Austin's 2015 Community Diversion Study

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Executive Summary

Austin Resource Recovery (ARR) commissioned Austin's 2015 Community Diversion Study (the Study) to calculate Austin's current citywide diversion rate. To accomplish this objective, the Study provides a comprehensive compilation and analysis of all materials citywide, including those managed through landfilling, recycling, composting, and reuse activities as well as those not generated as a result of waste reduction activities.

In addition to calculating the citywide diversion rate, the Study is also intended to provide qualitative information about disposal and diversion behaviors at commercial and large multifamily properties; these generators do not receive ARR collection service and are generally served by private haulers. To obtain this additional qualitative information, several information-gathering steps were completed:

- Survey of randomly selected businesses to understand current disposal and diversion behaviors, identify materials that are challenging to recycle, and quantify diversion practices not currently captured through City reporting programs;
- Field observations of trash, recycling, and organics containers across the city to identify common materials visible in the containers, assess visible contamination in the recycling stream and recyclables in the trash stream, and observe containers for proximity of recycling to trash options and presence of URO-compliant labels; and
- Limited sample sorting of trash and recyclable materials from commercial sources to assess the relative composition of each stream delivered to facilities serving the city.

Based on the information gathered and analysis completed in this Study, ARR can more accurately report diversion performance and progress towards its Zero Waste goal for all sectors of the city. Study information can also be used by ARR and the City to identify opportunities to increase diversion through future programs, services, and policies.

Austin's 2015 citywide diversion rate is estimated to be 42%. Table ES-1 below summarizes the component quantities used to calculate this diversion rate.

TABLE ES-1. 2015 CITYWIDE DIVERSION RATE CALCULATION

Management Method	Quantity (tons)	Percent of Total
Disposal	1,128,835	58.0%
Recycling, Composting, and Reuse	802,469	41.2%
Reduction and Prevention	15,789	0.8%
Total Generation	**1,947,092**	
Diversion Subtotal	**818,258**	
2015 Citywide Diversion Rate	**42.0%**	

1.0 Study Overview

1.1 Background

The Zero Waste International Alliance (ZWIA) adopted the first peer-reviewed and widely accepted definition of Zero Waste:

> *Zero Waste is a goal that is ethical, economical, efficient and visionary, to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use.*
>
> *Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them.*
>
> *Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health.* (ZWIA website, definition last revised August 12, 2009)

In 2008, Austin adopted a goal of becoming a Zero Waste community by 2040. Austin's definition of Zero Waste is largely consistent with ZWIA's definition. For Austin, Zero Waste means:

> *reducing the generation of wasted materials at the source and maximizing diversion methods to avoid landfills and incinerators. The overall goal is to strive for no waste burned or buried.* (ARR Master Plan, page 35)

The City's Zero Waste goal is to divert at least 90% of the materials currently sent to landfills or incinerators. Materials may be diverted from disposal to beneficial uses that create jobs, keep materials local, reduce environmental impacts, and extend the useful life of area landfills. In 2011, the Austin City Council approved Austin Resource Recovery's Master Plan (the Master Plan), which identifies the key strategies and resources to achieve Zero Waste. The Master Plan also included interim milestones for Zero Waste in Austin, with goals of 50% diversion by 2015 and 75% diversion by 2020.

Currently in Austin, residential materials from single-family homes and multifamily properties up to 4 units are collected and managed by Austin Resource Recovery (ARR). ARR's services include collecting trash, recyclables, yard trimmings, brush, bulk wastes, and household hazardous wastes. Using private contracts, private haulers collect all other materials from businesses, institutions, multifamily properties with more than 4 units, and government offices. Third party private waste haulers are licensed through the City of Austin to handle landfill trash, recycling, or organics.

ARR previously estimated that it collects approximately 25% of the material generated citywide, with third party private haulers collecting the remaining 75% of material. Based on data presented herein, ARR collection quantities are actually less than 15% of overall material collection and management in the city. Because residential services are managed directly by ARR, the City and ARR have the ability to design and establish services to maximize waste diversion within this sector. However, the majority of material generated citywide is privately managed and not within the direct control of the City/ARR. Therefore, significant consideration must be given to the impact on individual businesses and private

haulers if the City and/or ARR establish practices and programs to reduce disposal in landfills and incinerators.

1.2 Purpose and Objectives

ARR commissioned Austin's 2015 Community Diversion Study (the Study) to measure Austin's diversion rate as a community. The Study is intended to be used to identify opportunities to increase diversion and provide a baseline to evaluate the community's progress towards the Zero Waste goal. The Study is the first to comprehensively quantify the community's diversion rate and assess the composition of materials generated by the city's commercial sector.

The Study was first recommended in the Master Plan. In November 2013, the City Auditor's Office also recommended the Study in its Zero Waste Audit report to measure progress towards the City's Zero Waste goal. At that time, ARR possessed detailed information on the fraction of the community's waste stream it manages and was reporting diversion on that basis. However, as previously stated, ARR directly manages only a small fraction of the community's waste stream. The November 2013 Zero Waste Audit therefore recommended the Study to provide detailed information on citywide waste management quantities not previously available to ARR.

A two-step approach was taken to measure progress towards Zero Waste. First, to understand the characteristics of ARR-collected materials, ARR commissioned a City-Serviced Residential Waste Characterization Study to measure the waste and diversion metrics from properties serviced directly by ARR staff and equipment[1]. The residential study was performed in 2014 and the report completed in March 2015.

The current Study is the second step in the approach. Austin's 2015 Community Diversion Study focuses on estimating diversion from both ARR-serviced properties and commercial properties. Commercial properties include retail businesses, food service establishments, professional offices, industrial properties, institutional facilities, government facilities, and multifamily properties five units and larger. Most commercial properties utilize dumpster service provided by private haulers rather than ARR's cart-based collection service.

The Study includes a review of data collected by ARR on discarded and diverted materials. Supplemental data was gathered specifically for this Study through direct contact with specific generators, a survey of local businesses, field observation of materials in trash and recycling containers, and performance of trash and recycling stream sorts. Through these activities, the Study:

1. Estimates Austin's 2015 diversion rate for non-hazardous materials generated by Austin's residents and businesses.

2. Estimates the quantity of materials managed through diversion and disposal methods.

[1] Residential customers serviced by ARR's cart-based services include single-family homes, duplexes, triplexes, and fourplexes, as well as smaller commercial properties on residential routes.

3. Provides baseline data ARR can use to establish performance benchmarks for material streams impacted by Zero Waste programs.

4. Summarizes observations of materials present in the disposed waste stream, providing more data ARR can use to identify opportunities for diversion.

5. Provides empirical data and observations of commercial diversion and disposal practices through:
   - Self-reported information by non-residential generators and multifamily property managers, identifying waste reduction and diversion practices they have implemented and estimates of diversion achieved;
   - Field sorting or observation of randomly selected loads at landfills, material recovery facilities (MRFs), and organics processing facilities to evaluate composition of trash, recycling, and composting streams by component; and
   - Field observation of generator-level diversion and disposal behaviors.

6. Identifies data gaps that currently exist and may be targeted for further data collection efforts prior to the first 5-year Study update in 2020.

1.3 Diversion Rate Calculation Method

The Master Plan prescribed the method to measure diversion performance:

> *For the purpose of measurement, disposal includes waste sent to landfills and end-of-life disposition of materials sent to incinerators, waste-to-energy facilities and other disposal facilities. Diversion includes waste prevention activities and material sent to recyclers, composting systems, reuse facilities and other secondary use options. Waste generation is defined as disposal plus diversion.*

The formula for estimating waste diversion, in its simplest form, is:

$$\text{Generation} = \text{Diversion} + \text{Disposal}$$

$$\text{Diversion Rate} = \frac{\text{Diversion}}{\text{Generation}}$$

The Master Plan noted that there are challenges in calculating diversion for a number of reasons, including:

- Limited ability to track material generation and movement through the region;
- Inconsistencies in reporting methods; and
- A lack of documented diversion quantities.

Furthermore, including waste prevention activities in the diversion rate calculation is particularly difficult. Waste prevention activities refer to process improvements, product redesigns, and other practices that reduce generation of materials. This directly reduces the amount of material that would otherwise be landfilled or diverted. Waste prevention, also called waste reduction or source reduction, is the preferred option in the waste management hierarchy. However, it is difficult to quantify waste prevention's impact if there is not historical data on material quantities generated prior to implementing waste

prevention practices. To address this challenge, the Study included efforts to characterize the waste prevention activities being implemented at commercial properties.

The scope of the current Study includes quantifying the diversion of non-hazardous waste generated by residents, businesses, government offices, and institutions through recycling, composting, reuse, and reduction. The Study includes consideration of the following material flows:

- Recyclable commodities, including cardboard, newsprint, mixed paper, plastics, glass, and metals
- Organic materials, including yard trimmings, brush, and food waste
- Electronics, including computers, printers, televisions, and small and large appliances
- Food donation
- Furniture, mattresses, textiles, carpets, and clothing
- Pallets and packaging materials such as expanded polystyrene and pallet wrap
- Construction and demolition materials
- Scrap metal
- Tires
- Batteries, oil, paint, and antifreeze managed through City collection programs[2]
- Household hazardous wastes including cleaning products and lawn care chemicals, when these materials have been separately collected through the City's household hazardous waste collection program.

The Study does not include materials outside of the non-hazardous municipal waste stream, such as hazardous wastes, industrial process wastes, medical wastes, contaminated soils, or biosolids/sludge. These materials are regulated under federal statutes or are outside the City's authority to regulate, and therefore were determined to be appropriately excluded from measurement of diversion and progress towards the Zero Waste goal. Further, the Study does not include materials reused through direct person-to-person exchange (e.g., garage sales, used car sales, and Craigslist/eBay); significant estimation would be required to include these quantities, and estimates would be difficult to replicate in future studies. In addition, inclusion of these additional outlets for reuse of materials may result in questions regarding the credibility and reliability of the data upon which the Study and diversion rate calculation are based.

The Study concludes with a calculation of the best estimate of Austin's 2015 diversion rate, based on quantifiable data collected over the course of the Study. In addition to tracking and reporting on diversion performance, the Master Plan also recommends tracking disposal reduction, which is directly related to achieving Zero Waste. As a result, the Study also includes a calculation of the 2015 Citywide Disposal Rate. Disposal reduction is most typically measured as a reduction in the per capita disposal rate (often expressed in pounds per capita per day) compared to an initial base year.

[2] Batteries, oil, paint and antifreeze collected by private companies was not included in this Study except to the extent reported through Annual Diversion Plans and data collection/outreach performed specifically for this Study.

To supplement the quantitative data about the commercial sector's waste management practices, qualitative information was also gathered and considered, including identification of:

- Recyclable materials remaining in the disposed waste stream.
- Relative proportion of the waste stream that could be recycled through existing programs if segregated by the generator;
- Contaminants in the recycling and composting streams;
- Materials that are difficult for businesses to divert currently;
- Waste prevention / reduction practices businesses have implemented; and
- Reasons businesses do not recycle.

Combined with the quantitative data, the additional qualitative information will be valuable in ARR's consideration of future policies and programs.

The remainder of this report includes the following sections:

- Section 2.0 Data Sources
- Section 3.0 Business Survey Methodology and Findings
- Section 4.0 Field Observation Methodology and Findings
- Section 5.0 Limited Sample Sorting Methodology and Findings
- Section 6.0 Calculation of Austin's 2015 Diversion and Disposal Rates
- Section 7.0 Recommendations

2.0 Data Sources

A number of data sources were considered to develop a reliable estimate of Austin's 2015 diversion rate, including data currently collected by the City and other publicly available data.

In particular, the following City-tracked data sources were reviewed:

1. **Licensed Hauler Tonnage Reports.** Under City of Austin Code 15-6, Article 3, trash and recycling haulers must be licensed by the City and, as a condition of the license, report the quantity of material collected and delivered to a landfill, recycling facility, or organic material processor every 6 months[3]. Licensed hauler tonnage reports through mid-2015 were reviewed to provide an estimate of trash and diverted materials collected by licensed private haulers.

2. **Universal Recycling Ordinance (URO) Reports.** City of Austin Code 15-6, Article 5 establishes the City's URO. Implementation of the URO is being phased in and began in 2012. Upon full implementation in 2017, recycling will be required at over 12,000 properties in the city. Commercial properties over 50,000 square feet and multifamily properties with more than 25 dwelling units were affected by the URO starting October 1, 2014. This represents approximately 2,400 properties; over 95% of these properties reported recycling capacity in 2015 in the filing of their Annual Diversion Plan (ADP). ADP data was reviewed to identify additional recycling and waste reduction quantities not captured by the hauler licensing reports (e.g., materials self-hauled to recycling facilities and materials managed by companies not subject to hauler licensing).

3. **Austin Materials Marketplace Data.** The Austin Materials Marketplace was developed by ARR and Economic Development to facilitate business-to-business material reuse through an online platform. Data available from Austin Materials Marketplace was reviewed to identify reuse activities and quantities by businesses utilizing the platform.

4. **City of Austin Facility and Contract Data.** Quantities of landfill trash and recyclable materials collected from City of Austin facilities and through contracts for certain City programs or services (e.g., Fleet Services, Austin Energy, Public Works, and other City operations) were reviewed through mid-2015. Quantities managed directly by City departments were included in this Study. Any materials collected from City of Austin facilities under contract with a private hauler who also submits hauler licensing reports was excluded in this Study to avoid double-counting.

5. **Residential Collection Program Data.** The City, through ARR, provides collection services and programs principally to single-family residences and multifamily properties up to 4 dwelling units. Material collection quantities through mid-2015 were reviewed for trash, recycling, yard trimmings, mixed organics, bulk items, large brush, household hazardous waste (HHW), and Resource Recovery Center drop-offs. This data is used to estimate current diversion quantities from

[3] Licensed hauler tonnage reports are not audited by the City.

the residential sector; a more comprehensive estimate of residential diversion was provided in the City-Serviced Residential Waste Characterization Study completed March 2015.

In addition to the data sources compiled by the City noted above, ARR staff routinely corresponds with several large employers and generators as well as reuse organizations known to operate within Austin. However, there is no formal data collection performed with these businesses or reuse organizations. ARR contacted these businesses to obtain additional data for use in this Study:

1. **Large Employers and Generators.** ARR contacted more than 20 large commercial operations to obtain quantities of materials they recycle or reuse that would not be reported through the licensed hauler tonnage reports (e.g., baled cardboard, donated furniture, batteries, tires, used motor oil, etc.). Responding businesses generally provided their most recent year of data for consideration in this Study, representing 2014 quantities.

2. **Reuse and Repair Organizations.** ARR contacted a number of reuse and repair businesses to obtain quantities of materials they accept for reuse as well as quantities of recycling and disposal if those materials are not managed by licensed haulers (e.g., recycling of electronics or salvage textiles). Reuse-oriented organizations contacted included:

   - Donation centers and consignment shops
   - Material exchanges
   - Government surplus
   - Food banks and food donation services
   - Other donation or reuse providers

   As with the large employers and generators, reuse organizations provided the most recent year of data (2014).

Third-party publicly available data was also reviewed to identify broader trends in waste management practices in and around Austin, supplementing the city-specific data noted above. External sources included:

1. **Texas Commission on Environmental Quality (TCEQ) Facility Report Data.** Landfill disposal tonnage data reported to the TCEQ was reviewed to identify tonnages handled. This data provides information about regional trends in disposal; however, facilities do not report the source of the materials they receive (either by generator type or by jurisdiction), and therefore also include material quantities from outside the City of Austin.

2. **U.S. EPA Waste Stream Composition Data.** U.S. EPA produces an annual estimate of the composition of the national waste stream utilizing economic data and a materials-flow methodology. Though this methodology differs from the composition methodology used in this Study, it is useful for understanding national waste composition and high-level comparison of Austin's waste stream.

Finally, CB&I and ARR collaborated on the completion of several tasks to collect additional quantitative and qualitative data for use in this Study. These tasks included surveying a

sampling of Austin businesses; observing trash and recycling set-outs; and sorting a limited number of trash and recycling loads to gain further understanding of the materials' composition. The methodology and findings of these supplemental data-collection efforts are presented in the subsequent sections.

3.0 Business Survey Methodology and Findings

3.1 Business Survey Methodology

To identify current business and multifamily diversion practices in Austin, a survey of randomly selected businesses and multifamily properties was performed. The survey requested respondents to identify their current waste reduction, reuse, and recycling practices. The survey also sought to secure similar data to that collected under the URO, including estimates of material quantities generated and diverted. A copy of the business survey is provided in Appendix B.

Based on a third-party database of business properties obtained by ARR in July 2015, 37,555 businesses and multifamily (more than 4 dwelling units) properties were identified within Austin's city limits[4]. Surveying all businesses was not possible due to budget constraints. The Study team therefore surveyed a subset of 3,000 businesses. Figure 1 shows the location of all businesses in the city as well as the locations selected to participate in the survey.

To ensure the survey was distributed to a sample of businesses that represents the mix of business types in Austin, the business list was segregated by business type. The business type for each property was identified using the North American Industry Classification System (NAICS) sector recorded in the database for each property. Using the primary NAICS sector for each business, a proportional number of businesses in each NAICS sector was selected for surveying. For example, NAICS sector 72 (Accommodation and Food Services) is represented by a total of 2,822 businesses in Austin, which is 7.5% of the total businesses in the database; therefore, 7.5% of the 3,000 surveys, or 225 surveys, were sent to businesses within NAICS sector 72. Table 1 below identifies the distribution of businesses by NAICS sector and the number of businesses randomly selected from each sector for the survey.

The survey was mailed to the selected businesses in both English and Spanish. Additionally, the survey included a website link to allow respondents to complete the survey online. Approximately three weeks after the survey was mailed, ARR and CB&I began calling businesses that had not responded to the survey in an attempt to increase participation. Approximately 1,000 follow-up calls were attempted to the full range of business types in the city.

[4] The database was reviewed to exclude: duplicate entries; properties without a street address; properties with an Austin mailing address but physically located outside the municipal limits; and properties currently receiving ARR collection service, either through the former small commercial collection program or because the business is located at a residential property.

FIGURE 1. DISTRIBUTION OF BUSINESSES/MULTIFAMILY PROPERTIES

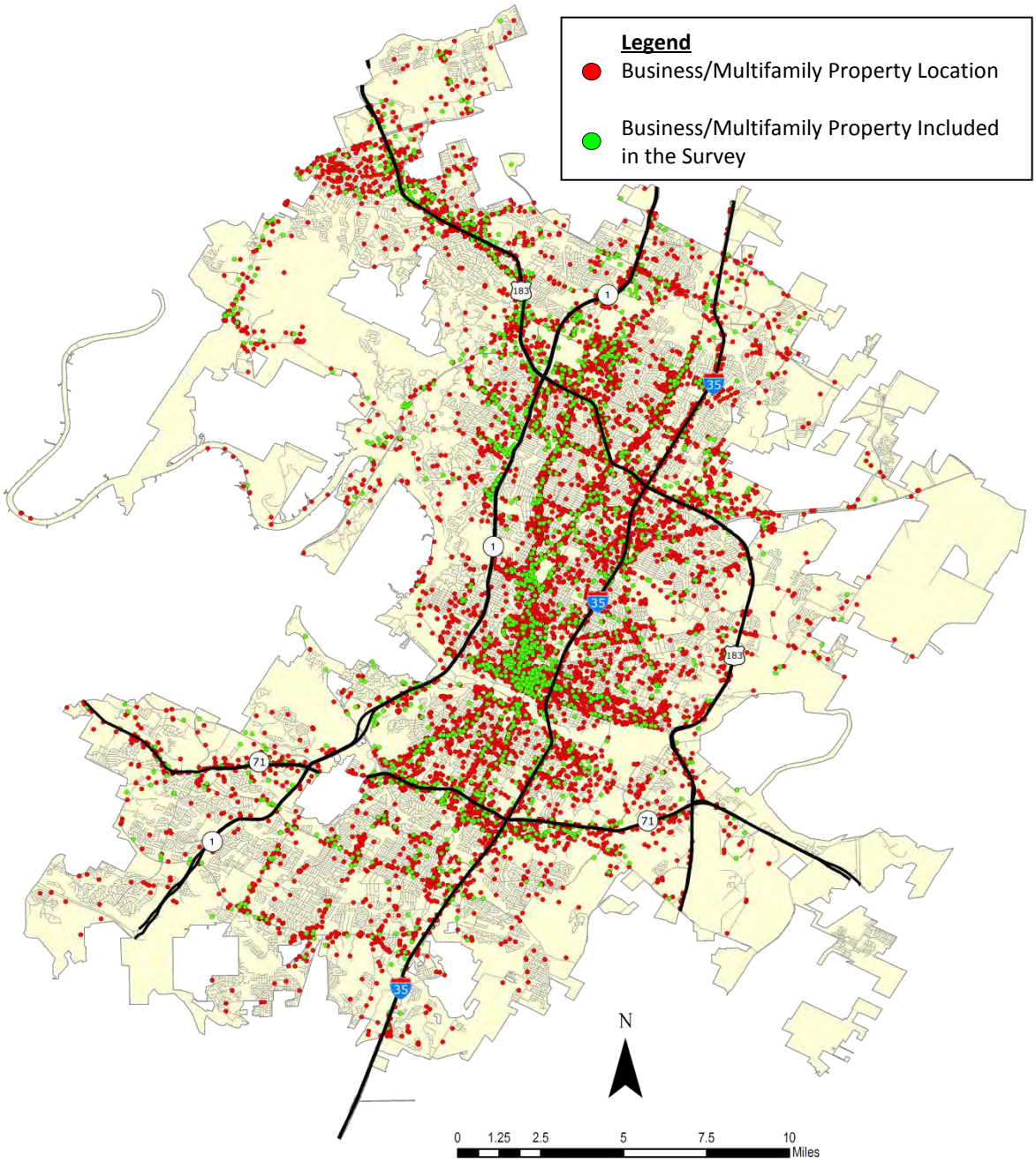


TABLE 1. BREAKDOWN OF AUSTIN BUSINESSES AND SURVEY DISTRIBUTION BY NAICS SECTOR

NAICS Sector	Code Description	Total Businesses	Businesses Surveyed
11	Agriculture / Forestry / Fishing / Hunting	33	3
21	Mining / Quarrying / Oil and Gas Extraction	67	5
22	Utilities	58	5
23	Construction	1,609	129
31-33	Manufacturing	873	70
42	Wholesale Trade	927	74
44-45	Retail Trade	4,726	378
48-49	Transportation / Warehousing	387	31
51	Information	904	72
52	Finance / Insurance	3,261	260
53	Real Estate / Rental / Leasing (apartments only)	751	60
53	Real Estate / Rental / Leasing (excluding apartments)	1,656	132
54	Professional, Scientific and Technical Services	5,195	415
55	Management of Companies / Enterprises	40	3
56	Administrative / Support / Waste Management / Remediation Services	1,143	91
61	Educational Services	934	75
62	Health Care / Social Assistance	5,567	445
71	Arts / Entertainment / Recreation	543	43
72	Accommodation / Food Services	2,822	225
81	Other Services (except Public Administration)	3,458	276
92	Public Administration	1,028	82
99	Unclassified Establishment	1,573	126
	Total	**37,555**	**3,000**

