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Mitigation Strategies for Municipal Solid Waste Generation in Lincoln

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Mitigation Strategies for Municipal Solid Waste Generation in Lincoln

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Abstract

This study was completed to explore mitigation solutions to Municipal Solid Waste (MWS) in the City of Lincoln. Due to population growth, especially in urban environments, waste generation is an increasingly difficult problem that requires complex solutions. This work is done to explore efficacy of various mitigation strategies such as recycling and composting of waste. This study will be conducted utilizing data found in the City of Lincoln Solid Waste Plan 2040 and applying it to the EPA Policy and Program Impact Estimator. Specifically, withing the EPA Policy and Program Impact Estimator, curbside collection and pay-as-you-throw (PAYT) programming will be applied to study landfill source reduction strategies within Lancaster County. Through the use of the estimator using a 6% annual increase in source reduction from PAYT and a 15% annual increase in source reduction from curbside collection it is estimated that the city of Lincoln would be able to divert 14,845 tons of food waste to composting programs and 3,788 tons to recycling programs. With the amount of food waste able to be diverted through compost being higher than the amount of recyclable materials able to be diverted through recycling we are able to understand that significant effects compost-forward policy could have in terms of MSW mitigation.

Introduction

This study will examine mitigation (the action of reducing severity and/or seriousness) strategies to reduce waste contributions. There are many different types of waste such as liquid and solid waste otherwise known as Municipal Solid Waste (MSW), recyclable waste, green waste, hazardous waste, medical waste, electrical waste, and construction and demolition waste being the most widely known and recognized. All human waste generation accumulates in municipal landfills to be buried or incinerated which contributes to Carbon Dioxide (CO2) and Methane (CH4) Greenhouse Gas (GHG) emissions, water contamination, and air pollution amongst various other environmental abhorrences. By 2025 there will be over 8 billion humans contributing to global waste generation globally and current systems and policies for waste reduction are failing due to the increasing population and consumer habits. Industrialized nations are better equipped to handle generation of waste, however, less developed nations are expected to generate more waste in the future and current solid management practices in low-income countries are not adequate to ensure proper disposal and environmental hygiene. Not only is infrastructure underdeveloped and inadequate, “over 90% of waste [is] openly dumped or burned in low-income countries” which disproportionately affects marginalized populations (What a Waste 2018). Consumerism and waste generation will continue to increase unless waste minimization habits are formed, government action is taken through policy and incentive strategies, and consumption is modified and adapted to lessen human impact on the environment. The impacts of waste accumulation significantly influence life with negative environmental impact through GHGs, bioaerosols, spread of potentially pathogenic organisms and rapid use of resources. The pressure from an increase in waste generation from rapid urbanization and

industrialization is diverse which impacts the surrounding ecosystems and environment and the infrastructure and systems humans have in place to protect the environment, thus impacting all life on earth.

