examples, and services that can make rural recycling more effective.

TABLE 9-1: POTENTIAL RESOURCES FOR RURAL OR UNDERSERVED COMMUNITIES

Resources	Examples	Services
Volunteer or community groups **Civic organizations** **Community service opportunities**	• Keep Texas Beautiful affiliates • Lions Club • Senior citizen groups • Gardening groups • Businesses or major employers with volunteer initiatives or service days	• Supervise and maintain drop off centers • Provide pick-ups for recycling at local businesses and schools • Staff recycling activities at local events • Educate residents and elected officials
Education groups and students	• Local school districts • College campuses • National Honor Societies	• Create marketing material • Assist in infrastructure research and design for drop off facilities • Make presentations to local businesses and elected officials • Operate local drop off center

9.5 MUNICIPAL AND REGIONAL CASE STUDIES

The following case studies of municipalities and regions in Texas represent a combination of challenges, successes, and opportunities associated with recycling in Texas. Figure 9-1 shows the location of each case study. Each case study includes:

- Recycling infrastructure currently in place
- Funding mechanisms to build or run the recycling program
- Recycling services provided in the city or region
- Opportunities, needs, and gaps
- Resident access to recycle in their community

City of El Paso – Overcoming Transportation Barriers and Providing Regional Recycling Opportunities in Far West Texas

The city of El Paso sits on the westernmost point of the state of Texas and borders the Rio Grande River and Mexico. The population of El Paso is approximately 650,000. The city provides weekly, cart-based, single stream, curbside recycling services, with material flowing to a local, privately owned MRF. Curbside recycling services are also complemented by four drop off centers, known as citizen collection stations, which offer a broader range of recycling services than the curbside system. These drop off sites accept typical recyclables, tires, electronics, and HHW. El Paso is also home to a U.S. Army post, Fort Bliss, which is mandated to provide recycling services to all who serve, live, and work at the post. In fact, the base has been successful in achieving a 51 percent recycling rate. Additionally, C&D material recycling services are provided by a local company that provides hauling and recycling services for wood, plastic, cardboard, concrete, gypsum, metal, and shingles. Recycling services are funded by a solid waste user fee paid by the residents of El Paso receiving solid waste collection services from the city.

In the early 2000s, recycling services were very limited in the El Paso region and were provided to residents only through drop off stations. The city decided to offer curbside recycling, and in 2007, based on a procurement conducted by the city, a local MRF was built. The El Paso Environmental Services Department (ESD) was then able to begin offering more comprehensive, curbside, single stream recycling services. This change, complemented with education and outreach, substantially increased participation in recycling services by El Paso residents, and the tonnage of recyclable materials generated in El Paso significantly increased. El Paso ESD recently developed a strategic plan and set priorities for 2016-2021, which include enhanced participation in the recycling program, developing compost programs, and decreasing the amount of contamination found in the recycling stream[2].

El Paso is limited by its location and distance to end markets. For instance, glass has not been viably recyclable in El Paso because of the cost and freight necessary to transport it to a secondary processor, which is located across the state. El Paso is working to overcome this issue by providing an opportunity for residents to recycle glass separately at its citizen collection stations. The glass is then crushed locally and provided to residents for free to use as landscape material. More information on glass markets in Texas is found in Section 6.1.

Access to organics recycling remains largely untapped, especially for food waste, as yard waste is collected through the citizen collection stations and provided to the community as mulch. Some mulch and compost is produced in the area, but because of the arid environment and weak regional markets, it is produced and sold on a limited basis. Organics recycling may continue to be a challenge for the community.

City of Booker – Kiowa Recycling Center – Community Partnerships Help Make Recycling Work in Rural Texas

Booker is a small rural town at the very top of the Texas Panhandle with a population around 1,500. The Kiowa Recycling Center is a drop off recycling site that is open 24 hours a day, 365 days a year and serves the rural population in Booker. The building contains a baler and a number of dumpsters that accept source-separated recyclable materials. The center also maintains old cotton trailers that it uses for collecting aluminum at various locations in town.

2. *El Paso Environmental Services Department 2016 Strategic Plan*. Burns & McDonnell. 2016.

In 2002, the city of Booker purchased equipment, including a baler, a skid loader, and a floor scale, to start a recycling program. However, the city had limited resources and staff and was unsuccessful in starting the program. In 2009, when Booker I.S.D. high school students learned about the unused equipment, they were determined to provide recycling to Booker residents. The city transferred the equipment to the school district, the students developed a business plan to request funds for a building from the Booker Economic Development Corporation, and the Chamber of Commerce donated the land for the building. The funds were approved, and a drop off recycling center opened in 2010. CTRA works with the Kiowa Recycling Center to market their recyclable materials, and the funds from commodity sales are reinvested into the program. Because of this revenue, they were able to fund two part-time employees to operate the recycling center and equipment during peak times. The students at Booker I.S.D. help operate the recycling center, picking up and sorting material from businesses throughout the city.

The Kiowa Recycling Center provides free recycling services to Booker residents through the drop off recycling center. The center accepts a range of materials including aluminum, PET #1 and HDPE #2 plastic bottles, corrugated cardboard, newspaper, mixed paper, magazines, phone books, inkjet cartridges, and tin and steel cans. Additionally, motor oil is accepted for recycling at Booker City Hall, and scrap metal is accepted for recycling at the Booker landfill. The Kiowa Recycling Center purchased a de-binder to recycle books from the schools, and takes cell phones and rechargeable batteries for recycling through an industry-funded voluntary stewardship program. More information about this program, as well as other industry-funded voluntary stewardship programs, is found in Section 6.1. Through a partnership with a local business, scrap tires are also collected and transported to an end market for recycling.

The Kiowa Recycling Center fills a need for recycling in a very rural part of Texas, where the closest large city, Amarillo, is more than a two-hour drive from Booker. Although a drop off recycling center is not as convenient for residents as curbside service, the Kiowa Recycling Center provides a solution.

City of Dallas – Public-Private Partnerships in North Texas Help Build Regional Recycling Infrastructure

The city of Dallas recognized the broader financial challenges associated with the recycling industry and pursued an innovative public-private partnership approach with a goal of increasing financial returns and recycling quantities for residents and businesses in Dallas and surrounding communities. This effort was intended to support the city's Solid Waste Management Plan, passed in 2011 and updated in 2013 that intends to increase diversion to 90 percent by 2040. The strategy for developing the public-private partnership was based on the city's Resource Recovery Planning and Implementation Study[3].