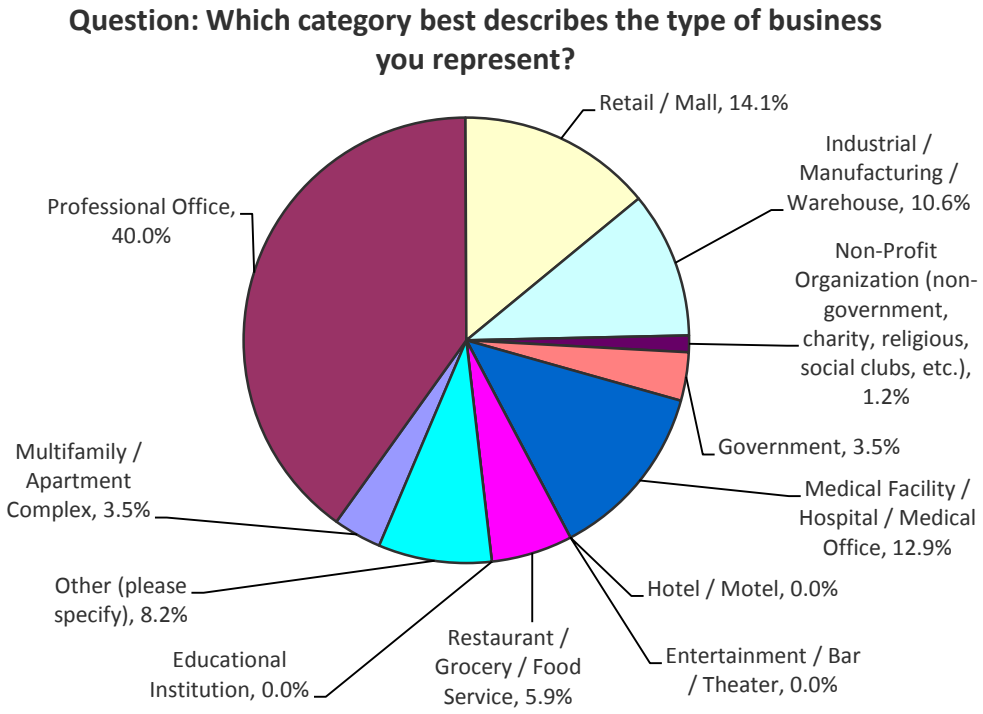
3.2 Business Survey Results

A total of 85 survey responses were received, with the vast majority provided through return mail. This represents a 2.8% survey response rate, which is not atypical for surveys of this type with limited pre-distribution outreach and post-distribution follow-up[5]. Based on the number of responses received, the survey results represent an approximately 10% margin of error at a 95% confidence level.

Survey responses indicated the following:

1. **Survey respondents by business type:** Figure 2 shows the proportion of responses received by business type. As shown, the majority of responses (40%) were received from businesses classified as professional offices. Other large categories of respondents included retail/mall businesses, medical offices and facilities, and industrial/manufacturing/warehouse operations.

FIGURE 2. DISTRIBUTION OF SURVEY RESPONSES BY BUSINESS TYPE



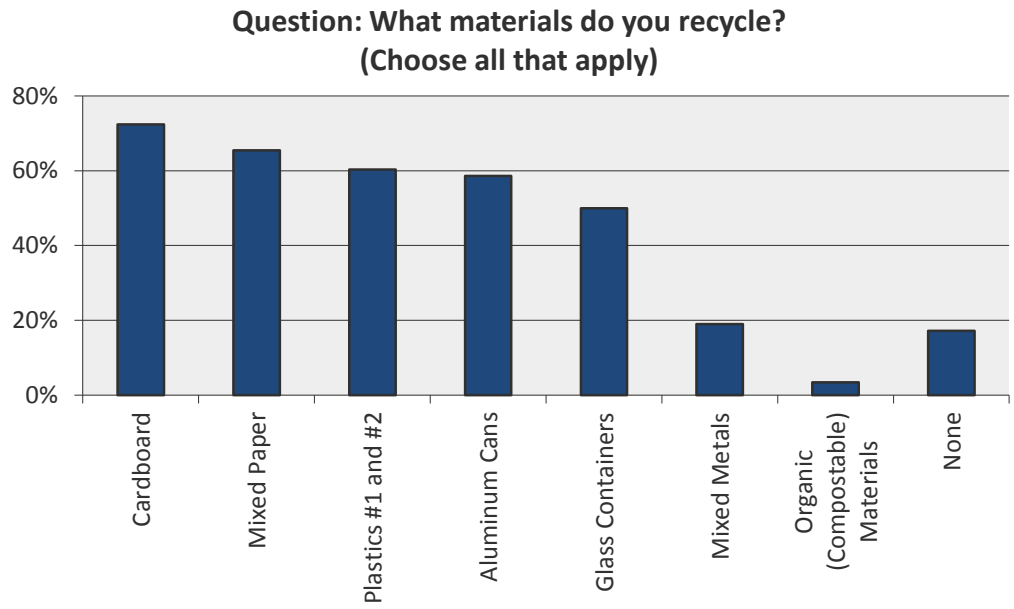
The distribution of survey responses did not precisely match the distribution of business types across the city. Professional offices showed a notably higher response rate than other business types, and large sectors such as

[5] Survey response rates are difficult to predict. SurveyGizmo, a commercial surveying tool, indicates that response rates below 2% may be observed when no incentive to complete the survey is offered or recipients do not feel motivated to respond to the survey. Section 7.0 includes a recommendation for increasing survey responses in future studies.

accommodation / food services and "other" services showed a lower response rate. However, on the whole, the survey responses were distributed across the NAICS sectors in similar proportions to the survey distribution.

2. **Materials recycled:** A total of 58 responses were received to this question. As shown in Figure 3, over 50% of respondents to this question[6] indicated that they recycle cardboard, mixed paper, plastic, aluminum cans, and/or glass. Only 3% currently recycle organic materials. Ten respondents to this question (17%) do not recycle any of the items listed.

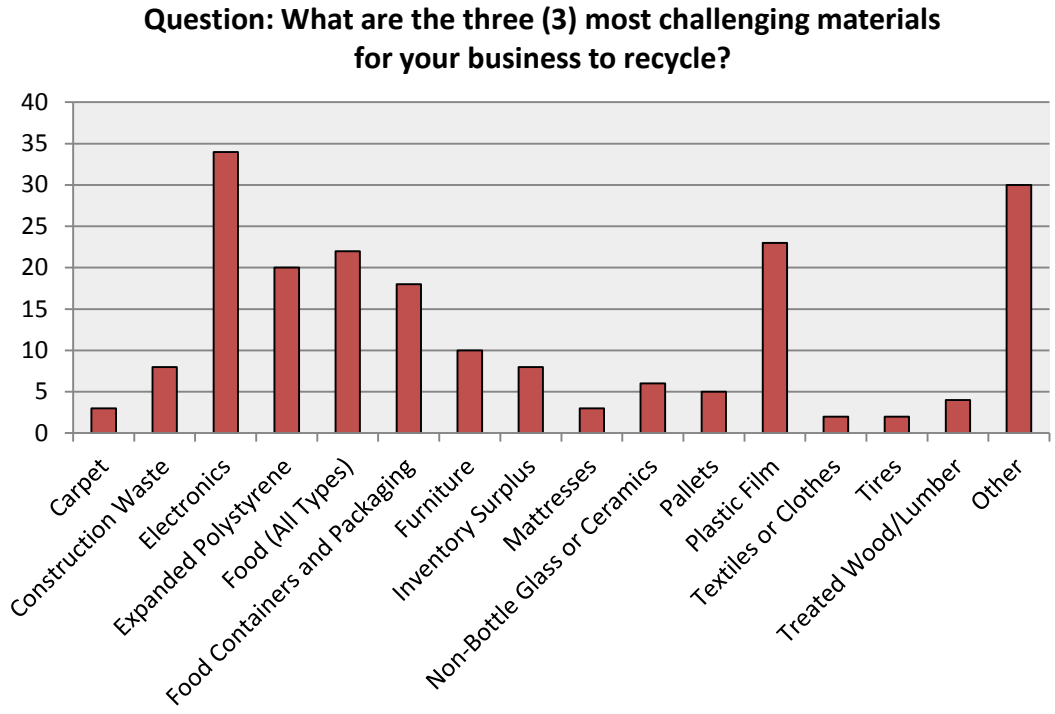
FIGURE 3. MATERIALS RECYCLED BY SURVEY RESPONDENTS



[6] Not all returned surveys included responses to all questions. When percentages are stated, they are based on the number of responses to the question, which may be less than the 85 surveys received.

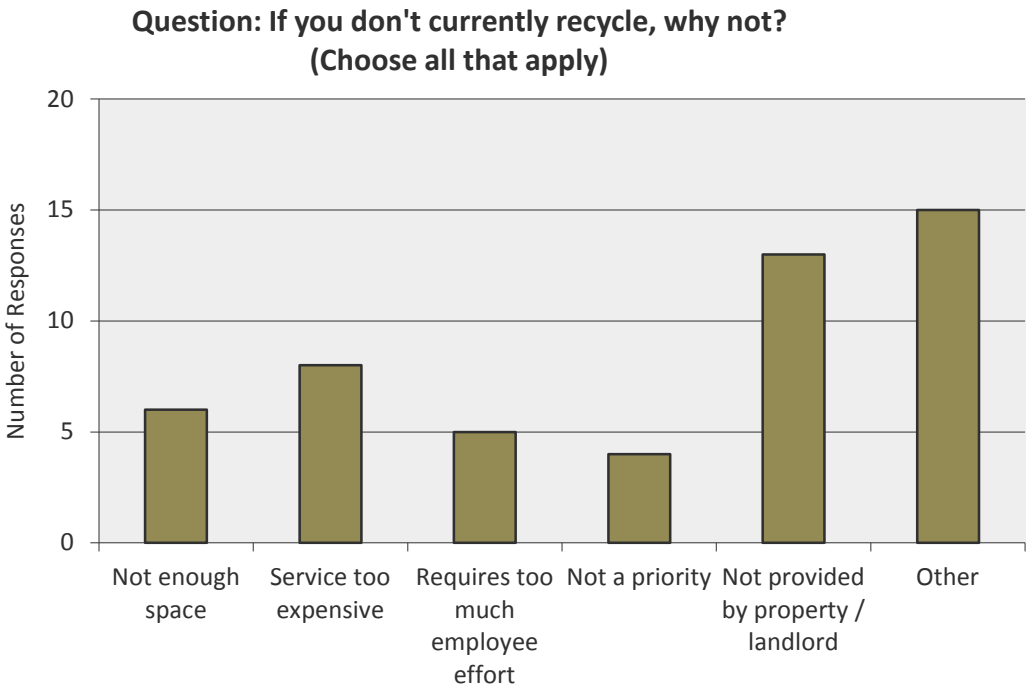
3. **Most challenging materials to recycle:** A total of 80 responses were received to this question. As shown in Figure 4, electronics appear to be the most challenging material for businesses to recycle with a total of 34 respondents ranking it in their top 3. Other top responses for materials that are challenging to recycle include plastic film (identified by 23 respondents), food (identified by 22 respondents), expanded polystyrene (identified by 20 respondents), and food containers and packaging (identified by 18 respondents). In addition, 30 respondents also identified "other" materials that are challenging to recycle; most frequently stated among these were: cardboard and boxes (noted by 6 respondents); shredded paper (noted by 5 respondents); paper and magazines (noted by 4 respondents); and waste oil and filters (noted by 2 respondents).

FIGURE 4. MOST CHALLENGING MATERIALS TO RECYCLE



4. **Reasons for not recycling:** Of the 85 respondents to the survey, 40% (34 businesses) reported they currently do not recycle[7]. As shown in Figure 5, these businesses cited multiple reasons for not recycling, including cost (8 times); space (6 times); too much effort (5 times); and not a priority (4 times). The "Other" category was cited 28 times; of those, 13 businesses indicated that recycling was not available at their building or from their landlord. Some businesses also indicated that they do not have much to recycle or that the items were too large to fit in the recycling container.

FIGURE 5. REASONS FOR NOT RECYCLING



5. **Materials recycled or sent to reuse, donation, resale, or repurpose:** Respondents were provided the option to indicate estimates of the quantity of materials they recycle or reuse annually. Material types included those that are generally outside of the traditional recycling collection system, and therefore include quantities that the City does not currently track[8].

[7] This is larger than the number of businesses reporting they did not recycle in Question 2, because not all businesses provided a response to Question 2.

[8] Some data is collected and tracked by the City for construction materials and landscaping materials, as these materials may be handled by licensed haulers.

Table 2 summarizes the reported pounds of each material type recycled and reused by respondents. While the data presented in Table 2 reflects generator estimates of recycling and reuse, it does not necessarily reflect the composition of recycling and reuse materials citywide due to the limited number of businesses participating in the survey.

TABLE 2. ESTIMATED RECYCLING AND REUSE BY MATERIAL TYPE (IN POUNDS)

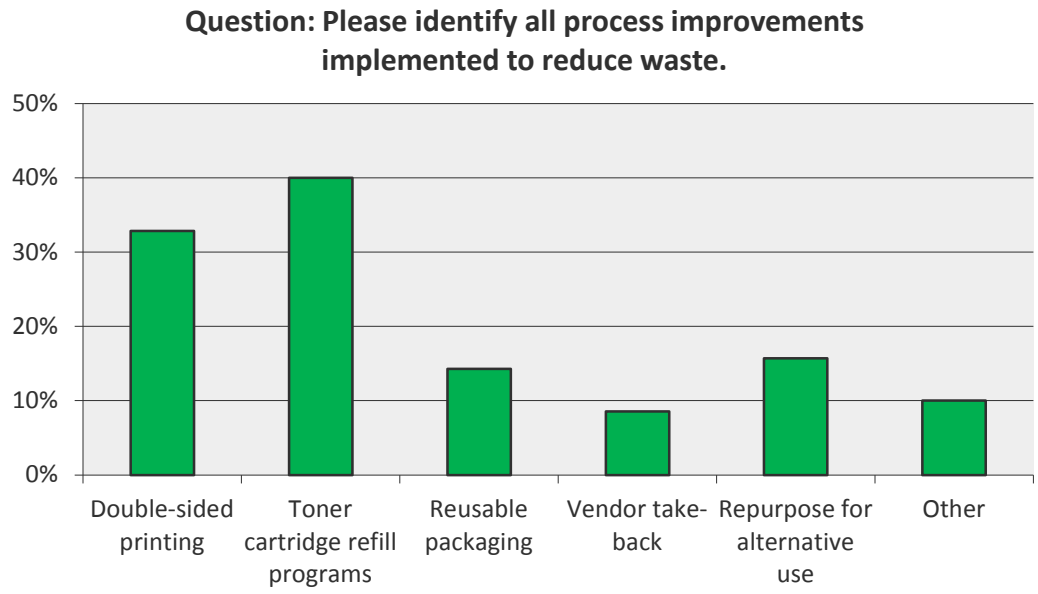
Material Type	Recycle	Reuse
Appliances (washer/dryer, refrigerator, microwave, etc.)	150	572
Batteries	25,159	23
Carpet		1,110
Cleaning Chemicals, Pesticides, Acids/Bases	50	100
Construction Materials (concrete, lumber, asphalt)	7,400,000	3,510
Electronics (PCs, printers, copiers, cell phones)	14,467	1,532
Food (All types)	85	452
Furniture	250	957
Inventory Surplus or Products Near Expiration	10	6,010
Landscaping Materials (brush, grass, leaves)	600,000	
Mattresses		100
Metals and Car Parts	28,651	150
Oils, Automotive Fluids, Lubricants	73,661	
Packaging, including expanded polystyrene	4,010	1,262
Paints	2,100	220
Pallets	1,401	303
Paper Shredding/Document Destruction	35,086	1,087
Plastic film	6,678	10,262
Textiles	500	2,151
Tires	45,320	
Other	24,836	1
Total (pounds)	8,262,414	29,802
Total (tons)	4,131	15

Note:

1. Construction materials and landscaping materials account for 8,000,000 pounds of recycling reported through the survey, all attributed to a single survey respondent. That survey respondent also provided information to ARR when contacted to provide data as a large generator. Excluding these quantities to avoid double-counting reduces survey-reported recycling quantities to 262,414 pounds (131.2 tons).

6. **Process improvements to reduce waste:** A total of 70 responses were received to this question. As shown in Figure 6, approximately 33% of respondents indicated they utilize double-sided printing to reduce waste, resulting in an estimated 2 ton (3,994 pound) reduction in paper. Approximately 40% reported using a toner cartridge refill program, resulting in about 0.9 tons (1,832 pounds) of waste reduction estimated by respondents. Approximately 10% of the respondents indicated they have implemented other waste reduction activities without specifying the particular activities. Respondents estimated other waste reduction activities result in a waste reduction of around 5 tons (10,006 pounds).

FIGURE 6. WASTE REDUCTION PRACTICES IMPLEMENTED



3.3 Summary Business Survey Findings

Overall findings of the business survey include the following:

- Businesses responding to the survey were predominantly office-based businesses (i.e., professional offices, medical offices).
- One or several traditional recyclable materials (cardboard, mixed paper, plastics, aluminum, and glass) are recycled by a majority of responding businesses.
- Electronics, plastic film, food and food containers, and expanded polystyrene are widely noted as materials that are challenging for businesses to recycle.
- Approximately 12% of businesses responding to the survey do not currently recycle common materials for which collection and processing services are widely available (i.e., cardboard, mixed paper, plastics #1 and #2, aluminum cans, glass containers,

mixed metals, and organic materials). Nearly half of these businesses stated they do not recycle because the service is not provided at their building or by their landlord. With full implementation of the URO, this barrier to recycling is expected to decline in future studies.

4.0 Field Observation Methodology and Findings

4.1 Field Observation Methodology

In addition to gathering information from a subset of Austin commercial properties through the business survey, a field observation study was performed at the generator level to assess the material set-outs by individual properties. Field observations were completed by locating trash and recycling containers that were readily accessible (i.e., not located inside of a building, not a compactor, and not located in a locked or otherwise secured enclosure) and "lifting the lid" for a visual assessment of contents. The lid-lifting task employed a rapid assessment of the generator's behaviors, providing qualitative, empirical information.

Utilizing the same database as used for the business survey, point locations of commercial and multifamily properties were mapped and aggregated into zones. The area within the Austin city limits was subdivided into 96 zones with an average of 110 properties per zone[9]. Due to aggregation methods using GIS software, zones contained approximately 80-150 properties each. Zones were then randomly selected for field observations in order to observe properties across the city[10].

Each team of observers was provided with a set of zone address lists and corresponding zone street maps. The maps included property point locations for spatial reference and identified the zone boundaries to be targeted during a given daily observation period. The zone maps were coded with the sequence that corresponded to the random selection. Reordering of the sequence in which zones were visited was not allowed.

A minimum of two teams of two field investigators each were deployed daily, with the goal of observing at least 50 containers per team per day within the designated zone. A total of 30 observation zones were targeted to be canvassed by the investigator teams over a 15-day period. A task-specific Health and Safety Plan (HASP) was prepared and discussed prior to initiating field activities. All investigators were required to review the plan and agree to its contents. Additionally, a daily safety analysis was performed by each crew prior to beginning daily observations.

A portion of the properties in each observation zone were assumed to not have containers visible or accessible for the Study. Based on the goal of 50 container observations per team per day, a total of at least 1,500 observations were expected by the completion of the Study. The actual number of observations completed daily was dependent on the accessibility of containers and the location and density of properties in each observation zone.

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[9] The number of locations eligible for observation was significantly less than the number of businesses from which the random selection was made for the business survey. This is because a single address (such as an office building with multiple suites) was assumed to have consolidated collection with a single grouping of containers serving all businesses located in the building. A total of 10,550 individual properties were identified and grouped for the field observations.

[10] Random selection of zones was made to ensure efficient use of field investigators' time and provide unbiased observation of various areas of the City. Zones observed were not analyzed to determine whether the business types present were proportional to the makeup of businesses in Austin.