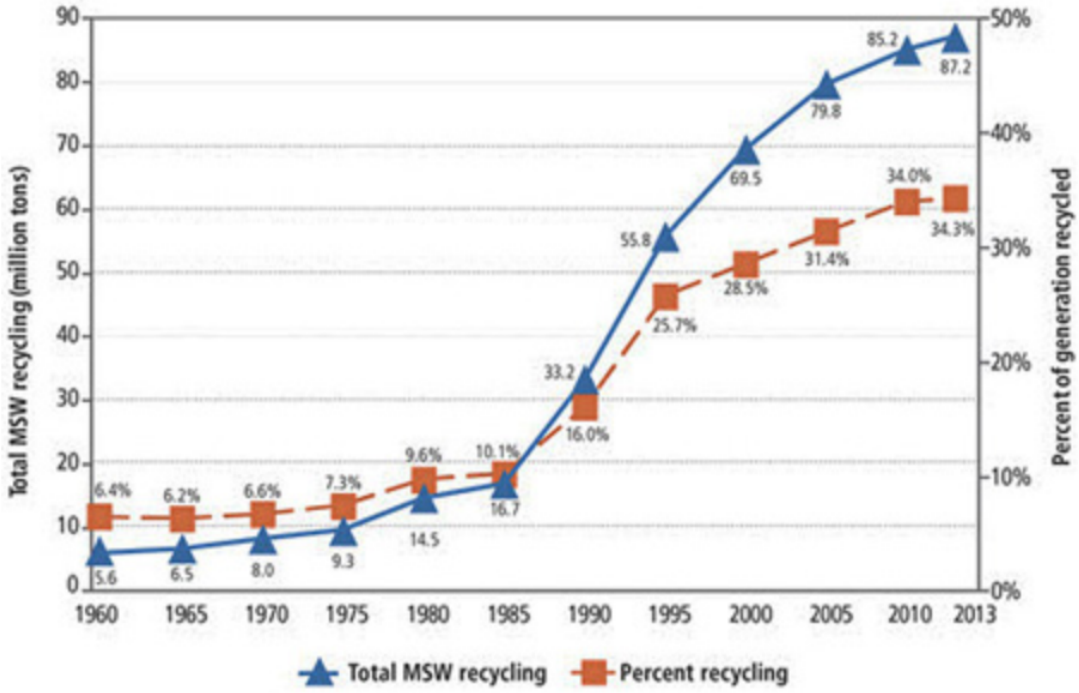
Consumers today have a lot of product and service choices, and product reliability is improving, but with the rate and amount of trash build up it is important to see value in products that are available to be purchased low waste. This would include products that are unpackaged, recyclable, and or compostable . By getting consumers to see the value in low waste, less trash will be created at the residential source, and with the growing population this technique could be beneficial to learn how to prevent rather than respond to growth concerns in relation to Municipal Solid Waste (Papa 2015). While there is a large focus on recycling as a response to waste mitigation, it is important to remember other reduction strategies such as composting of organic waste and green waste. Biodegradable and organic waste ending up in landfills is a cause for concern due to the anaerobic conditions found in landfills that do not allow for the bio-organics to properly decompose. Without proper decomposition the organic materials release GHGs, specifically Methane, into the atmosphere contributing to global warming effects. Methane traps 84 times more heat in our atmosphere than Carbon Dioxide in the short term and landfills are the third largest source of Methane emissions in the US, meaning reduction of Methane emitted into our atmosphere is imperative in the coming decade (Environmental Protection Agency). Landfills and waste generation contribute to climate change through pollution of the surrounding environments from leaching, which puts waterways and oceans at risk from pollution, and the release of gases into the atmosphere, which poses a significant and severe risk to individuals and their environment and contributes to the warming effect. Typically,

landfill gas consists of 50% Methane, 48% Carbon Dioxide, small amounts of hydrogen, oxygen, and nitrogen, and small amounts of non-methane organic compounds (NMOCs) which include volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) and odorous compounds (United States Environmental Protection Agency). Both Methane and Carbon Dioxide are greenhouse gases which accelerate climate change by trapping heat in Earth's atmosphere by absorbing infrared radiation therefore increasing global warming. Proper landfill and waste management and mitigation is crucial to reduce the amount of GHGs released into the atmosphere from landfills. By studying Lincoln's landfills and it's processes and policies for handling waste and organic waste, we can learn how to divert organic and decomposable materials out of our landfills and into healthy soils to aid the predominant agriculture industry.

Single-use disposable plastics are prevalent in daily life, and as landfills are filled, and trash is improperly sorted, littered, and dumped into natural ecosystems. Plastic waste is either processed for recycling or is burned to recover energy content, buried in landfills, or is littered and makes its way into the ocean. Plastic and microplastics in particular cause ever-lasting damage and contamination of waterways and coastal regions eventually dumping into oceans. Plastic and microplastic pollution has been estimated by an oceanographic model of floating debris to be an estimated minimum "5.25 trillion particles weighing 268,940 tons" (Eriksen 2014). Only some plastics are recycled and these synthetic polymers are widespread pollutants of terrestrial and marine ecosystems across the globe. The focus on recycling is inadequate and the environmental benefits are overestimated. "Recycling materials from end-of-life products has the potential to create environmental benefit by displacing more harmful primary material production. However, displacement is governed by market forces and is not guaranteed; if full

displacement does not occur, the environmental benefits of recycling are reduced or eliminated" (Zink 2017). While recycling can be a helpful action in terms of mitigation of MSW it is generally unsustainable while increasing burden on consumers. As seen in Figure 2 below in 2013, the year with the highest percent recycling, only 34.3% of all MSW generation was recycled.

Figure 1 MSW Recycling Rates, 1960-2013 (EPA Municipal Solid Waste)



While recycling rates have observable growth in past decades, the displacement rate of recycled waste does not outweigh nor fully offset the generation of new plastics. Producer-oriented legislation around plastics is generally a more efficient strategy when compared to recycling as a way to mitigate plastic waste entering our landfills or ecosystems.