The city of Dallas partnered with a private company in 2015 to design, build, and operate a new MRF to process recyclable materials from the city and other surrounding communities. This MRF is located on 15 acres at the McCommas Bluff Landfill (city-owned land), which provides an opportunity to become a broader resource recovery park with increased investment in materials management infrastructure. The newly built MRF can process approximately 120,000 tons of recyclable materials per year and started accepting recyclable materials from Dallas and other surrounding communities in January 2017.

The city of Dallas had historically been involved with traditional processing agreements with private recycling companies that had favorable financial terms for the city. Issues with this traditional contractual agreement became evident in 2012, when recycling markets crashed and commodity prices dropped. The city realized the nature of processing agreements was changing, and when their contract for recycling processing services was up, the city knew it would have to take an innovative approach to provide greater financial stability given fluctuating markets. The city of Dallas entered into a 15-year agreement (public-private partnership) with a private recycling company, where the company covered the initial capital cost of the new MRF, and the city provided the land for the MRF to be built, which was land that would have otherwise been used for the landfill. The city pays a processing fee of $70.54 per ton to the MRF and has a 50/50 revenue share on the net revenues after the sale of recyclable materials. Since the MRF is built and operated on city-owned land, the private company will pay a "host fee" of $15 per ton to the city for material that is generated by non-city sources, as well as an additional public education fee of $1 per ton. Given that the recycling materials sold can change in value and that a portion of the financial agreement is based on the value of the material, when commodity values are low, the revenue net of processing fees could be negative for the city. However, because of this innovative public-private partnership and risk sharing agreement, the MRF operator agreed that the city of Dallas will never have to make a payment to the operator, regardless of market conditions.

The city of Dallas provides weekly recycling curbside collection in 48-gallon, 64-gallon, or 96-gallon carts and as of 2013, the city had more than 237,000 single-family residential sanitation accounts. Materials collected for recycling include mixed paper, cardboard and paperboard, milk and juice cartons, aluminum, tin and steel cans, glass bottles and jars, and PET #1, HDPE #2, #3-5 and #7 plastic containers. The city operates its recycling collection program through a solid waste fee collected from its residents with city solid waste accounts.

The development of the new MRF provides an opportunity for surrounding areas to establish or expand their curbside recycling programs. The MRF is currently sourcing recyclable materials from Dallas and other cities in the region, potentially filling a gap for more rural or remote communities that have struggled with the transition from providing drop off only services to rolling out a curbside recycling program. This public-private partnership may serve as an example for other large metropolitan areas in Texas who are struggling with the financial realities of recycling given challenging market conditions.

Lower Rio Grande Valley – Opportunity Abounds as Population Grows in South Texas

The lower Rio Grande Valley (RGV) is an area located on the southernmost tip of Texas along the Rio Grande and the border of Texas and Mexico. The largest municipalities in this area are Brownsville and McAllen, and the population of the lower RGV is more than 1.3 million and growing. The city of McAllen Public Works Department owns and operates the only MRF in the area and provides weekly, curbside, cart-based, single-stream recycling service to its residents. McAllen charges its residents and commercial customers a recycling fee to fund its recycling program, and since the MRF is both owned and operated by the city of McAllen, revenues from the sale of recyclable materials come back directly into the department operations. The city also provides recycling services to businesses and schools on an as-needed basis. McAllen also operates a compost and mulch facility, provides monthly curbside pickup service for yard waste, and operates a drop off recycling center located next to the MRF. Other communities in the lower RGV – the cities of Alamo, Alton, Edinburg, Harlingen, Pharr, San Juan, and Weslaco – do not provide curbside recycling services but do operate drop off facilities.

Many communities in the lower RGV have grown their recycling programs through funding provided by the TCEQ Regional Solid Waste Grants Program that is administered through the Lower Rio Grande

3. *City of Dallas Local Solid Waste Management Plan 2011-2060.* HDR Engineering, Inc., in association with CP&Y, Inc. and Risa Weinberger & Associates, Inc. Updated 2013.

Valley Development Council. One prime example of the utilization of these funds for building recycling infrastructure occurred in Pharr, a community of nearly 78,000 people. Pharr built an extensive drop-off recycling center with solid waste grant funds. By purchasing hauling and baling equipment, Pharr collects, processes, and sends recyclable materials directly to a broker or end market.

The services provided by the communities in the lower RGV vary by community, ranging from no recycling services to curbside recycling. Services offered to residents and the materials that are accepted for recycling are dependent on the infrastructure that currently exists in the community. Some communities have the ability to accept and manage hard-to-recycle materials, such as tires, electronics, and batteries, while others are very limited on the materials they are able to accept, taking only typical recyclables such as paper, PET #1, HDPE #2, and metals.

While the current infrastructure in the lower RGV fills some needs, many gaps exist within the region. The McAllen MRF is over capacity, which leaves valuable material unrecovered, and the city is considering expanding its processing footprint to fulfill the needs of its residents, as well as some of the surrounding communities it takes material from. The MRF consists of one sort line that is entirely manually operated, leading to inefficiencies in processing and potentially recyclable materials that are not being captured. Opportunities exist for a more robust regional hub and spoke model if processing capacity is increased by automation at the MRF, and with a regional model comes the opportunity to source more material and provide more consistent educational outreach to residents throughout the lower RGV.

McAllen is the only municipality in the lower RGV that provides comprehensive curbside recycling services. All other recycling options for residents in the lower RGV are either subscription-based curbside service through a small number of private haulers or drop-off recycling centers.

APPENDIX A: DEFINITIONS

THE STUDY ON THE ECONOMIC IMPACTS OF RECYCLING

A DEFINITIONS

This section provides definitions used in the Study report and in the survey process. Terms are provided in the following categories:

- Study Report Terms
- Survey Definitions
  - Recyclable Material Processed/Received
  - Types of Processing
  - Types of Manufacturing/End Use

Study Report Terms

Municipal Solid Waste (MSW): Solid waste resulting from or incidental to municipal, community, commercial, institutional, and recreational activities, including garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and all other solid waste other than industrial solid waste.

