WASTE MANAGEMENT: UNREALIZED ENVIRONMENTAL & ECONOMIC BENEFITS FOR CHICAGOLAND

OCTOBER 2014

delta institute

ABOUT DELTA INSTITUTE

Established in 1998, Delta Institute is a Chicago-based nonprofit organization that works throughout the Great Lakes region to build a resilient environment and economy through sustainable, market-driven solutions. Over the last 16 years, Delta Institute has built a diverse portfolio of waste management work, including waste reduction, diversion strategies, landfill capacity analysis, and modeling of the environmental, economic, and social impacts of waste management strategies. Delta has led several successful waste infrastructure projects in recent years, including work with Cook County Department of Environmental Control on their waste audit and policies, assisting McHenry County to update their solid waste plan, developing tools and best practices around management of electronic waste, and founding and managing Chicago's Rebuilding Exchange.

Visit online at **www.delta-institute.org.**

This regional waste benchmarking study was made possible with support from Searle Funds at The Chicago Community Trust.

In addition, Delta would like to thank the organizations that played a key role in supporting Delta's research, including: Cook County, City of Chicago, the Illinois Environmental Council, Research Triangle Institute, South Suburban Mayors and Managers Association, Solid Waste Agency of Northern Cook County, National Waste & Recycling Association - Illinois Chapter, and the 20 municipalities that participated in this study.

TABLE OF CONTENTS

INTRODUCTION

Waste management in the U.S. is a $43 billion industry, employing 202,937 Americans[1]. While largely hidden from public view, our waste management system is a major economic driver with the potential to advance environmental sustainability objectives, such as waste reduction, resource conservation, and material reuse.

The Chicago Metropolitan Region's waste management statistics lag behind national averages. Currently, Cook County residents produce 7 pounds of waste per day compared to the average American who generates 4.4 pounds of waste per day, and Cook County's 29% (excluding Chicago) recycling rate trails the national average of 34%. Concerned by Cook County's above-average waste generation and below-average recycling rate, Delta Institute sought to determine the existing conditions of the region's waste management system and its associated environmental and economic impacts.

1 "Waste Collection Services in the US: Market Research Report," NAICS 56211

With support from Searle Funds at The Chicago Community Trust, Delta Institute conducted a regional waste benchmarking study. Using data supplied by Cook County and participating Chicagoland municipalities, we determined the economic and environmental costs of current waste management practices for 20 municipalities across the Chicago Metropolitan Region. The research team then modeled the economic and environmental costs in the year 2040[2] under three distinct future waste management scenarios. The three waste management scenarios include: 1) Status Quo in 2040, 2) 40% Recycling Rate in 2040, and 3) 60% Waste Diversion Rate, where waste diversion includes recycling and compost, in 2040.

We found that by increasing rates of recycling and waste diversion, the Chicago Metropolitan Region could create up to 39,000 regional jobs by 2040 and achieve significant environmental benefits, offsetting all greenhouses gas emissions from waste management-related practices, such as collection, disposal, transportation, and separation.

2 The year 2040 was selected to align with the Chicago Metropolitan Agency for Planning's GOTO 2040 regional, long-term comprehensive plan.

SUMMARY OF FINDINGS

Access to curbside recycling varies in and among communities.

Inconvenient recycling options result in lower recycling rates. Of the 20 communities benchmarked, recycling options varied, including one community that provided a drop-off option instead of curbside recycling.

Consumer education is needed to reduce contamination and improve recycling rates.

Both communities with strong recycling programs and those with less robust programs cited consumer education as key to reducing contamination and improving recycling rates.

Local government leadership on waste management is critical.

Communities with successful recycling programs either have sustainability plans or have adopted the goals of a joint action agency for waste management.

Collection is the most expensive cost component of waste management.

The cost of collection is projected to increase, as population growth will result in additional material generation.

Waste diversion can more than offset all waste management-related emissions.

By attaining or exceeding a recycling rate of 40%, we can more than offset waste-related emissions, because the remanufacturing of recycled materials displaces the energy-intensive process of extracting raw materials.

We can create 39,000 regional waste-related jobs by 2040.

If the regional waste diversion rate reaches 60% by the year 2040, more than 39,000 regional jobs could be generated through expanded recycling, composting, processing, and collection[3].

[3] See Appendix 4 for Jobs Forecasting Methodology.

METHODOLOGY

Delta began its research with a review of regional and national waste agency reports and solid waste management plans to understand the local and national state of the field. We then conducted 28 interviews with regional waste system stakeholders, including municipalities, waste haulers, advocacy groups, and recycling and diversion entrepreneurs.

Delta compiled publicly available data for two additional municipalities. Based on the literature review and stakeholder interviews, Delta designed a waste management survey for municipalities. The survey instrument was distributed to six municipal membership organization's mailing lists, and achieved a 33% response rate. The municipalities included in the model represent a geographically and socioeconomically diverse set of communities.

Delta used the Municipal Solid Waste Decision Support Tool (MSWDST) modeling program to measure current and future environmental and economic impacts of waste management practices for 20 municipalities in the Chicago Metropolitan Region. The MSWDST is a full cost accounting and life cycle assessment model developed by RTI International in partnership with the U.S. Environmental Protection Agency[4]. The data used as inputs for the model were from the above mentioned survey and a comprehensive review of waste agency reports.

To calculate the potential for job creation through waste diversion, we utilized the Ball State University's Bowen Center for Public Affairs[5] direct jobs multiplier table, which was prepared for the Indiana Recycling Coalition. Compared to other studies reviewed, the Ball State report offered the most conservative estimates for the number of jobs created through recycling and composting. The Ball State report is also relevant to this study, as the data was collected in the same Midwest region.

[4] See Appendix 1, Model Information and Methods, for full modeling methodology and more information on the MSWDST.

[5] See Appendix 4 for information on the article titled "The Untapped Jobs Potential of Indiana's Recycling Industry" and full details on job calculation methodology.