A goal to create eco-consumers with core values of environmental health over convenience can help mitigate waste accumulation. Incentivizing can play a key role in creating these eco-consumers with an organized approach that may possibly improve lives to be healthier in the future. From the journal of consumer affairs, “in markets where corporations lack effective incentives to regulate their own conduct responsibly, or where health, safety, or other special concerns are at issue - we need effective public oversight” (Guest). It is crucial that policy-makers, corporations, businesses, and consumers alike learn to research the best environmental option when choosing a new product or business, and hold companies accountable for the wasteful products that are often produced. Food packaging, single-use disposable plastics, food and convenience items should be reduced and reused before being recycled or disposed of to create better use of the non-biodegradable products at hand. If a biodegradable alternative is available, which could avoid contribution to landfills, there is recognized value in said alternative. Eco-innovation can be used by companies to determine Life Cycle Costs or LLCs to appeal to consumers. “Microeconomics, behavioral economics, technology diffusion, social psychology, and sociology” are the basis for decision models and can be used to study individual decision making for eco-innovation and pro-environmental behavior (Kaenzig).

Waste reduction, reuse, and recycling can be crucial to creating a pollution free economy and it is attainable as seen within the study by Dang of the Chinese town of Ziya. Ziya was once a highly polluted industrial town in the 1980’s and 1990’s due to their practices of burning electrical waste and improper dumping. Since then, Ziya has modified its industry practices while still maintaining employment for the roughly 60% of jobs in the town of Ziya being from

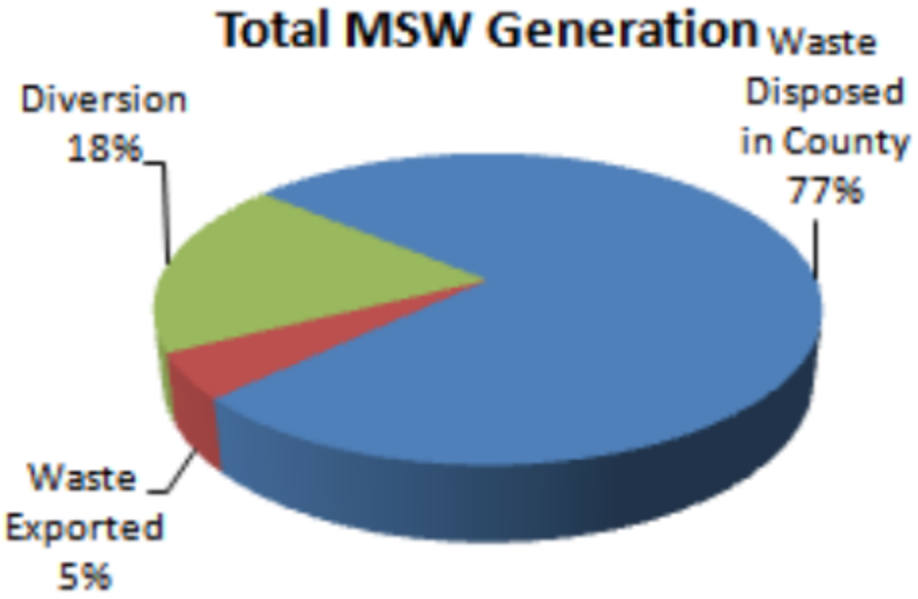
the electrical and industrial waste sector. 800 plus individual household workshops were integrated into 80 merged companies and moved to a designated location assigned by the area government for industrial production. This 135 square kilometer area is now known as Ziya's Circular Economy Industrial Park where it "is the largest of its kind in northern China. It has large areas set aside for manufacturing, forestry, scientific research and living facilities, all in line with the model of modern circular economy [where the overall goal is to eliminate waste and continuously reuse resources]. With the focus on recycling used machinery, electronics and cars, processing rubber, fine and deep processing of products, environmental protection technologies and new energy, the area fosters an industrial system that is regenerative, efficient, environment- and people-friendly. The park can disassemble and process 150 tons of waste every year, providing the market with 450, 000 tons of copper, 250,000 tons of aluminum, 300,000 tons of iron, 300,000 tons of rubber and plastic, and 200,000 tons of other materials. The process also reduces emissions of carbon dioxide by 1.66 million tons and sulfur dioxide by 100,000 tons" (DANG). This example of Ziya, a wasteland of the past turned into a livable industrial area, shows comprehensive energy conservation and environmental protection systems put in place by local governments to commit to a greener economy are successful when applied. In the United States if waste continues to build up the way it does new landfills will be needed every 25-30 years and incineration plants will be required every 5-7 years which is not sustainable, but [composting], minimization and recycling can be a long term solution (Yap). Adapting these techniques allows it to be possible to lessen environmental impact, but with the right implementation techniques and social understanding, it can be even more successful if granted the use of the proper tools, incentives and education.

