2022 Iowa Landfill Material Analysis

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SUMMARY DATA SHEET

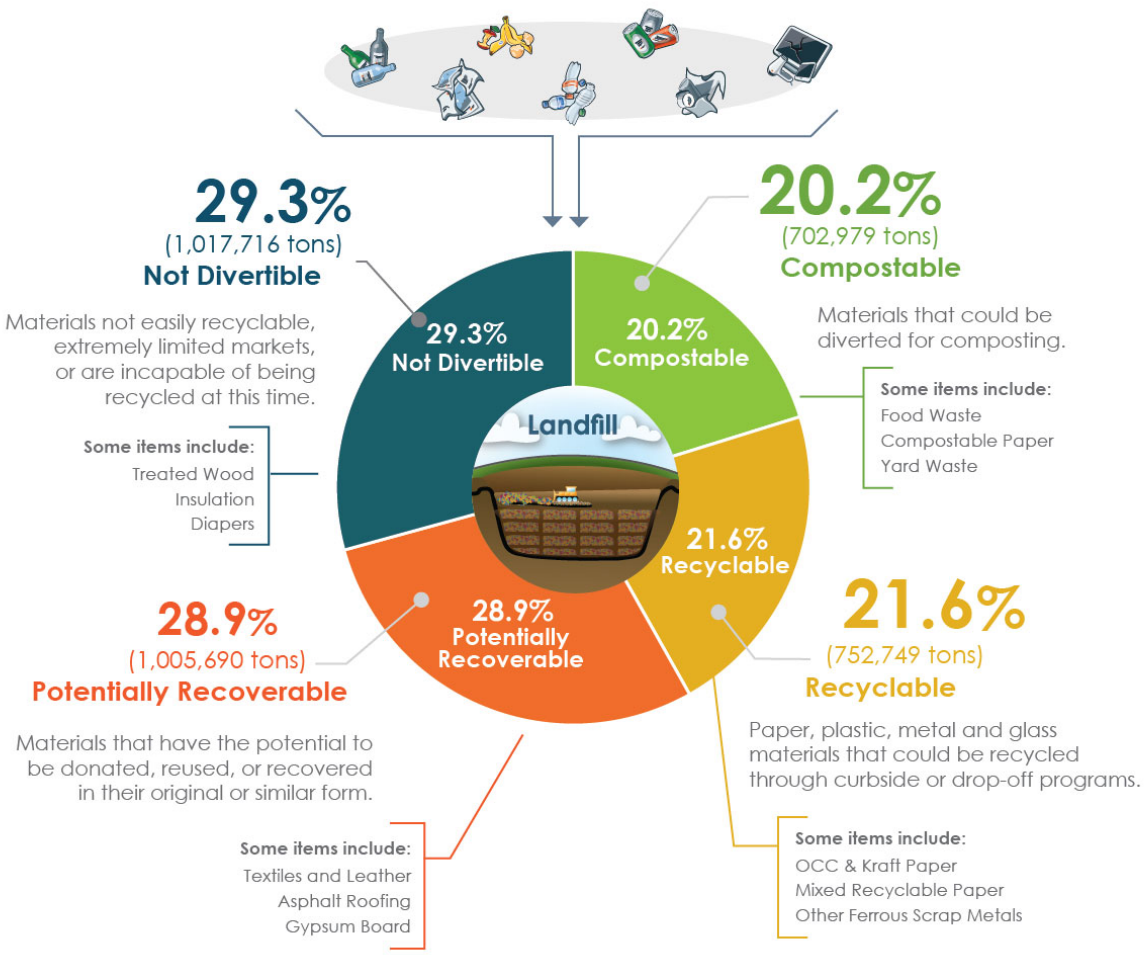
This section summarizes the findings of the Landfill Material Analysis Report in the form of infographics. The focus of this section is recoverability of materials and the impact the diverted materials may have on emissions reductions, job creation, and commodity revenue.

The full report containing the executive summary, background, methodology, and results can be seen following this section.

OVERVIEW

The overview depicts various results and impacts from diverting recoverable materials from landfill disposal. Based on results of the 2022 Iowa Statewide Material Characterization Study, material components were classified as shown in the graphic below. This graphic shows over 70 percent of the waste stream as divertible.

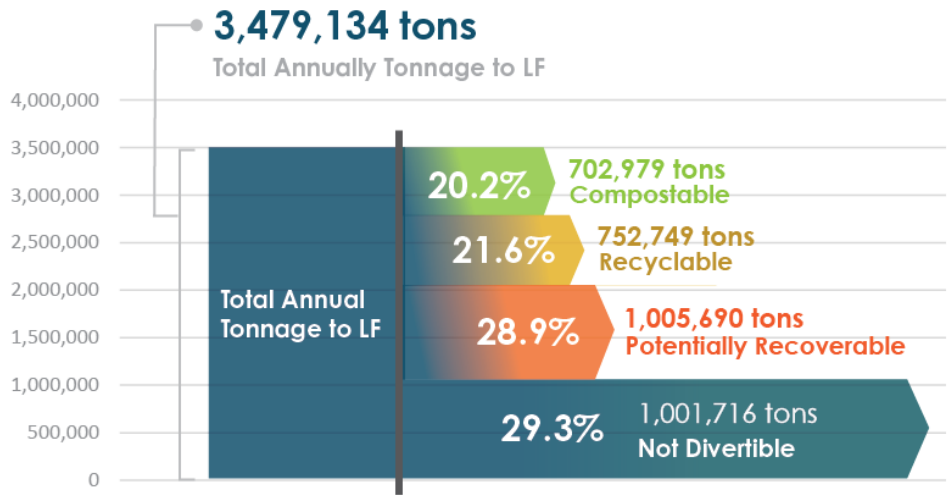
Recoverability of MSW and C&D Materials Disposed in 2022



OVERVIEW

The baseline tonnage disposed in 2022 can be seen below compared to the compostable, recyclable, and potentially recoverable tonnage.

Recoverability of MSW and C&D Materials Disposed in 2022 Compared to Baseline



The overall impact (reduction of carbon dioxide emissions, estimated jobs created, and potential commodity revenue) of diverting recyclable and compostable materials is shown in the following graphic.

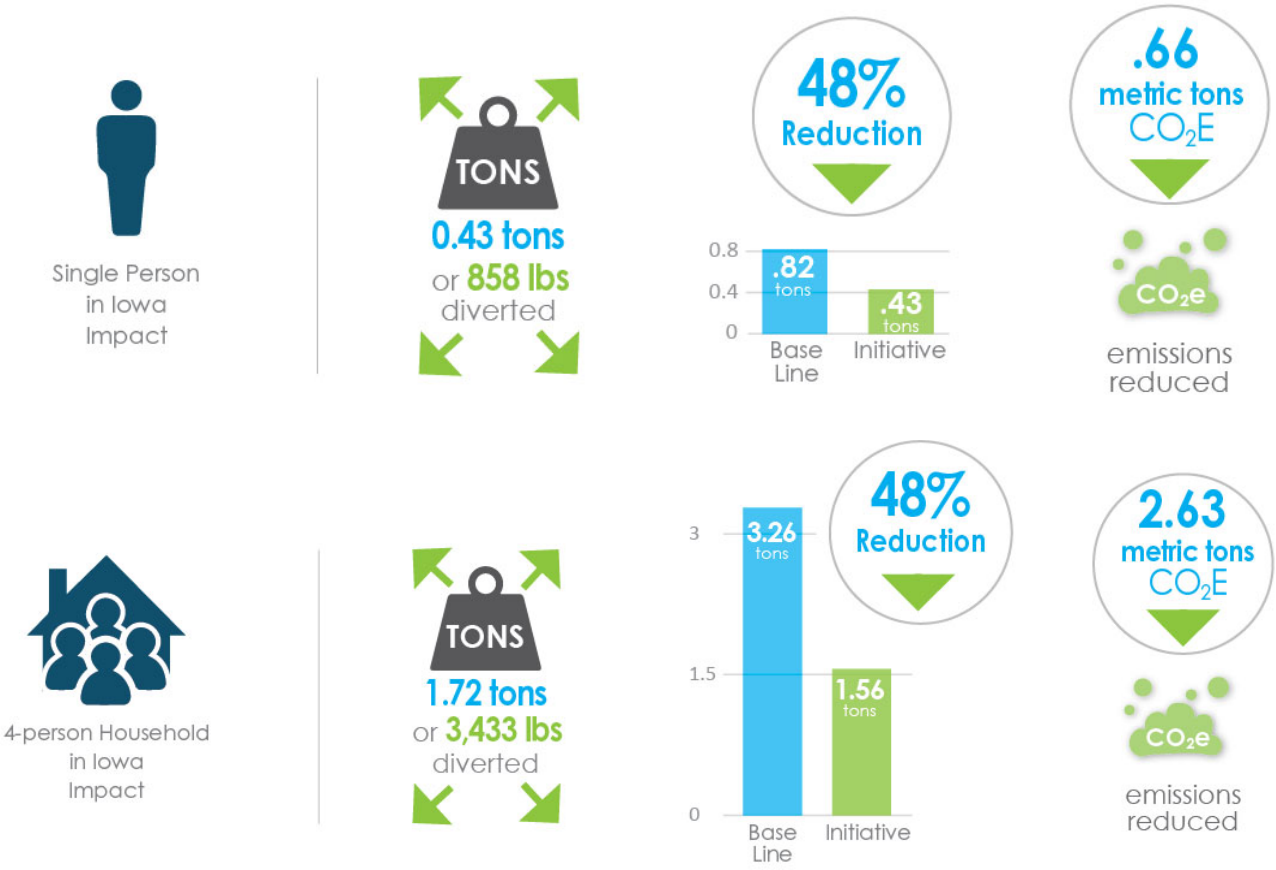
Impact of Diverting Recyclable and Compostable Materials

	Tonnage Reduced	Emissions Reduced	Jobs Created		Commodity Revenue
			Recycling	Reuse & Re-manufacturing	
MSW and C&D	1,455,728 tons	2,365,600	8,650	10,710	$96,535,000
MSW Only	1,369,124 tons	2,095,100	7,840	9,090	$95,077,100
C&D Only	86,604 tons	270,500	810	1,620	$1,457,900

OVERVIEW

The result of diverting recyclable and compostable materials was calculated to show the impact one Iowan and a four-person household in Iowa has on reducing garbage tons and reducing metric tons of carbon dioxide emissions.