BENCHMARKING CHICAGOLAND WASTE PRACTICES

Delta Institute began its research by establishing the current conditions of the Chicago Metropolitan Region's waste management practices, which are represented in the 2014 Base Case scenario. The three future scenarios modeled are projections to the year 2040, and they assume an increase in population based on Chicago Metropolitan Agency for Planning's (CMAP) 2040 forecast:

Future Scenarios

1) Status Quo, which assumes today's practices;

2) 40% Recycling Rate in 2040; and

3) 60% Waste Diversion Rate[6] in 2040, comprised of a 45% recycling rate, and a 15% compost rate (9% yard waste collection rate, and 6% food scrap recycling rate).

[6] See Figure 1 for full scenario details.

A recycling rate (RR) of 40% was selected as one of the future scenarios, because it represents what many municipalities have identified as their recycling goal. The 60% waste diversion rate (DR) was selected as one of the future scenarios because it is currently the maximum waste diversion rate achievable based on the region's current waste stream characterization[7]. This report summarizes the economic and environmental implications of each waste management scenario utilizing a lifecycle cost-based methodology.

[7] Delta Institute. 2012. Cook County Solid Waste Management Plan 2012 Update, Cook County Department of Environmental Control. See figures in Appendix 2.

Scenario Name	Year	Recycling Rate	Compost Rate (yard waste and food scrap
2014 Base Case	2014	22.3% (average of all communities surveyed)	6.5% (average of all communities surveyed)
2040 Status Quo	2040	22.3%	6.5%
2040 40% RR	2040	40%	6.5%
2040 60% DR	2040	45%	15% (both yard waste and food scrap compost)

Table 1: Detail of All Waste Management Scenarios Modeled

SURVEY RESULTS

To determine current practices, Delta Institute broadly distributed a survey on waste management practices to municipalities. The survey included questions about the waste management services they provide to residents, how they communicate with residents about recycling, and the barriers they see for increased waste diversion. Communities reported the following:

Communications

- 20 of 20 communities used newsletters to communicate information to residents.
- 13 of 20 used their website.
- 5 of 20 used social media.
- 1 of 20 used a call system for reminders.
- 1 of 20 retained a communications consultant.

Service contracts

- 19 of 20 used a waste hauler (1 community collected and hauled their waste).
- 10 of 20 leveraged their waste hauler procurement process to get recycling bins.

Recycling access

- 19 of 20 had curbside services.
- 1 of 20 had a drop-off center.

Additional waste materials collected

- 7 of 20 provided yard waste collection.
- 4 of 20 provided for electronic recycling.
- 1 of 20 had a pilot compost program.
- 2 of 20 were interested in providing textile collection.

Survey respondents highlighted the need for consumer education and information, regardless of whether the community had high or low recycling rates. Finally, communities with either published sustainability plans or membership in a joint action agency for waste management, such as Solid Waste Association of Northern Cook County, the West Cook Solid Waste Agency, or Solid Waste Association of Lake County, achieved higher recycling rates than those communities without sustainability plans or association membership.

ECONOMIC COSTS AND BENEFITS OF WASTE MANAGEMENT

Waste management is a complex system comprised of many processes, and different waste management practices have unique system-wide economic impacts. For this study, Delta looked at the full economic costs for all components of waste management, including collection, transfer, separation, treatment (composting), disposal, transportation, and remanufacturing[8].

The cost findings of this study do not solely represent the expenses borne by the municipality; rather, they represent system-wide financial costs associated with each waste management component. The MSWDST tool is not a cash flow model. The results provided are a total cost analysis, which represents the screening level engineering costs experienced by the public sector[9].

As seen in Figure 1, in each of the four scenarios, the largest cost of waste management is collection, where collection refers to residential pickup of mixed refuse in a single-compartment truck and the separate pickup of comingled recyclables. Between the 2014 Base Case and 2040 Status Quo scenarios, collection costs are projected to increase, because population growth will result in additional material generation. Collection costs continue to increase between 2040 Status Quo and 2040 40% RR, because an increase in the recycling rate will require a more complex collection structure. This more complex collection structure might include more collection vehicles or more frequent services. Between 2040 40% RR and 2040 60% DR, collection costs increase slightly with the introduction of food scrap compost collection, which will require an even more complex collection method. Compost is used here instead of anaerobic digestion, because the model does not provide an anaerobic digestion option. However, the Metropolitan Water Reclamation District has an anaerobic digester that may be made available to municipalities in the future.

8 For information regarding cost assumptions embedded in each waste management category, please see the MSWDST manual.
9 Research Triangle Institute, North Carolina State University, and U.S. Environmental Protection Agency. 2000. "A Decision Support Tool for Assessing the Cost and Environmental Burdens of Integrated Municipal Solid Waste Management Strategies: USERS MANUAL."

Waste Management

Collection: Transfer of solid waste from the point of use and disposal to the point of treatment or landfill.

Disposal: The processes of landfilling or incinerating waste.

Remanufacturing: Transforming a recycled material into a new good or product.

Separation: The process of taking comingled recycled materials and storing them by material type.

Transportation: The movement of waste and recycled materials through the mechanism of roadway transport.

Treatment: The process of composting yard waste or mixed organic waste.