When looking at Methane (CH4) emissions "Landfills were the third largest anthropogenic source of CH4 emissions in the United States (114.5 MMT 21 CO2 Eq.), accounting for 17.3 percent of total CH4 emissions in 2019. From 1990 to 2019, CH4 emissions from landfills decreased by 65.1 MMT CO2 Eq. (36.2 percent), with small year-to-year increases. This downward trend in emissions coincided with increased landfill gas collection and control systems, and a reduction of decomposable materials (i.e., paper and paperboard, food scraps, and yard trimmings)" which illustrates how mitigating and diverting organic and decomposable material out of landfills and into composting systems can make an observable effect of lowering GHG emissions from landfill (EPA). The average American generates 4.9 lbs of MSW waste in a day (Municipal Solid Waste). The United States Department of Agriculture equates to 103 million tons (84.1 billion pounds) of generated food waste, or 30-40 percent of the food supply in 2017. The average family of four has ~25% food waste losses which translate to approximately $1,365 to $2,275 annually due to lack of awareness and undervaluing of foods, confusion over label dates, and spoilage (Gunders 2012). On an individual scale this averages around 1 lb of food waste per day per person.

These North American averages are comparable to what Lincoln and Lancaster County sees in terms of waste generation. The city of Lincoln, Nebraska has two main facilities for MSW being the Bluff Road Municipal Solid Waste Landfill and Yard Waste Composting Facility and the North 48th Street Small Vehicle Transfer Station and Construction and Demolition Waste Landfill. A seasonal yard waste ban was implemented in 1994 where State statute prohibits disposal of grass and leaves into landfills from April 1 to December 1 of each year. Yard waste is instead processed by LinGROW in conjunction with the Bluff Road Yard Waste Composting

Facility. The finished compost from the yard waste collected at the Bluff Road Landfill is available from LinGROW Compost. For individuals the compost is free and available at the North 48th Street Transfer Station or for purchase ($15/cubic yard + tax) from the Bluff Road Solid Waste Management Facility. The MSW accumulated in these two landfills accounts for 77% of Total MSW Generation in Lancaster County while 5% of waste is exported and the remaining 18% is diverted to be recycled or composted. Below is a figure to summarize waste disposal and diversion in Lincoln and Lancaster County for 2011 by percentages by weight (City of Lincoln 2012).

Figure 2 Lincoln and Lancaster County 2011 Waste Disposal and Diversion



This research will be completed to understand the current problem of MSW buildup in Lincoln, barriers to waste reduction and composting waste, and how policy, incentives and education can help with MSW and green/organic waste mitigation implementation strategies in Lincoln households. Understanding current waste management practices and using environmental impact strategies to persuade effective change may prove an effective way to help with local trash and pollution issues surrounding MSW buildup. It is important to find compromise, and also economic benefit when collecting data and understanding how Lincoln can become an eco-city (Zaman).

Methods

Utilize data from the Solid Waste Management Plan 2040 for Lincoln and Lancaster County in conjunction with the Environmental Protection Agency (EPA) Policy and Program Impact Estimator to generate projected results for annual and accumulative tons of food waste diverted over a ten year time frame. This EPA calculator serves to generate an estimate for tons diverted 10 year period from expanding waste management programs through composting and curbside food-scrap collection within Lancaster County.