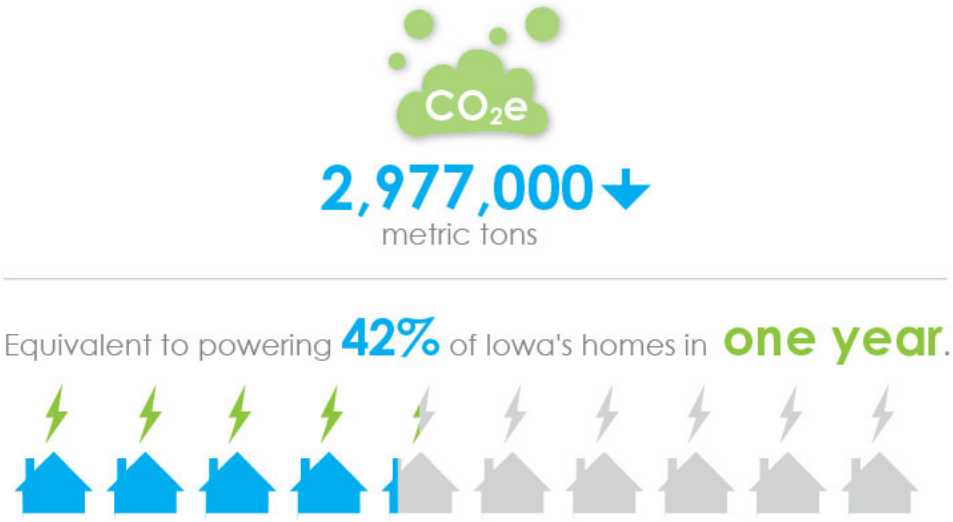
Impact of Diverting Recyclable and Compostable Material by Person and 4-Person Household in Iowa



EMISSIONS

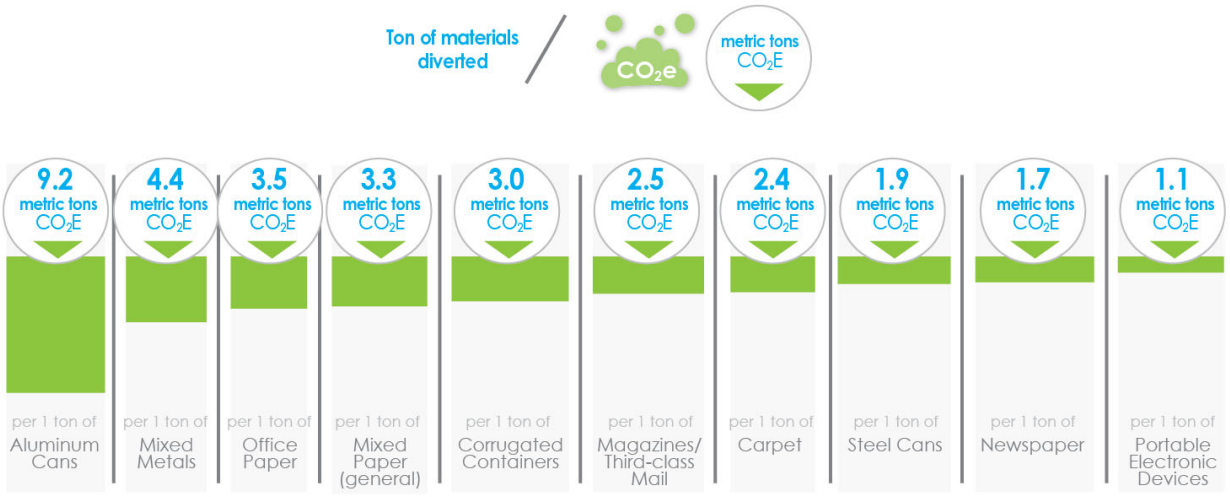
The emissions section displays graphics relating to the impact of diverting recyclable, compostable, and potentially recoverable materials from the overall Iowa waste stream (including MSW and C&D materials) on reducing the metric tons of carbon dioxide emitted into the atmosphere.

Carbon Dioxide Emissions Reductions Equivalency of Diverting Materials from Landfill Disposal



The graphic below shows the material components with the highest reduction of carbon dioxide emissions if one ton of the material was diverted from landfill disposal.

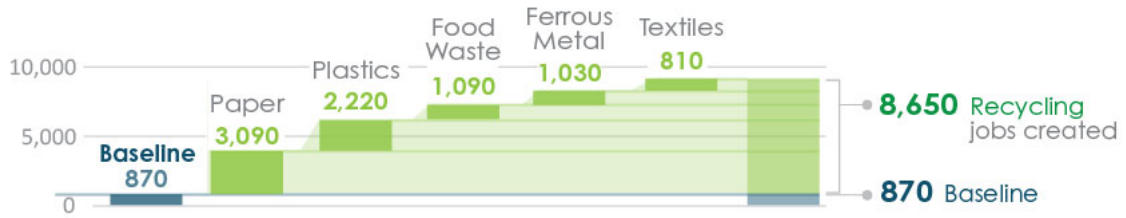
Diverted Material Components with the Highest Reduction of Carbon Dioxide Emissions



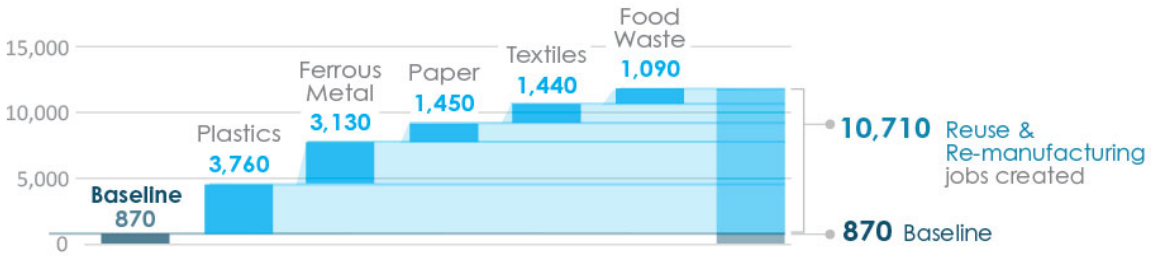
JOBS

As material may be diverted from the landfill, there is a potential to create and maintain jobs through recycling and/or reuse and re-manufacturing. The following graphics display the top five material components that, if diverted, create the most jobs per 1,000 tons of material in recycling or reuse and re-manufacturing. The baseline displayed is relating to the number of jobs that may be created through continuous waste collection and disposal operations.

Diverted Material Components with the Highest Potential Job Creation in Recycling



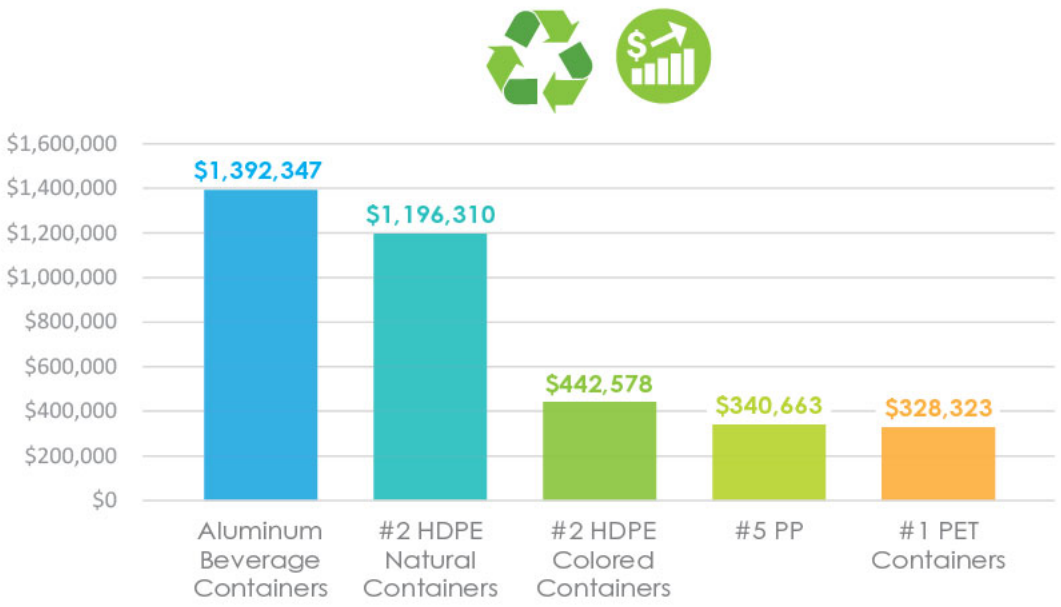
Diverted Material Components with the Highest Potential Job Creation in Reuse & Re-manufacturing



REVENUE

Once materials are diverted for recycling, the materials have the potential to be sold to generate revenue. The graphic below displays the top five material components of the MSW stream that have the highest potential revenue based on Iowa's waste composition from the 2022 Iowa Statewide Material Characterization.

Top Five Recyclable Material Components with the Highest Potential Revenue



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ACKNOWLEDGEMENTS

The SCS Engineers (SCS) project team would like to thank the Iowa Department of Natural Resources (DNR) staff who provided necessary information and collaboration to complete this project.

1.0 EXECUTIVE SUMMARY

The Iowa Department of Natural Resources (DNR) continues to take the initiative to measure aspects of material management throughout the state, which helps inform solid waste and resource management programs across Iowa. This measurement includes material characterization studies and analysis on recoverability, carbon dioxide emissions, job creation potential, and revenue potential based on those findings.

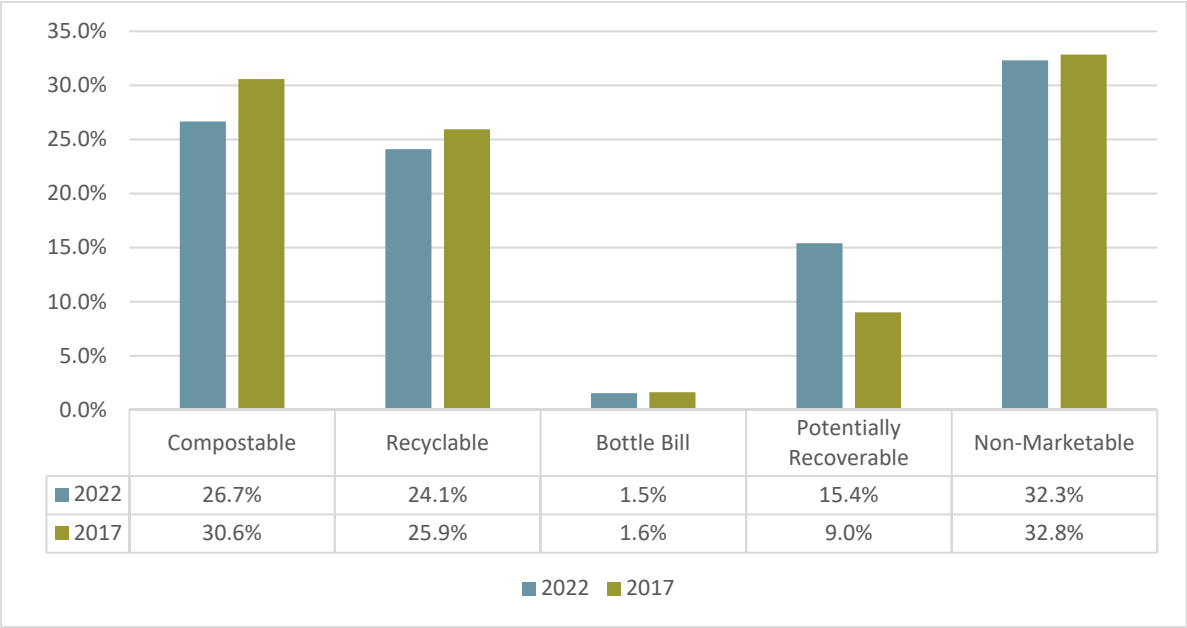
The DNR contracted with SCS Engineers (SCS) in 2023 to perform a 2022 Landfill Material Analysis (Study) using the results of the 2022 Iowa Statewide Material Characterization Study to implement stakeholder recommendations of the Sustainable Materials Management Initiative. This Study aimed to replicate and expand on the 2017 analysis as a part of the 2017 Iowa Statewide Waste Characterization Study.