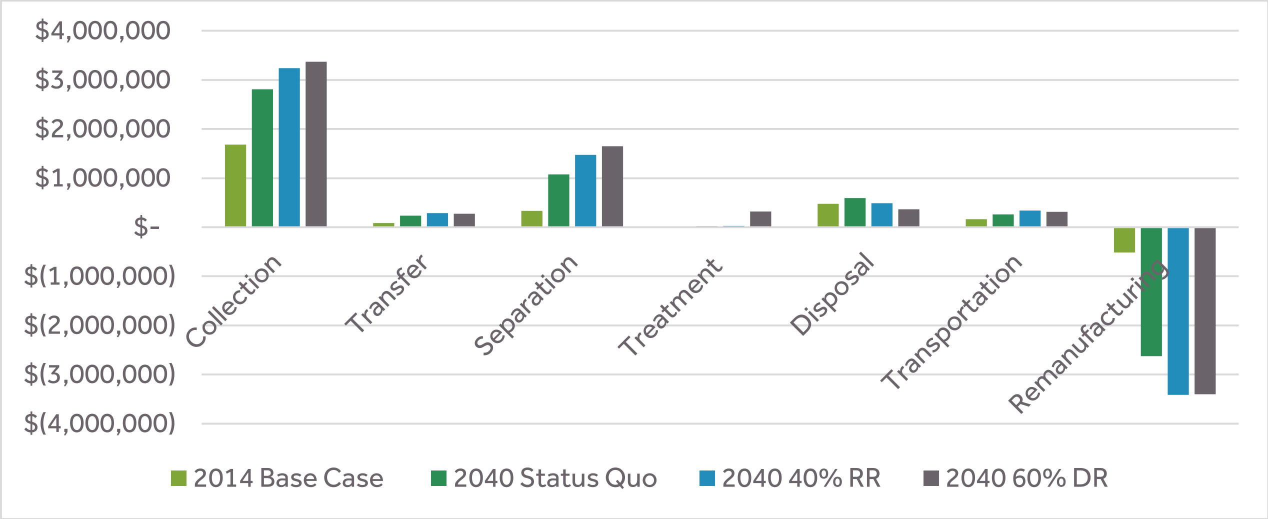

Figure 1. Average Total Costs of All Waste Management Components for 20 Municipalities in the Chicago Metro Region

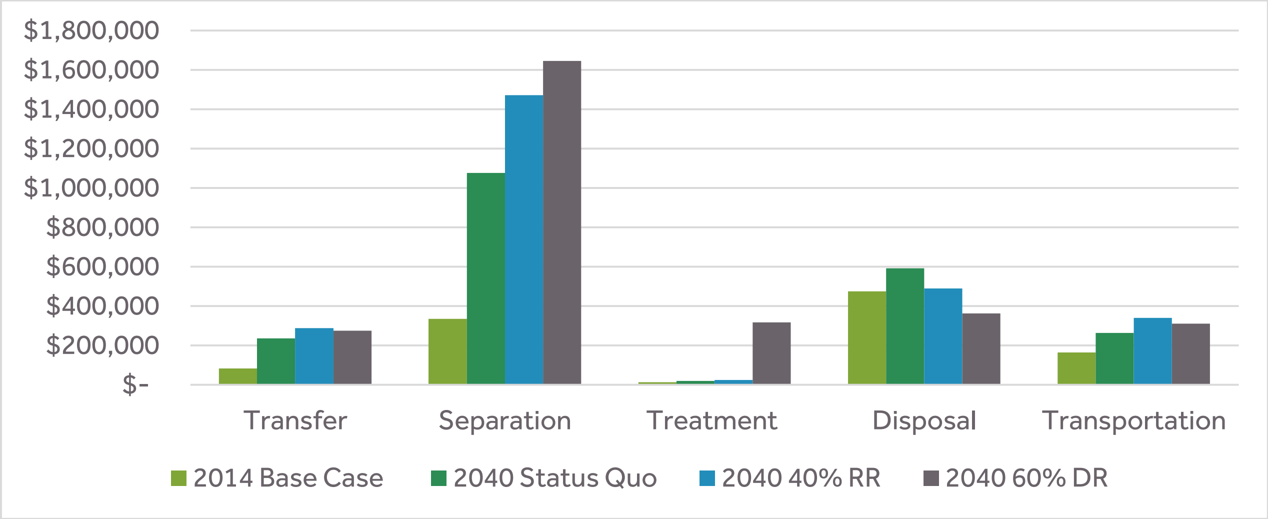

Figure 2. Average Cost of Select Waste Management Components for 20 Municipalities in the Chicago Metro Region

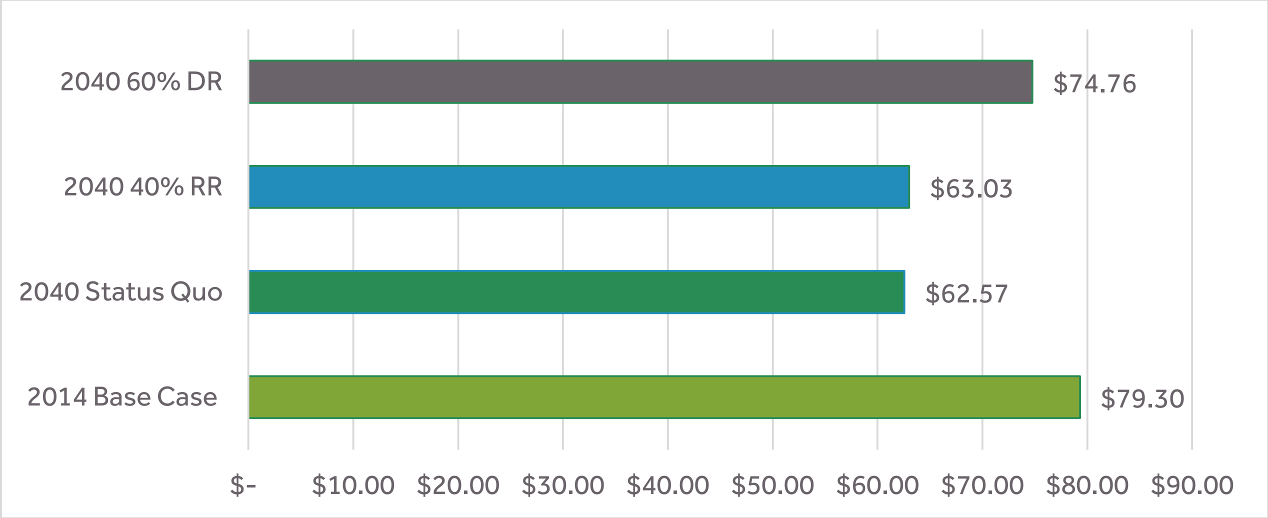

Figure 3. Total Cost Per Capita of All Waste Management Components for Each Scenario Modeled

While collection costs are expected to increase with improved recycling and diversion, those higher collection costs can be significantly offset through revenue from recycled materials. Between the 2014 Base Case and the 2040 Status Quo scenarios, remanufacturing revenues are expected to increase as the amount of recyclable material generated increases with a growing population[10]. The recycling rate continues to rise between 2040 Status Quo, 2040 40% RR, and 2040 60% DR, and remanufacturing revenues continue to increase as more material is collected in the form of recyclables. These materials can reenter the economy in the form of remanufactured goods. The revenues generated from remanufacturing goods can offset the cost associated with diverting them from landfills.