Basic Information (Demographics)

Area of Study: Lincoln, Nebraska

Base Year: 2011

Base Year Population: 256,189

End Year: 2021

Annual Population Growth: 0.08%

Estimated Population End Year: 258,117

Basic Information (MSW Tonnages)

Residential MSW: 156,399

Commercial MSW: 255,177

Total MSW: 411,576

Tons Recycled: 37,041

Tons Composted: 28,810

Annual Growth Rates for MSW

Residential: 4%

Commercial: 6%

Effects of Implementing Pay-As-You-Throw (PAYT) For Single-Family Homes

Annual Increase in Source Reduction due to PAYT: 6%

Annual Increase in Recycling due to PAYT: 6%

Annual Increase in Composting due to PAYT: 3%

Effects of Implementing a Curbside Food Waste Collection Program For Single-Family Homes

Low-End Default

Percentage of Single-family home food waste composted without this program: 0%

Annual Increase in Food Waste Composting due to Implementation of curbside collection: 4%

These numbers were estimated using thematic analysis based on historical and current waste data in Lincoln, NE specifically from the City of Lincoln Solid Waste Plan 2040 and its

provided baseline assessment from 2011. Projected data from the Policy and Program Impact Estimator will be explored through thematic analysis in comparison with current academic studies and literature. Applying deductive reasoning to the theoretical framework from this EPA Estimator serves to expand existing knowledge and theory in support of policy changes and program expansion.

Results

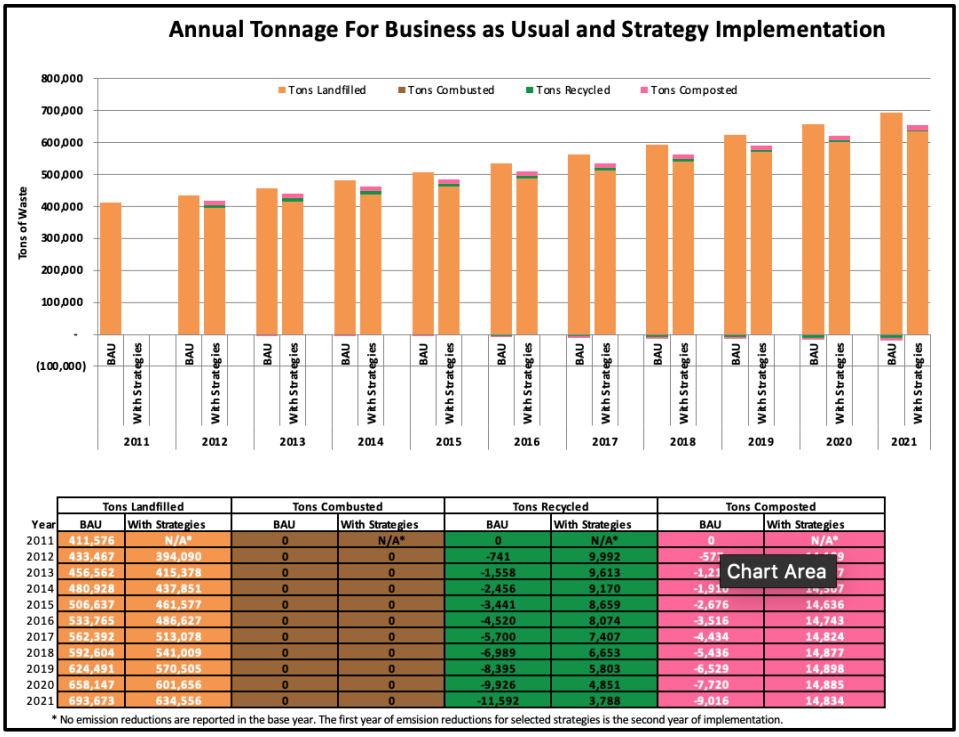
Figure 3: The results of implementing PAYT and curbside collection programming and the percent change.

2021 Benefits

	Business as Usual					*With Strategies Implemented*					*Percent Change*				
	Disposed or Incinerated		Diverted		Total Generated	Disposed or Incinerated		Diverted		Total Generated	Disposed or Incinerated		Diverted		Total Generated
	Tons Landfilled	Tons Combusted	Tons Recycled	Tons Composted	Tons Generated	Tons Landfilled	Tons Combusted	Tons Recycled	Tons Composted	Tons Generated	Tons Landfilled	Tons Combusted	Tons Recycled	Tons Composted	Tons Generated
Single-Family Homes	233,251	-	55,242	42,967	331,460	191,214	-	70,622	49,736	311,572	-18.0%	0.0%	27.8%	15.8%	-6.0%
Multi-Family Homes	-	-	-	-	-	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	460,422	-	(66,834)	(51,983)	341,606	443,342	-	(66,834)	(34,902)	341,606	-3.7%	0.0%	0.0%	-32.9%	0.0%
C&D	-	-	-	-	-	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	0.0%
Total	*693,673*	-	*(11,592)*	*(9,016)*	*673,066*	*634,556*	-	*3,788*	*14,834*	*653,178*	*-8.5%*	*0.0%*	*-132.7%*	*-264.5%*	*-3.0%*