Recycling: A process by which materials that have served their intended use or are scrapped, discarded, used, surplus, or obsolete are collected, separated, or processed and returned to use in the form of raw materials in the production of new products. Recycling includes:

- the composting process if the compost material is put to beneficial reuse as defined by the commission
- the application to land, as organic fertilizer, of processed sludge or biosolids from municipal wastewater treatment plants and other organic matter resulting from poultry, dairy, livestock, or other agricultural operations

Re-Trac Connect: Re-TRAC Connect was used for this survey and is the leading waste reduction and recycling measurement system used by the public sector, developed by Emerge Knowledge Design Inc.

Study: The Study on the Economic Impacts of Recycling, as outlined in House Bill 2763, passed during the 84th Legislative Session in 2015.

Survey Definitions

These terms were utilized as part of the online survey process and, in some cases, their definitions may differ from the Texas Health and Safety Code and the Texas Administrative Code. The Project Team's intent was to provide definitions that are easy to understand.

Recyclable Material Processed/Received

Construction & Demolition Material: Waste that is generated during the construction, remodeling, repair, or demolition of buildings, bridges, pavements, and other structures. C&D material includes: concrete, asphalt, lumber, steel girders, steel rods, wiring, dry wall, carpets, window glass, metal and plastic piping, tree stumps, soil, and other miscellaneous items related to the activities listed above. This category also includes natural disaster debris.

Electronics Materials: Post-consumer electrical or electronic devices from residential or commercial generators

Glass: Includes the two sub-categories defined below:

- **Containers:** Containers and packaging such as beer and soft drink bottles, wine and liquor bottles, and bottles and jars for food, cosmetics, and other products
- **Other Glass:** All other products, such as flat glass used in windows

HDPE #2: High density polyethylene (HDPE) typically used for products such as milk jugs, detergent bottles, and garbage containers.

Household Hazardous Waste (HHW): Hazardous products that are used and disposed of by residential - rather than industrial or commercial - consumers. These products include some paints, stains, batteries, varnishes, solvents, and pesticides, and other materials or products containing volatile chemicals that catch fire, react, explode under certain circumstances, or that are corrosive or toxic.

LDPE: Low density polyethylene

Metals: Includes the two sub-categories defined below:

- **Ferrous:** Magnetic metals derived from iron (steel). Products made from ferrous metals include major and small appliances, furniture, and containers and packaging (steel drums and barrels).
- **Non-Ferrous:** Nonmagnetic metals such as aluminum, lead, and copper. Products made from non-ferrous metals include containers and packaging such as beverage cans, food and other nonfood cans; non-ferrous metals found in appliances, furniture, electronic equipment; and non-packaging aluminum products (foil, closures, and lids from bimetal cans).

Mixed Paper: Paper that includes material like old newspapers, old magazines, office papers, telephone directories, bags, and paperboard packaging, including gable top and aseptic food and beverage cartons (e.g. milk and juice cartons)

Old Corrugated Containers (OCC): Old corrugated containers refers to containers made from unbleached, unwaxed paper with a ruffled (corrugated) inner liner

Other Paper: All other types of scrap paper not including mixed paper or OCC. Excludes pre-consumer material

Organics: Includes the three sub-categories defined below:

- **Yard Trimmings, Brush, and Green Waste:** Includes grass, leaves, tree branches, brush, and tree stumps from residential, institutional, and commercial sources
- **Food and Beverage Materials:** Uneaten food and food preparation wastes from residences and commercial establishments (grocery stores, restaurants, and produce stands), institutional sources (school cafeterias), and industrial sources (employee lunchrooms)
- **Biosolids:** Solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in treatment works

Paper: Paper products and materials, such as old newspapers, old magazines, office papers, telephone directories, old corrugated containers, bags, and some paperboard packaging. Examples of recycling include processing paper into new paper products (tissue, paperboard, hydromulch, animal bedding, or insulation materials).

PET #1: Polyethylene terephthalate (PET or PETE or polyester), a thermoplastic material used to manufacture plastic soft drink containers and rigid containers

Plastic: Plastic containers and packaging made from various resins, including PETE, HDPE, PVC, LDPE, PP, and PS

Plastics #3-7: Plastics labeled as #3 - #7, including polyvinyl chloride (PVC, #3), low density polyethylene (LDPE, #4), polypropylene (PP, #5), polystyrene (PS, #6), and other plastics (#7)

PP: Polypropylene

PS: Polystyrene

PVC: Polyvinyl chloride

Textiles: Fibers from discarded apparel, furniture, linens (sheets and towels), carpets and rugs, and footwear

Tires: Used tires from cars and trucks (other vehicles)

Types of Processing

Construction & Demolition Debris Processing: Accepting commingled or sorted construction and demolition (C&D) materials and processing them through sorting, size reduction, baling, or other processes for shipment to end-users or brokers

Electronics Processing: Processing of discarded electronics for recycling via deconstruction, shredding, sorting, baling, or other preparation, for sale to end-users or brokers. Does not include collection of materials for shipment to other processors, and does not include handling electronics for reuse purposes only.

Household Hazardous Waste Collection: Accepting household hazardous waste (HHW) from the public, including but not limited to paint, solvents, pesticides, fluorescent tubes, and other items identified as HHW

Material Recovery: Accepting source-separated recyclables and processing them for wholesale distribution through sorting, size reduction, baling, or other processes for shipment to end-users or brokers. Includes facilities that collect recyclables from public or commercial sources, and that sell the materials directly to brokers or an end market, but excludes such facilities that only aggregate and/or transport collected recycled materials to a materials recovery facility (MRF) for further processing.

Scrap Metal Processing: Accepting discarded ferrous and/or nonferrous metal scrap from the public and businesses for processing via sorting, size reduction, baling, or other preparations, for sale to end-users or brokers. Does not include smelters or remelting facilities, which are defined as end-product manufacturing.

Textile Processing: Accepting textiles from the public and/or businesses for the purpose of cleaning, sorting, size-reducing and/or other processes, for the purpose of shipping to end-users for recycling uses (not fuel or sale for reuse). Includes carpets, clothing, and other textile products. Excludes thrift stores and shipment of clothing for reuse.

Tire Processing: Receipt of whole, discarded tires and processing them through size reduction for the purpose of recycling, including production of crumb rubber, shredding for use in civil engineering projects, or other recycling applications. Excludes shipment of whole tires for reuse and of tire shreds for use as fuel.