This Study analyzed the following information for landfilled materials that could have been recovered for recycling, reuse, composting, and remanufacturing:

- Recoverability – The categorization of material components into compostable, recyclable, potentially recoverable, and non-marketable terms. This determines the number of materials that may be diverted from landfill disposal.
- WARM Analysis – An analysis of recyclable and compostable materials emissions reduction for carbon dioxide if diverted from landfill disposal using the United States Environmental Protection Agency's (EPA) WARM calculator model.
- Job Analysis – The determination of estimated job creation based on diversion of various recyclable materials.
- Economic Impact – An evaluation of potential revenue if 100 percent of recyclable materials were captured and sold by commodity.

The recoverability analysis shown in Exhibit 1, displays the historical comparison from 2022 and 2017. The total divertible percentage of the waste stream in 2022 equaled 67.7 percent, whereas in 2017, this percentage was 67.2. The divertible percentage includes recyclable, compostable, and potentially recoverable (materials that have the potential to be donated and reused in their original or similar form). This is a slight increase of available recoverable material, indicating an opportunity for expansion and creation of diversion programs.

Exhibit 1. Overall Recoverability Historical Comparison



	Compostable	Recyclable	Bottle Bill	Potentially Recoverable	Non-Marketable
2022	26.7%	24.1%	1.5%	15.4%	32.3%
2017	30.6%	25.9%	1.6%	9.0%	32.8%

Table 1 (next page) displays the municipal solid waste (MSW) emissions reduction for 2022 recyclable and compostable materials. The table lists diversion of material components listed on the left and the positive numbers indicate the amount of metric tons of carbon dioxide that could be reduced. The negative number indicates emissions could be increased by composting or recycling a material, specifically yard trimmings. This may be due to the emissions yard trimmings release as it decomposes, however there are other benefits to diverting this material such as increased landfill airspace and beneficial use of composted materials.

Table 1 (next page) displays about 2,095,100 metric tons of carbon dioxide could be reduced through recycling or composting various MSW materials.

Table 1. MSW Recyclable/Compostable Materials

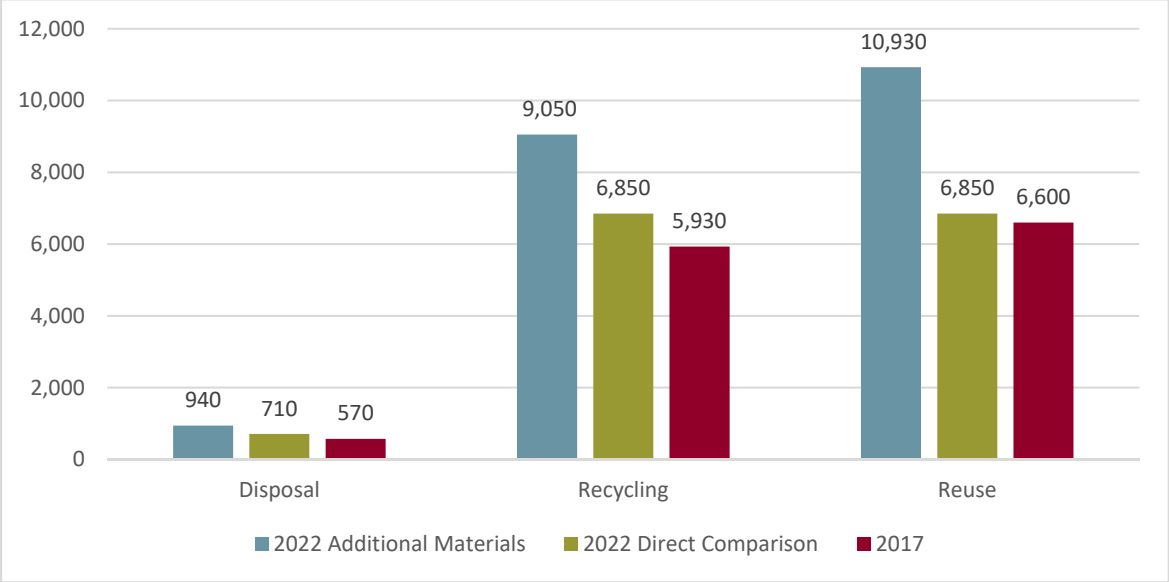
WARM Material Components		2022 Analysis	
		Tons Recycled/ Composted	Emissions Reduced (MTCO2E)
Paper	Corrugated Containers	195,700	589,000
	Magazines/Third-class Mail	12,900	32,200
	Newspaper	7,700	13,300
	Office Paper	31,000	108,800
	Mixed Paper (general)	131,600	439,100
	Subtotal	**378,900**	**1,182,400**
Organics	Food Waste	500,900	229,000
	Yard Trimmings[1]	65,000	-11,000
	Subtotal	**565,900**	**218,000**
Plastics	HDPE	24,600	19,100
	PET	40,700	42,900
	PP[1]	35,400	28,800
	Mixed Plastics	39,200	37,000
	Subtotal	**139,900**	**127,800**
Metal	Aluminum Cans	15,400	141,100
	Steel Cans	12,900	23,900
	Mixed Metals	88,700	391,400
	Subtotal	**117,000**	**556,400**
Glass	Glass	35,600	10,500
	Subtotal	**35,600**	**10,500**
	Overall Total	**1,237,300**	**2,095,100**

[1]Material component not included in 2017 analysis.

The job analysis historical comparison is listed below in Exhibit 2. The three colors shown represent the 2017 job creation findings, the 2022 direct comparison using the same material types, and the 2022 summary using additional material components not previously identified in 2017. Recycling and reusing are labor-intensive avenues for material diversion that potentially contribute to the job market. With the addition of material components, reusing material components provides the largest number of jobs created of 10,930 in 2022, as compared to 6,600 in 2017. If recyclable materials

are diverted for recycling and reuse, this may increase the jobs available to Iowans and strengthen the overall economy by creating a circular economy for materials throughout their life.

Exhibit 2. Job Analysis Historical Comparison



In addition to job creation, an economic impact analysis was performed to evaluate the revenue that may be generated from the diversion of material components. Table 2 on the following page shows the material categories and the comparison between 2022 and 2017 of estimated tons disposed and the estimated total market value. There was nearly a $35,000,000 increase from 2017 to 2022 in revenue of the material categories. This information is based on if 100 percent of the materials deemed recyclable can be diverted and recycled.

Table 2. Economic Impact Historical Comparison

	2022 Analysis		2017 Analysis[2]	
Material Categories	Estimated Tons Disposed[1]	Estimated Total Market Value ($)	Estimated Tons Disposed	Estimated Total Market Value ($)
Paper	378,900	$27,267,400	275,700	$20,414,250
Plastic	139,700	$44,022,300	163,100	$23,812,500
Metal	28,300	$23,787,400	24,100	$15,146,000
Glass	35,600	$0	32,300	$936,900
Overall Total	**582,500**	**$95,077,100**	**495,300**	**$60,309,650**

[1]Disposed tonnage based on FY 2022 tonnages reported from the DNR and composition from the 2022 Iowa Statewide Material Characterization Study.
[2]This information can be found in the 2017 Iowa Statewide Waste Characterization Study.

2.0 INTRODUCTION AND BACKGROUND

This report provides the methods used to analyze the disposed of materials and the findings of the analyses utilizing data from the 2022 Iowa Statewide Material Characterization Study.

The report is organized in the following sections:

- Background
- Methodology
- Results
- Conclusions

2.1 BACKGROUND

Since 1998, the DNR has made the measurement of municipal solid waste through material characterization studies a priority for understanding waste streams to enable diversion. In 2017, the Iowa Department of Natural Resources (DNR) contracted with SCS Engineers (SCS) to perform an analysis on the results of the waste composition study, also conducted in 2017. The purpose of the study was to determine the recoverability of materials that were disposed of and identify potential benefits of recovering these materials. The DNR requested a similar evaluation be performed based on the results of the 2022 Iowa Statewide Material Characterization Study (2022 Study).

3.0 METHODOLOGY

This section provides the methodology of recoverability, emissions impact, job, and economic analysis.

3.1 RECOVERABILITY

The 84 material components of municipal solid waste (MSW) and 30 material components of construction and demolition (C&D) from the 2022 Study were classified as compostable, recyclable, potentially recoverable, or non-marketable. The definitions of these terms can be seen in Table 3 (next page), comparing these to 2017 definitions. SCS classified the definitions from the two studies such that an analysis could be performed concerning material recoverability. It is important to note that it was assumed that 100 percent of the materials classified as recoverable could be recycled. This includes potential contaminated recoverable materials as the studies did not differentiate between contamination caused by collection or handling of materials.

Table 3. Recoverability Terms

Term	2017 Definition	2022 Definition
Compostable	Encompasses materials that could be diverted for composting operations and includes materials such as food waste, yard waste, and compostable paper.	Same as 2017 definition.
Recyclable	Includes materials traditionally accepted in curbside or drop-off recycling programs such as aluminum cans, plastic bottles, glass containers, corrugated cardboard, and mixed paper.	Same as 2017 definition.
Bottle Bill	Includes aluminum, plastic, and glass containers that are covered under Iowa's container deposit redemption law (Bottle Bill).	Joined term into the recyclable category.
Potentially Recoverable[1]	Materials that have the potential to be donated and reused in their original or similar form; includes construction/demolition debris and textiles and leather.	Same as 2017 definition with the inclusion of some household hazardous materials.
Non-Marketable	Includes materials that are typically not easily recyclable, markets are extremely limited, or are incapable of being recycled at this time including plastic film, non-compostable organics, fines, and diapers.	Same as 2017 definition.

[1]In 2017, the term Reusable was used in place of Potentially Recoverable.

3.2 WARM ANALYSIS

The Waste Reduction Model (WARM) is a tool produced by the EPA to provide comparisons of baseline and potential greenhouse gas emissions, economic impacts, and energy use. The WARM Version 16 was used to generate the metric tons of carbon dioxide (MTCO2E) for a baseline scenario and if materials were recycled or composted.

Once the material components from the 2022 Study were classified into recoverability terms, SCS combined various terms into two main categories: recyclable and potentially recoverable. The recyclable category stayed consistent with the 2017 methodology to directly compare results from the previous WARM analysis performed for the State. The recyclable category includes compostable and recyclable classified material components. Both the recyclable and potentially recoverable categories were used to generate the MTCO2E baselines and alternative scenario for both MSW and

C&D. The WARM tool provides material categories for the analysis, therefore SCS matched the material components of the 2022 Study to the tool.