At each business location visited where the trash and/or recycling containers were publicly accessible, observations were made and data was recorded for each individual container at the location. Data was entered into a web-based form using tablet computers with mobile internet access (a copy of the data observation form is provided in Appendix C). Data collected in the field observation included the following:

- Date of observation;
- Property address, including zip code, of individual business or business center with commercially serviced containers;
- Container type (e.g., trash, recyclables, or organics) and capacity;
- Approximate percent of capacity filled;
- For trash containers, whether or not a recycling container is co-located on-site;
- Whether containers are properly labeled (URO-compliant decals/labels or equivalent);
- Whether multiple businesses use the containers, or if they are dedicated to a single business;
- Whether the location employs multiple trash and/or recycling service vendors;
- Brief classification or description of visible materials in containers, identifying the two or three most predominant components;
- Whether or not there is any obvious contamination (i.e., recyclables in trash containers or trash in recyclable containers);
- Brief classification or description of contaminants in containers, identifying the most predominant components;
- Photographs of the outside and inside of each container observed.

Characterization of contents was based on visual inspection only; no sorting through, moving, opening of bags, or handling of any contents was performed. The detailed field observation protocol reviewed and approved by ARR is also contained in Appendix C.

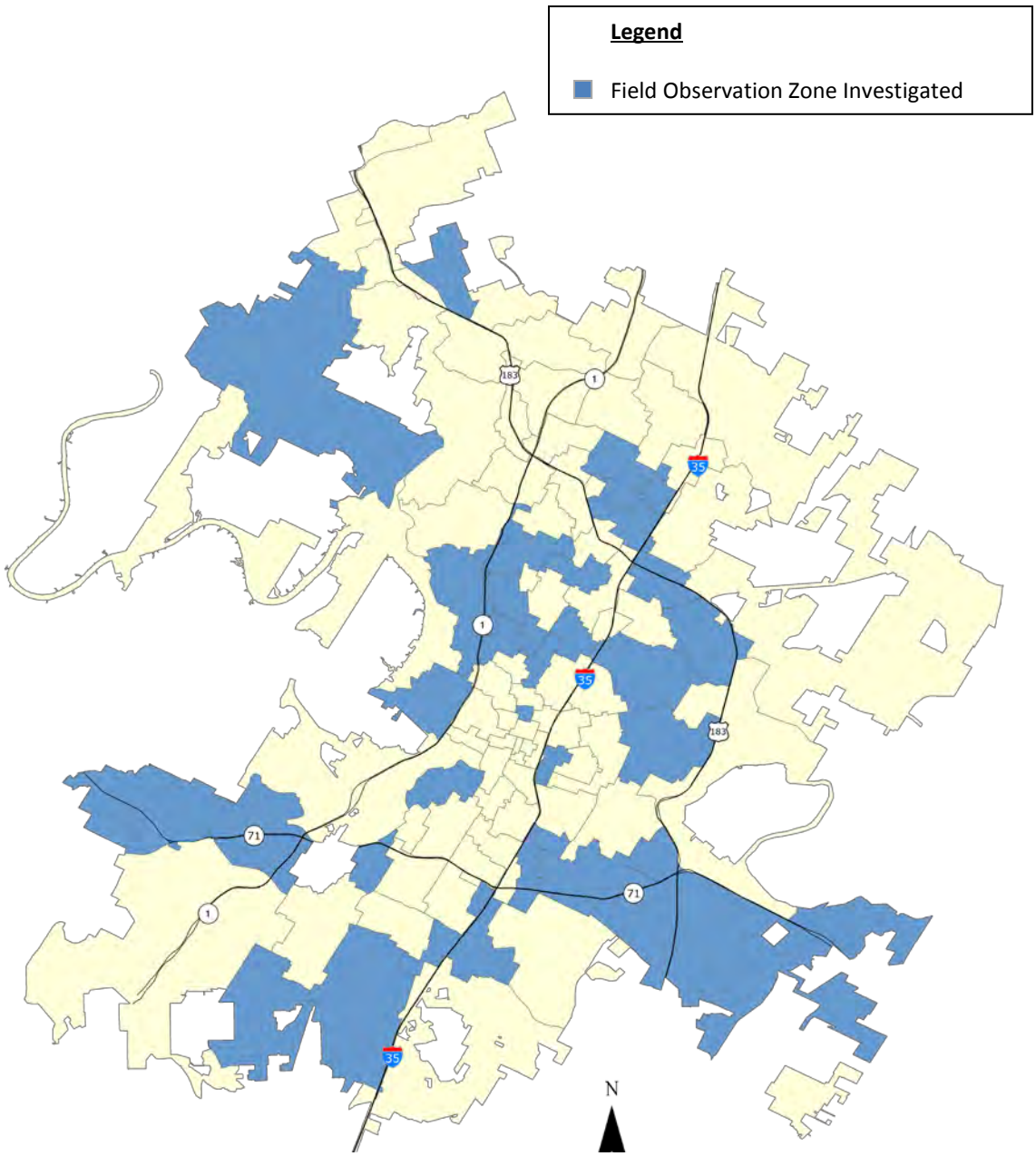
4.2 Field Observation Results

Field observations were conducted on 13 days between October 19 and November 6, 2015[11]. The data collection effort covered 29 randomly selected investigation zones, out of the total 96 zones identified within the city limits. A graphic depiction of the zones observed is shown in Figure 7.

Of the 29 zones included in the field observations, observation of accessible business and multifamily trash, recycling, and organic container locations was substantially completed for 27 zones[12]. Overall, this level of effort resulted in about 28% of the zones identified for this Study being observed, containing approximately 33% of the business and multifamily properties in the city.

[11] Two of the planned observation days were cancelled due to inclement weather.
[12] On the last day of data collection, 2 of the 29 sampling zones were only partially completed

FIGURE 7. FIELD OBSERVATION INVESTIGATION ZONES



Business types observed included: retail locations; industrial / manufacturing / warehouses; offices; religious / non-profits; medical facilities; hotel / motel; entertainment / bar / theater businesses; restaurant / grocery / food service; and apartments / condominiums / townhomes. Table 3 presents general characteristics of the containers observed. A photographic log is contained in Appendix D providing visual representation of a number of field observations.

TABLE 3. FIELD OBSERVATION CHARACTERISTICS

Characteristic	Number Observed	
Unique Business Addresses	979	
Sampling Zones	29	
Zip Codes within Sampling Zones	28	
Containers Observed (All Types)	2,255	
Types of Containers		
Container Type	**Number Observed**	**Percent of Total**
Trash	1,397	62.0%
Recycling	763	33.8%
Organics/Food Material	34	1.5%
Other/Indeterminable	61	2.7%
Total	2,255	100%

Observations were recorded at 979 locations out of an estimated 10,550 total unique addresses of commercial properties citywide. This represents approximately 10% of all commercial properties in the city. More than half of the properties visited during the field observation had publicly accessible containers. However, accessibility of containers was a factor affecting the proportion of Austin business properties represented in the field observations. Some businesses did not have publicly accessible trash and recycling containers, and kept the containers in secured enclosures or inaccessible areas of the property. This included some office, industrial, food service, and multifamily properties.

Physical observation data was collected for 2,255 containers. Many of the properties observed were strip centers or office buildings having several business tenants using one or more containers at a single address. On the other hand, large apartment complexes and other large establishments representing a single business and having several containers were also observed.

Field observations indicated the following:

1. **Individual or shared containers:** About 54 percent of containers observed were recorded as being used by a single business. More than 27 percent of all containers observed were determined to be shared by two or more businesses at the location. Container sharing was indeterminable for about 18 percent of containers observed. Given that more than one-quarter of all containers were determined to be used by multiple businesses, the field observation represents

data from a larger number of individual businesses than the 979 addresses recorded[13].

2. **Opportunity for recycling:** The field observations found that recycling containers were co-located with approximately 38% of trash containers observed (537 containers were co-located out of a total of 1,397 trash containers). It is important to note that the observation data is not expected to accurately represent the proportion of properties recycling, as recycling containers may be located in inaccessible areas at some businesses or recycling activities may be performed without the use of traditional recycling containers.

3. **Materials observed in recycling and trash containers:** The field observations provide information on the categories of materials observed in recycling and trash containers. Up to three predominant materials could be recorded for each container. Table 4 summarizes the percentage of trash and recycling containers noted to contain predominant quantities of each of the listed categories of materials. Percentages are calculated based on the number of containers that were not empty. Note that percentages will not sum to 100% because multiple materials were noted for many containers.

TABLE 4. PREDOMINANT MATERIALS OBSERVED IN RECYCLING AND TRASH CONTAINERS

Material Observed	Recycling Containers	Trash Containers
Cardboard	68.5%	51.7%
Mixed Paper	51.4%	22.4%
Hard Plastics	38.9%	18.1%
Metals	36.7%	5.9%
Glass	9.8%	2.1%
Unknown/Bagged	9.5%	61.9%
Trash	3.0%	26.7%
Plastic Films	9.8%	7.3%
Organics	1.8%	12.9%
Textiles	1.0%	3.3%
Other Materials	7.0%	17.3%

Notes:
1. Observations in this table are based on a total of 673 recycling containers and 1,228 trash containers. This table excludes 90 recycling containers and 169 trash containers that were empty.

[13] The actual number of businesses included in the field observations was not intended to be identified, given that materials are often managed on a property by property basis. This is consistent with the City's Universal Recycling Ordinance, which is also applicable to properties rather than individual businesses.

The three materials most predominantly observed in recycling containers were cardboard, mixed paper, and hard plastics. In trash containers, the three material categories most predominantly observed were unknown/bagged, cardboard, and trash.

4. **Observed recyclables in trash containers:** Recyclable materials currently accepted by commercial recycling facilities serving the city and observed within trash containers were logged as "contaminants". Nearly 70% (960 of 1,397) of trash containers contained visible recyclables commonly accepted at commercial recycling facilities. Of the trash containers containing recyclable materials, approximately 38% were co-located with recycling containers.

   The predominant recyclable materials observed in trash containers are summarized in Table 5. Cardboard, mixed paper, and hard plastics were the most frequently identified recyclables in trash containers at Austin businesses, consistent with the observation of these materials in greater frequency among all materials shown in Table 4 (including trash and bagged materials). These materials were also noted in Table 4 as the predominant materials present in recycling containers. This may be due to a combination of factors including an overall prevalence of these materials in the commercial waste stream[14] or the large size or dry nature of these materials resulting in them not being bagged before being placed in the trash container.

TABLE 5. PREDOMINANT RECYCLABLES OBSERVED IN TRASH CONTAINERS

Material Observed	Number of Containers	% of Containers
Cardboard	686	71.5%
Mixed Paper	341	35.5%
Hard Plastics	326	34.0%
Metals	129	13.4%
Glass	56	5.8%
Organics	45	4.7%
Plastic Film	37	3.9%
Textiles	16	1.7%
Other Materials	47	4.9%

5. **Contaminants (trash or unaccepted recyclable materials) observed in recycling containers:** Materials placed in the recycling container that are not recoverable by the single-stream recycling facilities serving the city were classified as contaminants. 32% (242 of 763) of recycling containers observed were found to contain visible contamination.

[14] Based on sorts of trash materials completed for this Study, cardboard, mixed paper, and rigid plastics constitute about 16% of disposed commercial material (see Section 5.0 and Appendix E).

The predominant contaminants observed in recycling containers are summarized in Table 6. Plastic films, trash, and organics were most frequently identified as contaminants in recycling containers. Of the containers with contamination noted, approximately 30% did not have a URO-compliant label. In addition, approximately 45% of containers with contamination were co-located with a trash container (i.e., located within 25 feet of a trash container), indicating that there was frequently convenient access to a trash container to properly manage observed contaminants[15].

TABLE 6. PREDOMINANT CONTAMINANTS OBSERVED IN RECYCLING CONTAINERS

Material Observed	Number of Containers	% of Containers
Plastic Films	94	38.8%
Trash	41	16.9%
Organics	39	16.1%
Unknown/Bagged	29	12.0%
Textiles	8	3.3%
Other Materials	107	44.2%

6. **Observations of organics containers:** A total of 34 containers for the collection of organic material were observed during the field observation. No contamination or material that would not be acceptable for composting was visible in any of the containers observed[16].

7. **Container characteristics:** A variety of trash, recycling, and organic container sizes and types were observed during the Study. The distribution of container capacities observed is given in Table 7. The most frequent sizes of trash containers observed were 6 and 8 cubic yard containers, representing more than 50% of total trash containers. By comparison, 96 gallon carts were the most frequent size of recycling container observed, representing nearly 43% of total recycling containers.

   Another aspect of containers that was assessed is whether they displayed labels or decals that were compliant with the URO labeling and signage requirements. Of the containers observed, 37.7% of the 1,397 trash containers had compliant

[15] The field observations also collected data on the relative quantity of material within each observed container. For those recycling containers co-located with a trash container, approximately 10% of the trash containers were observed to be full. This does not necessarily mean that trash materials were knowingly or intentionally placed in recycling containers due to the trash container being full, but it may indicate a need for assistance to businesses to adjust their trash and/or recycling capacity or service frequency.

[16] This is consistent with information provided by organics processing facilities during the limited sample observations performed, which indicated overall contamination of organics loads is relatively low (see Section 5.0).

labeling, 71.4% of the 763 recycling containers had compliant labeling, and 24% of the 34 organic containers had the URO-compliant decals meant to clearly identify container types.

TABLE 7. CONTAINER SIZES OBSERVED, BY MATERIAL TYPE

Capacity	Number of Containers	Percent of Containers
Trash Containers		
8 Cubic Yards	623	28.0%
6 Cubic Yards	495	22.2%
96 Gallons	423	19.0%
4 Cubic Yards	403	18.1%
2 Cubic Yards	76	3.4%
3 Cubic Yards	71	3.2%
10 Cubic Yards	57	2.6%
40 Cubic Yards	21	0.9%
64 Gallons	12	0.5%
30 Cubic Yards	11	0.5%
34 Cubic Yards	11	0.5%
Recycling Containers		
96 Gallons	346	42.9%
8 Cubic Yards	160	19.8%
6 Cubic Yards	121	15.0%
4 Cubic Yards	63	7.8%
10 Cubic Yards	16	2.0%
2 Cubic Yards	15	1.9%
3 Cubic Yards	13	1.6%
64 Gallons	7	0.9%
Organics Containers		
96 Gallons	11	26.8%
6 Cubic Yards	7	17.1%
32 Gallons	5	12.2%
2 Cubic Yards	4	9.8%
55 Gallons	4	9.8%
50 Gallons	2	4.9%
45 Gallons	1	2.4%

4.3 Summary Field Observation Findings

Overall findings of the field observations include the following:

- Approximately 70% of trash containers observed contained visible recyclables. Predominant recyclables in trash containers were cardboard, mixed paper, and hard plastics. Each of these materials are accepted at local recycling facilities serving the Austin area, indicating an opportunity to further educate businesses and multifamily residents about materials accepted at recycling facilities.

- Additionally, more than 50% of trash containers observed contained cardboard as a predominant material in the container. This made cardboard the second-most prevalent material observed in business trash containers (behind unknown/bagged items), highlighting the importance of continuing to explore ways to better facilitate cardboard recycling, reuse, or reduction at Austin businesses and focus on diverting this resource from landfills.

- Nearly one-third of recycling containers were observed to contain contamination. Plastic films, organics, and trash were the most predominant contaminants. This supports the need for ongoing education about materials that are and are not recyclable in existing programs and facilities and the impact of contamination on the quality and value of the recycling stream.

- No contamination was visible in the organics containers observed. Because few businesses are separately managing organics, this may indicate a greater effort by generators to properly prepare materials and by haulers and processing facilities to educate generators about the material types accepted.

- The majority of trash containers observed (approximately 55%) had a capacity of 6 cubic yards or more. By comparison, only 37% of recycling containers had a capacity of 6 cubic yards or more, and the most common recycling container size observed was a 96-gallon cart. This indicates a lesser capacity in individual containers for recycling than trash. In addition, the observed prevalence of cardboard and hard plastics in trash containers and common use of smaller recycling containers may indicate a need for greater recycling capacity to facilitate recycling of larger materials.

5.0 Limited Sample Sorting Methodology and Findings

5.1 Limited Sample Sorting Methodology

This Study also included limited sorting or observation of trash, recyclables, and organics loads to assess their composition. Composition data assists in identifying what materials are being recovered now, the proportion of materials remaining in the waste stream that could be recovered through existing programs, and what materials in the waste stream are not currently recoverable under existing programs. An additional objective of the limited sorts was to provide a high-level observation of disposal habits of the business community.

Because a small number of samples were sorted in the Study, the quantitative data gathered from the sorting effort is not statistically significant and primarily provides qualitative information (with some quantitative basis). Austin may use this information to identify the potential for increased material recovery and to understand the types and prevalence of contamination present in the recycling and composting streams. Sorting of a larger number of samples may provide additional data to support policy or program changes, particularly for less prevalent components of the waste stream which may not be accurately characterized in the limited sorting completed for this Study.

The principal facilities that manage the targeted material streams include landfills (for disposed trash), material recovery facilities (MRFs) (for recycled materials), and composting facilities (for organic materials). Therefore, samples were selected and characterized from incoming loads delivered to each type of facility.

Facilities known to handle large quantities of material generated in Austin were identified for participation. This enabled samples to be selected from loads that were collected largely within the Austin city limits. Working with ARR to secure facility participation, a number of issues had to be addressed, including:

- Space requirements: Adequate available space located in a safe area was needed at each facility;
- Site operation impacts: Facilities were requested to assist in identifying loads for sampling, providing a dedicated sorting area, and providing equipment and staff to assist in procuring samples. Sensitivity to daily operating responsibilities was important to minimize the impact on the participating facilities;
- Use of the data obtained: Facilities questioned how the data would be reported and how it would be used in the future. The sampling protocol also needed to consider these questions to determine whether meaningful information would be obtained to provide the basis for future policy decisions.

Of the facilities contacted to participate in the Study, only one facility declined to participate[17].

[17] CB&I and ARR secured participation of the following facilities for this portion of the Study: Texas Disposal Systems Landfill; Waste Management Austin Community Landfill; Republic Services Sunset Farms Landfill; Texas Disposal Systems MRF; Balcones Resources Recycling Facility; Wilco Recycling; Texas Disposal Systems Compost Facility; Organics by Gosh.

Upon securing facility participation, each facility agreed to a preferred date and time, specific location within the facility, and sampling protocol. Agreeing upon a date and time for sampling proved challenging because not all site owners are responsible for collection and delivery of the materials they handle and most facilities receive material collected by third-party customers in addition to their own company. Therefore, participating facilities were limited in their ability to confirm specific times for delivery of loads intended for sampling. In addition, based on how collection routes are defined by haulers, it was not possible to sample only loads collected entirely within the city limits[18]. For purposes of this Study, it was decided that partial collection from outside the city limits would not bias the sample results, because commercial behaviors and load compositions are not expected to be notably different between properties within and outside of Austin.

Trash and Recycling Streams

To assess the composition of the disposed trash and recycling streams, a sorting protocol was developed. The protocol included the method used to procure a 200-300 pound sample from each selected load and to sort the materials of each sample into the desired material categories. The sampling and sorting methodology was consistent with the method outlined in ASTM Standard D 5231-92: Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste. The methodology deviated from the ASTM Standard in the number of samples to be sorted, due to project budget constraints. As a result, the number of samples sorted was too low to be statistically valid[19].

The sampling protocol prepared by CB&I is briefly summarized below. The detailed sampling protocol, expanded definitions of the material categories, and visual examples of each material are provided in Appendix E. Additionally, a task-specific Health and Safety Plan (HASP) was prepared, read and agreed to by all personnel involved with the sorting activities. Daily safety meetings were held to emphasize the requirements of the HASP and to discuss any new items that may have come up during previous activities.

Random loads of trash and recyclables delivered to participating facilities were identified in consultation with the facility. CB&I and ARR coordinated with facility personnel to direct route drivers to the sample unloading area.

[18] Collection routes are typically established based on customer location and transportation routes, not municipal boundaries. As a result, collection routes will often cross municipal boundaries, and this was confirmed to be the case in Austin through discussion with the haulers and facilities.

[19] To be statistically valid, a minimum of 40 samples would be required to be sorted from each material stream.

After the driver emptied the load, a sample of the material weighing 200 to 300 pounds was selected. Samples were obtained from a random area of the load, and the location of the sample selection from the pile varied by sample. Facility staff assisted in the sample collection using onsite equipment to extract the desired material and transport it to the sorting area. The sample was placed on a tarp for sorting by CB&I and ARR personnel and photographed (see Figure 8).

FIGURE 8. LANDFILL SAMPLE TO BE SORTED

Table 8 identifies the material classes and categories into which materials were sorted. Materials in Table 8 are grouped into larger material classes for ease of presentation. Refer to Appendix E for definitions and examples of the categories used during landfill and material recovery facility sorts.

TABLE 8. MATERIAL STREAM COMPONENTS

Material Class	Material Category	
Paper	Mixed paper	Corrugated cardboard
Plastics	Polyethylene terephthalate (PET) (#1)	Rigid / durable plastics (#3/#5)
	High density polyethylene (HDPE) (#2)	Other plastics (#7)
	Low density polyethylene (LDPE) (#4)	
Metals	Ferrous metal	Other metals
	Aluminum	
Glass	Glass bottles and jars	
Compostable Materials	Yard trimmings	Wood
	Food waste	Other organics / combustibles
	Soiled, waxed, or food-contaminated paper	
Reusable / Recoverable Materials	Electronics	Thin plastic bags
	Household hazardous waste	Thick / durable plastic bags
	Textiles	Plastic film
	Carpet	Cartons
	Furniture	Pallets
	Polystyrene / expanded polystyrene (#6)	Tires
	Construction and demolition (C&D) material	
Hard to Sort / Landfill Materials	Other glass / ceramics	Residuals
	Unfixable furniture	

Rigid, non-absorbent containers (e.g., laundry baskets and 5-gallon buckets) were used to hold the sorted items for each category. When containers were full, and when sorting was complete, the container and its contents were weighed, the container weight subtracted, and the sample material weight recorded (see Figure 9).