Figure 2 illustrates that as waste diversion rates increase with each scenario, there is an inverse cost relationship between the separation of waste (recycling) and the disposal of waste (landfilling).

As more material is introduced into the recycling stream, the amount of material being landfilled is reduced. For all 2040 scenarios, separation costs greatly increase due to the increased material and RTI's assumption that 2040's need for recyclables will be much greater than today. Between the 2040 Status Quo and the 2040 60% DR scenarios, there is a significant reduction in disposal costs, as less tonnage of material is being landfilled. The resulting increased tonnage of material undergoing separation will increase the total separation cost.

10 See Modeling Future Waste Management Scenarios Using the MSWDST in Appendix 3.

The system-wide cost of most waste management processes is expected to increase between Base Case 2014 and 2040 Status Quo. The increased costs are a result of expected population growth between the years 2014 and 2040. For this study, the research team assumed that per capita waste generation rates will remain the same between 2014 and 2040, but overall waste generation will increase with a larger population. To analyze these costs without the variable of population size, we looked at per capita costs of waste management for the various scenarios, as seen in Figure 3.

In the 2014 Base Case scenario, per capita cost of all waste management components is $79.30 per year. The per capita cost decreases between the 2014 Base Case and the 2040 Status Quo scenarios to $62.57 per year. This decrease in per capita cost is associated with the expected increase in value of recyclable commodities. Despite the expected increase in recyclable commodity value, there is an increase in per capita cost between 2040 Status Quo and 2040 40% RR, and an even higher increase between 2040 40% RR and 2040 60% DR. The increase is a result of material separation costs being greater than the material disposal costs.

Despite the increase in per capita cost associated with increased waste diversion, the 2014 Base Case per capita cost is still greater than the 2040 60% DR scenario per capita cost. Also, the end products of waste diversion (soil amendments and recyclable material) can potentially provide a source of revenue to offset their high cost.

WASTE DIVERSION IMPACT ON GREENHOUSE GAS EMISSIONS

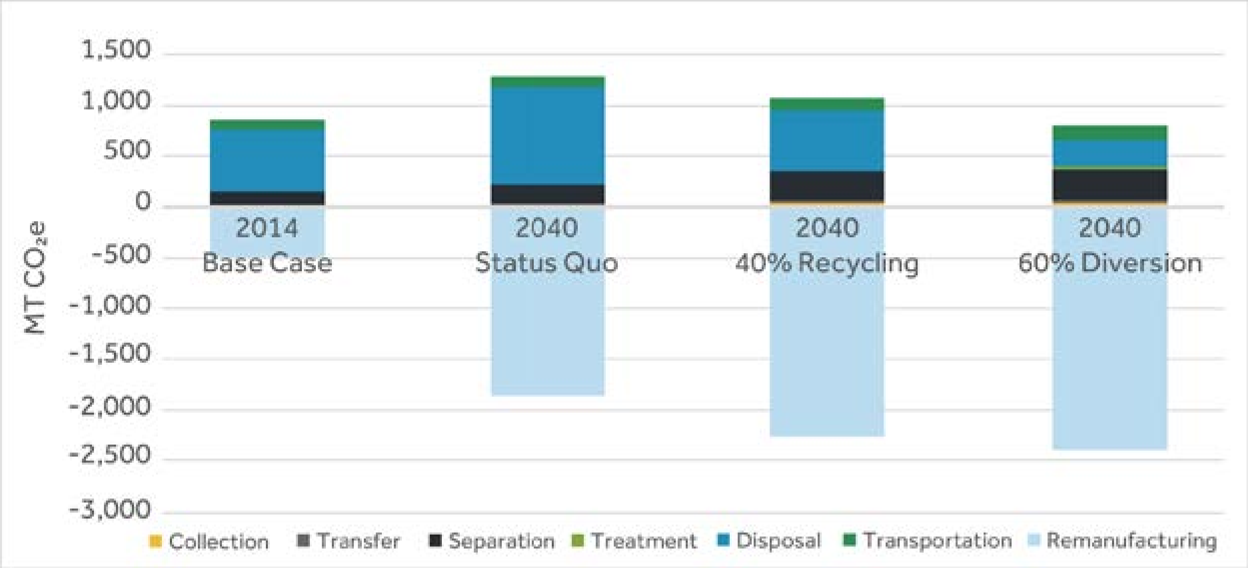

Figure 4. Average CO2e Emissions Generated for All Waste Management Components for 20 Municipalities in the Chicago Metro Region

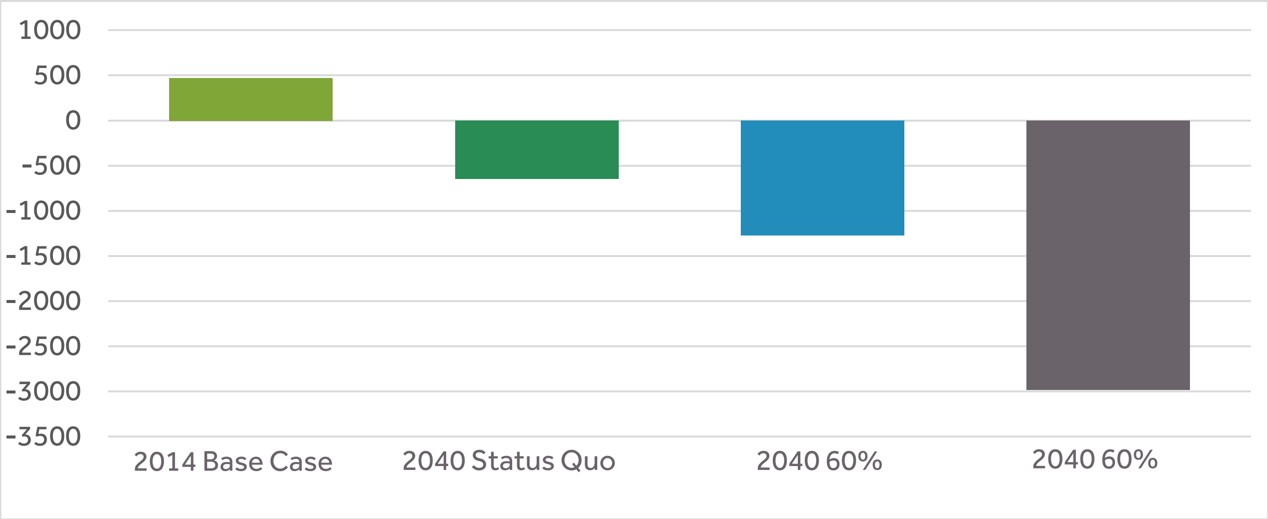

Figure 5. Average Net CO2e Emissions Generated From All Waste Management Components for 20 Municipalities in the Chicago Metro Region