3.3 JOB ANALYSIS

The purpose of a job analysis is to determine the number of jobs created by diverting waste or maintaining the current waste disposal system. The methodology to obtain results is similar to the methods used in the 2017 study. A report by the Natural Resources Defense Council and written by the Tellus Institute titled *More Jobs, Less Pollution: Growing the Recycling Economy in the U.S.* was utilized to estimate the number of jobs that could potentially be created through recycling, reuse, and disposal. This report uses several methods and sources to estimate the number of jobs created during the different processes of reuse, recycling, and disposal.

SCS selected material components from the 2022 Iowa Statewide Material Characterization Study (2022 Study) to match with the Tellus Institute report materials seen in Figure 1 below. The percentage by material component found in the 2022 Study was applied to the reported municipal solid waste reported in fiscal year of 2022 to determine the estimated tons to apply to the job analysis. These tons were multiplied by the total number of jobs determined by using Figure 1 to estimate the number of jobs that could potentially be created in Iowa through reuse, recycling, and disposal.

Figure 1. Diverted Waste & Disposed Waste Job Production Estimates (MSW)

	DIVERTED WASTE					DISPOSED WASTE		
	Collection 2008	Collection 2030	Processing	Manufacturing	Reuse/ Remanufacture	Collection	Landfill	Incineration
	Jobs per 1000 tons	*Jobs per 1000 tons*	*Jobs per 1000 tons*	*Jobs per 1000 tons*	*Jobs per 1000 tons*	*Jobs per 1000 tons*	*Jobs per 1000 tons*	*Jobs per 1000 tons*
MATERIALS								
Paper & Paperboard	1.67	1.23	2.00	4.16	N/A	0.56	0.10	0.10
Glass	1.67	1.23	2.00	7.85	7.35	0.56	0.10	0.10
Metals								
Ferrous	1.67	1.23	2.00	4.12	20.00	0.56	0.10	0.10
Aluminum	1.67	1.23	2.00	17.63	20.00	0.56	0.10	0.10
Other Nonferrous	1.67	1.23	2.00	17.63	20.00	0.56	0.10	0.10
Plastics	1.67	1.23	2.00	10.30	20.00	0.56	0.10	0.10
Rubber & Leather	1.67	1.23	2.00	9.24	7.35	0.56	0.10	0.10
Textiles	1.67	1.23	2.00	2.50	7.35	0.56	0.10	0.10
Wood	1.67	1.23	2.00	2.80	2.80	0.56	0.10	0.10
Other	1.67	1.23	2.00	2.50	N/A	0.56	0.10	0.10
Other Wastes								
Food Scraps	1.67	1.23	0.50	N/A	N/A	0.56	0.10	0.10
Yard Trimmings	1.67	1.23	0.50	N/A	N/A	0.56	0.10	0.10
Misc. Inorganic Wastes	1.67	1.23	0.50	N/A	N/A	0.56	0.10	0.10

3.4 ECONOMIC IMPACT

The study that was conducted in 2017 included a revenue impact analysis on the recovery of recyclable materials found in the material characterization study. In the 2022 Study, a similar methodology was used to compare results from 2017 and continue to estimate the value of materials that were disposed. Table 4 show materials that are part of the economic analysis.

Table 4. Materials Included for Economic Analysis

Paper	Plastic	Metal	Glass
High Grade Office Paper	#1 PET IA Deposit Beverage Containers	Aluminum IA Deposit Beverage Containers	Glass IA Deposit Containers
Mixed Recyclable Paper	#1 PET Beverage Containers	Aluminum Beverage Containers	Clear Glass Containers
Newsprint	#1 PET Other Non-Beverage Containers	Ferrous Food and Beverage Containers	Green Glass Containers
Magazines/Catalogs	#2 HDPE Natural Containers		Brown /Other Colored Glass Containers
OCC and Kraft Paper	#2 HDPE Colored Containers		
Aseptic/Gable Top Containers	#3 PVC		
	#4 LDPE		
	#5 PP		
	#6 PS		
	#7 Other/Unknown Plastic		
	Retail Shopping Bags		

The commodity price was identified through www.recyclingmarkets.net for each of the material types listed above. The descriptions defined on the recycling markets guided which price by commodity to use. SCS calculations utilized a 5-year average of price per ton to normalize the price and minimize large discrepancies over the years. This average price is regional to the Midwest/Central region of the country. Once the price was calculated, SCS applied this to the number of tons disposed of in 2022 based on DNR reporting and the 2022 Study results.

4.0 RESULTS

This section includes the methodology and results of the following activities:

- Recoverability Analysis
- WARM Analysis
- Job Analysis
- Economic Analysis

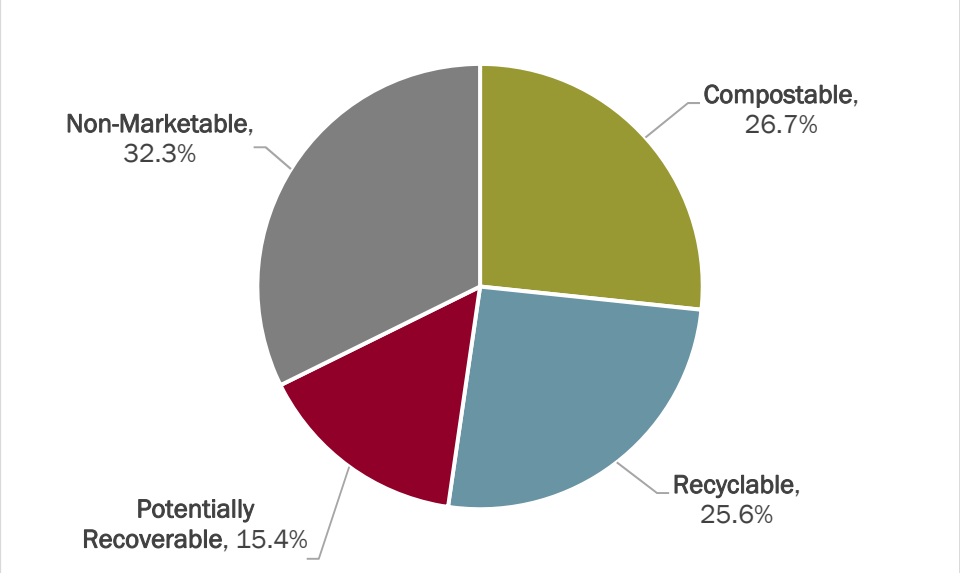
4.1 RECOVERABILITY ANALYSIS

This section analyzes the recoverability of materials found in the 2022 Study for both MSW and C&D debris.

4.1.1 MSW Overall Recoverability

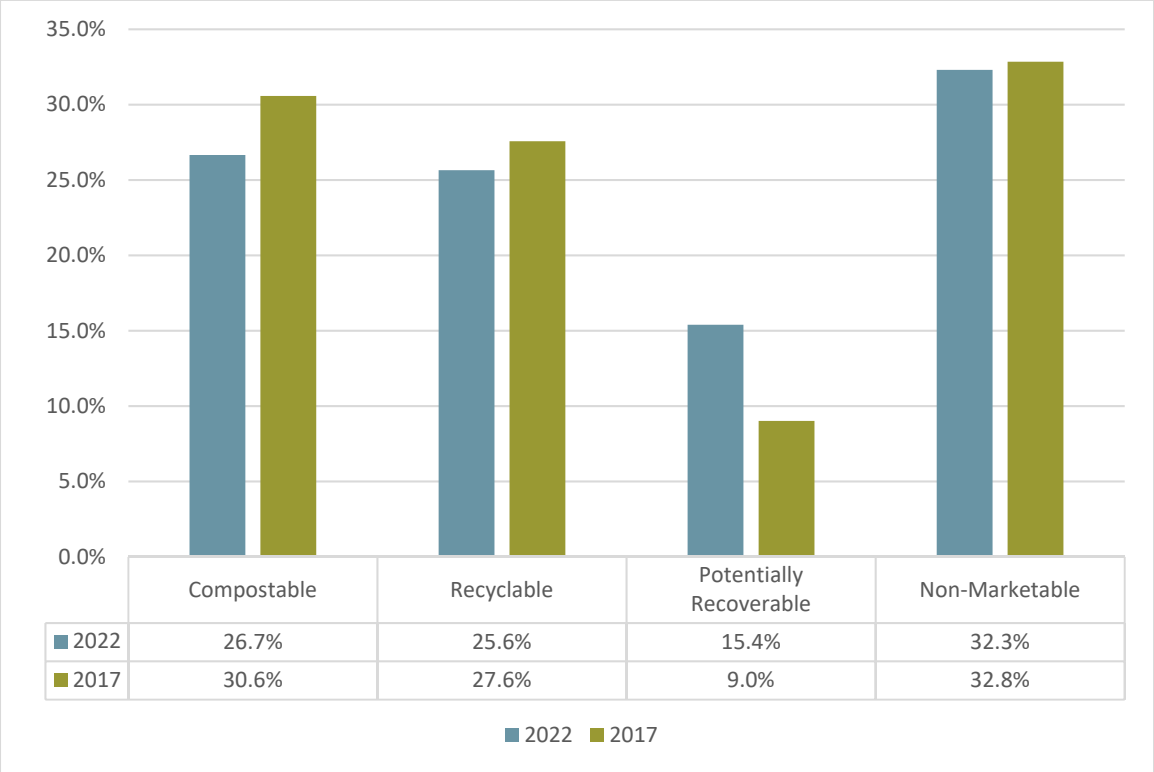
Exhibit 3 below displays the comparison of the five recoverability classifications of the 2022. Nearly 70 percent of disposed material in 2022 has been classified as divertible by being recyclable, compostable, or potentially recoverable.

Exhibit 3. 2022 Overall Recoverability Composition



The recoverability results from 2017 compared to the 2022 Study can be seen in Exhibit 4. For all classifications except potentially recoverable, the categories slightly decreased in percentage from 2017. The potentially recoverable category increased by 6.4 percent. This increase is largely due to C&D material components found in the MSW composition, going from 3.1 percent to 9 percent. While it may be unclear to for direct causes, the economy changes due to the COVID-19 pandemic and an increase in storm events could have contributed to this increase.

Exhibit 4. Overall Recoverability Historical Comparison



	Compostable	Recyclable	Potentially Recoverable	Non-Marketable
2022	26.7%	25.6%	15.4%	32.3%
2017	30.6%	27.6%	9.0%	32.8%

4.1.2 MSW Compostable Materials

Exhibit 5 displays the material components that comprise the compostable classification in 2022. Compostable materials equal nearly 27 percent of the overall composition of the disposed materials. Within this classification, the largest material component is Food Waste – Loose at 14.6 percent. Food in general (loose and packaged) makes up nearly 20 percent of the compostable materials disposed. The second largest individual material component is Compostable Paper at 5 percent.

Table 5 lists the material components as a direct comparison to the 2017 data. The compostable materials found in the 2022 waste stream equaled slightly less than found in 2017. The only material component to increase percentage is Food Waste – Loose by 1.3 percent.