**Note: Increases in source reduction, recycling, and composting from policy/program implementation are assumed to occur in full beginning 1 year after the base year and every year thereafter. To estimate landfilling waste after measure implementation the same breakdown of Business as Usual Waste (Landfilling) is used.*

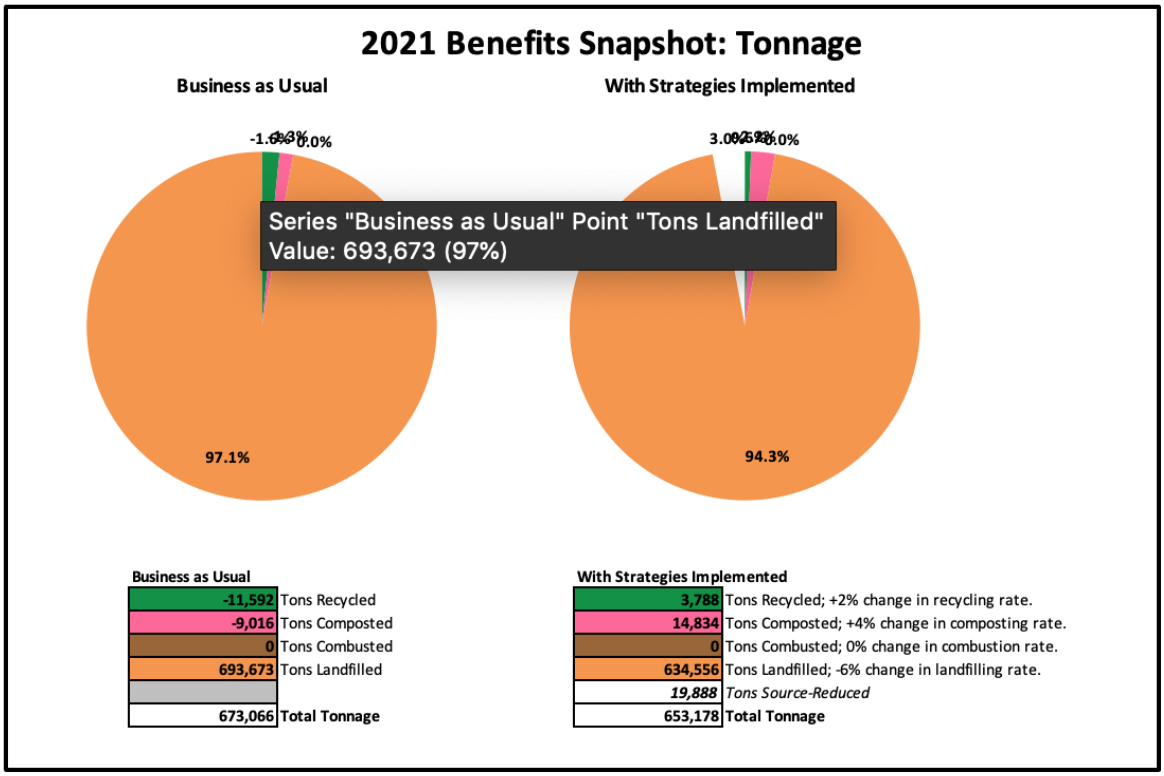
Figure 4: Change in MSW tonnages with implementation over the course of 10 years.



Year	Tons Landfilled		Tons Combusted		Tons Recycled		Tons Composted	
	BAU	With Strategies	BAU	With Strategies	BAU	With Strategies	BAU	With Strategies
2011	411,576	N/A*	0	N/A*	0	N/A*	0	N/A*
2012	433,467	394,090	0	0	-741	9,992	-57	
2013	456,562	415,378	0	0	-1,558	9,613	-1,21	
2014	480,928	437,851	0	0	-2,456	9,170	-1,91	
2015	506,637	461,577	0	0	-3,441	8,659	-2,676	14,636
2016	533,765	486,627	0	0	-4,520	8,074	-3,516	14,743
2017	562,392	513,078	0	0	-5,700	7,407	-4,434	14,824
2018	592,604	541,009	0	0	-6,989	6,653	-5,436	14,877
2019	624,491	570,505	0	0	-8,395	5,803	-6,529	14,898
2020	658,147	601,656	0	0	-9,926	4,851	-7,720	14,885
2021	693,673	634,556	0	0	-11,592	3,788	-9,016	14,834

* No emission reductions are reported in the base year. The first year of emsision reductions for selected strategies is the second year of implementation.