Greenhouse gases (GHGs) are emitted in the form of carbon dioxide, methane, nitrogen oxides, and sulfur oxides in each stage of the waste stream. Such emissions are a result of fossil fuel combustion, energy use, and natural byproducts of decomposition. Each step in the waste management process emits varying quantities and types of these GHGs. For the purpose of this report, all GHGs have been converted to carbon equivalents (metric tons of CO2e) to allow for comparison between waste management components.

As seen in Figure 4, the largest sources of emissions generated are waste disposal and separation. In the Base Case 2014 scenario, disposal accounts for more than 90% of the total emissions generated in the waste management process. This includes emissions generated through operations, initial construction, closure, as well as landfill gas and leachate release. In the 2040 Status Quo scenario, disposal emissions greatly increase and separation emissions slightly increase, because of the increased tonnage of waste produced in 2040. When the recycling rate is increased to 40% (2040 40% RR), emissions associated with disposal significantly decrease. As more material is moved from the disposal process to the separation process, separation-related emissions increase.

The emissions associated with the remanufacturing of recycled materials are represented as negative in the model's outputs. This is a result of the difference between the emissions produced to collect and process recyclable commodities, and those produced to extract and process its virgin material equivalent. Virgin material extraction and production is extremely energy-intensive compared to recycled material collection, separation, and processing. Consequently, as more recyclable materials are introduced into the market for remanufacturing, there is potential for a negative effect of CO2e emissions.

Figure 5 represents the average net emissions generated through all components of waste management in each of the scenarios for the 20 communities surveyed. In the 2014 Base Case scenario, net emissions are positive, because the CO2e emitted through collection, transfer, separation, treatment, disposal, and transportation of waste is greater than the negative emissions generated through the remanufacturing process. In the 2040 Status Quo scenario, net emissions are negative, because there is a greater absolute amount of material recycled in 2040 compared to 2014. Recycling positively influences CO2e emissions. Average net emissions continue to decrease between 2040 Status Quo and 2040 60% DR, as more material is diverted from disposal and introduced into the remanufacturing process.

JOB CREATION POTENTIAL OF WASTE DIVERSION

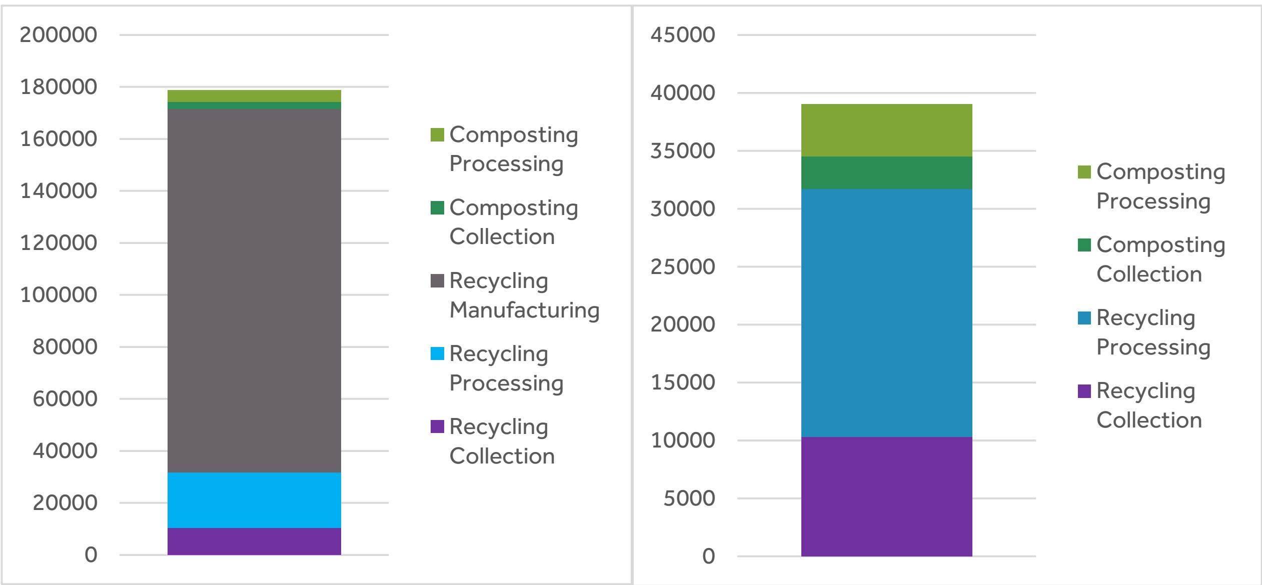

Figure 6. Potential Regional Jobs Created Through 2040 40% RR and 2040 60% DR, Respectively.

	Recycling			**Composting (YW and Food Scrap)**	
	Collection	Processing	Remanufacturing	Collection	Processing
2040 40% RR	8,4701	7,488	114,472	N/A	N/A
2040 60% DR	10,348	21,365	139,365	2,784	4,528

Table 2. Detail of Potential Regional Jobs Created Through 2040 40% RR and 2040 60% DR.

Not only does waste diversion have economic implications in terms of costs and savings, but it could also have significant implications for regional job creation. Much of the material that is thrown away can play an important role in the commodities market. As more value is derived from waste material (like aluminum, cardboard, and paper), the job market to support their collection, processing, and remanufacturing can expand.