Types of Manufacturing/End Use

Compost/Mulch Production: Production of compost, mulch, or other soil amendment or landscaping products from recovered yard waste, food waste, or biosolids. Excludes land application and production of fuel.

Construction & Demolition Debris End-Use: Receipt of recycled C&D materials for the purpose of producing new products or using the materials in end-use applications (e.g., road base or as construction aggregate). Excludes direct reuse and combustion.

Fiberglass Manufacture: Receipt of crushed glass, typically from glass beneficiators and/or materials recovery facilities, for the purpose of manufacturing fiberglass

Glass Beneficiation: Receipt of crushed glass, typically from materials recovery facilities, and/or whole glass containers, flat glass, and/or other products direct from generators, and processing through further cleaning, sorting, and crushing to meet manufacturer specifications, for sale to end-users or brokers

Glass Containers Manufacture: Receipt of crushed glass, typically from glass beneficiators and/or materials recovery facilities, for the purpose of manufacturing new glass containers

Other End Product Manufacturing: Accepting recyclables from processors for the purpose of manufacturing recycled-content products for sale to consumers or other industries as intermediate products. Excludes direct reuse and combustion.

Plastics Reclamation: Receipt of recycled plastics, typically from material recovery facilities, and cleaning, sorting, and size reducing the plastics through grinding and/or extrusion of pellets meeting manufacturer specifications, for sale to end-users or brokers or on-site use to manufacture products

Plastics Product Manufacture: Receipt of recycled plastics, typically from plastics reclaimers and/or material recovery facilities, for the purpose of manufacturing new plastic products and/or product components

Pulp, Paper, or Paperboard Manufacture: Receipt of baled scrap paper, typically from materials recovery facilities, other processors or directly from commercial generators, for the purpose of manufacturing pulp, paper or paperboard products

Secondary Metals Smelter, Melter or Product Fabrication: Receipt of recycled metals, typically from scrap processors and/or material recovery facilities, for the purpose of producing refined recycled raw materials for use by other manufacturers, and/or for producing new products or product components

Recycled Tire Product Manufacture/ End-Use: Receipt of whole tires or tire-derived materials, typically from scrap tire processors, for the purpose of producing new products or using the materials in end-use applications (e.g., as tire-derived aggregate or as synthetic turf infill). Excludes direct tire reuse and combustion.

Textiles End-Use: Receipt of recycled textiles for the purpose of producing refined recycled raw materials for use by other manufacturers, and/or for producing new products or product components. Excludes direct reuse of clothing and other textiles.

APPENDIX B:

CONFIDENTIALITY PLAN

THE STUDY ON THE ECONOMIC IMPACTS OF RECYCLING

Confidentiality Plan

With respect to confidentiality of proprietary information, it is Contractor's policy to comply with all applicable laws, regulations and policies and not knowingly infringe upon the intellectual property rights of others; protect third-party information that is subject to a confidentiality obligation in accordance with the terms of such obligation(s); and require that subcontractors agree to adhere to any confidentiality obligations imposed by Contractor.

In accordance with our policy and capabilities, Contractor intends to manage Business Sensitive Information related to the Study on the Economic Impacts of Recycling in a manner that is aimed at protecting sensitive, confidential, trade secret, and proprietary information from disclosure contrary to executed confidentiality agreements, except as required by applicable law. All collected data will remain the exclusive property of the entity providing such data for the project (hereinafter "Responding Party").

Business Sensitive Information shall include any facility or operation information related to any survey results concerning amounts of recyclable materials, economic or financial data, or solid wastes processed, managed, or directed by a Responding Party.

Business Sensitive Information shall not include information that was in the public domain at the time of its release or which becomes a part of the public domain through no fault of Contractor; information that is released with the written approval of the disclosing firm; information that is released by a Responding Party after five (5) years from the receipt of the information; or information that must be released pursuant to the provisions of a court order. Contractor will protect such Business Sensitive Information with the same degree of care that Contractor uses to protect its own proprietary or confidential information.

Contractor will take the following steps during the course of this project aimed at keeping Business Sensitive Information confidential:

- Contractor will execute a confidentiality agreement with each subcontractor engaged on this project (Attachment 1);
- Contractor will offer to execute a confidentiality agreement with any Responding Party that completes a survey (Attachment 2);

- Contractor will require each employee engaged on the project to sign a statement acknowledging their understanding and acceptance of the confidential nature of data associated with this project;
- Contractor employees not engaged in this project will not be allowed access to confidential project files;
- To address the confidential nature of individual Responding Parties' data, Contractor will aggregate confidential data received from the Responding Parties for presentation to the public, Client, or the Recycling Industry Committee;
- Contractor will not release raw, company-specific data, or Responding Party proprietary or confidential information (unless directed to do so under order of law, which is defined as pursuant to a court order, governmental proceeding, or applicable law, including rulings by the Attorney General under the Public Information Act, Government Code Chapter 552, in which case we will notify Client and the Responding Party).

Contractor makes no representation that data collected will not be subject to state or federal open records laws or regulations or the Freedom of Information Act, as information subject to such rules is governed by the applicable statute/rule. Contractor has no control over the disclosure of such information by court order or as required by applicable law and shall not be held liable for the release of the information as required by law.

Attachments:

1. Subcontractor Non-Disclosure Agreement (MSC-8)
2. Mutual Non-Disclosure Agreement (MSC-9)

ATTACHMENT 1- SUBCONTRACTOR NON-DISCLOSURE AGREEMENT (NDA)

SUBCONTRACTOR NON-DISCLOSURE AGREEMENT (NDA)
(Doc. No. MSC-8)

This AGREEMENT is made as of , 20 , by and between _____ (hereinafter called “SUBCONTRACTOR”) and Burns & McDonnell Engineering Company, Inc., a Missouri corporation (hereinafter called “BME”). BME has entered into an agreement with The Texas Commission on Environmental Quality (hereinafter called the “CLIENT”) for services related to reporting the amounts of recyclable materials, economic, or financial data or solid wastes processed, managed, or directed (the “Project”), and the CLIENT has required that BME and its subcontractors maintain the confidentiality of certain data and information which CLIENT has provided to BME, or which BME has or will develop or obtain related to the Project (the “Confidential Information”). It is the intent of this Agreement that SUBCONTRACTOR agrees to likewise maintain the confidentiality of such Confidential Information.