Exhibit 5. 2022 Compostable Composition

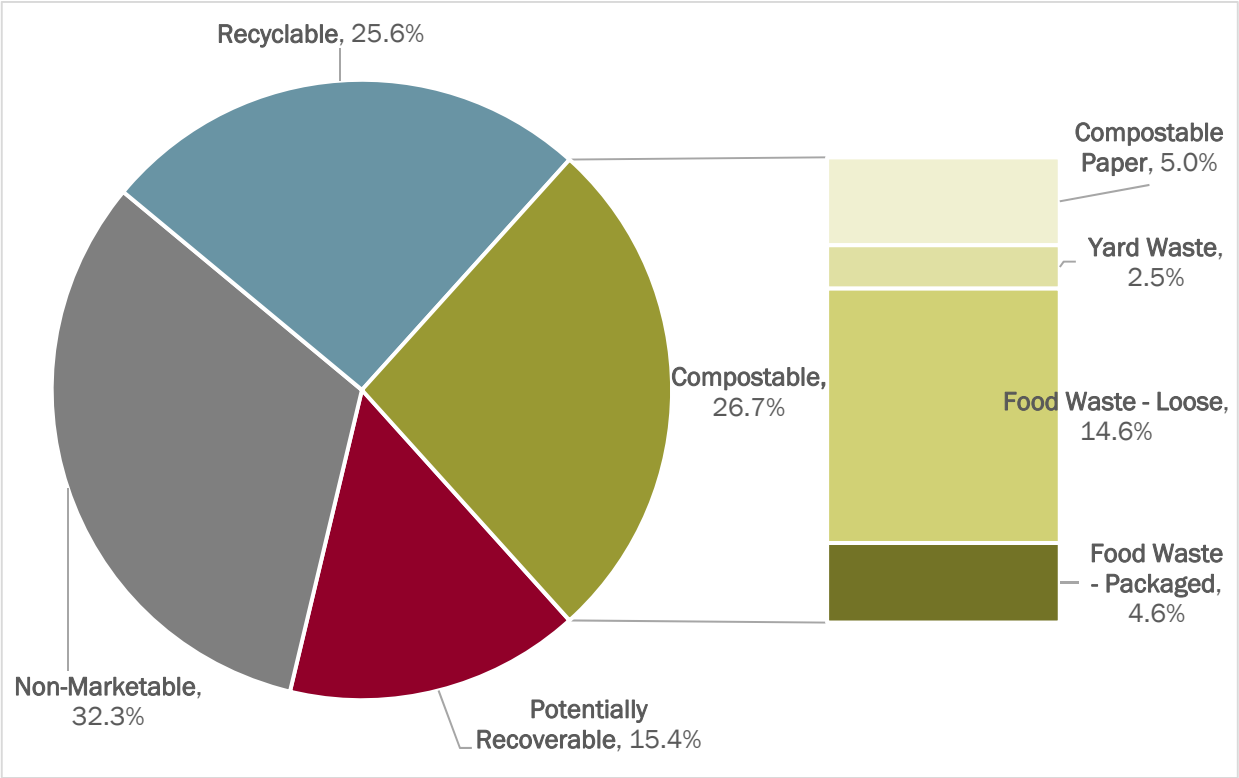


Table 5. Compostable Historical Comparison - Detailed

Material Component	2022 Data	2017 Data
Compostable Paper	5.0%	7.6%
Yard Waste	2.5%	2.9%
Food Waste – Loose	14.6%	13.3%
Food Waste – Packaged	4.6%	6.7%
Total	**26.7%**	**30.5%**

4.1.3 MSW Recyclable Materials

Exhibit 6 displays the material components that comprise the recyclable classification in 2022. Recyclable is the third largest grouping of materials found in the waste stream at 25.6 percent. The paper material category is the largest within this group at 14.5 percent. The material component that contributes most to the 14.5 percent recyclable paper is OCC and Kraft Paper with a percentage of 7.5 percent.

Table 6 lists the material components as a direct comparison to the 2017 data. Each material category slightly decreased except the metal category. Other Ferrous Scrap Metal increased from 2017 to 2022 by nearly 1 percent.

Exhibit 6. 2022 Recyclable Composition

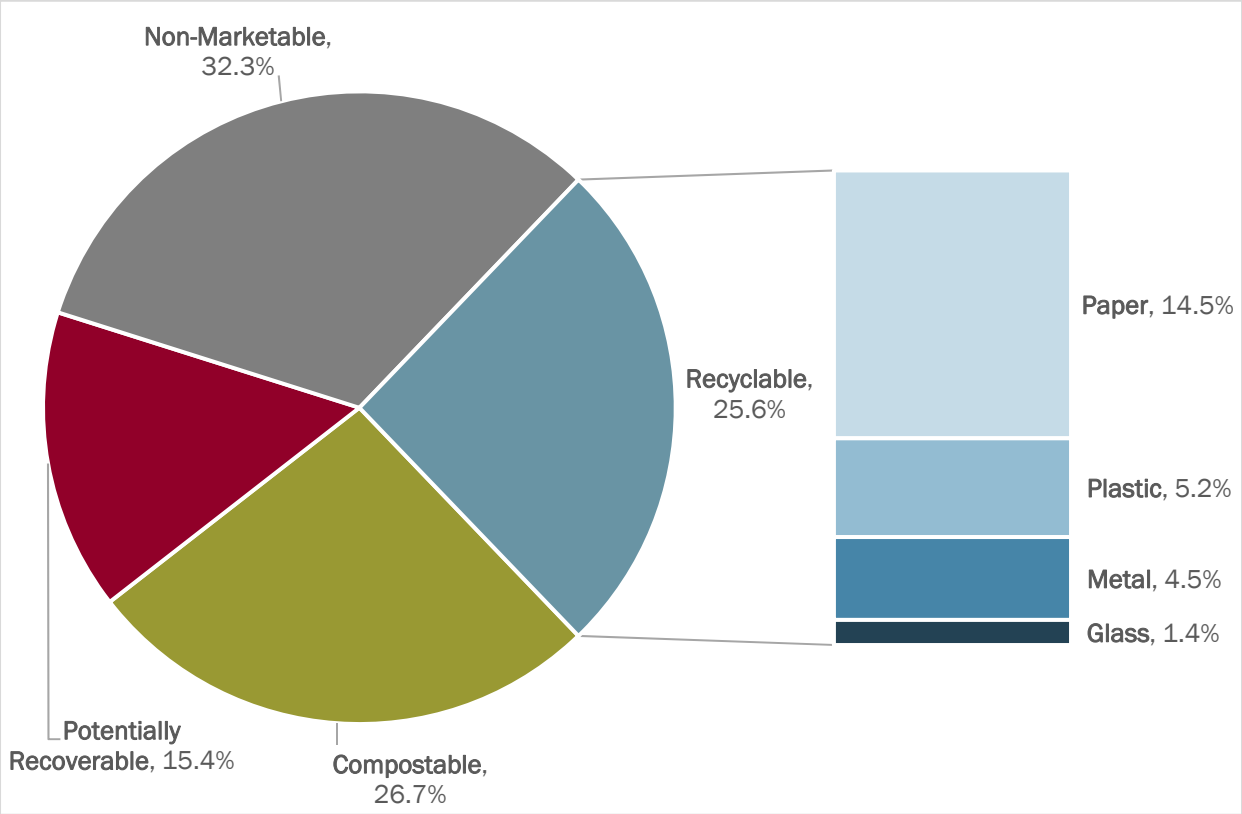


Table 6. Recyclable Historical Comparison – Detailed

Material Category	2022 Data	2017 Data
Paper	14.5%	14.9%
Plastic	5.2%	6.3%
Metal	4.5%	3.4%
Glass	1.4%	0.9%
Total	**25.6%**	**25.5%**

4.1.4 MSW Potentially Recoverable Materials

Exhibit 7 displays the potentially recoverable materials in 2022. C&D materials found in the MSW waste steam make up the largest percentage of this category with 9 percent. The material

components that contribute to this 9 percent are mostly Wood – Untreated (2.3 percent), Carpet and Carpet Padding (2.0 percent), Furniture (1.5 percent), and Soil, Rock, Sand (1.4 percent).

Table 7 displays the historical comparison between 2017 and 2022 analyses. There has been an increase of potentially recoverable materials in the waste stream. The largest increase of material categories being C&D materials with a 5.9 percent difference.

Exhibit 7. 2022 Potentially Recoverable Composition

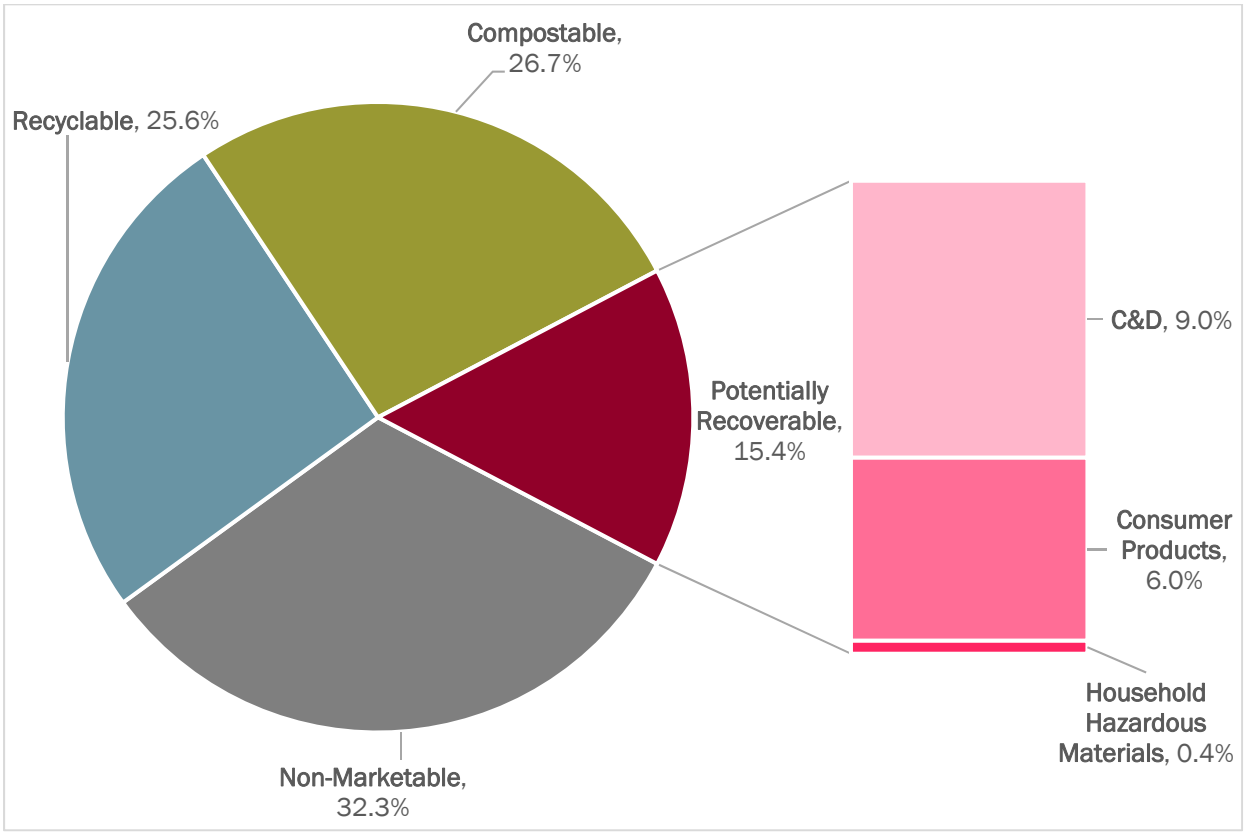


Table 7. Potentially Recoverable Historical Comparison – Detailed

Material Category	2022 Data	2017 Data
C&D	9.0%	3.1%
Consumer Products	6.0%	5.5%
Household Hazardous Materials	0.4%	0.4%
Total	**15.4%**	**9.0%**

4.1.5 MSW Non-Marketable Materials

Exhibit 8 shows the non-marketable classified material components in 2022. Non-marketable materials comprise over one-third of the total recoverability analysis. The Other material category is the largest contributor to this total with a percentage of 13. Plastic materials are the second largest at 10 percent.