Figure 5: Benefits of implementation strategies on total tonnage.



Business as Usual	
-11,592	Tons Recycled
-9,016	Tons Composted
0	Tons Combusted
693,673	Tons Landfilled
673,066	Total Tonnage

With Strategies Implemented	
3,788	Tons Recycled; +2% change in recycling rate.
14,834	Tons Composted; +4% change in composting rate.
0	Tons Combusted; 0% change in combustion rate.
634,556	Tons Landfilled; -6% change in landfilling rate.
19,888	*Tons Source-Reduced*
653,178	Total Tonnage

Discussion

From the tables and graphs produced with the EPA Policy and Program Impact Estimator we can see values over the ten year span of implementation of PAYT and Curbside Composting Programs as a means to mitigate and divert waste away from Lancaster County Landfills. Approximately 19,888 total tons would be source-reduced from landfill operations through the use of composting program expansion. Of the 19,888 tons diverted includes 14,834 tons of food scraps able to be diverted to compost. This number of tons able to be diverted to compost is greater than the estimated 3,788 tons able to be recycled. This supports the general hypothesis that composting, when incentivized and/or supported through policy and programming, is a more effective strategy to mitigate waste in landfills when compared to recycling. However, further studies would be needed to show if the source reduction total amounts are worth the finances required to implement curbside compost collection programming. While examining key relationships it is seen that single-family homes have a higher capability to compost as compared to multi-family residences. Due to few compost collection sites in the city of Lincoln, compost cost and waste storage can be a barrier to in home composting. Also, lack of accessibility for curbside programs require costly implementation of strategies. With this we can observe barriers to composting programs such as the ability to ensure proper storage of food waste/scraps between weekly pickups. Cost can also be a barrier to composting food scraps.

Summary & Conclusions

This study was completed to examine mitigation strategies for MSW generation in the Lincoln and Lancaster County area. In order to determine the most successful waste mitigation strategies the EPA Policy and Programming Impact Estimator was used to examine data presented in the City of Lincoln Solid Waste Plan 2040. By further applying the current and past data found in this plan to the estimator we can use deductive reasoning to determine the most successful waste mitigation strategies. This estimator helps to conclude that both recycling and composting can be effective strategies in terms of waste mitigation, however when comparing recycling tonnages reduced and composting/food scrap waste reduced, composting programs presented higher percentages of reduction to landfill waste generation. This helps to understand the efficacy of PAYT and Curbside collection programming for collection of food waste and food scraps for composting. If these programs were to be successfully applied and implemented within the City of Lincoln they could have a large impact on our landfills in terms of tonnages of waste reduced, and potentially lower Methane (GHG) emissions from the reduction of decomposing food waste in landfills..

By using the Policy and Program Impact Estimator, it can be determined that with the right implementation strategies and education, the overall MSW that is being accumulated in Lancaster County can be reduced through the use of composting and increased ability and accessibility to compost. The overall amount of MSW that can be reduced can vary due to the overall impact of the implementation strategies. Through the use of this estimator, by changing the annual increase in food waste composting through the use of curbside collection there is a noticeable decrease in MSW being landfilled. An important implementation strategy that

decreased overall MSW was the addition of PAYT programming. With just a small, yet significant change in annual source increase for PAYT programming, this benefitted single family homes from an increased amount of food scraps being composted. Based on the data above, over the course of ten years about 14,834 tons can be diverted. This would be done by the addition of PAYT programs as well as an increase in curbside collection of MSW for composting. Lancaster County currently has access to curbside composting, but as stated before cost can be a barrier to these programs.

For future studies a cost-benefit analysis of recycling programs and composting programs would be recommended to determine the City of Lincoln's ability to increase waste mitigation programming. A cost-benefit analysis of compost could also include applying the finished compost to be used in agriculture to learn if it is beneficial to agricultural yields. Additionally, studies that include waste audits would also be beneficial to determine the amount of food waste that is able to be composted from single family and multi family residences. Another recommendation would be to apply the reduction totals found from the Policy and Program Impact Estimator to the EPA Warm calculator to determine the potential GHG emission reduction totals from tonnages reduced from aggressive policy and programming implementation within the city of Lincoln and Lancaster County.

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