FIGURE 9. WEIGHING SAMPLES

Any material remaining at the conclusion of sorting into the material categories identified was considered a residual. Residual material generally consisted of diapers, chip bags, candy wrappers, multi-layered pouches, items of unknown material makeup, small pieces of broken glass or plastic, scraps of paper, and dirt and grit. These materials either do not currently have diversion outlets available or would be recyclable if segregated by the generator or present in a large enough size to be recovered by recycling facility sorting equipment (such as small pieces of glass and plastic).

A minimum of five loads were planned to be sampled from each facility, yielding 15 samples from each material stream (trash and source-separated recycling) and a total of 30 samples across all facilities. The actual number of samples collected and sorted was dependent on the availability of material delivered to each facility, the size of the collected sample, and the number of sorters.

Organics Stream

The Study was originally intended to sort sample loads delivered to organics processing facilities in the same manner as the trash and recyclables loads. Early in the Study, the project team visited one of the composting facilities to observe its operations and discuss

the sorting protocol with the operator. Based on the team's observations of the material and information gathered from the site operator, CB&I and ARR agreed that a visual characterization of the delivered organics and the process used to prepare materials for composting would provide the desired information for this Study.

The organics stream is predominantly composed of materials from two sources: landscape maintenance (including grass clippings, tree and bush trimmings, and other brush materials) and food waste (including food production facilities, grocery stores, restaurants, and post-consumer sources). The visual characterization therefore sought to identify contaminants present in the organics waste stream delivered to organics processing facilities.

Loads selected for observation were identified in cooperation with the site operators. The project team sought to observe loads that included source-separated food wastes or mixed organic wastes (i.e., food waste mixed with landscape materials); loads containing exclusively landscape wastes were not targeted in the Study. Two incoming loads at each participating facility were observed. Due to the infrequent delivery of mixed organics and food waste loads delivered to the facilities, fewer load observations were performed compared to the trash and recyclables sampling.

The observation team inspected the sample loads to identify the materials present in the load (including both organics appropriately included and contaminants within the loads). The team also spoke with site representatives to gather additional information on the source of the load, its contents, and how it compared to other incoming loads that were received at the facility. Material processing operations were observed at each facility to understand material inspection, sorting, screening, size reduction, and composting processes. Finally, finished compost was observed to identify any potential contaminants remaining.

5.2 Landfill Results

Five samples were sorted from each of the landfills. Sample sizes at Facility A ranged from 182 to 601 pounds; Facility B ranged from 193 to 506 pounds; and Facility C ranged from 151 to 443 pounds. Overall the average sample size was 328 pounds, slightly greater than the study objective.

Appendix F contains a full summary of materials by sample and material category. Figure 10 provides a high-level depiction of the landfilled material, grouped by the material classes identified in Table 8 and Appendix E.

As shown in Figure 10:

- Compostable materials represented the largest fraction of the samples at the landfills at an average of 37%.

- Recyclables were the next largest category, representing approximately 26% of the trash stream, with paper (including cardboard and other mixed papers) constituting the largest portion of this category.

- Reusable / recoverable materials represented 18% of the trash stream. These materials included items that can be recovered outside the current single stream

system (e.g., plastic films) as well as materials that could be reused (e.g., electronics, textiles, furniture).

- Hard to sort / landfill materials represented 19% of the trash stream. These materials include items of unknown composition and materials where the only management option in the current system is landfilling (e.g., diapers, chip bags, candy wrappers). These materials also include wastes that were too small to be reasonably segregated during the sorting process or were part of a wet mass that consisted of mixed amounts of food waste, dirt and other fine particles, and liquids, constituting a residual fraction after all other materials had been sorted..

FIGURE 10. AVERAGE COMPOSITION OF PRIVATELY-COLLECTED TRASH STREAM, BY MATERIAL CLASS

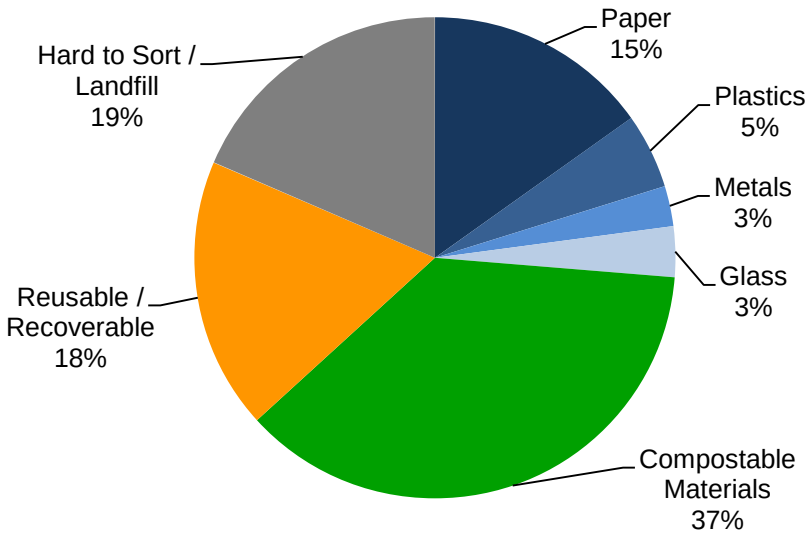


Figure 11 provides a more detailed summary of landfill composition based on material categories (note that, for presentation and discussion purposes, some categories have been combined). The following observations are made at the category level:

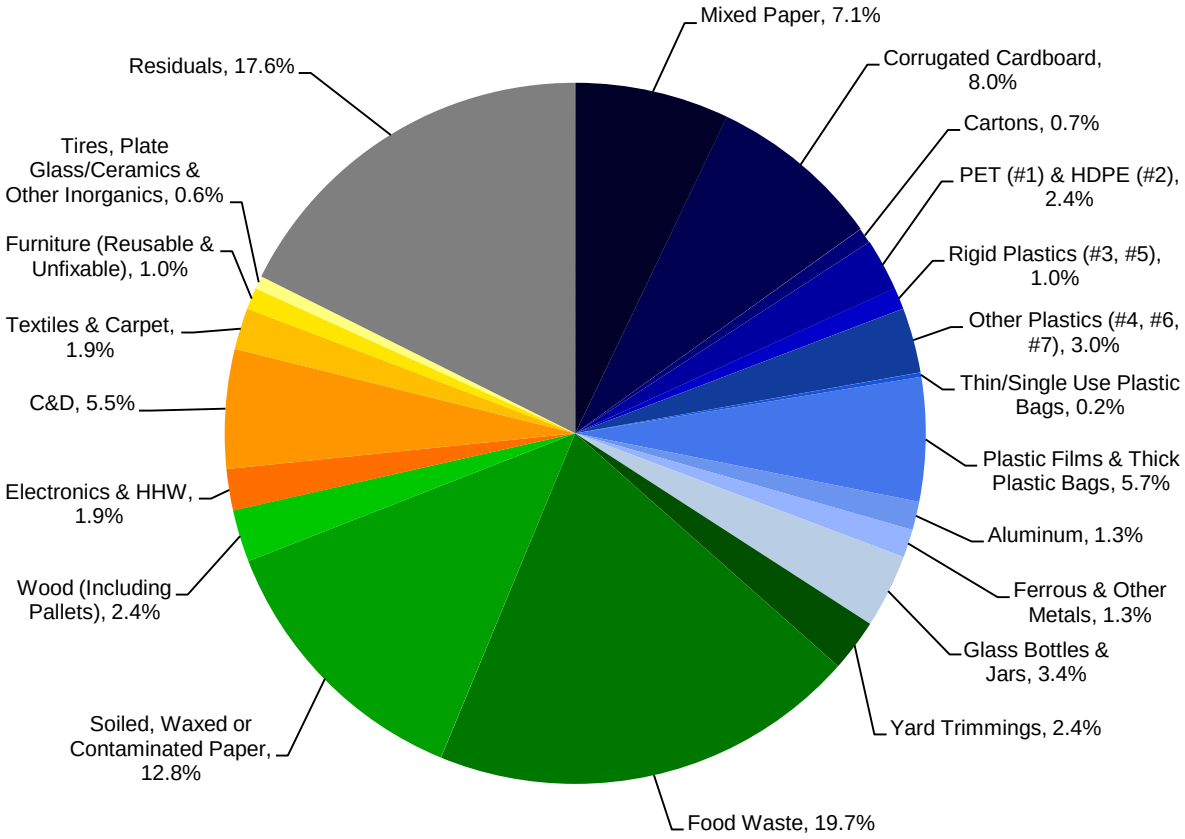
- Food waste represents nearly 20% of the disposed trash stream. Food waste could have been composted if segregated at the time of generation.

- Residuals (the hard to sort fraction of the hard to sort / landfill class) represent nearly 18% of the disposed trash stream. The sorting teams observed that the residual category contained a large proportion of materials that could have been managed by recycling and composting practices if segregated by generators prior to disposal (e.g., broken glass, small pieces of plastic, and organics). The residual material also contained a small amount of dirt inadvertently picked up by site equipment in samples that were taken from the bottom of the pile.

- Soiled, waxed, or contaminated paper represents nearly 14% of the disposed trash stream. Soiled and contaminated paper included items such as cardboard boxes,

napkins, and paper plates contaminated with food waste, either prior to being disposed as trash (in the case of a pizza box, for example) or once mixed with the disposed trash stream (in the case of a shipping box that could have been recycled but was contaminated by food and liquids after being placed in the trash). These items could be composted if segregated from the disposed trash stream.

FIGURE 11. AVERAGE COMPOSITION OF PRIVATELY-COLLECTED TRASH STREAM, BY MATERIAL CATEGORY



Though there were not enough samples sorted for the results to be statistically significant, the samples in the limited sorts included a large proportion of recyclable and organic materials that are currently accepted by MRFs or composting facilities. This indicates that there are additional opportunities to educate businesses about diversion opportunities available in Austin.

A review of estimated waste composition data from U.S. EPA[20] indicates that the predominant materials in the city's disposed commercial waste stream are also the predominant materials contained in the national disposed waste stream. Based on the most recent data published by U.S. EPA, nationally, paper comprises 15% of the disposed waste stream while compostable materials constitute 37% of the disposed waste stream.

[20] U.S.EPA, Advancing Sustainable Materials Management: Facts and Figures 2013, June 2015.

Comparisons are not readily made for other material categories (e.g., plastics, metals, and glass) included in this Study because of differences in the types of materials characterized and the methodology employed between this Study and the U.S. EPA data.

5.3 Material Recovery Facility Results

The goal of collecting five samples from each MRF was also achieved, with 6 samples collected at Facility A, 10 at Facility B, and 6 at Facility C. Sample sizes at Facility A ranged from 190 to 437 pounds; Facility B ranged from 73 to 108 pounds; and Facility C ranged from 105 to 231 pounds. Overall the average sample size was 170 pounds, slightly less than the objective; this was largely impacted by the method of sample selection at Facility B, due to space constraints[21].

Appendix E contains a full summary of material sort results by sample and material category. As in the landfill sorts, materials were sorted into the categories identified previously in Table 8 and defined in Appendix E. Materials that were too small to be separated by type were weighed and classified as residual when each sample was sorted. Items comprising the residual fraction varied, but typically included broken glass and small pieces of plastic[22] (a visual example is provided in Appendix E). While glass bottles or larger plastic containers may have initially been placed in the recycling stream by generators, it is known that a certain amount of breakage occurs during the collection and handling process prior to recyclables being sorted at the MRF. Therefore, the MRF is challenged to recover all recyclable materials due to size reduction below the threshold for which MRF equipment is designed to capture materials.

Figure 12 provides a high-level depiction of the composition of material delivered to MRFs grouped by the material classes identified in Table 8 and Appendix E. As shown in Figure 12:

- Paper (including both cardboard and other mixed paper) represented the largest fraction of the samples at the MRFs at an average of 69%. As shown in the detailed data in Appendix F, cardboard alone constituted 50% of the sorted MRF material by weight.

- In total, approximately 83% of materials sorted at the MRFs included commodity recyclables (paper, plastics, metal, glass).

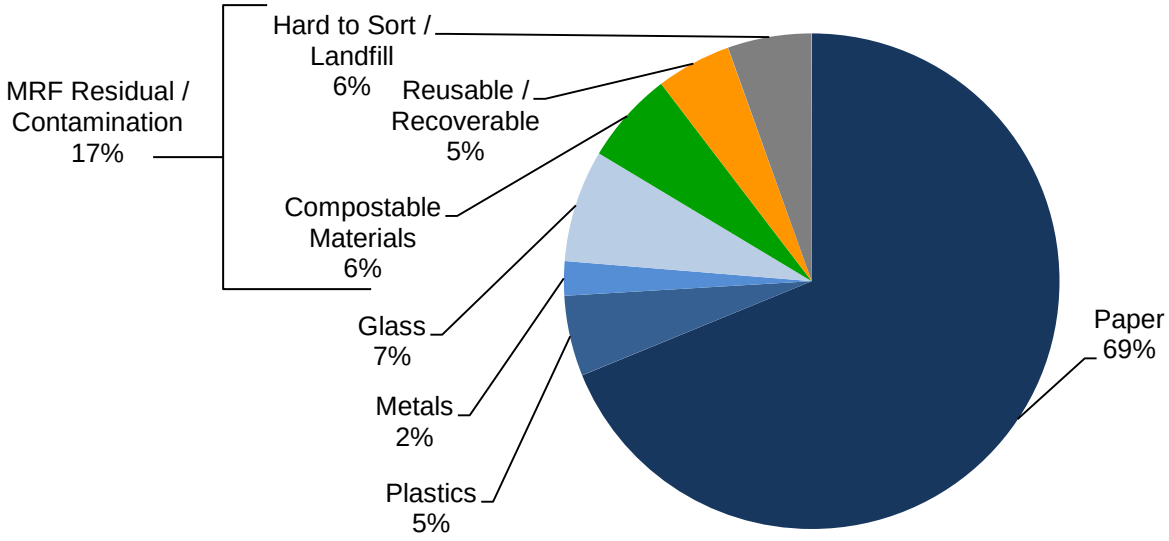
- The remaining 17% of materials included compostable materials, reusable/recoverable materials, and residuals which are not expected to be recovered at a MRF. These materials are considered residue or contamination by the MRFs and are managed as trash. MRF contaminants that are recoverable, reusable, or compostable (estimated to be 11% of the material sent to Austin MRFs), could be diverted through other outlets if properly segregated by generators.

[21] If MRF samples are sorted in future studies, CB&I recommends reviewing the sample selection protocol to ensure the target sample size of 200-300 pounds is achieved to be consistent with the ASTM Standard for waste characterization.

[22] Other components of the residual fraction included bottle caps, broken pieces of expanded polystyrene, and food wastes. Expanded polystyrene and food wastes are typically considered contaminants at recycling facilities.

This would reduce the residual rate at the MRF and potentially increase the total diversion of materials. It is important to note that additional materials may also be considered a residual by the processors. Due to market conditions, limits to what the facility agrees to accept, recovery capability of the MRF equipment, and other factors, the actual amount of material potentially disposed after being accepted by the MRFs may be higher than observed in the material sorts performed.

FIGURE 12. AVERAGE COMPOSITION OF PRIVATELY-COLLECTED RECYCLABLES, BY MATERIAL CLASS



5.4 Organics Facility Results

Material delivery and processing operations were observed at two organics processing facilities serving Austin generators. Two incoming loads were observed at each facility. The number of loads observed was reduced compared to the loads sampled and sorted from landfills and MRFs due to the lower volume of material and infrequent deliveries at the organics facilities.

The facilities accept various feedstocks; the type of feedstocks that each facility can accept is based, in part, on the authorization received from TCEQ[23]. For purposes of this Study, loads observed included either primarily food waste materials (e.g., from grocery stores or restaurants) or mixed organics (e.g., from mixed sources and including food wastes, contaminated paper, yard trimmings, and brush).

[23] The TCEQ authorization includes identification of acceptable feedstocks, processing requirements, end product requirements, and testing to verify that pathogen reduction has been achieved.

Figure 13 shows the material contained in a load received from mixed sources.

FIGURE 13. COMPOST FEEDSTOCK FROM MIXED SOURCES

Though the steps involved in organics processing vary somewhat by facility, they typically include: removal of contaminants through semi-automated and manual screening; grinding and shredding to reduce particle size; mixing carbon-heavy feedstocks (woody material) with nitrogen-heavy feedstocks (food and green waste); anaerobic (static pile) or aerobic (windrow) processing; and fine grinding, bagging, and/or preparation of finished compost for end use markets. The organics processing facilities produce various compost products, soil blends, and mulch based on feedstock availability and market demand.

In general, contamination was observed to be low at the organics facilities. Facility operators and information gathered during the Study's field observation portion indicate this may be due to generators' efforts to reduce contamination levels at the source. Their effort is encouraged by the facility operators because the impact of contamination on finished compost is significant, and intensive effort is needed to remove contaminants either before or after composting.

Figure 14 shows the material remaining after initial screening of an incoming load. While a significant portion of this material ultimately is compostable, further separation is performed manually.

FIGURE 14. OVER-SIZE MATERIALS AFTER FIRST SCREENING OF MIXED COMPOST FEEDSTOCK

Contaminants are largely composed of plastic film and bags, plastic bottles, expanded polystyrene plates and food containers, broken glass, non-compostable material (e.g., chip bags), other hard plastics (broken items), rubber items, vinyl gloves, and other miscellaneous items. Biodegradable and compostable bags contaminate the compostable waste stream in the same way as regular plastic bags because they do not degrade as quickly in the composting process as other organics. Bags generally are removed as a contaminant during pre-processing due to the difficulty in determining whether a bag is biodegradable / compostable or not. Loads from residential sources also may contain clothing and shoes. Glass was noted by the facility operators as one of the most problematic contaminants, due to the difficulty in removing it from the organic material as well as the safety concerns it raises. Further, residential loads were noted by facility operators as being more challenging to process due to the higher rate of contamination compared to commercial loads.

Figure 15 depicts typical contamination present in incoming commercial loads.

FIGURE 15. ORGANIC FEEDSTOCK CONTAMINANTS

With further processing, a relatively small amount of residual contamination remains visible in the final product (see Figures 16 and 17).

FIGURE 16. FOOD WASTE INCORPORATED WITH WOODY MATERIAL

FIGURE 17. FINISHED COMPOST WINDROW

5.5 Summary Limited Sample Sorting Findings

Overall findings of the limited sample sorting include the following:

- Compostable materials represented more than one-third of trash sorted at participating landfills. Food waste and contaminated, waxed, or soiled paper were the predominant compostable materials observed, with lesser quantities of yard trimmings and woody wastes present.

- On average, more than 60% of the trash stream consists of materials that are currently recyclable (paper, metals, plastic, glass) or compostable by existing infrastructure serving the city. Only 19% of the trash stream was classified as hard-to-recycle or residual materials, indicating significant potential future growth in diversion through existing programs.

- Of the loads sampled, cardboard and mixed paper represent the vast majority (69%) of the materials collected for recycling from Austin businesses. The second-largest macro-segment included items that are not meant for MRF recovery, such as compostable, reusable, or very small materials, representing approximately 17% of materials in the MRF samples analyzed. These materials are generally not recoverable by MRF equipment and are managed as contaminants or residue in the recycling process and disposed as trash. ARR-collected curbside recyclables have approximately 16-18% residue/contamination based on data reported to ARR by the MRFs and included in the City-Serviced Residential Characterization Study, consistent with the commercial findings in this Study.

- Organics processing facilities utilize intensive, manual sorting processes to reduce contamination, because contamination significantly impacts the quality of the

finished compost. Principal contaminants of concern at organics processing facilities include plastic film and glass. Additionally, residentially collected organics typically are more contaminated than commercially collected organics. As organics collection increases, consideration should be given to methods that minimize contamination to ensure the effectiveness of the composting process and the quality of the finished compost.

6.0 Calculation of Austin's 2015 Diversion and Disposal Rates

The overall objective of the Study is to calculate Austin's 2015 citywide diversion rate, providing comprehensive data from both the residential sector (principally served by ARR) and the commercial sector (served by private haulers and self-hauling of materials). In addition to these primary sectors, the Study also sought to include the impact of waste reduction and reuse practices, which represent activities of both the residential and commercial sector.

To perform this calculation, data collected through the existing hauler licensing program, Annual Diversion Plans, and various contractual services was supplemented with additional information gathered in this Study:

- Recycling and reuse quantities estimated by randomly-selected businesses participating in the business survey (Section 3.0);
- Waste reduction quantities estimated by randomly-selected businesses participating in the business survey (Section 3.0);
- Data collected by ARR from reuse organizations and large generators; and
- MRF contamination rates observed through limited sorting of samples of commercial loads of recyclable materials (Section 5.0).

This section provides further discussion and detailed calculation of the citywide diversion and disposal rates.

6.1 Diversion Rate Calculation

The current citywide diversion rate is calculated by dividing the amount of all materials diverted by the amount of all waste and materials generated:

$$\text{Diversion Rate (\%)} = \frac{\text{Tons Recycled + Tons Composted + Tons Reused + Tons Reduced}}{\text{Tons Diverted + Tons Disposed}}$$

To calculate the components of the diversion rate, data from a number of sources was reviewed and compiled. Careful consideration was given to each of the data sources to ensure that activities and materials were not double-counted.