Table 8 highlights the historical comparison differences between 2022 and 2017. Overall, non-marketable materials decreased slightly by 0.9 percent. The two material categories that have increased in percentage since 2017 is C&D and Consumer Products.

Exhibit 8. 2022 Non-Marketable Composition

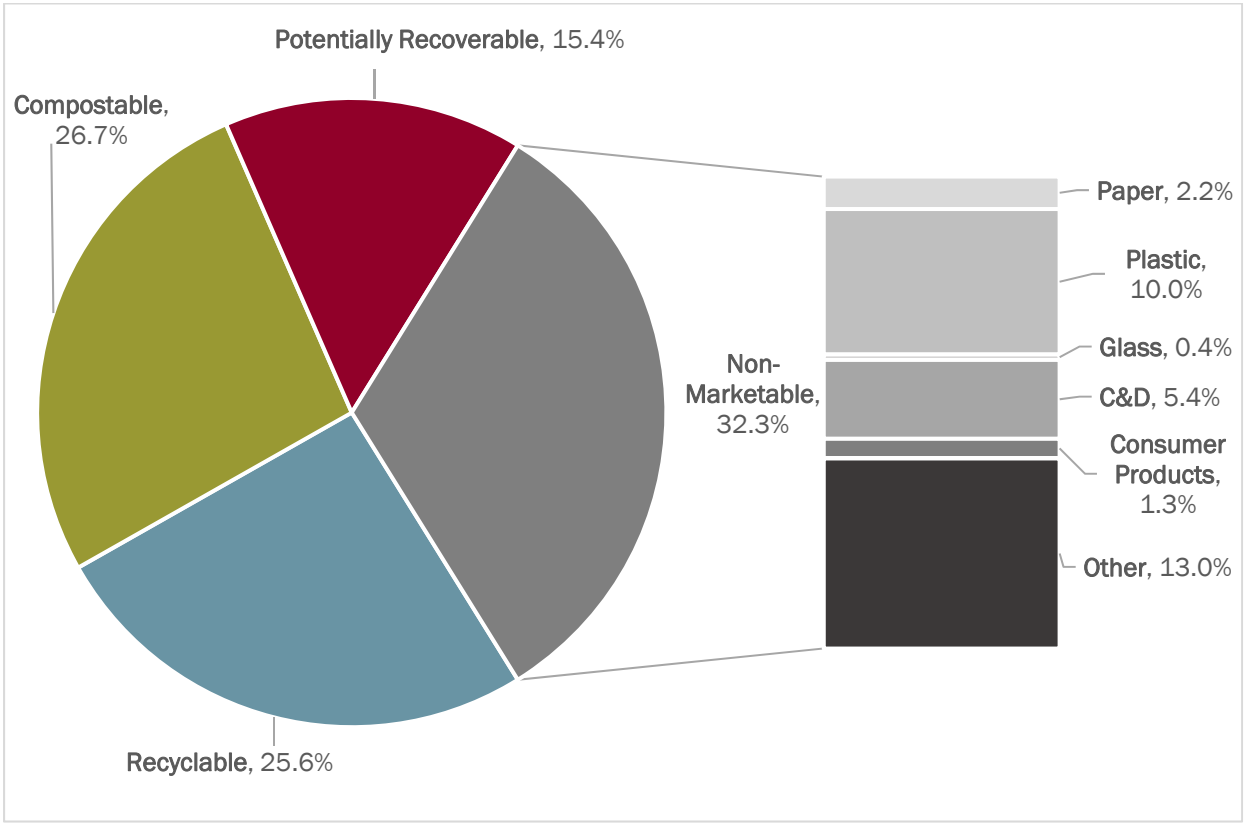


Table 8. Non-Marketable Historical Comparison – Detailed

Material Category	2022 Data	2017 Data
Paper	2.2%	2.9%
Plastic	10.0%	11.6%
Glass	0.4%	0.4%
C&D	5.4%	2.2%
Consumer Products	1.3%	1.0%
HHM	0.0%	0.1%
Other	13.0%	15.0%
Total	**32.3%**	**33.2%**

4.1.6 C&D Material Recoverability Results

Exhibit 9 displays the overall recoverability of C&D materials in 2022. The smallest portion of the recoverability categories is compostable with a percentage of 0.6 (Table 9). The next largest is recyclable materials (9.5 percent) in Table 10 with Ferrous Scrap Metal contributing the most to this category (4.9 percent). The largest divertible category is potentially recoverable at 70 percent as seen in Table 11. The material components Roofing Materials (30.7 percent) and Gypsum Board (10.9 percent) equal over half of this total for potentially recoverable. Lastly, Table 12 displays the non-marketable material components that make up 20 percent of the overall recoverability analysis for C&D materials.

Exhibit 9. 2022 C&D Overall

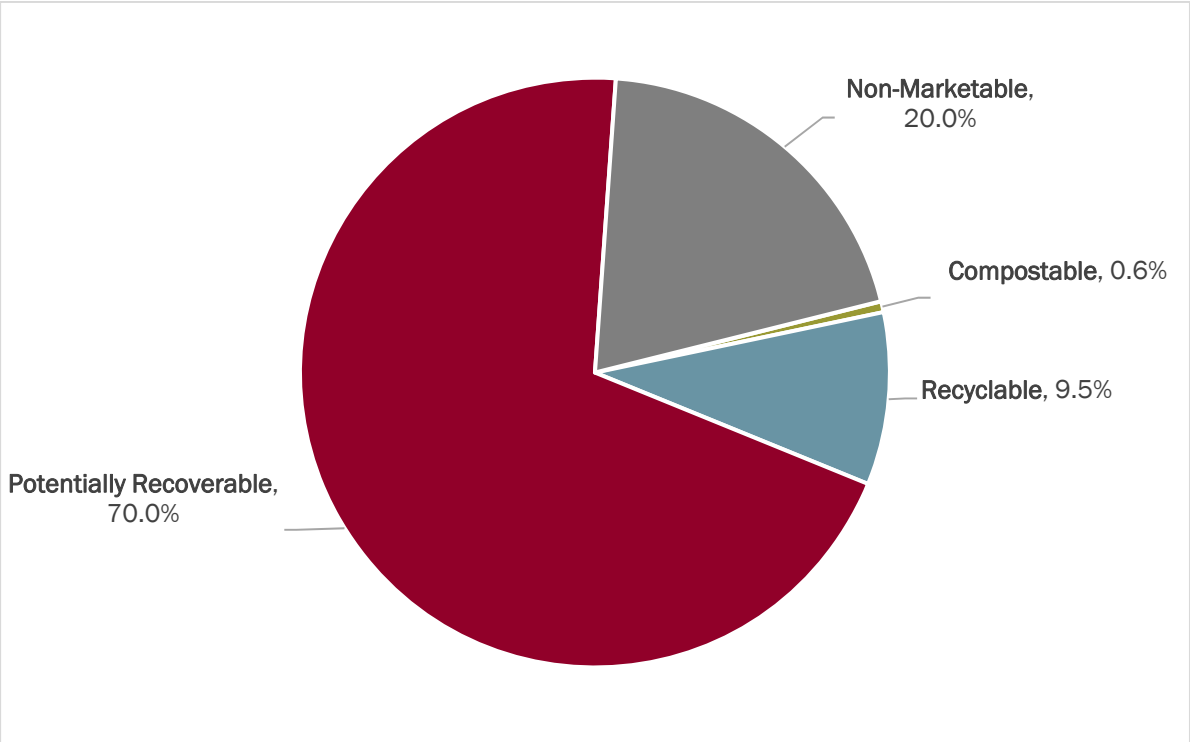


Table 9. Compostable Composition – Detailed

Material Component	2022 Data
Yard Waste	0.6%
Total	**0.6%**

Table 10. Recyclable Composition – Detailed

Material Component	2022 Data
Ferrous Scrap	4.9%
Cardboard	1.9%
Plastic Products	1.3%
Plastic Piping	0.9%
Non-Ferrous Scrap	0.4%
Composite Metal (Wire)	0.1%
Total	**9.5%**

Table 11. Potentially Recoverable – Detailed

Material Component	2022 Data
Roofing Materials	30.7%
Gypsum Board	10.9%
Soil, Rock, Sand	6.5%
Brick	6.1%
Untreated Dimensional Lumber	4.4%
Concrete	3.6%
Wood Pallets	2.9%
Carpet	1.6%
Untreated Wood	1.4%
Furniture	0.9%
Asphalt Paving	0.4%
Electronics	0.3%
Mattresses	0.1%
Bulky Items	0.1%
Plastic Lumber	0.1%
Appliances	0.0%
Total	**70.0%**

Table 12. Non-Marketable – Detailed

Material Component	2022 Data
Painted/Stained Wood	11.6%
Glass	5.2%
Ceramics, Porcelain	1.4%
Other	1.0%
Insulation	0.4%
Bagged Waste	0.2%
Ceiling Tile	0.2%
Total	**20.0%**

4.2 WARM ANALYSIS

SCS used the WARM tool from the EPA (described in Section 3.2) to perform an analysis on MSW and C&D materials that fall into the recoverability classifications of recyclable, compostable, and potentially recoverable. This expands on the 2017 study of only analyzing recyclable and compostable MSW materials.

SCS applied the material percentages identified in the waste from the 2022 Study to reported disposed tonnages in fiscal year (FY) 2022. It is important to note that this analysis captures emissions through the creation of material, transportation, gas collection, etc. all in relation to management of this material through recycling or composting. In some cases, there is a negative number of emissions, indicating the different management of this material has an increase of emissions as compared to the baseline. Although there may be an increase in emissions for the diversion of a particular material, there are multiple benefits to diverting materials that can be seen in the other sections of this report.