As part of this research, Delta analyzed the potential for job creation in the field of recycling and compost collection, processing, and manufacturing in the year 2040 for 60% Waste Diversion scenario (comprised of 45% recycling, and 15% yard waste and food scrap compost)[11].

As seen in Figure 6, 60% waste diversion in the Chicago Metropolitan Region has the potential to create 180,000 direct jobs in the fields of recycling collection, processing and manufacturing, as well as compost collection and processing. The vast majority of these jobs would be in the field of recyclable remanufacturing. However, these remanufacturing jobs would not necessarily stay in the Chicago Metropolitan Region, as most of the recycled material currently produced in the area is exported out of state or overseas to be remanufactured into new products. This represents an economic delevopment opportunity for the region.

Jobs related to recycling collection and processing will inherently be in the region from which the material is generated. Based on this assumption, we can estimate that over 39,000 regional jobs could be created through recycling and composting processing and collection if the waste diversion rate reaches 60% by the year 2040[12]. Of the potential regional jobs created through 60% waste diversion in 2040, recycling processing and collection offered the greatest potential for job creation. This can be attributed to the fact that a larger portion of the waste stream is composed of recyclable material (about 45%) when compared to compostable material (about 15%).

11 See Appendix 4 for jobs calculations methodology.

12 See Appendix 4 for jobs calculations methodology.

CONCLUSION

Current waste management practices in the Chicago Metropolitan Region lag behind the national average[13]. Some metropolitan areas, such as San Francisco and Seattle, are currently achieving waste diversion rates well above 50%[14]. With an increase in population (and potentially an increase in per capita consumption) major changes in waste management practices on both the individual consumer level and the municipal decision-making level will be needed to exceed our region's current 29% waste recycling rate.

The results of this regional waste benchmarking study show that improvements to waste management practices can offer significant regional benefits. If our region achieves a 60% waste diversion rate by the year 2040, our net greenhouse gas emissions would be negative, allowing for the offset of other emissions-intensive activities. Sixty percent waste diversion could also increase regional economic activity and create more than 39,000 jobs for the residents of Chicago Metropolitan Region.

While this research has revealed the potential for significant environmental and economic benefits, making improvements to our region's waste management practices will take time and require investment in our regional waste infrastructure. Based on our work, we offer the following recommendations to reverse barriers to recycling and attain a vibrant local economy.

Recommendations

Provide all municipalities with model waste management procurement language to help communities optimize their service proposals to meet their needs, and potentially acknowledge the value of their diverted waste.

Provide training and support to municipalities operating outside of a waste association or agency to facilitate the procurement process.

Reverse policies that hinder expansion of composting and food scrap collection, such as inappropriate permit requirements for greater than 25 cubic-yard containers.

Convene meetings with waste haulers, municipalities, and trade groups to assess needs and strategies for social marketing and consumer education around waste reduction and diversion.

Support feasibility assessments for expanding anaerobic digestion capacity while promoting environmental justice.

Assess social, environmental and economic impacts of waste-to-energy technologies.

[13] United States Environmental Protection Agency. 2014. Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012. EPA-530-F-14-001.
[14] City of Seattle. 2010. City of Seattle 2010 Recycling Rate Report. Seattle Public Utilities.

APPENDIX 1: MODEL INFORMATION AND METHODS

Survey and Data Collection

Delta Institute began this waste benchmarking project by gathering demographic and waste management data on 20 communities in the Chicago Metropolitan Area. To collect data, Delta distributed a survey to municipal public works departments across the region, and the first 20 respondents were selected for analysis. The survey included both qualitative and quantitative questions relating to each community's waste diversion efforts. The data collected provided model inputs parameters to construct a baseline scenario against which future scenarios were compared. As a supplement to the survey, a literature review of waste agency documents and waste management plans was conducted to collect regional data on current waste generation rates, recycling rates, and future waste diversion goals.

Modeling

Delta used the Municipal Solid Waste Decision Support Tool (MSWDST), developed by RTI International, for this study. The MSWDST is a peer-reviewed, U.S EPA-funded, life cycle assessment and full-cost accounting tool that simulates and optimizes alternative waste management strategies[15]. Using this tool, Delta simulated current waste diversion practices, and three future scenarios in the year 2040. The three future scenarios modeled were: 1) Status Quo (no change in waste diversion rate); 2) 40% recycling rate; and 3) 60% waste diversion (composed of 45% recycling, 4% yard waste compost collection, and 11% house hold compost collection). The year 2040 was selected to align with the Chicago Metropolitan Agency for Planning GO TO 2040 report, and future scenario diversion rates were selected based on the goals set by various metro area waste agencies.

15 RTI International, Tools and Models.

Regional data for waste stream composition and electricity grid composition were required model parameters. These variables remained constant throughout each scenario (current and 2040). Recycled commodity prices and fuel prices were dynamic to better represent the expected costs in the year 2040. Current and projected populations were collected from the Chicago Metropolitan Agency for Planning (CMAP)[16]. Delta obtained waste generation rates from each community through the Cook County Solid Waste Management Plan[17], and recycling and yard waste collection data were obtained from the communities' corresponding waste agency or were reported directly by the community in the survey process[18]. For the two municipalities included in this study that do not belong to a waste agency, the waste generation rates of the nearest community were applied, and similar demographics and waste management practice were assumed.

Results

Once all the variables were entered into the MSWDST, the model provided estimates for various financial and environmental costs associated with scenario. The model was optimized for economics (dollars) and greenhouse gas emissions (carbon equivalents, MTCO2e). The data presented outlines the results of the modeling process.

16 CMAP Demographic Data, Population Forecast.
17 Cook County Solid Waste Management Plan 2012 Update.
18 SWALCO, 2009 Solid Waste Management Plan Update for Lake County, Illinois.
SWANCC, Solid Waste Management Plan Update 2014.