In general, data from July 2014 through June 2015 was used to estimate the 2015 diversion rate, as this was the most recent data available. In some instances, calendar year data from 2014 was used as an estimate of 2015 quantities, again because it was the most recent data available.

Principal data sources used to estimate the 2015 diversion rate included:

- **ARR-Collected Materials.** ARR tonnage data from its self-serviced operations, including: residential trash collection, litter control, street cleaning, bulk material trash and recycling/reuse, household hazardous waste disposed and recycled/reused, Resource Recovery Center recycling, tires, and residential organics including yard trimmings, brush, and the residential organics pilot.

- **City Departments / Contracts.** City departments' self-serviced trash and recycling operations.

- **Licensed Hauler Reports.** Self-reported tonnage data from licensed haulers, including trash, recycling, and composting quantities. Through discussion with ARR, it was determined that certain types of haulers (construction and demolition debris haulers and landscape waste haulers specifically) are not fully represented in the licensed hauler report. Licensed hauler tonnages were adjusted upward to account for this under-representation. For C&D haulers, ARR estimates that about 90% of haulers managing only C&D are licensed and reporting and about 10% of companies managing exclusively landscape waste are licensed and reporting. Quantities for these sectors were increased by half of the estimated missing proportion. Trash and recycling quantities reported by exclusive C&D haulers were increased by 5%, and recycling and composting quantities reported by exclusive landscape waste haulers were increased by 45%.

  Limited sample sorting at area MRFs identified that approximately 17% of incoming material is comprised of materials that are not recoverable by the MRFs and are considered residue or contamination, as discussed in Section 5.3. The quantity of recycling reported through the licensed hauler reports reflects tons of material collected for recycling, prior to processing at a MRF. Because MRF residue is generally sent to landfills, reported recycling tonnages[24] were reduced by 17% to reflect the residue after recyclables are processed at the MRF. In addition, one-third of this 17% residue was added to landfill disposal tonnages based on ARR discussion with MRF operators and haulers to determine whether post-processing residue is reported as landfill tonnage in the licensed hauler reports.

- **Other Direct Contacts.** Tonnage data from other direct contacts made by ARR staff. ARR contacted large generators to quantify any of their material managed outside of the licensed hauler system. ARR also contacted reuse businesses to gather data on reuse quantities which are not currently formally collected and tracked by the City.

- **Annual Diversion Plan Reports.** Recycling and reduction quantities reported in Annual Diversion Plans submitted by businesses subject to the Universal Recycling Ordinance[25]. Approximately 2,400 properties in the city were subject to the URO through September 2015, including multifamily properties with 25 units or more and commercial properties greater than 50,000 square feet. ARR estimates that these affected properties represent approximately 9% of commercial properties and 53% of total multifamily properties in the city. No upward adjustment to diversion quantities contained in the Annual Diversion Plans was made because implementation of the URO is occurring in a phased approach, and it is not

[24] Only recycling tonnage reported by haulers known to collect single-stream recyclables was reduced to address MRF residue. Other haulers reporting recycling tonnage are predominantly roll-off hauling businesses serving the construction industry; the 17% residue rate was not applied to those haulers.

[25] Five businesses directly contacted by ARR for this Study also submitted Annual Diversion Plans. Their ADP data was therefore excluded from the calculations in Table 9 to avoid double-counting.

expected that diversion reported through the URO by large commercial and multifamily properties is representative of all properties.

- **Business Survey.** Reuse, non-traditional recycling, and reduction quantities extrapolated from data reported by businesses responding to the business survey conducted for this Study. Based on a total of 37,555 businesses in the city and excluding the 2,477 businesses submitting Annual Diversion Plans under the URO, the average reuse (350.61 pounds), non-blue bin recycling (3,087 pounds), and reduction (190.6 pounds) quantities reported through the survey was applied to 50% of the businesses in the city to estimate additional reuse, recycling, and reduction tonnages. In future updates to this Study, the need to perform this extrapolation should be reevaluated because the URO will be fully implemented and there may be significant risk of double-counting[26].

- **Reduction and Prevention.** Estimates of waste prevention / reduction quantities resulting from organics management activities including backyard composting of food scraps, grass-cycling, and mulching and wood-chipping.

    - Backyard composting quantities (assumed to include only food wastes[27]) were estimated based on the number of households completing the City's backyard composting rebate program from October 2011-June 2015. A survey of a small number of rebate program participants in 2013 found an average of 5.4 pounds of organics were diverted per household each week (equating to approximately 280 pounds per year). An additional evaluation comparing the City's residential curbside organics collection pilot quantities to the traditional curbside yard trimmings collection program results in an estimated average diversion of 220 pounds of food wastes annually per household. Applying this average to the 2,564 households that completed the backyard composting rebate program provides the reduction estimate for backyard composting in Table 9.
    - Grass-cycling[28] quantities were estimated based on ARR's collection of approximately 37,700 tons per year of yard trimmings from 193,000 households receiving yard trimmings collection. Assuming this tonnage represents collection from 75% of the city's households, this results in an average per household setout of 520 pounds per year. For the remaining 25% of households, grass-cycling quantities in Table 9 are estimated by applying the per household rate of 520 pounds per year.

[26] Reporting on reuse, non-traditional recycling, and reduction quantities is optional for properties subject to the URO, and as such these activities may not be reported by all properties. In addition, the URO is applied to properties, while the business survey was distributed to individual businesses, resulting in challenges to cross-reference the two possible data sources and avoid double-counting of diversion quantities.

[27] Backyard composting typically requires blending of yard waste materials such as leaves or dried grass with food waste. The quantities estimated for backyard composting reflect only the food waste component; yard waste reductions are reflected in estimates of grass-cycling and wood chipping/mulching quantities.

[28] Grass-cycling refers to the practice of leaving grass clippings on the lawn rather than collecting them for set-out with trash or yard trimmings.

- Wood chipping and mulching quantities were estimated assuming an additional 5% of materials managed by landscapers for recycling / composting are chipped or mulched.

Table 9 summarizes the available data by management method and source. Based on this data, the 2015 citywide diversion rate is estimated to be 42.0%.

TABLE 9. 2015 CITYWIDE DIVERSION RATE CALCULATION

Management Method	Quantity (tons)	Percent of Total
Disposal		
ARR-Collected Materials	144,907	7.4%
City Departments / Contracts	11,794	0.6%
Licensed Hauler Reports	957,704	49.2%
Other Direct Contacts	2,270	0.1%
Residue from ARR-Collected MRF Materials	4,555	0.2%
Residue from Recycling Collected by Licensed Haulers	7,605	0.4%
Recycling, Composting, and Reuse		
ARR-Collected Materials (Excluding MRF Residue)	84,150	4.3%
City Departments / Contracts	45,055	2.3%
Licensed Hauler Reports (Excluding MRF Residue)	425,341	21.8%
Other Direct Contacts	58,560	3.0%
Annual Diversion Plan Reports	159,144	8.2%
Business Survey (extrapolated)	30,219	1.6%
Reduction and Prevention		
Annual Diversion Plan Reports	556	<0.1%
Business Survey (extrapolated)	1,676	<0.1%
Backyard Composting	282	<0.1%
Grass-cycling	12,545	0.6%
Mulching / wood chipping	730	<0.1%
Summary		
Total Generation	**1,947,092**	**100%**
Disposal Subtotal	**1,128,835**	**58.0%**
Diversion Subtotal	**818,258**	**42.0%**
2015 Citywide Diversion Rate	**42.0%**	

By comparison, the ARR-serviced residential sector was estimated to achieve a diversion rate of 38% in the City-Serviced Residential Waste Characterization Study completed in March 2015. The estimate for residential diversion in that study was reflective of ARR

collection quantities only. It did not include estimates of reuse and reduction, which are challenging to apportion separately to the residential and commercial sectors.

Based on the estimated diversion of ARR-collected materials from the 2015 residential study and the broader estimate of citywide diversion developed in this Study, Austin's residential and commercial sectors appear to be achieving similar rates of diversion.

6.2 Disposal Rate Calculation

Based on the data presented in Table 9, a per capita generation rate can be calculated. Given the generation of 1,947,092 tons per year and a 2014 Census estimated population of 912,791, Austin's 2015 generation rate is estimated to be 11.7 pounds per capita per day. Considering the quantity of material disposed (1,128,835 tons) and diverted (818,258 tons), Austin had a 2015 disposal rate of 6.8 pounds per capita per day and a diversion rate of 4.9 pounds per capita per day.

On a statewide basis, TCEQ calculates a disposal rate of 6.58 pounds per capita per day based on 2014 disposal data. The Capital Area Council of Governments (CAPCOG) region, which includes Austin, had a FY2014 disposal rate of 5.7 pounds per capita per day, based on total tonnage landfilled in the region[29]. Austin is an urban community, and it is not unusual for large urban areas to exhibit higher rates of disposal than surrounding rural areas.

Looking at disposal by hauler type, the data in Table 9 indicates a disposal rate of 0.9 pounds per capita per day for trash collected by ARR and 5.9 pounds per capita per day for trash collected by licensed haulers and managed through self-haul. Though other reports have estimated that ARR provides collection of approximately 25% of material generated citywide, this breakdown in disposal rates indicates that ARR serves a smaller portion of the city, collecting approximately 13% of the trash disposed citywide.

Finally, the data in Table 9 can be used to calculate a Household Disposal Rate, which is the weight disposed by residents receiving ARR collection service (i.e., in single-family homes and multi-family properties up to 4 units) divided by the number of households serviced by ARR. The data indicates a household disposal rate of 4.3 pounds per household per day. Disposal rate results are summarized in Table 10.

[29] As reported to TCEQ, the CAPCOG landfills received 2,104,062 tons of trash for disposal. The CAPCOG region had a 2014 Census estimated population of 2,060,139. The calculation of the CAPCOG disposal rate does not include consideration of trash imports into CAPCOG landfills or exports of trash from CAPCOG counties to landfills outside the region; future studies could include additional scope to further evaluate Austin's disposal and diversion metrics compared to other local/regional data or data from communities with similar Zero Waste goals nationally.

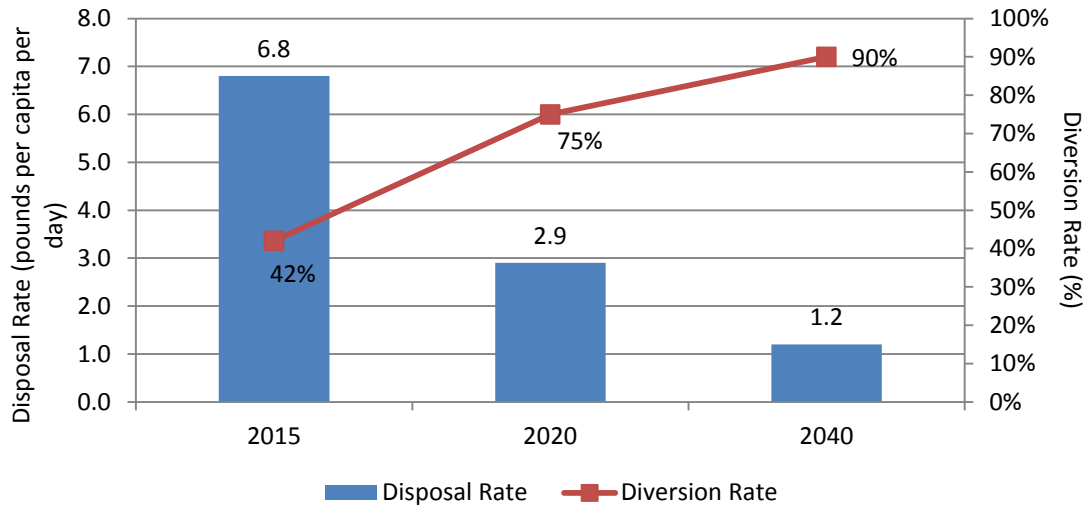
TABLE 10. SUMMARY DISPOSAL RATES					
Disposal Rate	**Disposal (tons)**	**Affected Population**		**Disposal Rate**	
		Group	**Value**	**(tons/year)**	**(pounds/day)**
Citywide	1,128,835	Citywide	912,791	1.24	6.8
Commercial Fraction	979,373	Citywide	912,791	1.07	5.9
ARR-Hauled Fraction	149,462	Citywide	912,791	0.16	0.9
Household	149,462	ARR-served households	191,462	0.78	4.3

Sources:
1. Population: 2014 Census Bureau estimate.
2. Households: ARR, average number of trash collection customers served by ARR, FY2015.

Notes:
1. "Commercial Fraction" includes disposal reported through the licensed hauler reports, self-hauled tonnages from City departments and other direct contact with large generators, and residue from recycling collected by licensed haulers.
2. "ARR-Hauled Fraction" includes trash collected by ARR as well as residue from recycling collected by ARR.

Assuming the 2015 disposal rate of 6.8 pounds per capita per day serves as the baseline for measuring Austin's future waste diversion progress, Austin's disposal rate will need to be reduced to 2.9 pounds per capita per day to meet the 2020 diversion goal of 75% and to 1.2 pounds per capita per day to meet the 2040 diversion goal of 90% (refer to Figure 18 for a graphical depiction of 2015 calculated rates and projected 2020 and 2040 rates based on current generation and diversion goals).

FIGURE 18. TARGETED FUTURE DISPOSAL RATES



6.3 Data Limitations

The data relied upon for this Study is comprehensive and represents the best available information upon which to base the calculation of the 2015 citywide diversion rate. There are, however, certain limitations to the interpretation and use of the data gathered. Where appropriate, recommendations to address the data limitations are provided.

1. **Business Survey Responses Reflect A Small Percentage Of The City.** The business survey provided insights into the commercial waste reduction and diversion practices implemented in the city. While the survey response rate of 2.8% is consistent with response rates of similarly distributed surveys, it is possible that the responses are not representative of the broader business community because: 1) returned surveys were not equally proportional to the makeup of businesses citywide; and 2) it is possible that there is bias in the survey responses, with businesses responding to the survey being more engaged in sustainability practices and feeling more comfortable sharing information with the City. To be conservative, the average per-business non-blue bin recycling, reuse, and reduction quantities estimated were applied to only half of the businesses in the city that were not subject to the URO as of September 2015. To address this limitation in future studies, it is recommended that a scientific survey of a sampling of businesses citywide be performed. A scientific survey ensures responses are secured proportional to the distribution of business types in the city and minimizes response bias (refer to Recommendation 1 in Section 7.0).

2. **Field Observations Limited To Visible Material.** Data obtained from the field observations only provides information on the size of the containers and the materials that could be visibly observed. For a variety of reasons, observers did not sort or pick through the containers. Therefore, field data does not provide a complete understanding of trash and recycling characteristics at the generator level. No information was obtained on the frequency or timing of container collection, so no conclusions can be drawn about material quantities from the field observations. In addition, because only visible materials in the containers were observed, the field observations cannot be used to identify contaminants in the recycling stream or recyclables in the trash stream that are bagged. This data limitation does not require addressing in future studies; however, to the extent that further information is desired to be obtained through field observations of containers, the City may consider modifying the methodology to collect additional data, expanding the information gathered through this Study component. Additional data may include the timing and frequency of collection, or opening bags to identify materials contained.

3. **Sample Sorting Not Statistically Valid.** The limited sample sorting conducted did not include enough samples to be statistically valid and therefore cannot be considered representative of trash and recycling composition citywide. It also did not provide observations to determine the impact of seasonal changes. Therefore, the composition data collected in this Study should not be relied upon as the sole basis for significant policy or program decisions. Additionally, the sorting crews noted that the method of procuring samples from the overall loads of deposited material may have had an impact on the composition of both trash and recycling samples sorted. Samples selected from the bottom of the pile were observed to

have a larger percentage of fines or residuals, especially from the landfill loads. This may have resulted from settling of smaller materials towards the bottom of the pile and the possibility of small amounts of surface dirt being collected from the unloading area along with the sample.

Two samples are of particular note for their composition:

- Sample 1 at Landfill A was reported to be composed of a greater proportion of materials in the "residuals" category, due in part to the inexperience of the Study's sorting personnel at the commencement of the sample sorting. Later samples showed an overall decrease in the amount of material placed in that category.

- Sample 4 at MRF A was not a unique sample. It was procured from the combined mix of non-sampled materials from the loads that provided Samples 1-3 at MRF A. This allowed sorting personnel to make the most use of their time until an additional load was available. If a statistical calculation was to be made on the data, this sample would have been excluded because it was not a unique sample. In addition, this sample was obtained from the bottom of the combined pile and showed a greater prevalence of materials that are typically smaller in size (glass, plastic, metal). This again supports the observation that the location of the sample within the overall load may impact the composition of materials present. For this reason, it is important to select samples from varying locations within the load and only select a single sample from each load.

Recommendation 4 in Section 7.0 provides possible alternatives to address this data limitation.

4. **Self-Reported Data Has Not Been Verified.** Many of the data sources utilized in the Study are self-reported and have not been independently verified by ARR or CB&I. Study findings and the calculated diversion rate therefore assume data reported by others is accurate. Chief among these include data in the licensed hauler reports, reuse and recycling quantities obtained by ARR from direct contact with certain businesses, and data contained in the Annual Diversion Plans.

   As a check on the disposal data compiled for Austin in this Study, Austin's calculated disposal rate was compared to the disposal rate calculated for the CAPCOG region and the State of Texas. The CAPCOG and statewide disposal rates were less than Austin's disposal rate by 3% to 19%. While it is not unusual for large urban areas to exhibit higher rates of disposal than surrounding rural areas, consistent with the observation herein, it is also possible that trash quantities are being overstated in reports to the City. Further discussion with the licensed haulers to understand the method by which they track and compile the data they report to the City would assist in confirming the accuracy of the data. In addition, outreach to the facilities providing disposal and diversion service to Austin generators as described in Recommendation 8 in Section 7.0 may assist in addressing this limitation.

5. **Data Was Not Obtained From All Self-Hauled Businesses and Reuse Operations.** ARR attempted to collect data from large generators known to provide

their own disposal or diversion services (self-haul), because these tonnages are not captured in the licensed hauler reports or other data collection methods in place. However, a few large generators (e.g., the State Capitol complex) were not able to be captured, and therefore quantities from this sector are likely understated in both the diversion and disposal categories. ARR also attempted to collect data from reuse businesses but obtained only limited data due to constraints imposed by the project schedule and staff availability as well as data-tracking practices of the businesses (e.g., some reuse businesses do not track weights or quantities of materials collected or distributed for reuse).

Further, the Annual Diversion Plans available at the time of the Study provide data for only approximately 20% of commercial properties in the city. Of those, only a portion provide information on recycling and reuse quantities because these components of the plans are optional. Additional reuse and recycling activities being performed by commercial properties may be handled through self-hauled or broker-hauled arrangements (not a licensed waste or recycling hauler), and therefore data on these quantities may be incomplete. Furthermore, because Annual Diversion Plans are required to be submitted only by those businesses subject to the URO, and URO implementation is being phased in, the data cannot be extrapolated to other properties. However, the URO will be fully implemented when this Study is next performed in 2020, providing greater information for future analysis.

To assist in addressing this data limitation, implementation of formal data collection methods to gather tonnage information from reuse and related businesses (refer to Recommendation 9 in Section 7.0) is recommended. In addition, development of a database of self-hauled businesses will facilitate outreach and data collection with these generators prior to the preparation of the 5-year update to this Study.

6. **Study Data Did Not Separately Quantify Materials from the Three Categories of Generators Contemplated by the City Auditor's Office in the 2013 Zero Waste Audit Report.** The 2013 Zero Waste Audit Report recommended this Study include data representing three distinct categories of generation: single-family residential (i.e., ARR-collected households), commercial and industrial (including multifamily), and institutional (including government, education and religious institutions). The Study includes data for all of these categories. However, commercial and industrial materials and institutional materials are not separately quantified and reported, because licensed haulers do not separately collect and manage these materials (e.g., a commercial collection route can include both commercial businesses and institutional facilities). If the City desires to quantify and assess the commercial and industrial stream separate from the institutional stream in the future, additional data will be required to be gathered from haulers and generators.

6.4 Summary of Findings

Austin's 2015 Community Diversion Study provides a baseline understanding of current diversion performance in Austin. The Study includes both quantitative observations used to calculate diversion and disposal rates and qualitative observations obtained from business surveys, container observations, and limited sample sorting of waste and recycling streams.

The data collection components of the Study were designed to obtain information and make observations that individually and collectively lead to a more comprehensive understanding of waste and diversion practices in Austin. The individual components of the Study identified a number of findings, as noted in discussion of each Study component previously. On a collective basis, several of these findings were reinforced and observed through multiple data collection methods:

- Commercial properties in Austin widely recycle traditional commodity recyclables such as cardboard, mixed paper, plastics, aluminum, and glass. This observation was noted in responses to the business survey, in field observations of recycling containers, and in the sorting of recyclables. More than two-thirds of recyclables collected from commercial properties were found to be cardboard and mixed paper, indicating these materials represent a proportionally greater share of the overall materials generated by businesses than other commodities.

- Commercial properties also continue to dispose of large quantities of traditional commodity recyclables. The largest component of recyclable materials in the disposed waste stream (in addition to the recycling stream) appears to be paper and cardboard. This was noted both in field observations of trash containers and in the sorting of landfill trash. There continues to be opportunity for businesses to increase their diversion of materials that are readily accepted for recycling in the city.

- Food wastes are noted by commercial properties as being challenging to divert, and they also represent a large component (approximately 20%) of the disposed waste stream. Organics were also noted as a principal contaminant in recycling containers during field observations. For those properties that are diverting food wastes and other organics, field observations of containers and of incoming material at area composting facilities indicated that the segregated organics stream contains little contamination compared to the recycling stream. As commercial properties increase their efforts to divert food wastes, significant effort by generators and education by haulers collecting organics will be required to properly segregate and manage organics for collection.