4.2.1 MSW Material Analysis

Table 13 shows the historical comparison between 2022 and 2017 in tons that could have been recycled/composted and emissions reduced by metric tons of carbon dioxide if diversion were to occur. The material categories that have an increased potential for reduced emissions directly compared to 2017 are the following categories:

- Paper – 325,500 metric ton increase
- Metal – 53,500 metric ton increase
- Glass – 1,600 metric ton increase

When including the added material components to the 2022 analysis for metals, this number is a 444,900 metric ton increase in emission reductions. These increases contribute to an overall rise in potential emissions reduced by nearly 685,000 metric tons since 2017.

Table 13. MSW Recyclable/Compostable Materials Historical Comparison

WARM Material Components		2022 Analysis		2017 Analysis[2]	
		Tons Recycled/ Composted	Emissions Reduced (MTCO2E)	Tons Recycled/ Composted	Emissions Reduced (MTCO2E)
Paper	Corrugated Containers	195,700	589,000	84,200	262,800
	Magazines/Third-class Mail	12,900	32,200	27,800	85,300
	Newspaper	7,700	13,300	23,900	65,700
	Office Paper	31,000	108,800	16,400	46,900
	Mixed Paper (general)	131,600	439,100	112,200	396,200
	Subtotal	**378,900**	**1,182,400**	**264,500**	**856,900**
Organics	Food Waste	500,900	229,000	370,100	266,200
	Yard Trimmings[1]	65,000	-11,000	--	--
	Subtotal	**565,900**	**218,000**	**370,100**	**266,200**
Plastics	HDPE	24,600	19,100	19,800	17,200
	PET	40,700	42,900	36,300	40,600
	PP[1]	35,400	28,800	--	--
	Mixed Plastics	39,200	37,000	107,000	109,400
	Subtotal	**139,900**	**127,800**	**163,100**	**167,200**
Metal	Aluminum Cans	15,400	141,100	9,300	84,700
	Steel Cans	12,900	23,900	14,800	26,800
	Mixed Metals[1]	88,700	391,400	–	–
	Subtotal	**117,000**	**556,400**	**24,100**	**111,500**
Glass	Glass	35,600	10,500	32,300	8,900
	Subtotal	**35,600**	**10,500**	**32,300**	**8,900**
	Overall Total	**1,237,300**	**2,095,100**	**854,100**	**1,410,700**

[1]Material component not included in 2017 analysis.
[2]This analysis can be found in the 2017 Iowa Statewide Waste Characterization Study.

Table 14 on the following page displays the results for potentially recoverable materials in the waste stream from 2022 that may have been diverted to reduce CO2 emissions. Diverting these materials may decrease emissions by 507,500 metric tons. The largest contributing material category is construction materials making up 94 percent of the total reduction. Within this category, carpet is the main contributor to the reduction in emissions with 438,700 metric tons reduced by diversion.

Table 14. MSW Potentially Recoverable Materials

WARM Material Components		2022 Analysis	
		Tons Recycled/ Composted	Emissions Reduced (MTCO2E)
Plastics	Mixed Plastics	4,700	4,500
	Subtotal	**4,700**	**4,500**
Electronics	Portable Electronic Devices	21,400	23,200
	Flat-Panel Displays	200	200
	Electronic Peripherals	1,700	700
	Hard Copy Devices	700	400
	Mixed Electronics	1,100	1,000
	Subtotal	**25,100**	**25,500**
Construction Materials	Asphalt Concrete	700	100
	Asphalt Shingles	8,800	1,000
	Carpet	182,600	438,700
	Concrete	17,000	500
	Dimensional Lumber	61,300	38,100
	Drywall	10,500	-900
	Subtotal	**280,900**	**477,500**
	Overall Total	**310,700**	**507,500**

4.2.2 C&D Material Analysis

Of all C&D materials found in the waste stream, a small amount are classified as recyclable or compostable. However, diverting these materials still has a positive impact on CO2 emissions. Table 15 on the following page displays the result of diverting recyclable and compostable materials from the C&D waste stream. The largest reduction in CO2 emissions comes from diverting mixed metals (205,100 metric tons reduced), followed by corrugated containers (48,500 metric tons reduced).

Table 15. C&D Recyclable/Compostable Materials

WARM Material Components		2022 Analysis	
		Tons Recycled/ Composted	Emissions Reduced (MTCO2E)
Paper	Corrugated Containers	16,100	48,500
	Subtotal	**16,100**	**48,500**
Organics	Yard Trimmings	5,200	-900
	Subtotal	**5,200**	**-900**
Plastics	Mixed Plastics	18,800	17,800
	Subtotal	**18,800**	**17,800**
Metals	Mixed Metals	46,500	205,100
	Subtotal	**46,500**	**205,100**
	Overall Total	**86,600**	**270,500**

The reduction in CO2 emissions for potentially recoverable materials can be seen in Table 16 (next page). Construction materials account for over 97 percent of the overall potential reduction in CO2 emissions for potentially recoverable materials. Dimensional lumber (46,200 metric tons reduced), carpet (32,500 metric tons reduced), and asphalt shingles (29,200 metric tons reduced) largely make up this total.

Table 16. C&D Potentially Recoverable Materials

WARM Material Components		2022 Analysis	
		Tons Recycled/ Composted	Emissions Reduced (MTCO2E)
Plastics	Mixed Plastics	400	400
	Subtotal	**400**	**400**
Electronics	Mixed Electronics	2,700	2,500
	Subtotal	**2,700**	**2,500**
Construction Material	Asphalt Concrete	3,700	400
	Asphalt Shingles	264,800	29,200
	Carpet	13,600	32,500
	Concrete	30,900	900
	Dimensional Lumber	74,400	46,200
	Drywall	94,200	-8,200
	Subtotal	**481,600**	**101,000**
	Overall Total	**484,700**	**103,900**

4.3 JOB ANALYSIS

The job analysis was performed on recyclable materials that were determined recyclable by the recoverability study and materials that were studied in 2017. This includes materials from the MSW generating sector.

Table 17 on the following page displays the number of jobs created through manufacturing of recyclables. The plastics material category would provide the largest number of jobs (3,310 jobs) if this material was diverted from disposal.

Table 18 on the following page shows additional material components that were not previously included for diverted waste in 2017. The additional material components potentially add over 2,000 jobs to the economy, with textiles being the largest contributor to this number.

Table 17. Estimated Job Creation for Manufacturing of Recyclables

Divertible Materials	Estimated Divertible Tons	Diverted Waste				
		Estimated Jobs Creation				
		Collection	Processing	Manufacturing	Total	Estimate for Iowa
Paper	378,900	1.67	2.00	4.16	3.67	1,390
Glass	35,600	1.67	2.00	7.85	11.02	390
Ferrous Metal	12,900	1.67	2.00	4.12	23.67	310
Nonferrous Metal	15,400	1.67	2.00	17.63	23.67	360
Plastics[1]	139,700	1.67	2.00	10.3	23.67	3,310
Food Waste	500,857	1.67	0.50	--	2.17	1,090
TOTAL	**1,083,357**					**6,850**

[1]Other Plastic Products was included in the 2017 Job Analysis but has been removed as this material component has been determined to be excluded from markets.

Table 18. Estimated Job Creation for Manufacturing of Recyclables – Additional Materials

Divertible Materials	Estimated Divertible Tons	Diverted Waste				
		Estimated Jobs Creation				
		Collection	Processing	Manufacturing	Total	Estimate for Iowa
Yard Waste	65,010	1.67	0.5	--	2.17	140
Ferrous Metal	76,929	1.67	2	4.12	7.79	600
Nonferrous Metal	11,794	1.67	2	17.63	21.30	250
Textiles	130,975	1.67	2	2.5	6.17	810
Wood	61,334	1.67	2	2.8	6.47	400
TOTAL	**346,041**					**2,200**

Table 19 on the following page displays the number of jobs created through the reuse of recyclable and compostable materials. The largest contributor to job creation is paper materials, estimating 2,970 jobs by reusing and remanufacturing this material.

Table 20 on the following page displays additional material components that were not previously included for diverted waste in 2017. The addition of these materials for diversion would increase the jobs created by 4,080. Ferrous Metal (1,820 jobs) and Textiles (1,440 jobs) contribute the most to this total.

Table 19. Estimated Job Creation for Reuse of Recyclables

Divertible Materials	Estimated Divertible Tons	Diverted Waste				
		Estimated Jobs Creation				
		Collection	Processing	Reuse/Remanufacture	Total	Estimate for Iowa
Paper	378,900	1.67	2.00	--	7.83	2,970
Glass	35,600	1.67	2.00	7.35	11.52	410
Ferrous Metal	12,900	1.67	2.00	20	7.79	100
Nonferrous Metal	15,400	1.67	2.00	20	21.30	330
Plastics[1]	139,700	1.67	2.00	20	13.97	1,950
Food Waste	500,857	1.67	0.50	--	2.17	1,090
TOTAL	**1,083,357**					**6,850**

[1]Other Plastic Products was included in the 2017 Job Analysis but has been removed as this material component has been determined to be excluded form markets.

Table 20. Estimated Job Creation for Reuse of Recyclables – Additional Materials

Divertible Materials	Estimated Divertible Tons	Diverted Waste				
		Estimated Jobs Creation				
		Collection	Processing	Reuse/Remanufacture	Total	Estimate for Iowa
Yard Waste	65,010	1.67	0.5	--	2.17	140
Ferrous Metal	76,929	1.67	2	20	23.67	1,820
Nonferrous Metal	11,794	1.67	2	20	23.67	280
Textiles	130,975	1.67	2	7.35	11.02	1,440
Wood	61,334	1.67	2	2.8	6.47	400
TOTAL	**346,041**					**4,080**

Table 21 on the following page shows the number of jobs created by supporting the disposal of recyclable materials. Disposal is the least labor-intensive management method for recyclable materials, creating a total of 710 jobs.

Table 22 on the following page displays the potential job creation with the additional materials for recycling being disposed, supporting an additional 230 jobs.