In consideration of the promises contained herein and other good and valuable consideration which the Parties deem adequate, the Parties hereby agree as follows:

1. BME or the CLIENT may supply SUBCONTRACTOR with data or information regarding the Project, and such data or information, which is confidential or proprietary, and shall be deemed to be Confidential Information as discussed in this Agreement. Oral information related to the Project which is said to be confidential or proprietary at the time of disclosure shall likewise be deemed to be Confidential Information. SUBCONTRACTOR EXPRESSLY AGREES THAT UNLESS DATA OR INFORMATION PROVIDED IS MARKED AS “NOT CONFIDENTIAL” OR FALLS WITHIN THE CATEGORIES MENTIONED IN SECTION 2, BELOW, ALL INFORMATION PROVIDED TO THE SUBCONTRACTOR RELATING TO BME, THE CLIENT OR TO THE PROJECT SHALL BE DEEMED TO BE, AND SHALL BE TREATED AS, CONFIDENTIAL INFORMATION.

2. Information shall not be deemed to be Confidential Information where: (i) it is or becomes public information or otherwise generally available to the public through no act or fault of SUBCONTRACTOR; or (ii) it was, prior to the date of this Agreement, already in the possession of the SUBCONTRACTOR and was not received by SUBCONTRACTOR directly or indirectly from the CLIENT or BME; or (iii) it is hereafter rightfully received by the SUBCONTRACTOR from a third person who did not receive the same directly or indirectly from the CLIENT or BME; or (iv) it is at any time independently developed by employees or subcontractors of SUBCONTRACTOR who have not had access to Confidential Information in the possession of the SUBCONTRACTOR. The SUBCONTRACTOR shall bear the burden of proof that such employees or subcontractors have not had access to Confidential Information. Specific information shall not be deemed to be within the exceptions of subparts (i) - (iv) merely because it is embraced by more general information within such exceptions, nor shall a combination of features be deemed to be within such exceptions merely because the individual features are within such exceptions.

3. SUBCONTRACTOR agrees that any Confidential information which has been or will be disclosed directly or indirectly to it by or on behalf of the CLIENT or BME shall be maintained in confidence, and shall not be disclosed to any third person without BME’s prior express written consent. The Confidential Information shall not be used by SUBCONTRACTOR to compete against BME or the CLIENT.

4. SUBCONTRACTOR may disclose Confidential Information to any governmental or regulatory authority requiring such disclosure under order of law, provided that: (i) the SUBCONTRACTOR notifies the governmental or regulatory authority that the materials are Confidential Information; (ii) the SUBCONTRACTOR, at the time of submission of such materials to the governmental or regulatory authority, requests such confidential treatment of such materials as may be available under applicable law; and (iii) prior to such disclosure, BME is given prompt notice of the required disclosure so that it or the

CLIENT or BME may take whatever action either deems appropriate, including intervention in any proceeding and the seeking of an injunction or other order to prohibit such disclosure.

5. SUBCONTRACTOR agrees that it will not make use of any Confidential Information received pursuant to this Agreement except for the limited purposes expressly given without the express prior written consent of BME.

6. This Agreement shall not be construed as a license or authorization to the SUBCONTRACTOR to utilize the Confidential Information for any purpose other than directly related to the Project.

7. This Agreement does not establish a joint venture, partnership, or other type of business entity between the Parties, and in no event shall the Parties represent to other persons that a joint venture, partnership, or other type of business entity has been formed. In addition, this Agreement alone shall not be construed as authorizing the order or purchase of engineering or construction services or equipment related to the Project.

8. This Agreement is for the benefit of CLIENT and BME and, without prejudice to the rights and remedies otherwise available to them, either CLIENT or BME shall be entitled to equitable relief by way of injunction if the SUBCONTRACTOR breaches or threatens to breach any of the promises of this Agreement, and to any other remedies provided by law, including attorney's fees and costs.

9. This Agreement shall be interpreted, governed, and construed under the laws of the state of Missouri as if executed and to be performed wholly within the state of Texas, and that venue for any such action shall be Travis County, Texas.

10. This Agreement: (i) contains the entire agreement and understanding between the Parties, their agents, and employees as to the subject matter of this Agreement; (ii) supersedes in its entirety all previous communications between the Parties on this topic (including all previous versions of this Agreement); and (iii) shall only be modified in writing by the Parties, signed by a representative of each.

11. Upon completion of the performance of services by SUBCONTRACTOR, or a termination of any Project subcontract between BME and SUBCONTRACTOR, and upon written request of BME, the SUBCONTRACTOR shall return to BME all Confidential Information including copies thereof, in all media as practically can be obtained and returned, or otherwise destroyed as agreed to by BME.

12. This Agreement may be executed in multiple counterparts, each of which shall be deemed to be an original.

13. This Agreement is effective as of the date fully executed by both Parties and shall terminate five (5) years thereafter. With regard to BME's financial information (if any is disclosed), there shall be no termination date as to the SUBCONTRACTOR's obligation to maintain confidentiality of the same.

SUBCONTRACTOR:		**Burns & McDonnell Engineering Company, Inc.**	
By:	____________________	By:	____________________
Name:	____________________	Name:	____________________
Title:	____________________	Title:	____________________

ATTACHMENT 2- MUTUAL NON-DISCLOSURE AGREEMENT (NDA)

MUTUAL NON-DISCLOSURE AGREEMENT (NDA)
(Doc. No. MSC-9)

This AGREEMENT is made as of , 20 , by and between _____ (hereinafter called “Responding Party”) and Burns & McDonnell Engineering Company, Inc., a Missouri corporation (hereinafter called “BME”). Each of the parties hereto, including their affiliates or subsidiaries, if any, is hereinafter designated as a "Party" or as the "Parties".