- Plastic film (excluding plastic bags) is also noted to be challenging to recycle and was observed as a principal contaminant in recycling containers. Landfill samples indicated that plastic film comprised nearly 6% of the disposed waste stream, indicating there is both opportunity for and interest in diversion of additional material to the extent that collection options and markets are available for plastic film.

- Not all commercial properties are currently provided recycling service, and for those properties that are served it appears that less capacity is provided for recycling than for trash. This may represent a physical and logistical barrier to achieving high diversion performance. This was noted through the business survey and during the field observation of containers. Continued implementation of the URO is expected to reduce some of these barriers, but continued efforts by private haulers and the City to increase recycling capacity and service levels may be needed to achieve greater diversion performance.

On a quantitative basis, recycling represents the predominant diversion method utilized in the city in 2015, as shown in Table 11. Together, composting and recycling account for the vast majority (more than 90%) of total diversion estimated in Austin. Reuse and reduction practices divert approximately 3.3% of total generation citywide. As has been noted, data collection methods are not established to formally track reuse activity citywide, and quantifying reduction impacts is challenging. While these factors may result in an underestimation of reuse and reduction quantities contributing to the overall diversion rate, it is clear that significant additional activity in the reuse and reduction sectors would need to be documented to make a significant impact on the diversion rate.

TABLE 11. CITY OF AUSTIN WASTE MANAGEMENT METHODS, 2015

Management Method	Quantity (tons)	Percent of Total
Landfill	1,128,835	58.0%
Recycling	574,578	29.5%
Composting	178,289	9.2%
Reuse	49,602	2.5%
Reduction	15,789	0.8%
Total Generation	**1,947,092**	**100%**
2015 Citywide Diversion Rate	**42.0%**	

7.0 Recommendations

Based on the experience gained through the completion of Austin's 2015 Community Diversion Study, the following recommendations for Study scope and approach are made to facilitate future diversion rate studies:

1. Conduct a scientific survey of a representative, random sample of businesses citywide. A scientific survey can be completed either by phone or by mail and would include more intensive follow-up to secure additional responses representative of all business sectors in the city.

2. Modify the survey questionnaire to focus on assessment of business waste reduction and diversion behaviors and attitudes. Because the first five-year update to this Study will be prepared after the phase-in of the URO is complete, there may not be a need to request recycling, reuse, or reduction quantity data from businesses through the survey.

3. Modify the field observation data collection form to include identification of the type of property being observed in order to provide greater ability to evaluate observations for subsets of commercial properties in the city.

4. Expand the sample sorting effort to be a statistically valid sampling. Procuring and sorting 40 or more samples at each of the facilities included in the Study will provide greater confidence in the composition data collected. If this is precluded by the project budget, focusing the sorting effort to landfill trash only is recommended, in order to gain greater insight into materials remaining within the disposed waste stream.

5. Allow additional time to coordinate with private facilities for sorting and observations. To facilitate discussions with site representatives, a project fact sheet and proposed sampling protocol should be developed prior to contacting facilities to address anticipated questions.

6. Reduce the targeted number of field observations of accessible containers to 500 randomly selected business locations. The field observations provide valuable qualitative information about individual set-outs of trash and recyclables but contribute little quantitative data in relation to the time and effort expended.

7. Include observations of construction and demolition debris operations in the Study. This is recommended to include both C&D processing facilities (providing recycling of a portion or all of the C&D materials they manage) and C&D disposal facilities.

8. Interview the facilities serving Austin to understand their operations and the proportion of their materials managed that they estimate are generated in the city. For disposal facilities, seek estimation of the proportion of incoming material received from Austin as a check on the licensed hauler tonnage data reported to the City. For diversion facilities, discuss the level of contamination of incoming material and the disposition of any contamination (e.g., landfill, other recyclers, etc.).

9. Implement a routine data collection protocol for reduced, reused, and repurposed material quantities, securing data annually from known businesses providing these services in the city.

10. Complete the collection of all tonnage data to be provided by ARR prior to the commencement of the Study.

11. Give greater consideration to analyzing the disposal rate as part of the Study. The disposal rate is a second measure of progress that is reasonably considered alongside the diversion rate and, in comparison, is more directly quantified and reliable. As a result, analyzing the disposal rate could allow for more frequent calculation, possibly on an annual basis, to more closely track Austin's progress towards Zero Waste.

12. Compare the diversion rate and disposal rate calculated for the City of Austin to peer cities with Zero Waste or high diversion goals (e.g., Seattle, San Jose) and to other cities within Texas. This was not an element identified for inclusion in this initial baseline study, which focused on data collection and analysis specific to Austin. It may be desirable for a community comparison to be completed based on the 2015 data contained in this Study to assist ARR and the City to further report on its diversion performance and identify opportunities for growth. Comparison of rates between communities will require review of the materials included in each community's data (e.g., some communities may exclude construction and demolition debris) to ascertain comparability with Austin. In addition, the data review should consider analysis of tonnage data rather than reported percentages to provide greater certainty that appropriate comparisons are made.

APPENDIX A

DEFINITIONS

Austin's 2015 Community Diversion Study - Appendix A, Definitions

5-Year Diversion Rate Study - The study recommended by the ARR Master Plan to periodically measure and report on the progress towards Austin's Zero Waste goal.

ARR Master Plan - The Austin Resource Recovery Master Plan (Master Plan) projects future activities and services provided by Austin Resource Recovery for the next 30 years. The Master Plan looks at the Department in its entirety, laying a framework for how the Department provides services to its customers and empowers the Austin community to achieve Zero Waste.

Baseline Study - The initial diversion rate study completed for year 2015 to comprehensively assess generation and diversion in Austin; the Baseline Study is comprised of the City-Serviced Residential Waste Characterization Study and the citywide 2015 Community Diversion Study.

Commercial – Austin Resource Recovery defines the Commercial sector as all businesses or residences that do not fall under the definition of "Residential." In Austin, Commercial properties have their trash and recycling provided by Private Haulers. Commercial properties include multifamily dwellings.

Composition Study (or, **Waste Composition Study**) - A process to identify the components that make up a particular material stream (e.g., waste or recycling), determined by the sorting of a sample quantity into desired material categories.

Disposal Rate - A measure of the quantity of materials managed through disposal methods; typically expressed as a unit rate (e.g., pounds per person per day), the disposal rate is calculated as: (total annual tons disposed x 2,000 pounds per ton) divided by (population) divided by (365 days per year).

Diversion Rate - A measure of the quantity of materials managed through reduction, reuse, recycling, composting, and/or other management methods that are considered diversion and are not classified as disposal; typically expressed as a percentage, the diversion rate is calculated as: (total tons diverted) divided by (total tons diverted + total tons disposed).

Generation Rate - A measure of the quantity of materials generated and requiring management through reduction, reuse, recycling, composting, disposal, and/or other discard management methods; typically expressed as a unit rate (e.g., pounds per person per day), the generation rate is calculated as: (total annual tons generated x 2,000 pounds per ton) divided by (population) divided by (365 days per year).

Landfill - A location at which the placement of waste occurs in or on designated land according to sanitary, environmental protection, and other safety requirements.

Licensed Hauler Tonnage – Landfill, recycling, and organics stream tonnage reported by entities with a Private Hauler License, per City of Austin Ordinance.

Material Recovery Facility (or, **MRF**) - A facility at which recoverable recyclable materials are sorted by material type and prepared for transport to recycling markets.

Multifamily – Any property with 5 or more units, where residents stay 30 days or more

Austin's 2015 Community Diversion Study - Appendix A, Definitions

Participation Rate - Percentage of units (e.g., businesses) participating in identified programs (e.g., recycling collection).

Per Capita - A quantity expressed as the average per a given population or per person, using population data from a point in time that is representative of the period for which the data is relevant (i.e., for 2014 data, a Census estimate for 2014 may be used); generation and disposal rates are typically expressed on an average pounds per capita per day basis.

Private Hauler (aka **Third-Party Hauler** or **Private Service Provider**) - A company or person that collects, removes, or transports waste, recycling, and /or organic/compost for a fee

Recycle- The series of activities by which materials that are no longer useful to the generator are collected, sorted, processed, and converted into raw materials and used in the production of new products. (ARR Master Plan)

Recycling Rate - A measure of the quantity of materials managed through recycling and composting methods (excluding materials managed through reduction and reuse methods) compared to the total quantity of materials generated; typically expressed as a percentage, the recycling rate is calculated as: (total annual tons recycled + total annual tons composted) divided by (total tons diverted + total tons disposed).

Reduce- To make something smaller or use less, resulting in a smaller amount of waste (NIEHS website). The first "R" in the famous, "Reduce, Reuse, Recycle" mantra.

Repair - Fix, mend, or restore an item to a good or sound condition for its continued use.

Repurpose- To adapt for use in a different purpose. Example: Cutting the top off an old 2-liter soda bottle and repurposing the bottle into a flower pot.

Residential – Austin Resource Recovery defines the Residential sector as 1-4 family homes. This type of residence is serviced by ARR collection for both trash and recycling. All customers are provided with a 96 gallon recycling cart and a trash cart size selected by the customer based on their needs. Containers are variably priced depending on size, with the smallest carts available at the lowest cost.

Reuse- Using a discarded item for the same or similar function while preserving the embodied energy of its original form (ARR Master Plan). Reuse keeps new resources from being used awhile longer, and old resources from entering the waste stream (NRDC blog).

Self-Haul- When a business or entity provides their own waste, recycling, or organics/compost hauling service and does not contract a third-party private hauler for this service.

URO- The Universal Recycling Ordinance requires affected properties to ensure that tenants and employees have access to convenient recycling. During this study period, all commercial properties over 25,000 square feet and multifamily properties with more than 10 dwelling units were affected by the URO, effective October 1, 2015.

Waste to Energy - A combustion processing technology that burns waste and generates electricity

APPENDIX B

BUSINESS SURVEY

The City of Austin's Zero Waste goal means a 90 percent reduction of materials sent to landfills and incinerators by 2040. To measure progress towards Zero Waste, the City is conducting a citywide Diversion Rate Study. Please help us reach Austin's Zero Waste goal by completing the following survey. It should take less than ten minutes once you have your business's trash and recycling information, and your responses will contribute to a cleaner, more efficiently run city for everyone.

Responses can be mailed via the form below, or **online at** www.surveymonkey.com/r/AustinBizDiversion2015 by **Sept. 25, 2015**. If your company has recycling data compiled, please feel free to send information in lieu of the survey to CommercialRecycling@austintexas.gov with "Diversion Rate Survey" as the subject.

Why is the Diversion Rate Study important to Austin businesses?
Zero Waste initiatives can help businesses reduce production costs, right-size landfill trash services and transform discarded materials into valuable products. With your input, the Diversion Rate Study will help measure material flows including recycling and reuse activities in Austin. This information will assist the City in developing future incentives, programs and policies that support Austin businesses.

Why is the Diversion Rate Study important to the City?
The City has established milestones for Zero Waste including a goal of 50 percent diversion of material sent to the landfill by 2015. This Study will measure Austin's progress towards Zero Waste and capture recycling challenges encountered by the business community. The City's goal is to create common-sense policies, identify economic development opportunities, and create rebates that support Austin's investment in recycling.

We appreciate your time to complete the survey. Please call City of Austin staff at 512-974-9727 if you have any questions or suggestions.

Para participar en la encuesta en español, visite www.surveymonkey.com/r/AustinBizDiversion2015spanish

a) Which category best describes the type of business you represent?

1. Multifamily /Apartment Complex
2. Professional Office
3. Retail/Mall
4. Industrial/Manufacturing/Warehouse
5. Non-Profit Organization (non-government, charity, religious, social club, etc.)
6. Government
7. Medical Facility/Hospital/Medical Office
8. Hotel/Motel
9. Entertainment/Bar/Theater
10. Restaurant/Grocery/Food Service
11. Educational Institution
12. Other:_____

---

b) What materials do you recycle? (Choose all that apply)

1. Cardboard
2. Mixed paper
3. Plastics #1 and #2
4. Aluminum Cans
5. Glass Containers
6. Mixed Metals
7. Organic (Compostable) Materials
8. None

---

c) What process improvements to reduce waste have you implemented?

1. Double sided printing: _____ pounds per year avoided
2. Toner cartridge refill programs: _____ pounds per year avoided
3. Reusable packaging (i.e. crates instead of cardboard boxes)
4. Vendor take-back
5. Repurpose for alternative use
6. Other: _____

---

d) Approximately how much material does your property generate annually for:

1. Trash: _____ pounds per year
2. Recycling: _____ pounds per year
3. Compost: _____ pounds per year
4. ReUse/Donate/Resell: _____pounds per year

If you do not track trash and recycling by weight, please use the table below to indicate the service volume at your business. The size and frequency of service can often be found on your hauler's invoices. If you completed "section d" with weights, please move to "section e".

Type of Container	**Number**	**Volume**	**Unit** (Cu. Yards or Gallons)	**Service Frequency**	**Unit** (Per Week, Mo, Yr)	**Compactor?** (Yes or No)
Dumpster						
Carts						
Roll-off						
Other						

---

e) What are the three (3) most challenging materials for your business to recycle? If you have estimated quantities, please enter them in "Table 1" on the last page.

- ☐ Carpet
- ☐ Construction waste
- ☐ Electronics
- ☐ Expanded Polystyrene/Styrofoam
- ☐ Food (All types)
- ☐ Food containers and packaging
- ☐ Furniture
- ☐ Inventory Surplus
- ☐ Mattresses
- ☐ Non-bottle glass or ceramics
- ☐ Pallets
- ☐ Plastic film (shrink wrap, plastic bags and sheeting)
- ☐ Textiles or clothes
- ☐ Tires
- ☐ Treated Wood, Lumber
- ☐ Other_____

---

f) If you don't currently recycle, why not? (Choose all that apply)

1. Not enough space
2. Service too expensive
3. Requires too much employee effort
4. Not a priority
5. Other reasons, please specify:_____
   _____

---

g) To avoid duplicate responses from the same business entity, please provide the following information (this will not be published, and your responses will remain confidential):

Business Name: _____

Location Address: _____

Thank You for Your Participation! Please use the included postage paid envelope to mail paper surveys to Austin Resource Recovery:

Mailing Address:
City of Austin
Attn: ARR Business Outreach Team
P.O. Box 1088
Austin, TX 78767

Fax Number:
(512) 974-1999, Attention: Business Outreach Team

Email Address:
CommercialRecycling@austintexas.gov

***Please* estimate the AMOUNTS of difficult to recycle items on the next page! → → →**

Table 1: Difficult to Recycle Items

In the table below, please estimate the amounts of materials your organization generates annually in discards, reuse, and recycling. For items not applicable to your business, please enter "0".

	Discards Generated	**Reuse, Donate, Resell, Repurpose**	**Recycle**
	(lbs. per year)	(lbs. per year)	(lbs. per year)
Appliances (Washer/Dryer, Refrigerator, microwaves, etc.)			
Batteries			
Carpet			
Cleaning Chemicals, Pesticides, Acids/Bases			
Construction Materials (Concrete, lumber, asphalt, etc.)			
Electronics (PC's, printers, copiers, cell phones, etc.)			
Food (All types - Spent grain, kitchen scraps, unused food, etc.)**			
Furniture			
Inventory surplus or products near expiration			
Landscaping materials (brush, grass, leaves, etc.)**			
Mattresses			
Metals and Car Parts			
Oils, Automotive Fluids, Lubricants			
Packaging including Styrofoam			
Paints			
Pallets			
Paper Shredding/Document Destruction			
Plastic film (shrink wrap, pallet wrap, plastic bags and sheeting)			
Textiles			
Tires			
Other (Please Specify here _____)			
Other (Please Specify here _____)			
Other (Please Specify here _____)			

**** If COMPOSTED, please list amount under "Recycle". If DONATED, place under "Reuse, Donate".**

APPENDIX C

FIELD OBSERVATION PROTOCOL AND DATA COLLECTION FORM

City of Austin
City-Wide Diversion Rate Study
Material Observation Protocol

INTRODUCTION

In order to gain further insight into the disposal practices of Austin businesses, a qualitative review will be performed of material placed in waste, recyclable and organics containers at commercial facilities. This will consist of a field observation study at the generator level to assess the composition of materials set out at individual properties. This procedure is estimated to take place over a three-week period or 15 working days. Two teams will be deployed with two people per team. The goal is to observe a minimum of 50 locations per team per day or 1,500 observations during this portion of the study.

SAFETY

Equipment needed:

- PPE – gloves, hard hats, steel-toed boots, safety vest, safety googles, long sleeve shirt
- Insect Spray
- Charged cell phone (communication device)
- Camera
- Tablet and/or paper forms
- Letter from City
- City Badges
- Step stool or selfie stick for taller containers
- Backup batteries and/or charging device for camera and tablet
- Zone maps with boundaries and expected business point locations
- Water

Stay hydrated, even though the weather will be cooling off, it will still be warm and a lot of walking will be involved.

LOGISTICS

Business point locations will be mapped and zones will be identified which contain 80-150 businesses each. Zones will then be randomly selected by CB&I for field observation. Each team will be given a set of individual zone maps identifying the boundaries of the zones they are to

target during the observation period. The zone maps will be provided in the sequence that corresponds to the random selection; reordering of the zones will not be allowed.

Depending on the accessibility of containers for observation, each team may complete one zone or multiple zones on a given day. The object will be to observe as many accessible containers as possible for each day. Teams will canvass an entire zone before moving to the next zone.

Upon the start of work each day, each team will park in a convenient location for access to the properties in the first zone. Zones covering a larger geographic area may be best served by periodically relocating the vehicle. It is important to watch for traffic at all times and to maintain contact with your team members. The team will proceed to the first observation point and input the property address and GPS coordinates on the tablet. Note the physical location of the container(s).

If the containers are publicly accessible, observe the number and type of containers and the size of each and input in the tablet (or on paper forms as appropriate). Be on the lookout for the possible presence of guard dogs/animals/rodents that may be nearby, as well as materials that may be protruding from or piled around containers. If possible, note whether multiple businesses use the containers or if they are dedicated to a single location.

OBSERVATIONS

Carefully approach the container(s) and look inside. If the containers are closed, carefully open the side door or top lid (using gloves) and observe the approximate amount of material in each container (i.e. percent full), and the top two major visible components. If visible, also note if there is material in the container that does not belong there (i.e. trash in the recyclables container or recyclables in the waste container). Do not attempt to reach inside the container(s) to see what is underneath the top layer or within bags. If the containers are locked, move on to the next location. When opening and closing containers, watch for pinch points and insects and/or vermin (or homeless that could be taking shelter there).

The team will take one photograph of the outside and one photograph of the contents of each container observed. Picture numbers must be recorded on the tablet or form provided. Return all container doors/lids to the original position.

If the containers at an initial location are not publicly accessible, proceed to the next location available. For every property that is observed to be a business by either its point location on the zone map or by visual characteristics in the field, attempt to perform an observation.

If the property owner or occupant asks questions, show them the letter from the City and be prepared to move on to the next location. Always be courteous, explaining the purpose of the study.

Download data at the end of the day or beginning of the next day to prevent data loss.