Table 21. Estimated Job Creation for Disposal of Recyclables

Divertible Materials	Estimated Divertible Tons	Diverted Waste			
		Estimated Jobs Creation			
		Collection	Disposal	Total	Estimate for Iowa
Paper	378,900	0.56	0.1	0.66	250
Glass	35,600	0.56	0.1	0.66	20
Ferrous Metal	12,900	0.56	0.1	0.66	10
Nonferrous Metal	15,400	0.56	0.1	0.66	10
Plastics[1]	139,700	0.56	0.1	0.66	90
Food Waste	500,857	0.56	0.1	0.66	330
TOTAL	**1,083,357**				**710**

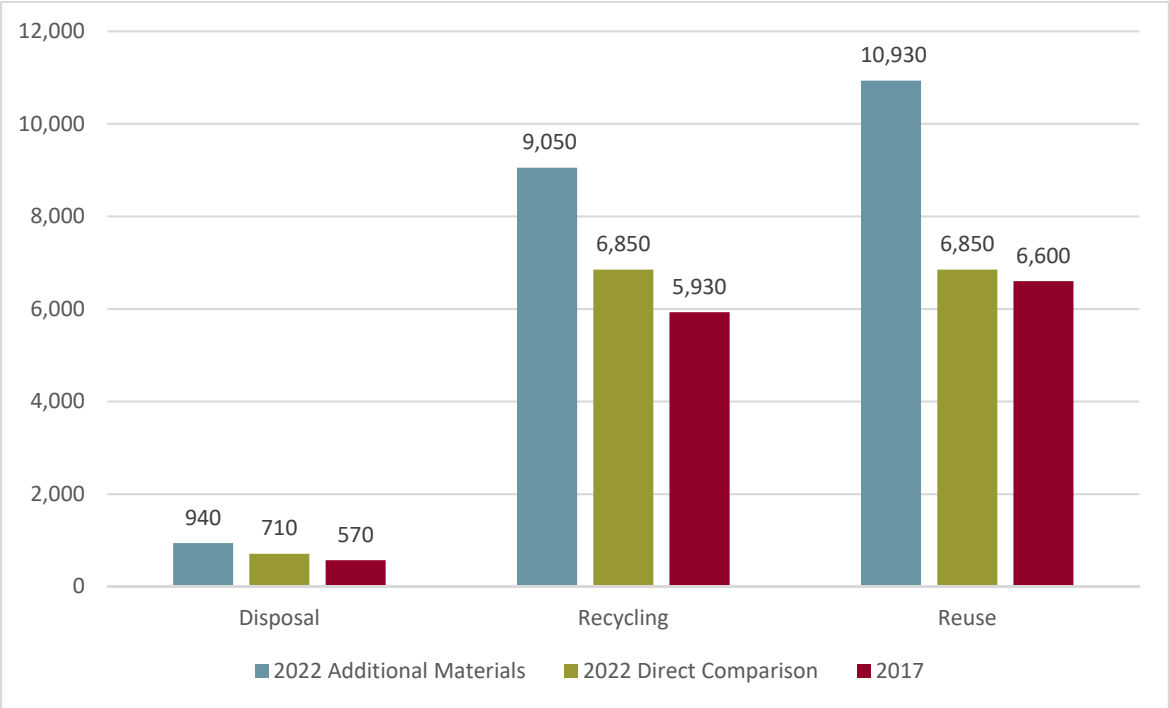
[1]Other Plastic Products was included in the 2017 Job Analysis but has been removed as this material component has been determined to be excluded form markets.

Table 22. Estimated Job Creation for Disposal of Recyclables – Additional Materials

Divertible Materials	Estimated Divertible Tons	Diverted Waste			
		Estimated Jobs Creation			
		Collection	Disposal	Total	Estimate for Iowa
Yard Waste	65,010	0.56	0.1	0.66	40
Ferrous Metal	76,929	0.56	0.1	0.66	50
Nonferrous Metal	11,794	0.56	0.1	0.66	10
Textiles	130,975	0.56	0.1	0.66	90
Wood	61,334	0.56	0.1	0.66	40
TOTAL	**346,041**				**230**

Exhibit 10 displays the historical comparison of the job analysis between 2017 and 2022. There are two graph bars for 2022 relating to the addition of material components and the direct comparison to 2017 material components. In general, recycling and reusing materials is more labor-intensive, therefore diverting this material has the potential to create more jobs. Reusing with additional materials added creates the most job opportunities.

Exhibit 10. Job Analysis Historical Comparison



4.4 ECONOMIC IMPACT

The economic impact analysis was performed on recyclable materials that were determined recyclable by the recoverability study, were able to be defined on the recycling market website, and materials that were studied in 2017. This includes materials from the MSW generating sector.

Table 23 displays the results of the 2022 and 2017 analysis. It is estimated that a total of over $95,000,000 could have been captured as revenue if 100 percent of the tons listed were diverted for recycling. This revenue is nearly a 58 percent increase as compared to the 2017 analysis. The plastic material category has increased in total market value even with a decrease in disposed tons.

Table 24 displays the 2022 and 2017 comparison by material components. Each of the material components list the estimated tons disposed, average market price, and estimated total commodity market rate in U.S. dollars. Below lists observations by material category.

- Paper – OCC and Kraft Paper is the largest contributor to the total commodity market rate with nearly an estimated $18,000,000. This number almost doubles the findings of OCC and Kraft Paper from 2017.
- Plastic – HDPE products have increased in disposed tons and average market price since 2017, increasing the estimated commodity market rate of these material types. #2 Natural HDPE Containers have increased in market rate by over 100 percent and #2 Colored HDPE Containers have increased in market rate by over 78 percent.
- Metal – Aluminum IA Deposit Beverage Containers had the largest increase in disposed tons and commodity market rate from 2017.

- Glass – Glass currently has a total commodity market rate of $0 per ton. While this material may not produce revenue from sales to markets, there are other benefits and user values to recycling this material.

Table 23. Economic Impact Historical Comparison

	2022 Analysis		2017 Analysis	
Material Categories	Estimated Tons Disposed[1]	Estimated Total Commodity Market Rate ($)	Estimated Tons Disposed	Estimated Total Commodity Market Rate ($)
Paper	378,900	$27,267,400	275,700	$20,414,250
Plastic	139,700	$44,022,300	163,100	$23,812,500
Metal	28,300	$23,787,400	24,100	$15,146,000
Glass	35,600	$0	32,300	$936,900
Overall Total	**582,500**	**$95,077,100**	**495,300**	**$60,309,650**

[1]Disposed tonnage based on FY 2022 tonnages reported from the DNR.

Table 24. Economic Impact Historical Comparison – Detailed

Material Components		2022 Analysis			2017 Analysis		
		Estimated Tons Disposed[1]	Average Market Price ($/ton)[2]	Estimated Total Commodity Market Rate ($)	Estimated Tons Disposed	Average Market Price ($/ton)[5]	Estimated Total Commodity Market Rate ($)
PAPER	High Grade Office Paper	31,000	$70	$2,158,700	16,400	$210	$3,444,000
	Mixed Recyclable Paper	116,100	$43	$5,001,300	112,200	$33	$3,646,500
	Newsprint	7,700	$70	$535,200	23,900	$38	$896,250
	Magazines/Catalogs	12,900	$70	$898,700	27,800	$88	$2,432,500
	OCC and Kraft Paper	195,700	$92	$18,004,900	84,200	$108	$9,051,500
	Aseptic/Gable Top Containers	15,500	$43	$668,600	11,100	$85	$943,500
	Subtotal	**378,900**		$27,267,400	**275,700**		**$20,414,250**

Material Components		2022 Analysis			2017 Analysis		
		Estimated Tons Disposed[1]	Average Market Price ($/ton)[2]	Estimated Total Commodity Market Rate ($)	Estimated Tons Disposed	Average Market Price ($/ton)[5]	Estimated Total Commodity Market Rate ($)
PLASTIC	#1 PET IA Deposit Beverage Containers	6,500	$328	$2,140,500	6,800	$295	$2,006,000
	#1 PET Beverage Containers	21,500	$328	$7,061,600	20,900	$295	$6,165,500
	#1 PET Other Non-Beverage Containers	12,600	$328	$4,151,300	8,600	$295	$2,537,000
	#2 HDPE Natural Containers	9,300	$1,196	$11,070,600	8,600	$635	$5,461,000
	#2 HDPE Colored Containers	15,300	$443	$6,785,300	11,200	$340	$3,808,000
	#3 PVC[4]	3,200	$19	$61,600			
	#4 LDPE[4]	1,500	$19	$29,300			
	#5 PP[4]	35,400	$341	$12,061,000	41,200	$20	$824,000
	#6 PS[4]	12,600	$19	$242,100			
	#7 Other/Unknown Plastic[4]	5,900	$19	$113,800			
	Retail Shopping Bags[4]	15,900	$19	$305,200			
	Other Plastic Containers[3]	--	--	--	9,300	$20	$186,000
	Other Plastic Products[3]	--	--	--	56,500	$50	$2,825,000
	Subtotal	**139,700**		**$44,022,300**	**163,100**		**$23,812,500**
Metal	Aluminum IA Deposit Beverage Containers	13,700	$1,392	$19,138,200	7,700	$1,370	$10,549,000
	Aluminum Beverage Containers	1,700	$1,392	$2,345,400	1,600	$1,370	$2,192,000
	Ferrous Food and Beverage Containers	12,900	$178	$2,303,800	14,800	$163	$2,405,000
	Subtotal	**28,300**		**$23,787,400**	**24,100**		**$15,146,000**
GLASS	Glass IA Deposit Containers	20,300	-$24	<100	15,600	$28	$429,000
	Clear Glass Containers	12,500	-$24	<100	14,900	$31	$461,900
	Green Glass Containers	1,300	-$24	<100	200	$10	$2,000
	Brown/Other Colored Glass Containers	1,500	-$24	<100	1,600	$28	$44,000
	Subtotal	**35,600**		**$0**	**32,300**		**$936,900**
	Overall Total	**582,500**		**$95,077,100**	**495,300**		**$60,309,650**

[1]Disposed tonnage based on FY 2022 tonnages reported from the DNR.
[2]5-year average of market price.

[3]These material components included in the 2017 Market Analysis but has been determined now to be excluded from markets.
[4]These material components were combined for the characterization in 2017.

5.0 CONCLUSION

The diversion of waste from disposal at landfills supports a circular system leading to a sustainable materials management (SMM) system. The state of Iowa continues to prioritize SMM principals by performing analyses similar to this report and beyond to inform future material management plans and assessment of current programs. There are multiple benefits to recovering materials for recycling and reuse such as: an increase of jobs for processing materials, and additions of revenue for the sale of recyclable materials, and a reduction in metric tons of carbon dioxide emissions.

The recoverability analysis determined that nearly 70 percent of MSW and 80 percent of C&D materials disposed in 2022 could have been diverted through recycling, composting, or specific recycling programs. This information encourages opportunities of diversion by providing evidence of materials available to expand and create recycling and composting programs. Applying these percentages to fiscal year 2022 tons disposed provided by the DNR, it is estimated that 1,772,228 tons of MSW and 689,190 tons of C&D material could be diverted from the waste stream. This estimated 2,641,417-ton increase in materials being processed would likely need to be supported by an increase in education, infrastructure, and labor.

With the potential to expand and create programs, this leads to the creation of jobs and supporting the work force in Iowa. The potential jobs created through recycling materials identified in this study are estimated at 9,050 and 10,930 jobs created through reuse and remanufacturing. Recycling, reuse and remanufacturing are more labor-intensive material management strategies that would allow for the support of the Iowa workforce.

Another aspect of this circular economy system is the revenue that may be produced through the sale of this recovered material. The revenue of the recyclable materials identified in this study equaled over $95,000,000. This revenue would continue to support the robust recycling infrastructure within Iowa, while also supporting Iowa's economy in general.

In addition to the increased recycling/composting tons, jobs, and revenue, there is a benefit of reducing the carbon dioxide emissions through recycling and composting activities. Through diverting both MSW and C&D materials, this equals a reduction of an estimated 2,997,000 metric tons of carbon dioxide emissions. Not only does this create a more sustainable system of materials management in Iowa, but this increases the general well-being of the public by protecting Iowa's land, water, and air through reducing emissions.