The Parties hereby agree as follows:

1. The Responding Party may supply BME with data or information regarding the amounts of recyclable materials, economic, or financial data or solid wastes processed, managed, or directed (the “Transaction”), and such data or information, which is confidential or proprietary, and shall be deemed to be "Confidential Information" as provided for in this Agreement. Ownership of the data will remain with the Responding Party. Oral information related to the Transaction which is said to be confidential or proprietary at the time of disclosure shall likewise be deemed to be Confidential Information. THE PARTIES EXPRESSLY AGREE THAT UNLESS DATA OR INFORMATION PROVIDED IS MARKED AS “NOT CONFIDENTIAL”, ALL INFORMATION PROVIDED TO THE RECIPIENT PARTY RELATING TO THE DISCLOSING PARTY OR TO THE TRANSACTION OR FALLS WITHIN THE CATEGORIES MENTIONED IN SECTION 2 BELOW SHALL BE DEEMED TO BE, AND SHALL BE TREATED AS, CONFIDENTIAL INFORMATION.

2. Information shall not be deemed to be Confidential Information where: information that was in the public domain at the time of its release or which becomes a part of the public domain through no fault of Consultant; information that is released with the written approval of the disclosing firm; information that is released by a Responding Party after five (5) years from the receipt of the information; or information that must be released pursuant to the provisions of a court order or as required by law.

3. Each Party agrees that any Confidential information which has been or will be disclosed directly or indirectly to it by or on behalf of the other Party shall be maintained in confidence, and shall not be disclosed to any third person without the other Party’s prior express written consent. The Confidential Information shall not be used by either Party to compete against the other Party.

4. BME may disclose Confidential Information to any governmental or regulatory authority requiring such disclosure under order of law, provided that (i) BME notifies the governmental or regulatory authority that the materials are Confidential Information; (ii) BME, at the time of submission of such materials to the governmental or regulatory authority, requests such confidential treatment of such materials as may be available under applicable law; and (iii) prior to such disclosure, the Responding Party is given prompt notice of the required disclosure so that it may take whatever action it deems appropriate, including intervention in any proceeding and the seeking of an injunction to prohibit such disclosure.

5. The Parties agree that they will not make use of any Confidential Information received pursuant to this Agreement except for the purpose relating to the Transaction without the express prior written consent of the Responding Party.

6. This Agreement does not establish a joint venture, partnership, or other type of business entity between the Parties, and in no event shall the Parties represent to other persons that a joint venture, partnership, or other type of business entity has been formed.

7. In no event will either Party be liable for any special, indirect, or consequential damages including, without limitation, damages or losses in the nature of increased costs, loss of revenue or profit, lost

production, claims by customers, or governmental fines or penalties. The Parties waive and release each other from any claims, liability, or damages arising out of or relating to the Transaction or this Agreement.

8. This Agreement shall be interpreted, governed, and construed under the laws of the state of Texas as if executed and to be performed wholly within the state of Texas, and that venue for any such action shall be Travis County, Texas.

9. This Agreement: (i) contains the entire agreement and understanding between the Parties, their agents, and employees as to the subject matter of this Agreement; (ii) supersedes in its entirety all previous communications between the Parties on this topic (including all previous versions of this Agreement); and (iii) shall only be modified in writing by the Parties, signed by a representative of each.

10. This Agreement may be executed in multiple counterparts, each of which shall be deemed to be an original.

11. This Agreement is effective as of the date fully executed by both Parties and shall terminate five (5) years thereafter.

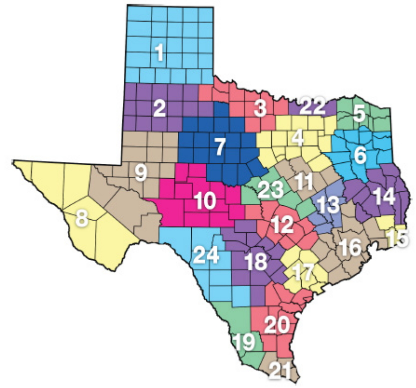
RESPONDING PARTY:		**Burns & McDonnell Engineering Company, Inc.**	
By:	______________________	By:	______________________
Name:	______________________	Name:	______________________
Title:	______________________	Title:	______________________

APPENDIX C:

FACILITY DIRECTORY

THE STUDY ON THE ECONOMIC IMPACTS OF RECYCLING

As part of the online survey, respondents were given an opportunity to be listed in the following directory. The respondents that chose to be included had the ability to choose the information that is shared here. The directory is organized by Council of Government regions so that readers of this report can identify recycling facilities in their region. The Study and TCEQ do not endorse products or services. The directory is voluntary and inclusion does not certify compliance with state or federal law.



Region Name	Number	Abbreviation
Alamo Area Council of Governments	18	AACOG
Ark-Tex Council of Governments	5	ARK-TEX
Brazos Valley Council of Governments	13	BVCOG
Capital Area Council of Governments	12	CAPCOG
Central Texas Council of Governments	23	CTCOG
Coastal Bend Council of Governments	20	CBCOG
Concho Valley Council of Governments	10	CVCOG
Deep East Texas Council of Governments	14	DETCOG
East Texas Council of Governments	6	ETCOG
Golden Crescent Regional Planning Commission	17	GCRPC
Heart of Texas Council of Governments	11	HOTCOG
Houston-Galveston Area Council	16	H-GAC
Lower Rio Grande Valley Development Council	21	LRGVDC
Middle Rio Grande Development Council	24	MRGDC
Nortex Regional Planning Commission	3	NORTEX
North Central Texas Council of Governments	4	NCTCOG
Panhandle Regional Planning Commission	1	PRPC
Permian Basin Regional Planning Commission	9	PBRPC
Rio Grande Council of Governments	8	RGCOG
South East Texas Regional Planning Commission	15	SETRPC
South Plains Assocation of Governance	2	SPAG
South Texas Development Council	19	STDC
Texoma Council of Governments	22	TEXOMA
West Central Texas Council of Governments	7	WCTCOG

Directory Legend

The following legend is for the contact tables below.

Abbreviation	Definition
F	Facility
O	Owner/Operator
POC	Point of Contact
RA	Recycling Activities
L	Location
WWW	Web Page

Directory

The following tables contain contact information for survey respondents who opted to be listed in the directory.