Lid-Lifting Observation Form

Date *
12/15/2015

Investigators Last Name, and First Initial (Example: Nelson, W.) *

Address (Street Number, Name, and Suite) *

Zip Code

GPS Coordinates 1

GPS Coordinates 2

NAICS Code
if known

Photo 1 - Front of container *
Choose File No file chosen

Photo 2 - Inside of container *
Choose File No file chosen

Is the container shared with multiple tenants?
- Select -

Are multiple trash/recycling vendors on site? *
- Select -

Container Observation Description Table

Size *

Units *
- Select -

Type of Container *
- Select -

URO compliant decals on the container? *
- Select -

Percent Full *
- Select -

Predominant Materials 1 *
- Select -

Predominant Materials 2 *
- Select -

Predominant Materials 3
- Select -

Contamination Present? *
- Select -

Notes

500 character limit

Save

APPENDIX D

FIELD OBSERVATION PHOTOS

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 1 Observation ID:394220	
Description: URO Compliant Recycling Container Label	
Photograph No. 2 Observation ID: 397415	
Description: Non-URO Compliant Recycling Container Label	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 3 Observation ID: 397412	
Description: URO Compliant Trash Container Label	
Photograph No. 4 Observation ID: 397405	
Description: Non-URO Compliant Trash Container Label	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 5 Observation ID: 396283	
Description: URO Compliant Organics Container Label	
Photograph No. 6 Observation ID: 395205	
Description: Non-URO Compliant Organics Container Label	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No.7 Observation ID: 396658	
Description: Trash Container with predominantly bagged materials and organics	
Photograph No. 8 Observation ID: 396596	
Description: Trash Container with predominantly cardboard materials	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 9 Observation ID: 396450	
Description: Trash Container with predominantly bagged materials and hard plastics	
Photograph No. 10 Observation ID: 394816	
Description: Trash Container with predominantly bagged materials and glass	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 11 Observation ID: 397316	
Description: Trash Container with predominantly bagged materials	
Photograph No. 12 Observation ID: 395021	
Description: Recycling setout with predominately cardboard materials	

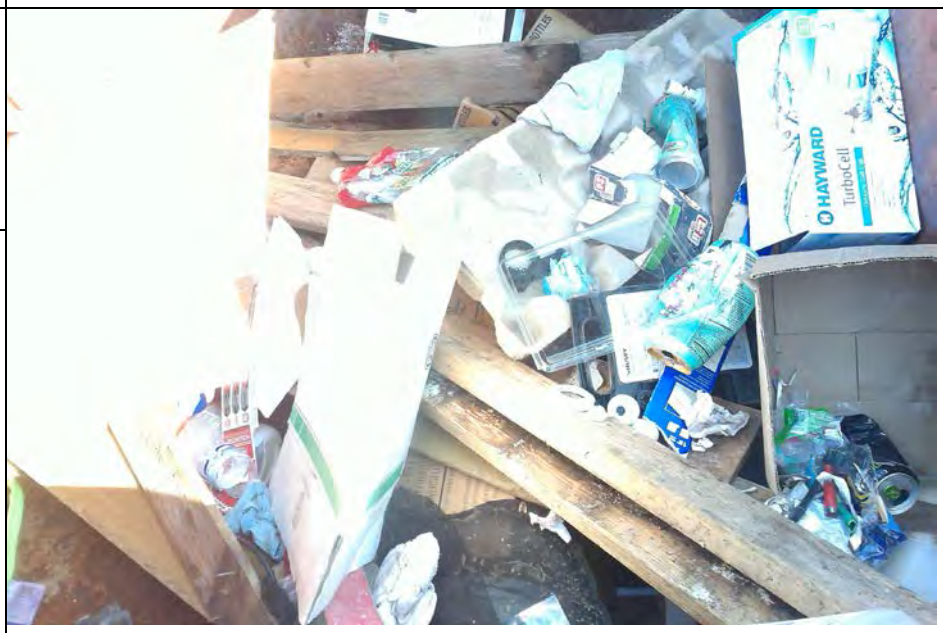
Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 13 Observation ID: 393786	
Description: Recycling container with predominately cardboard and mixed paper materials	
Photograph No. 14 Observation ID: 394403	
Description: Recycling container with predominately cardboard and metal materials contaminated with unknown bagged materials	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 15 Observation ID: 397043	
Description: Recycling container with predominately cardboard and hard plastic materials contaminated by organic materials	
Photograph No. 16 Observation ID: 396003	
Description: Recycling container with predominately cardboard and hard plastics contaminated by wood materials	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 17 Observation ID: 395419	
Description: Organic Container with predominantly landscape trimmings	
Photograph No. 18 Observation ID: 395158	
Description: Organic Container with predominately food and landscape waste	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 19 Observation ID: 395427	
Description: Organic Container with predominately food waste	
Photograph No. 20 Observation ID: 397215	
Description: Multiple business trash container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 21 Observation ID: 397021	
Description: Multiple business trash container	
Photograph No. 22 Observation ID: 396894	
Description: Single business trash container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 23 Observation ID: 396818	
Description: Single business trash container	
Photograph No. 24 Observation ID: 396326	
Description: Multiple business recycle container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 25 Observation ID: 396126	
Description: Multiple business recycle container	
Photograph No. 26 Observation ID: 396035	
Description: Single business recycle container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 27 Observation ID: 396979	
Description: Single business recycle container	
Photograph No. 28 Observation ID: 395769	
Description: Multiple business trash container with predominantly organic waste	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 29 Observation ID: 397146	
Description: Multiple business trash container with predominantly organic waste	
Photograph No. 30 Observation ID: 394592	
Description: Single business organics container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 31 Observation ID: 396386	
Description: Single business organics container	
Photograph No. 32 Observation ID: 395605	
Description: Trash Container 40 cubic yards	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 33 Observation ID: 395287	
Description: Trash Container 8 cubic yards	
Photograph No. 34 Observation ID: 395210	
Description: Trash Container 2 cubic yards	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 35 Observation ID: 394869	
Description: Trash Container 96 gallons	
Photograph No. 36 Observation ID:	
Description: Recycle Container 40 cubic yards	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 37 Observation ID: 397391	
Description: Recycle Container 8 cubic yards	
Photograph No. 38 Observation ID: 396042	
Description: Recycle Container 2 cubic yards	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 39 Observation ID: 395770	
Description: Recycle Container 96 gallon	
Photograph No. 40 Observation ID: 396676	
Description: Organics Container 6 cubic yards	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 41 Observation ID: 394418	
Description: Organics Container 2 cubic yards	
Photograph No. 42 Observation ID: 396278	
Description: Organics Container 96 gallons	

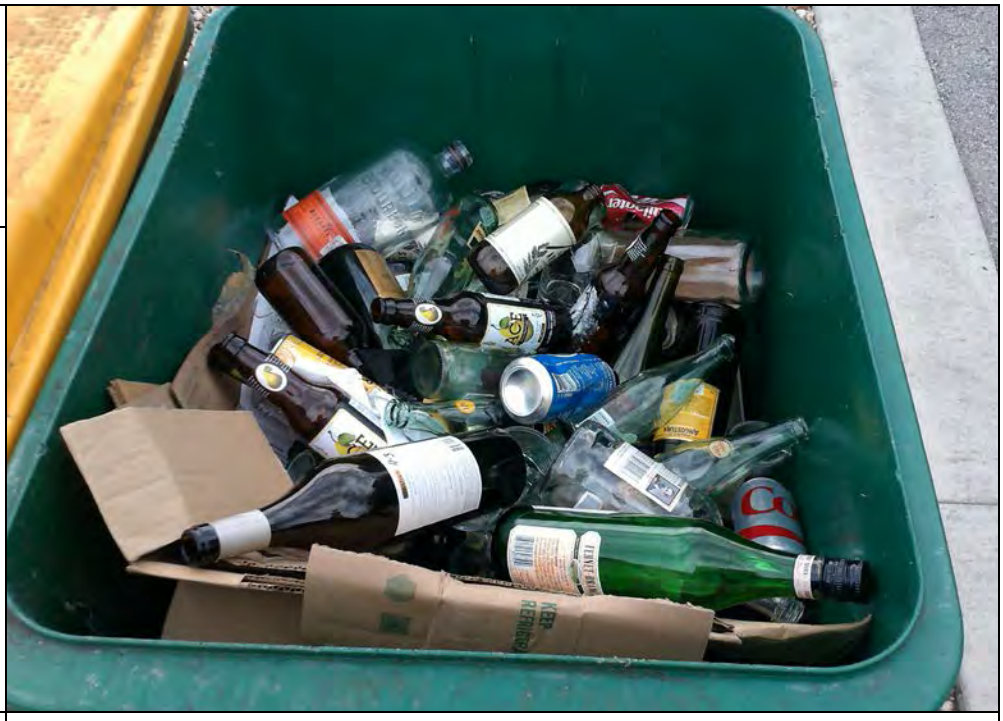
Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 43 Observation ID: 397391	
Description: Multi-family recycling container	
Photograph No. 44 Observation ID: 397388	
Description: Hospital recycling container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 45 Observation ID: 397309	
Description: Bar recycling container	
Photograph No. 46 Observation ID: 396351	
Description: Community Center recycling container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 47 Observation ID: 396376	
Description: Multi-family trash container	
Photograph No. 48 Observation ID: 397384	
Description: Restaurant trash container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 47 Observation ID: 397279	
Description: Car repair shop trash container	
Photograph No. 48 Observation ID: 394501	
Description: Nursing home trash container	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 47 Observation ID: 394592	
Description: Elementary school organics container	

APPENDIX E

LIMITED SAMPLE SORTING PROTOCOL AND COMPONENT PHOTOS

City of Austin – Austin Resource Recovery
City-Wide Diversion Rate Study
Sampling and Sorting Methodology - Garbage and Recyclables

Sample Selection.

Samples will be obtained from Commercial collection vehicles that have been pre-selected to contain the majority of waste collected within the City.

Once the designated vehicle(s) enter the landfill/MRF, the gate attendant, or other facility personnel, will instruct the driver to proceed to the unloading location, which will be in proximity to that day's active working face for garbage and on a designated area for recyclables. The vehicles selected for sampling will empty their loads in an elongated pile in the designated location. From each pile, the field crew will select one sample from the pile, choosing from different locations for each load. Then 200 to 300 pounds of garbage or recyclables will be extracted from the designated cell and transported to the sorting location. Care will be taken when sampling from the bottom of the pile to avoid collecting any material (dirt and soil typically) from the unloading area.

Bulky items may be encountered in some garbage loads. The use of a grid-selection process to identify whole-sample cells helps ensure that such items are accounted for when encountered. Occasionally, however, bulky items in a sample may result in a sample weight in excess of 300 pounds. Bulky items will be reduced to component parts to the extent possible and be included in the total sample.

Once the sample has been extracted from the pile, it will be transported to the sorting location and deposited on a tarp. The crew supervisor will visually check the approximate weight of the material. If more is needed, it will be obtained from the pile as noted above, or, if too much has been extracted, a portion will be removed and not sorted. The sample will then be sorted as described below.

Once the appropriate amount of material has been delivered to the sorting location, the remainder of the load can be incorporated into the active portion of the landfill or the recyclable's sorting queue, or otherwise removed for disposal.

Sorting Methodology.

Samples will be selected based on the protocol described above. When a sample meets the range of 200-300 pounds, the sample will be photographed and the crew will begin sorting the waste into the appropriate categories listed below. Laundry baskets and/or plastic tubs will be used to hold materials as the sample is sorted. Bags, boxes, and containers encountered in the sample will be emptied and their contents sorted. Wastes containing materials from multiple categories (e.g., a child's electronic toy comprised of paper, plastic, and electronic components) will be sorted into the category with the most weight, i.e., paper and plastic would go to the "mixed paper and materials" category if the weight of the paper was estimated to be more than the weight of the plastic. Recyclable materials that contain multiple categories will be designated as residuals.

The field crew will sort samples to the greatest reasonable level of detail, until no more than a small amount of material remains. Many samples, after being sorted down to five pounds or less, contain small residual pieces of material which are difficult to separate. Material which cannot be further separated will be characterized as "Fines" and recorded as such. This is most applicable to the garbage sort, but could be necessary for the recyclables.

Once the sample sorting is complete, baskets will be visually checked for accuracy and the samples weighed. The weight of any individual items weighing more than 150 pounds will be estimated by the crew, usually by having two or more members lift the object and agreeing on the estimated weight. A visual estimate of the composition of any fines will be made and recorded. Any additional observations

about the sample, such as the presence of bulky items or unusual wastes, will be recorded. Additional photographs of the sorted materials will be taken for quality assurance purposes.

All weights and observations will be recorded in written form on paper data forms. The paper forms will be organized according to category, and each form will have a designated line for the recording of the weight. Additionally, all forms will prompt for the following basic information to be included: Date; Site Location; Sample ID. Space will also be provided for general notations and comments. Once a form is completed, it will be reviewed for completeness and accuracy and compared to the visual observations of the material. Once the form is deemed complete, it will be placed into a folder for recordkeeping.

Once the sample data has been recorded, the sorted material will be placed into a roll-off or similar container provided by the facility for disposal or further processing of recyclables. If the sorted recyclables are to be sent to a processing facility, they can be placed into a separate container if provided.

The following are the sort categories for the material:

TABLE 1. MATERIAL STREAM COMPONENTS

Material Category	Material Component	
Paper	Mixed Paper	office paper, mail, newspapers, phone books, cereal boxes, boxboard
	Corrugated cardboard	OCC
Plastics	Polyethylene terephthalate	PET (#1)
	High Density Polyethylene	HDPE (#1)
	Low Density Polyethylene	LDPE (#4)
	Rigid/Durable plastics	buckets, children's toys, lawn chairs, laundry baskets
	Other Plastics	(#7)
Metals	Ferrous metal	Iron / steel, cans
	Aluminum	cans and foil
	Other metals	copper pipe, galvanized tubs, pipes
Glass	Glass bottles and jars	
Compostable Materials	Yard trimmings	grass, leaves, twigs
	Food waste	
	Soiled, Waxed, or Food contaminated paper	
	Wood	other than yard trimmings or C&D (Stumps, large tree branches)
	Other organics/combustibles	dead animals
Reusable / Recoverable Materials	Electronics	
	Construction and demolition (C&D) material	non-painted wood or drywall

TABLE 1. MATERIAL STREAM COMPONENTS		
Material Category	**Material Component**	
	Household hazardous waste	paints, oils, batteries, cleaners, pesticides
	Textiles	clothing, shoes, linens
	Carpet	carpet, rugs, and backing
	Furniture	fixable / repairable
	Expanded Polystyrene	# 6
	Thin Plastic bags	single use bags, vegetable bags
	Thick/Durable Plastic Bags	shopping bags
	Plastic Film	pallet wrap, clean food service film, ziploc bags, vacuum back bags/pouches
	Cartons	gable top cartons, juice or milk containers
	Pallets	
	Tires	
Hard to Sort / Landfill Materials	Other Glass / Ceramics	broken plate glass, non-container glass, ceramics
	Unfixable Furniture	painted wood, particle board, plywood furniture
	Residuals	diapers, doggie bags, multi-layer material pouches, chip bags, candy wrappers, unknown material

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 1	
Description: Mixed Paper	
Photograph No. 2	
Description: Corrugated Cardboard	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 3	
Description: Plastic #1 (PET)	
Photograph No. 4	
Description: Plastic #2 (HDPE)	

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Project Number: 154813

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Photograph No. 5	
Description: Plastic #4 (LDPE)	
Photograph No. 6	
Description: Rigid Plastics #3 and #5	

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Project Number: 154813

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Photograph No.7	
Description: Hard Plastics #6 and #7	
Photograph No. 8	
Description: Ferrous Metal	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 9	
Description: Aluminum	
Photograph No. 10	
Description: Other Metal	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 11	
Description: Glass	
Photograph No. 12	
Description: Yard Trimmings	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 13	
Description: Food Waste	
Photograph No. 14	
Description: Contaminated Paper / Compostable	

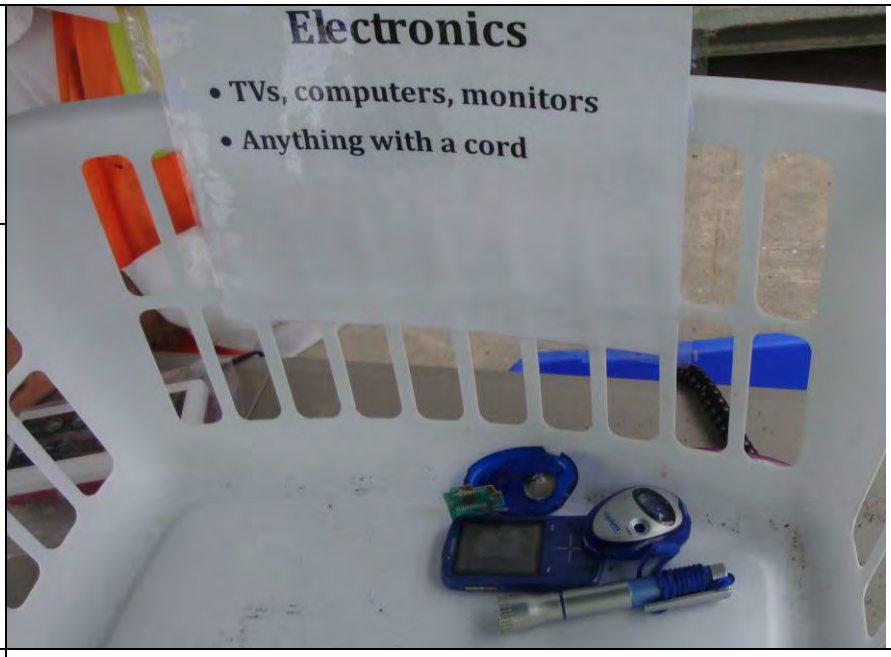
Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 15	
Description: Wood	
Photograph No. 16	
Description: Other Inorganics	No Photograph Available – Not encountered during study

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 17	
Description: Electronics	
Photograph No. 18	
Description: Construction and Demolition Material	

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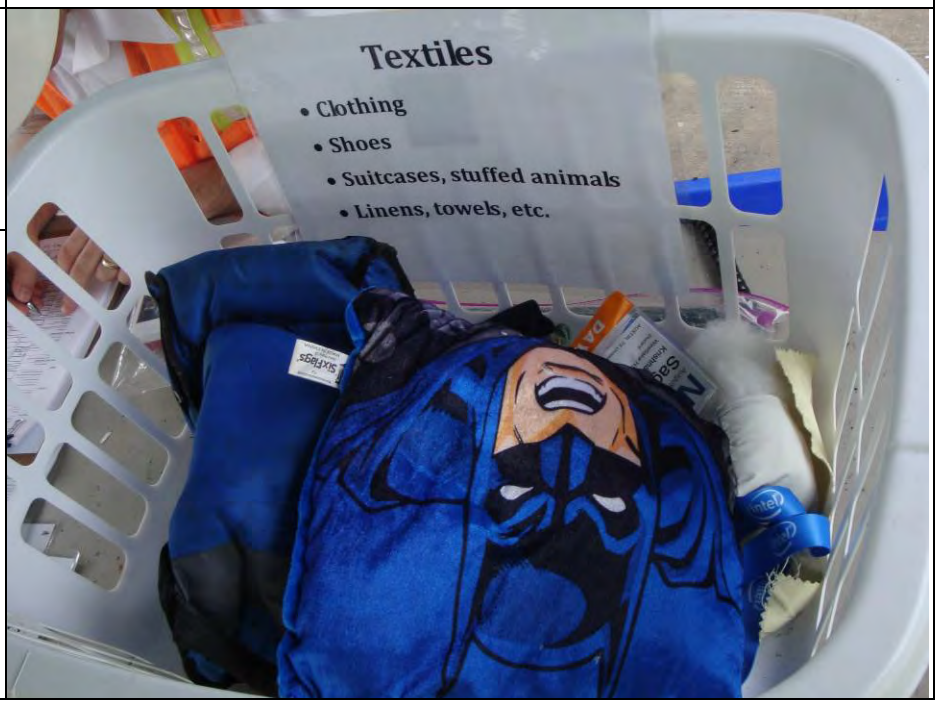
Photograph No. 19	
Description: Household Hazardous Waste	
Photograph No. 20	
Description: Textiles	

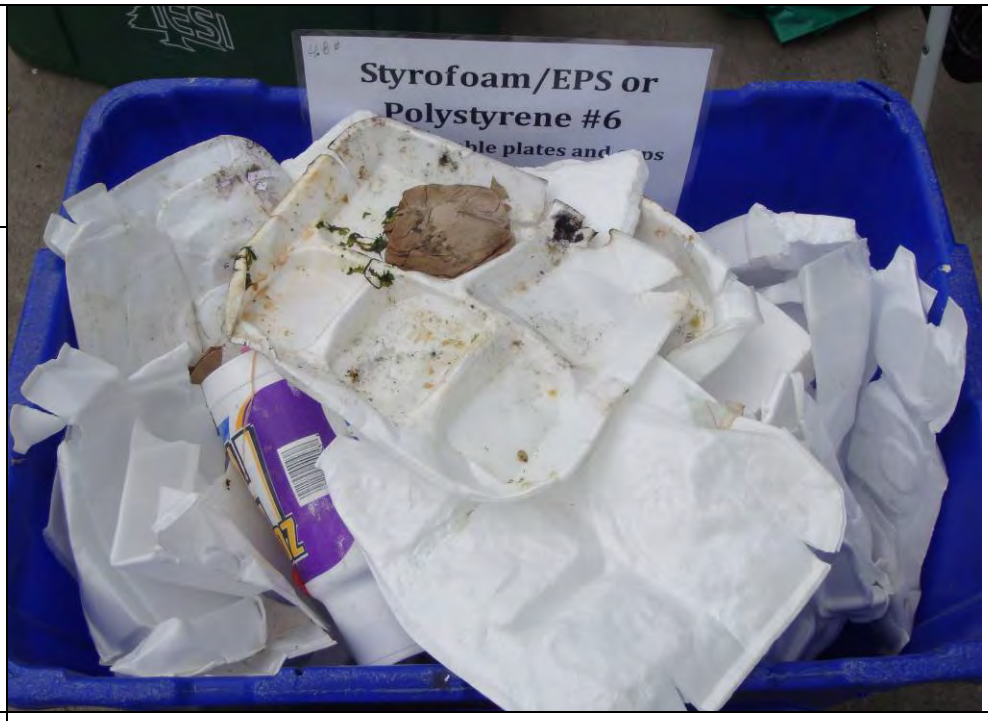
Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 21	
Description: Carpet	No Photograph Available
Photograph No. 22	
Description: Furniture	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 23	
Description: Expanded Polystyrene / Polystyrene # 6	
Photograph No. 24	
Description: Thin Plastic Bags	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 25	
Description: Plastic Film	
Photograph No. 26	
Description: Cartons	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 27	
Description: Pallets	
Photograph No. 28	No Photograph Available – Not encountered during study
Description: Tires	

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 29	
Description: Plate Glass / Ceramics	
Photograph No. 30	
Description: Unfixable Furniture	No Photograph Available – Not encountered during study

Client: City of Austin
Project Number: 154813

Prepared by: CB&I

Photograph No. 31	
Description: Residual Material	
Photograph No. 32	
Description: Residual Material, from MRF sort	