APPENDIX 2: WASTE CHARACTERIZATION

Waste Item	Percent Composition
Yard Trimmings, Leaves	0.0120
Yard Trimmings, Grass	0.0120
Yard Trimmings, Branches	0.0220
Old News Print	0.0540
Old Corr. Cardboard	0.1610
Office Paper	0.0150
Phone Books	0.0250
Books	0.0240
Old Magazines	0.0210
3rd Class Mail	0.0240
HDPE - Translucent	0.0350
HDPE - Pigmented	0.0370
PET	0.0410
Ferrous Cans	0.0090
Ferrous Metal - Other	0.0360
Aluminum Cans	0.0050
Aluminum - Other #1	0.0040
Glass - Clear	0.0090
Glass - Brown	0.0090
Glass - Green	0.0090
Food Waste	0.1050
Misc. Combustible Waste	0.2340
Misc. Non-Combustible Waste	0.0970
Totals	**1.0000**
Recyclable Fraction	**0.51**
Compostable Fraction - all	**0.48**
Compostable Fraction - YW and FW	**0.15**
Combustible Fraction	**0.85**

Table 3. Cook County Waste Characterization as Pulled from: The Delta Institute. 2012. Cook County Solid Waste Management Plan 2012 Update Cook County Department of Environmental Control.

APPENDIX 3: MODELING FUTURE WASTE MANAGEMENT SCENARIOS USING THE MSWDST

Introduction

Delta Institute used the Municipal Solid Waste Decision Support Tool (MSWDST), a lifecycle assessment model that measures impacts associated with alternative waste management practices and community characteristics[19], to project the current and future economic and environmental costs of the Chicago Metropolitan Region's waste management practices. To model future scenarios, assumptions were made about population, recyclable commodity prices, and energy prices to reflect, as accurately as possible, the cost and emissions of the region's waste management practices. Delta has refined the following inputs to model future (2040) scenarios and predict future impacts.

Population

Population projections for each municipality were obtained from the CMAP report GO TO 2040[20].

Recyclable Commodity Pricing

Focus Materials: metal steel cans, aluminum steel cans, glass (flint, amber, and green), plastic PET, plastic HDPE (natural and opaque), soft mixed paper, newspaper, corrugated cardboard, and office paper[21].

19 The MSWDST was developed by RTI international. For more information on RTI international and the MSWDST click here.
20 CMAP, Go To 2040.
21 These specific materials were recommended to us by one of the MSWDST model developers, Keith Weitz, because they represent the largest portion of the recycling waste stream.

SecondaryMaterialPricing.com[22] provided data for regional current and historical pricing.

Future pricing for the year 2040 was based on commodity trends, inflation and industry accepted predictions. The extent of region-specific data reported for each material varied. Some material's historical data went as far back as 2002, while others begin in 2005. Most of the materials have data up April 2014, but a few materials did not have data that extends past 2009. Table 4 (page 21) shows the time frame for which historical data was available.

To project future prices of recyclable commodities out to 2040, the historical data was used to generate a linear trend line. First, averages were taken for each year of the pricing data. Then the average prices were plotted on the y axis against time (in years) on the x axis. Using the trend line function in Microsoft Excel, a linear formula was produced representing the expected growth of each material based on historical data. To calculate the projected price of the material in the year 2040, 2040 can be entered into the "time" variable (X) in the linear equation. See Table 4 for each material's trend line equation and projected price in 2040.

The price of steel and aluminum were greatly affected by the economic recession compared to other recyclable commodities. This can be attributed to the slump in activity by the construction sector

22 Secondary Materials Pricing, CHICAGO (Midwest/Central) .

that followed the recession, as the building and construction industry are large consumers of steel and aluminum [23]. Because of this, there are significant outliers in the historical pricing data for these two materials which greatly distort the overall growth trend for scrap steel and aluminum pricing. To mitigate this, national historic pricing data for the virgin material equivalent (raw aluminum and steel) was compared to the trend line produced by the scrap material historical pricing data. The data representing the virgin materials has a much wider range, providing us with a more accurate trend line to project into the future. The national data, extending back to 1990, shows a much steeper slope then the regional data. A value that is a midpoint between these two projections was used to model future scenarios because the lower estimate has a limited data range, and the upper estimate represents a higher quality form of the material.

Energy Prices

The modeling process for the future waste management case projections required that future energy prices for the year 2040 be determined for robust cost accounting. Model inputs including electricity and diesel, which are both expected to increase in price in years to come.

The energy price projections used in the MSWDST model were based on the U.S. Energy Information Administration's (EIA's) Annual Energy Outlook 2014. This report is focused on the factors that shape the U.S. energy system over the long term. Under the assumption that current laws and regulations remain unchanged throughout the projections, the EIA Reference case provides the basis for examination and discussion of energy production, consumption, technology, and market trends and the direction they may take in the future.
The following energy price assumptions were approximated for future cases from EIA data in Table 5.

Table 5. Approximated Energy Price Assumptions approximated for 2040 from EIA data.

23Ritusmita Biswas. "Economic Recession Results in Severe Impact on Scrap Metal Industry," RecycleINME.

Material	Data Range	Most recent Average price ($)	2040 projection Price ($)	Units	Trend line formula
Glass Flint	2005-2014	31	40.36	$/ton	Y=0.5313X – 1043.4
Glass Amber	2005-2014	21 4	3.01	$/ton	Y=0.9228X – 1839.5
Glass Green	2005-2014	8.5	21.80	$/ton	Y=0.5201X – 1039.2
Plastic PET	2005-2014	19.10	35.76	¢/lb.	Y=0.5566X – 1099.7
Plastic Natural HDPE	2005-2014	38.55	46.72	¢/lb.	Y=0.4734X – 919.02
Plastic Colored HDPE	2005-2014	28.99	30.51	¢/lb.	Y=0.2415X – 462.15
Soft Mixed Paper	2002-2008	77.50	312.67	$/ton	Y=7.2817X – 14542
News Paper	2002-2008	79.5	262.03	$/ton	Y=5.7608X – 11490
Corrugated Containers	2002-2008	97.70	372.96	$/ton	Y=8.374X – 16710
Office Paper	2002-2008	201.19	517.44	$/ton	Y=10.836X – 21588
Metal-Steel Sorted Cans	2009-2014	115.00	**400*	$/ton	Y=7.7223X – 15426
Metal-Aluminum Cans	2009-2014	73.19	**112.5*	¢/lb.	Y=2.2583X – 4469.2

Table 4: 2040 Pricing for Recyclable Commodities as Calculated from the Municipal Solid Waste Decision Support Tool.