Alamo Area Council of Governments	
F	ReCommunity
POC	Tim Tiemann, Plant Manager
RA	Material Recovery
L	1949 Hormel Drive, San Antonio, TX 78219
F	Nelson Road Brush Recycling Center
O	City of San Antonio
POC	Joseph Krupa, Solid Waste Manager
RA	Compost/Mulch Production
L	8963 Nelson Road, San Antonio, TX 78252
F	Southwaste Disposal
RA	Compost/Mulch Production
L	20805 Lamm Road, Elmendorf, TX 78112
WWW	www.southwaste.com
F	Goodwill Industries of San Antonio
POC	Angelique De Oliveira, Director of Business Development
RA	Electronics, Paper, Metals, and Textile Processing
L	406 West Commerce Street, San Antonio, TX 78207

Ark-Tex Council of Governments

F	Texarkana Water Utilities — Compost Division
POC	Donnie Crittenden, Pollution Control Division Manager
RA	Compost/Mulch Production
L	4000 S. State Line Ave., Texarkana, TX 75501
WWW	www.twu.txkusa.org
F	Caraustar RFG
POC	Sharon Strawn, General Manager
RA	Pulp, Paper, or Paperboard Processing
L	112 South Lelia Avenue, Texarkana, TX 75501
WWW	www.caraustar.com

Capitol Area Council of Governments

F	Austin Wood Recycling
POC	Jerome Alder, President
RA	Compost/Mulch Production
L	3875 East Whitestone Blvd, Cedar Park, TX 78613
WWW	www.austinwoodrecycling.com
F	Balcones Resources
POC	Sara Koeninger, EVP
RA	Material Recovery
L	9301 Johnny Morris Road, Austin, TX 78724
WWW	www.balconesresources.com
F	City of Austin Recycle & Reuse Drop off Center
POC	Dawn Whipple, ADM
RA	Household Hazardous Waste Collection, Material Recovery, and Scrap Metal Processing
L	2514 Business Center Drive, Austin, TX 78744
F	Goodwill-Central Texas
POC	Donnie Brown
RA	Material Recovery
L	6505 Burleson Rd, Austin, TX 78744
WWW	www.goodwillcentraltexas.org

F	TRI Recycling
POC	Nancy Dobbs, Office Administrator
RA	C&D Processing
L	8700 Lava Hill Rd, Austin, TX 78744
F	Kinser Ranch, LLC
POC	Al Kinser, Owner
RA	Compost/Mulch Production
L	10701 Kinser Lane, Austin, TX 78736
WWW	www.kinserranch.com
F	Organics by Gosh
RA	Compost/Mulch Production
L	13602 Farm to Market Road 969, Austin, TX 78724
WWW	www.organicsbygosh.com
F	Simple Recycling
POC	Sonny Wilkins
RA	Textile Processing
L	2120 Grand Avenue Pkwy #175, Austin, TX 78728
F	Resale Resource Corporation
POC	Sara Ruiz, EQHS Manager
RA	Electronics Processing
L	10200 McKalla Place, Suite 200, Austin, TX 78758
WWW	www.resaleresource.net
F	T7 Enterprises L.L.C.
POC	David Schussler
RA	Tire Processing
L	3345 Texas 29 E. Burnet, TX 78611
WWW	www.reliabletiredisposal.com
F	Texas Big Worm
POC	Brian Faus
RA	Compost/Mulch Production
L	4625 East State Hwy 29, Bertram, TX 78605

Coastal Bend Council of Governments	
F	Republic Services - Corpus Christi
POC	Steve Carr, Government Affairs
RA	Material Recovery
L	4414 Agnes Street, Corpus Christi, TX 78405

Heart of Texas Council of Governments	
F	Sunbright Paper Recycling
O	Evergreen Companies, Inc.
POC	Tim Haugh, Owner
RA	Material Recovery
L	701 Texas Central Parkway, Waco, TX 76712
WWW	www.sunbright-recycling.com

Houston-Galveston Area Council	
F	Ball
O	Reterra Corporation
POC	Jason Ball, President
RA	Plastics Reclamation
L	2103 Lyons Avenue, Houston, TX 77020
WWW	www.reterra.com
F	Harris County HHW Collection F
POC	Cheryl Burton Fentress, Program Manager
RA	Household Hazardous Waste Collection
L	6900 Hahl Road, Houston, TX 77040
WWW	www.HCHHW.org
F	Crawford — Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	6019 Crawford Road, Houston, TX 77041
WWW	www.cherrycompanies.com

F	Fort Bend County Recycling Center
O	Fort Bend County
POC	Jose Ramirez Jr., Recycling/HHW Coordinator
RA	Household Hazardous Waste Collection
L	1200 Blume Road, Rosenberg, TX 77471
F	Hitchcock — Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	502 Texas 6, Hitchcock, TX 77563
WWW	www.cherrycompanies.com
F	Holmes - Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	4601 Holmes Road, Houston, TX 77033
WWW	www.cherrycompanies.com
F	City of Galveston Recycling Center
POC	James Robinson, Recycle Center Coordinator
RA	Compost/Mulch Production
L	702 61st Street, Galveston, TX 77551
F	Katy Hockley — Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	9929 Katy Hockley Road, Cypress, TX 77433
WWW	www.cherrycompanies.com
F	Koeblen — Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	6400 Koeblen Road, Richmond, TX 77469
WWW	www.cherrycompanies.com
F	McHard — Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	616 FM 521, Fresno, TX 77545
WWW	www.cherrycompanies.com

F	NOVUS Wood Group
POC	Roger D Oldigs, CFO
RA	Compost/Mulch Production
L	5900 Haynesworth Lane, Houston, TX 77034
WWW	www.novuswoodgroup.com
F	Pinafore— Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	909 Pinafore Lane, Houston, TX 77039
WWW	www.cherrycompanies.com
F	Riley Fuzzel — Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	5810 Riley Fuzzel Road, Spring, TX 77386
WWW	www.cherrycompanies.com
F	Avangard Innovative, LP
POC	Jon Stephens, EVP
RA	Plastics Reclamation
L	11906 Brittmoore Park Drive, Houston, TX 77041
WWW	www.avaicg.com
F	We CAN Recycle Inc.
POC	Mark Austin, Owner
RA	Material Recovery
L	723 N. Drennan St., Houston, TX 77003
WWW	www.wecanrecycle.org
F	Stella Roberts Recycling Center
O	City of Pearland
RA	Material Recovery, Household Hazardous Waste, Electronics Processing
L	5800 Magnolia Street, Pearland, TX 77584
WWW	www.mykpb.org
F	Strategic Materials, Inc.
POC	Curt Bucey, VP
RA	Glass Beneficiation
L	825 South Loop West, Houston, TX 77054