APPENDIX F

LIMITED SAMPLE SORTING DATA

		Landfill A					Landfill B					Landfill C					Average (by weight)				Average (by percent)			
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Landfill A	Landfill B	Landfill C	All Sites	Landfill A	Landfill B	Landfill C	All Sites
PAPER	Units:	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	%	%	%	%
	Mixed Paper - office paper, mail, newspapers, phone books, cereal boxes, boxboard)	15.8	12.8	28.75	8.4	29.2	28	72.2	12	18.4	28.8	13	25.5	17.8	19	19.2	19.0	31.9	18.9	23.3	6.0%	7.6%	7.7%	7.1%
	Corrugated Cardboard	56.8	30.4	9.8	31.4	22.4	28	20	37.6	6.3	17.8	33.4	14.6	1.5	35	51.1	30.2	21.9	27.1	26.4	9.5%	5.2%	11.0%	8.0%
PLASTICS																								
	PET (#1)	6.6	3.4	6.6	2.4	4	10.8	7.8	9.2	3.8	9.2	4.4	4	4.6	2	5.6	4.6	8.2	4.1	5.6	1.4%	1.9%	1.7%	1.7%
	HDPE (#2)	5.2	0	1.8	1.6	2.2	1.6	4.8	3.8	1	4.8	2.4	2	0	0.2	2.5	2.2	3.2	1.4	2.3	0.7%	0.8%	0.6%	0.7%
	LDPE (#4)	0	0.6	0	0	0	0	0.2	0	0	0.4	0.2	0.2	0	0.1	2.6	0.1	0.1	0.6	0.3	0.0%	0.0%	0.2%	0.1%
	Rigid/Durable Plastics (#3, 5)	2.2	0.4	7	1.4	1.4	5	7.6	3.8	3.4	5.2	2	0.2	2	2.4	5	2.5	5.0	2.3	3.3	0.8%	1.2%	0.9%	1.0%
	Other Plastics (#7)	2.2	5.6	5.5	1	0.8	10.6	9	6.2	3.4	9.2	3	9.4	3.8	5	3	3.0	7.7	4.8	5.2	0.9%	1.8%	1.9%	1.6%
METALS																								
	Ferrous (Iron/Steel, cans)	9.2	0.6	3.2	1.5	0	8.8	4.4	5	2.3	14	0	2.8	1.6	1	1.5	2.9	6.9	1.4	3.7	0.9%	1.6%	0.6%	1.1%
	Aluminum (cans, foil)	21.2	0.8	6	0.4	3.2	3	4.2	5.6	2.8	5.2	3	3.6	1.4	1.8	4	6.3	4.2	2.8	4.4	2.0%	1.0%	1.1%	1.3%
	Other/Non-ferrous (copper pipe, galvanized tubs, pipes, etc.)	2.4	0	0	0	0	0	0	0	0	1	4.8	0.2	0.6	0.4	0.5	0.5	0.2	1.3	0.7	0.2%	0.0%	0.5%	0.2%
GLASS																								
	Bottles and Jars	22.4	3.8	0.8	1.8	4	14.8	18.6	27	1.8	16.6	16	17	6	3.6	14.4	6.6	15.8	11.4	11.2	2.1%	3.8%	4.6%	3.4%
COMPOSTABLE MATERIALS																								
	Yard Trimmings (grass, leaves, twigs)	15.2	0	0	2.2	0	35	7.5	0	1.2	0	0	0	0	6.6	52.6	3.5	8.7	11.8	8.0	1.1%	2.1%	4.8%	2.4%
	Food Waste	31.4	12.6	72	28.6	26.4	129	70.8	191.8	49.6	147.5	14.6	25.6	28	10.2	130.2	34.2	117.7	41.7	64.6	10.8%	28.0%	16.9%	19.7%
	Soiled, wax or contaminated paper	39.2	17.4	38.2	35.4	28.8	82.2	75.2	60.4	37.2	61.4	31.4	7.2	18	28.4	68.6	31.8	63.3	30.7	41.9	10.0%	15.0%	12.4%	12.8%
	Wood - (branches, other than yard trimmings or C&D)	0	0	2	40.8	0	0.6	0	2.4	3	0	25.8	1.2	0	3.8	3.2	8.6	1.2	6.8	5.5	2.7%	0.3%	2.8%	1.7%
	Other organics (dead animals.)	0	0	0	0	0	11	1	0	0	0.6	5.4	0	0	0.1	0	0.0	2.5	1.1	1.2	0.0%	0.6%	0.4%	0.4%
REUSABLE / RECOVERABLE																								
	Electronics	0.8	52.6	14.2	1.4	0	0.8	0	0	0	2.6	0	12.4	0.8	0	0.1	13.8	0.7	2.7	5.7	4.3%	0.2%	1.1%	1.7%
	C&D debris (non-painted wood or drywall)	62.4	0	3.8	70.8	1.6	1.8	4.6	0	1	0	28	11.8	60.2	0.6	21.6	27.7	1.5	24.4	17.9	8.7%	0.4%	9.9%	5.5%
	Household Hazardous Waste/BOPA	0	0	0.1	0.6	0.1	2.8	0.3	0.4	0	0.8	1.2	0.8	0.2	0.2	0	0.2	0.9	0.5	0.5	0.1%	0.2%	0.2%	0.2%
	Textiles (clothing, shoes, linens)&Carpet	10.6	2.6	5.2	4.6	4.2	2.8	1.8	2.6	0.6	19.2	2.4	18.4	7.4	2	6.4	5.4	5.4	7.3	6.1	1.7%	1.3%	3.0%	1.9%
	Carpet (carpet, rugs, and backing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
	Furniture (fixable/repairable)	2.8	0	0	0	0	1.2	0	3	0	0	2.8	1.8	0.8	1.4	0	0.6	0.8	1.4	0.9	0.2%	0.2%	0.6%	0.3%
	Polystyrene #6/Expanded Polystyrene	1.3	5.2	17.8	1	1.4	6.8	4.2	1.6	2.6	9	4	3	1.8	2.4	3.6	5.3	4.8	3.0	4.4	1.7%	1.1%	1.2%	1.3%
	Thin/Single Use Plastic Bags (SUB, veggie bags)	0.2	0	0.8	0.2	0.2	4.2	0.4	2.6	0	0.8	0.2	0.2	0.1	0.8	0.2	0.3	1.6	0.3	0.7	0.1%	0.4%	0.1%	0.2%
	Thick/Durable Plastic bags (shopping bags)	0.4	0.1	0.2	0.8	0.4	0	0	0.6	1.8	0.4	1.2	0.6	1	0.1	1.6	0.4	0.6	0.9	0.6	0.1%	0.1%	0.4%	0.2%
	Plastic Films (pallet wrap, clean food service film, ziploc bags, vacuum back bags/pouches)	18	11.8	27.6	5.2	9.8	26	32	41.8	11.8	40	12.6	6.8	11.6	5.8	19.3	14.5	30.3	11.2	18.7	4.6%	7.2%	4.5%	5.7%
	Cartons (gable top cartons, juice or milk containers)	0	0	13	1.4	1	6.6	1.6	3	3	2.2	0.4	0	0.8	0	0.1	3.1	3.3	0.3	2.2	1.0%	0.8%	0.1%	0.7%
	Pallets	0	0	0	0	33.6	0	0	0	0	0	0	0	0	0	0	6.7	0.0	0.0	2.2	2.1%	0.0%	0.0%	0.7%
	Tires	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%
HARD TO SORT / LANDFILL																								
	Plate Glass / ceramics	1.4	0	0	0	0	0.6	0	3	2	0	0	0	0	1.6	3.6	0.3	1.1	1.0	0.8	0.1%	0.3%	0.4%	0.2%
	Unfixable furniture (painted wood, particle board, plywood furniture)	25.4	0	0	0	0	0	0.6	0	0	0	0	7	0	0	0	5.1	0.1	1.4	2.2	1.6%	0.0%	0.6%	0.7%
	Residuals (diapers, doggie bags, multi-layer material pouches, chip bags, candy wrappers, unknown material)	247.8	21.8	71.6	14.8	36.2	84	119.5	56.8	38.8	56	23.4	17.2	40.4	16.6	22	78.4	71.0	23.9	57.8	24.7%	16.9%	9.7%	17.6%
	Daily Totals:	**600.9**	**182.5**	**335.95**	**257.7**	**210.9**	**506**	**468.3**	**480.2**	**195.8**	**452.7**	**235.6**	**193.5**	**210.4**	**151.1**	**442.5**	**317.6**	**420.6**	**246.6**	**328.3**	100.0%	100.0%	100.0%	100.0%

	Landfill A					Landfill B					Landfill C					Average (by weight)				Average (by percent)			
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Landfill A	Landfill B	Landfill C	All Sites	Landfill A	Landfill B	Landfill C	All Sites
PAPER	72.6	43.2	38.55	39.8	51.6	56	92.2	49.6	24.7	46.6	46.4	40.1	19.3	54	70.3	49.2	53.8	46.0	49.7	15.5%	12.8%	18.7%	15.1%
PLASTICS	16.2	10	20.9	6.4	8.4	28	29.4	23	11.6	28.8	12	15.8	10.4	9.7	18.7	12.4	24.2	13.3	16.6	3.9%	5.8%	5.4%	5.1%
METALS	32.8	1.4	9.2	1.9	3.2	11.8	8.6	10.6	5.1	20.2	7.8	6.6	3.6	3.2	6	9.7	11.3	5.4	8.8	3.1%	2.7%	2.2%	2.7%
GLASS	22.4	3.8	0.8	1.8	4	14.8	18.6	27	1.8	16.6	16	17	6	3.6	14.4	6.6	15.8	11.4	11.2	2.1%	3.8%	4.6%	3.4%
COMPOSTABLE MATERIALS	85.8	30	112.2	107	55.2	257.8	154.5	254.6	91	209.5	77.2	34	46	49.1	254.6	78.0	193.5	92.2	121.2	24.6%	46.0%	37.4%	36.9%
REUSABLE / RECOVERABLE	96.5	72.3	82.7	86	52.3	53	44.9	55.6	20.8	75	52.8	55.8	84.7	13.3	52.9	78.0	49.9	51.9	59.9	24.6%	11.9%	21.0%	18.2%
HARD TO SORT / LANDFILL	274.6	21.8	71.6	14.8	36.2	84.6	120.1	59.8	40.8	56	23.4	24.2	40.4	18.2	25.6	83.8	72.3	26.4	60.8	26.4%	17.2%	10.7%	18.5%
Totals:	**600.9**	**182.5**	**335.95**	**257.7**	**210.9**	**506**	**468.3**	**480.2**	**195.8**	**452.7**	**235.6**	**193.5**	**210.4**	**151.1**	**442.5**	**317.6**	**420.6**	**246.6**	**328.3**	100.0%	100.0%	100.0%	100.0%

		MRF A						MRF B										MRF C						Average (by weight)				Average (by percent)			
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	MRF A	MRF B	MRF C	All Sites	MRF A	MRF B	MRF C	All Sites
PAPER	Units:	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	%	%	%	%
	Mixed Paper - office paper, mail, newspapers, phone books, cereal boxes, boxboard)	85.2	8.2	17.4	80.2	101.8	92.4	8.4	16.4	50.6	7.6	4.2	7.6	6.4	7.2	7.8	12.8	18.6	30.4	29.6	50.6	13	23.4	64.2	12.9	27.6	30.9	21.4%	13.1%	17.4%	18.2%
	Corrugated Cardboard	261.2	192.6	146.6	96.2	124.6	134.2	51	73.4	67.4	47	60.6	58.4	69.6	74.6	77.4	48.2	48.4	59	97.2	15.8	47.6	35.6	159.2	62.8	50.6	85.8	53.2%	64.0%	31.9%	50.6%
PLASTICS																															
	PET (#1)	6.4	0.1	1.4	10.2	6	11	1.5	1.8	1.4	0.8	0.6	2.6	0.8	0.8	0.6	1.8	3	3.6	4.6	2	1	2.6	5.9	1.3	2.8	2.9	2.0%	1.3%	1.8%	1.7%
	HDPE (#2)	2.6	1.6	2.8	7	2.6	6.4	0.3	0.8	0.6	0.2	4.2	0	0.6	0.4	2.8	0	1.4	1.2	1.2	2.2	2.4	1	3.8	1	1.6	1.9	1.3%	1.0%	1.0%	1.1%
	LDPE (#4)	0	0	0	0.2	0	0.4	0	0.1	0	0	0	0	0.2	0	0.1	0	0	0.1	0	0	0	0.1	0.1	0	0	0.1	0.0%	0.0%	0.0%	0.1%
	Rigid/Durable Plastics (#3, 5)	0.8	0	0.6	2.6	1	3.2	0.2	0.1	0.2	0	0.4	0.8	0.2	1.8	0.4	1	0.6	0.4	4.6	1.8	1	1.6	1.4	0.5	1.7	1.1	0.5%	0.5%	1.1%	0.6%
	Other Plastics (#7)	3.2	1.8	0.4	12	1.9	2.6	2.9	4	0.6	0.1	0.2	0.2	3.2	0.8	0.2	3.2	3.4	5.2	4.8	6.8	7.4	0.4	3.7	1.5	4.7	3	1.2%	1.5%	3.0%	1.8%
METALS																															
	Ferrous (Iron/Steel, cans)	1.8	0.1	0	8	15.4	2.6	0.2	0.1	0	0	0.2	0.2	0.2	2.6	0.2	1.6	2.2	2	12.8	3	0.2	0.8	4.7	0.5	3.5	2.5	1.6%	0.5%	2.2%	1.5%
	Aluminum (cans, foil)	2.4	0	0.2	2.4	1.6	1.8	2.6	1.4	1.4	0.4	0.4	0.4	0.4	0.4	0.8	3.3	2.6	1	1.8	0.8	1.8	1.4	1.4	1.2	1.6	1.3	0.5%	1.2%	1.0%	0.8%
	Other/Non-ferrous (copper pipe, galvanized tubs, pipes, etc.)	0.2	0	0.1	0	0	0	0	0	0.2	0	0	0	0.1	0	0	0	0	0	0	0.4	0	0	0.1	0	0.1	0	0.0%	0.0%	0.1%	0.0%
GLASS																															
	Bottles and Jars	27.1	0	0.4	31.8	5.8	32.8	10.2	1	1.4	0	0.2	1.8	2.6	0.4	1.4	2.4	0	8	2.4	6.8	1.4	134.2	16.3	2.1	25.5	12.4	5.4%	2.1%	16.1%	7.3%
COMPOSTABLE MATERIALS																															
	Yard Trimmings (grass, leaves, twigs)	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0	0	0	0.3	0	0.1	0.1	0.1%	0.0%	0.1%	0.1%
	Food Waste	3	0	0	4.2	4.2	2.2	1.4	0.2	0.1	0	0	0	0	0	0	0	5.6	0.1	3.2	0	5	1.4	2.3	0.2	2.6	1.4	0.8%	0.2%	1.6%	0.8%
	Soiled, wax or contaminated paper	14.2	0.1	11.6	25.8	17.4	16	9.4	2.8	6	4	3.2	7	0.8	4.2	2.6	9	7.4	1.8	4.6	28.2	5	8.6	14.2	4.9	9.3	8.6	4.7%	5.0%	5.9%	5.1%
	Wood - (branches, other than yard trimmings or C&D)	0	0	0	0	0.4	0	0	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0.1	0.1	0.1	0.1	0.0%	0.1%	0.1%	0.1%
	Other organics (dead animals.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%
REUSABLE / RECOVERABLE																															
	Electronics	2.2	0	1.6	0	0	0.2	0	0	0	0	0.4	0	0	0	0	0	0.2	0	0	0	0	0.4	0.7	0	0.1	0.2	0.2%	0.0%	0.1%	0.1%
	C&D debris (non-painted wood or drywall)	0	0	0	0	0	0	0	0.8	0	0	0	0	0	4	0	0	4.4	0	0	0	0	0	0	0.5	0.7	0.4	0.0%	0.5%	0.4%	0.2%
	Household Hazardous Waste/BOPA	0.8	0	2.4	0.2	0	0.2	0	0	0	0	0	0	0	0	0.1	0	0	0.2	1.8	0	0	0	0	0.6	0	0.3	0.3	0.2%	0.0%	0.2%	0.2%
	Textiles (clothing, shoes, linens)&Carpet	2	0	0	3.4	0	0.8	0.2	0.1	0	0	0	0	0	0	0.1	0	0.8	2.6	5.2	0	1.6	3.6	1.6	1	0.1	2.4	1	0.3%	0.1%	1.5%	0.6%
	Carpet (carpet, rugs, and backing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Furniture (fixable/repairable)	0	0	0	0	0	7.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1.3	0	0.7	0.5	0.4%	0.0%	0.4%	0.3%
	Polystyrene #6/Expanded Polystyrene	2.8	1.2	0.8	1.4	1.8	3.2	1.4	0.6	0.2	0.8	0	1.8	0.6	1.4	0.8	2	1.8	1.2	0.4	6.8	0.6	2	1.9	1	2.1	1.5	0.6%	1.0%	1.3%	0.9%
	Thin/Single Use Plastic Bags (SUB, veggie bags)	0.2	0	0	0.2	0.2	0.4	0	0	0	0	0	0	0	0	0.1	0	0	0.2	1.2	0.2	0.4	0.2	0.1	0.2	0	0.4	0.2	0.1%	0.0%	0.3%	0.1%
	Thick/Durable Plastic bags (shopping bags)	0.4	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.4	0	0	0.1	0	0.1	0.1	0.0%	0.0%	0.1%	0.1%
	Plastic Films (pallet wrap, clean food service film, ziploc bags, vacuum back bags/pouches)	3	0.1	2.6	5	8.6	5.6	7.8	1.6	1.2	0.8	0.4	1.2	3.2	7.8	1.4	2	12.8	3.2	4.8	6.4	4.2	2.8	4.2	2.7	5.7	3.9	1.4%	2.8%	3.6%	2.3%
	Cartons (gable top cartons, juice or milk containers)	0.2	0	0	0.2	0.6	1.2	0	0	0	0	0	0	0	0	0	0	0.2	0	0.1	0.2	0.2	0	0.4	0	0.1	0.1	0.1%	0.0%	0.1%	0.1%
	Pallets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%
	Tires	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0.1	0	0.0%	0.0%	0.1%	0.0%
HARD TO SORT / LANDFILL																															
	Plate Glass / ceramics	0	0	0	0.2	0	0	0	0	0	0	0	0	0.8	0	0	0	0.8	0	0	0	0	0	0	0.1	0.1	0.1	0.0%	0.1%	0.1%	0.1%
	Unfixable furniture (painted wood, particle board, plywood furniture)	0	0	0	1.2	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	4.6	0.2	0	0.8	0.3	0.1%	0.0%	0.5%	0.2%
	Residuals (diapers, doggie bags, multi-layer material pouches, chip bags, candy wrappers, unknown material)	14.8	0.2	0.6	27.2	9.6	16.6	9.4	2	2.2	11.6	0.2	4	2.4	1.2	1	12.2	16.2	5	5.2	40.8	5.8	7.6	11.5	4.6	13.4	8.9	3.8%	4.7%	8.4%	5.3%
	Daily Totals:	**436.5**	**206**	**189.5**	**319.8**	**303.5**	**341.6**	**106.9**	**107.2**	**134.1**	**73.3**	**75.2**	**86**	**92.1**	**107.9**	**97.8**	**100.3**	**133.8**	**130.4**	**177.5**	**175**	**104.4**	**230.6**	299.5	98.1	158.6	169.5	100.0%	100.0%	100.0%	100.0%

	MRF A						MRF B										MRF C						Average (by weight)				Average (by percent)			
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	MRF A	MRF B	MRF C	All Sites	MRF A	MRF B	MRF C	All Sites
PAPER	346.4	200.8	164	176.4	226.4	226.6	59.4	89.8	118	54.6	64.8	66	76	81.8	85.2	61	67	89.4	126.8	66.4	60.6	59	223.4	75.7	78.2	116.7	74.6%	77.2%	49.3%	68.8%
PLASTICS	13	3.5	5.2	32	11.5	23.6	4.9	6.8	2.8	1.1	5.4	3.6	5	3.8	4.1	6	8.4	10.5	15.2	12.8	11.8	5.7	14.8	4.4	10.7	8.9	4.9%	4.5%	6.7%	5.3%
METALS	4.4	0.1	0.3	10.4	17	4.4	2.8	1.5	1.6	0.4	0.6	0.6	0.7	3	1	4.9	4.8	3	14.6	4.2	2	2.2	6.1	1.7	5.1	3.8	2.0%	1.7%	3.2%	2.2%
GLASS	27.1	0	0.4	31.8	5.8	32.8	10.2	1	1.4	0	0.2	1.8	2.6	0.4	1.4	2.4	0	8	2.4	6.8	1.4	134.2	16.3	2.1	25.5	12.4	5.4%	2.1%	16.1%	7.3%
COMPOSTABLE MATERIALS	19.2	0.1	11.6	30	22	18.2	10.8	3	6.7	4	3.2	7	0.8	4.2	2.6	9	13.8	1.9	7.8	28.2	10	10.4	16.9	5.1	12	10.2	5.6%	5.2%	7.6%	6.0%
REUSABLE / RECOVERABLE	11.6	1.3	7.4	10.6	11.2	19.4	9.4	3.1	1.4	1.6	0.8	3	3.8	13.5	2.3	4.8	22.8	12.6	5.5	15.8	12.8	6.9	10.3	4.4	12.7	8.3	3.4%	4.5%	8.0%	4.9%
HARD TO SORT / LANDFILL	14.8	0.2	0.6	28.6	9.6	16.6	9.4	2	2.2	11.6	0.2	4	3.2	1.2	1.2	12.2	17	5	5.2	40.8	5.8	12.2	11.7	4.7	14.3	9.3	3.9%	4.8%	9.0%	5.5%
Totals:	**436.5**	**206**	**189.5**	**319.8**	**303.5**	**341.6**	**106.9**	**107.2**	**134.1**	**73.3**	**75.2**	**86**	**92.1**	**107.9**	**97.8**	**100.3**	**133.8**	**130.4**	**177.5**	**175**	**104.4**	**230.6**	**299.5**	**98.1**	**158.6**	**169.5**	**100.0%**	**100.0%**	**100.0%**	**100.0%**