Energy Source	2014 Price	2040 Price	Units
Electricity Purchased	.0749	.114	$/kWh
Diesel Fuel	4.01	10	$/gal
Scrap Iron	350	925	$/ton
Electricity Buy Back*	.03	.06	$/kWh

*The 2040 Electricity Buy Back rate was not directly provided by EIA. To make this forecast, we used the rate of increased for the price of electricity purchased and applied it to the buyback rate. Energy prices affect waste management costs associated with collection, transport, processing, and recycling. The higher the energy price, the higher the management cost which can influence management choices and associated market and environmental impacts.

APPENDIX 4: JOBS FORECASTING LITERATURE REVIEW AND METHODS

Introduction

As part of the this research, Delta sought to determine the missed regional employment opportunities municipalities will experience in the future if they do not increase waste diversion rates. Delta conducted a literature review of publications that investigate the number of jobs that could be created through waste recycling and composting, compared to the status quo of disposal.

Overview of Study

Of all the sources reviewed, a report conducted by Ball State University's Bowen Center for Public Affairs[24], titled "The Untapped Jobs Potential of Indiana's Recycling Industry" was selected to provide a framework for calculating the job creation potential of waste diversion practices in the metro area. The study was published July 31, 2013. Its two chief sources for data were the Purdue-Calumet University statewide report "Municipal Solid Waste Characterization Study for Indiana" and the EPA's "2010 Facts and Figures", a summary of an annual, national assessment of recycling and waste generation. The study had four primary areas of focus: the composition of Indiana's solid waste stream, the jobs that are created by recycling rather than disposal of solid waste, manufacturers' demand for recycled materials, and the success of an Indiana electronic waste law passed in 2009.

24 The study was prepared for the Indiana Recycling Coalition (IRC) by Stacy Wheeler of the Bowen Center for Public Affairs. The IRC is a recycling advocacy group dedicated to increasing the rate at which Indiana recycles and composts. The Bowen Center is a free-standing, nonpartisan center at Ball State University. It is nationally recognized for the quality of its studies, the most notable of which is the annual Hoosier Survey, a study that measures public opinion in Indiana on both national and state level issues.

	Discarded	Diverted		
	Total Waste Collection, Landfill, and Incineration	Collection	Processing	Manufacturing (remanufacturing)
Materials	Jobs Created/1,000 Tons			
Recyclable				
Paper & Paperboard	0.00076	0.00123	0.002	0.00416
Plastic	0.00076	0.00123	0.002	0.0103
Metal				
Ferrous	0.00076	0.00123	0.002	0.00412
Aluminum	0.00076	0.00123	0.002	0.01763
Other Nonferrous	0.00076	0.00123	0.002	0.01763
Glass	0.00076	0.00123	0.002	0.00785
Compostable				
Food Scraps	0.00076	0.00123	0.002	n/a
Yard Trimmings	0.00076	0.00123	0.002	n/a

Table 6: Direct Job Multiplier Table. Source: The Untapped Jobs Potential of Indiana's Recycling Industry, Bowne Center for Public Affairs.

Compared to other studies reviewed, this report offered the most conservative estimates for the number of jobs created through recycling and composting. This report is also relevant to Delta's waste benchmarking study as the data was collected in the same Midwest region. Table 6 is a summary of the report's findings, illustrating the number of jobs created through diversion and disposal of various recyclable and compostable materials.

Using the information provided in Table 6, the number of potential jobs created through waste diversion can be calculated for the different processes associated with waste diversion (collection, processing, and manufacturing). The formulas used to makes these calculations can be viewed below. This process was then repeated for all stages of diversion in all 20 municipalities that were surveyed.

Recycling:
[(Tons of recycling produced in 2040 60% scenario) - (Tons of recycling produced in 2014 scenario)]
X
[(Jobs/ ton created by recyclable material diversion) – (Jobs/ ton created by recyclable material disposal)]
=
Potential Job opportunities created through diversion of recyclable materials from the solid waste stream

Compost:
[(Tons of waste composted in 2040 60% scenario)-(Tons of waste composted in 2014 scenario)]
X
[(Jobs/ton created by compostable material diversion) – (Jobs/ton created by compostable material disposal)]
=
Potential job opportunities created through diversion of compostable material from the solid waste stream

Once these calculation were made for the 20 communities involved in the survey and modeling process, we expanded these findings out to account for the Chicago Metropolitan Region. The municipalities that were surveyed represent about 7% of the Chicago Metro Region's population and have the potential to create X regional jobs, and Y jobs that will be dispersed with the recycled material into our global commodity trade. Using a simple ratio, this finding was applied to the region.

Literature Review Bibliography

2010 Recycling Economic Information Study Update for Illinois. DSM Environmental Services, INC., 2010.

Abramowitz, Harvey, and Sun Yu. Municipal Solid Waste Characterization Study Fro Indiana. Purdue University Calumet, 2012.

More Jobs, Less Pollution: Growing the Recycling Economy in the U.S. Tellus Institute, 2009.

More Jobs, Less Waste: Potential for Jobs Creation through Higher Rates of Recycling in the UK and EU. Friends of the Earth, 2010.

Morris, Jeffrey, and Clarissa Morawski. Returning to Work: Understanding the Domestics Jobs Impacts from Different Methods of Recycling Beverage Containers. Container Recycling Institute, 2011.

Municipal Solids Waste Generation, Recycling, and Disposal in the United States, Tables and Figures for 2012. U.S Environmental Protection Agency Office of Resources Conservation and Recovery, 2014.

Recycling Economic Information Study Update: Delaware, Maine, Massachusetts, New York, and Pennsylvania. DSM Environmental Services, INC., 2009.

Recycling Means Business. Institute for Local Self-Reliance, 2002.

U.S Recycling Economic Information Study. R. W. Beck INC.

Wheeler, Stacy. The Untapped Job Potential of Indiana's Recycling Industry. Ball State University Bowen Center for Public Affairs, 2013.