F	JMJ Organics LTD
POC	Dean Warrens, Owner
RA	Compost/Mulch Production
L	U.S. 59, Porter, TX 77365
F	Simple Recycling
POC	Sonny Wilkins
RA	Textile Processing
L	6116 Milwee, Houston, TX 77092
F	McCarty Road Landfill
O	Living Earth Technology Co.
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	5757 Oates Rd, Houston, TX 77078
F	Living Earth Technology Co.
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	5802 Crawford Rd, Houston, TX 77041
F	CJM The Soil Supermarket
O	Living Earth Technology Co.
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	16717 Katy Freeway, Houston, TX 77094
F	CJM the Soil Supermarket
O	Living Earth Technology Co.
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	1700 E Highway 90A, Houston, TX 77406
F	Living Earth Technology Co.
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	1503 Industrial Dr, Missouri City, TX 77489
F	CJM The Soil Supermarket
O	Living Earth Technology Co.
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	1000 FM 1266, Dickinson, TX 77539

F	Living Earth Technology Co.
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	20611 Highway 59 N, New Caney, TX 77357
F	Living Earth
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	16138 Highway 6, Rosharon, TX 77583
F	Living Earth Technology
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	5210 S Sam Houston Pkwy E, Houston, TX 77048
F	Living Earth
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	27733 Katy Fwy, Katy, TX 77494
F	Living Earth Technology
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	12200 Cutten Rd, Houston, TX 77066
F	Rosharon— Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	4635 CR 418, Rosharon, TX 77583
WWW	www.cherrycompanies.com
F	Winfield— Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	9200 Winfield, Houston, TX 77050
WWW	www.cherrycompanies.com
F	Selinsky— Cherry Companies
POC	Leonard Cherry
RA	C&D Processing
L	6131 Selinsky Rd, Houston, TX 77048
WWW	www.cherrycompanies.com

F	The Letco Group LLC
O	Living Earth Technology
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	17555 I 45 S, Houston, TX 77385
F	Living Earth Technology
POC	Lora Hinchcliff, Municipal Solutions Manager
RA	Compost/Mulch Production
L	10310 Beaumont Hwy, Houston, TX 77078
F	Republic Services – Houston Resource Renewal Center
POC	Steve Carr, Government Affairs
RA	Material Recovery
L	5757 B Oates Rd, Houston, TX 77078

Lower Rio Grande Valley Development Council	
F	City of McAllen Recycling Center
O	City of McAllen
POC	Roberto Trevino Jr., Renewable Resources Manager
RA	Material Recovery
L	4101 N. Bentsen Road, McAllen, TX 78504
WWW	www.mcallenpublicworks.net

North Central Texas Council of Governments	
F	Evergreen Paper Recycling
POC	Tim Haugh, Owner
RA	Material Recovery, Scrap Metal Processing
L	1110 Everman Parkway, Everman, TX 76140
F	Balcones Resources Inc.
POC	Heather Douglas, Recycling Program Manager
RA	Material Recovery
L	13921 Senlac Drive, Farmer's Branch, TX 75234
WWW	www.balconesresources.com

F	City of Denton Beneficial Reuse
POC	Gayla Wright, Beneficial Reuse Manager
RA	Compost/Mulch Production
L	1100 S. Mayhill Road, Denton, TX 76208
WWW	www.cityofdenton.com/dyno
F	City of Lewisville Residential Convenience Center
POC	Lisa Weaver, Sustainability Manager
RA	Household Hazardous Waste Collection
L	330 W. Jones St., Lewisville, TX 75057
WWW	www.cityoflewisville.com
F	City of Grand Prairie landfill
RA	Composting/Mulch Production
L	1102 Macarthur Boulevard, Grand Prairie, TX 75050
F	Recycle Revolution
POC	Maria Lott
RA	Electronics Processing
L	7600 Sovereign Row, Dallas, TX 75247
F	Dlubak Glass
POC	Tom Lassetter, Plant Manager
RA	Glass Beneficiation
L	400 Mushroom Road, Waxahachie, TX 75165
F	City of Denton Solid Waste & Recycling Services
O	City of Denton
POC	Scott Lebsack, Development & Administrative Manager
RA	Composting/Mulch Production, Material Recovery
L	215 East McKinney Street, Denton, TX 76201
F	Simple Recycling
POC	Sonny Wilkins
RA	Textile Processing
L	350 S Belt Line Rd #116, Irving, TX 75060
F	Owens Corning
POC	Jason Dulaney, Recycled Content Sourcing Leader
RA	Fiberglass Manufacture
L	3700 North Interstate 35 East Service Road, Waxahachie, TX 75165

F	North Texas Municipal Water District 121 Regional Disposal Facility
O	North Texas Municipal Water District
POC	Jeff Mayfield, Assistant Deputy Director-Solid Waste
RA	Material Recovery
L	3820 Sam Rayburn Highway, Melissa, TX 75454
WWW	www.ntmwd.com
F	Universal Recycling Technologies
O	Hendricks Holding Company
POC	Roy Gordon, Regional Account Manager
RA	Electronics Processing
L	2301 Franklin Drive, Fort Worth, TX 76109
WWW	www.urtsolutions.com
F	McKinney MRF
O	Progressive Waste Solutions
POC	Steve Shannon, Municipal Marketing Manager
RA	Material Recovery
L	2138 Country Lane, McKinney, TX 75069
F	Republic Services – Plano
POC	Steve Carr
RA	Material Recovery
L	4200 East 14th Street, Plano, TX 75074
F	Republic Services – North Texas
POC	Steve Carr
RA	Material Recovery
L	6200 Elliot Reeder Road, Fort Worth, TX 76117

Rio Grande Council of Governments

F	Hal Flanders Recycling Center
POC	Patsy McWilliams, Coordinator
RA	Compost/Mulch Production, Glass Beneficiation
L	3300 Old Cemetery Road, Alpine, TX 79830

South Plains Association of Governments	
F	American Fibers
POC	Ruben Lopez, Manager
RA	Material Recovery
L	2002 Weber Drive, Lubbock, TX 79404

Out of State	
F	Call2Recycle
POC	Tim Warren, US Regional Acct Manager
RA	Household Hazardous Waste Collection
L	1000 Parkwood Circle, Atlanta, GA 30339
WWW	www.call2recycle.org