Summary

Based on the results produced by the functions and models derived from linear regression, it can be concluded that the amount of plastic produced and plastic recycled will both increase over the next decade. Although the linear regression function depicts a constant growth of plastic in landfills over time, the actual value could change from unexpected factors. A decade after the year 2013, about 357.3900919 million tons or 2644.68668 million cubic yards of plastic waste will fill landfills.

The base model predicted the best method of recycling per city dimensions for our initial cities. The smallest city, Price, Utah, should use drop-off recycling methods. The medium-sized city, Fargo, North Dakota, should use dual-stream weekly methods. The largest city, Wichita, Kansas, should use single-stream weekly. The model takes into consideration the cost of building a recycling center, population and area, purchase of trucks (and eventual conversion from diesel- to electric-powered trucks), and upkeep costs. The funds for these expenses come from the average tax per person allocated to waste collection.

Further implications of this model will produce sound methods for various United States regions dependent on square mileage, population, and population density. This program will encourage Americans to recycle instead of waste; they will eventually even use electric-powered trucks to minimize environmental damage. In order to ensure a practical agenda for this program, multiple monetary checkpoints will guide each type of system in every town.

The Problem

It takes ten to twenty years for a plastic bag to decompose. It takes 450 years for plastic beverage bottles to decompose. Over the past decade, with growing awareness of the biodegradability of plastics, concern over this issue has expanded. As plastics fill our landfills, with no indication of letting up, creation of recycling programs has become a prominent issue. It is imperative to determine the amount of plastics accumulated in landfills and the growing rate of production of this material. These results will show the importance of implementing systems to protect our environment from this nearly inert polymer over the next ten years, with respect to the current growth rate of both recycling tendencies and plastic production.

After this consideration, a model for a recycling program will be created. It will take into consideration the three types of recycling methods: single-stream recycling, dual-stream recycling, and drop-off locations. Additional factors, including types of trucks and facilities for recycling will also be considered in relation to city size and population. After applying this model to three cities of varying populations and land area (Fargo, North Dakota; Price, Utah; Wichita, Kansas), we will then apply it on a nationwide scale.

Assumptions

Our model assumes that the following points are true:

- All plastic waste not recycled goes into a landfill. The amount that reaches other destinations is negligible.
- Plastic production and recycling increase at a linear rate as time passes, based on an extrapolation of the data found.
- The easier the program is for the individual, the more likely he or she is to recycle regularly.
- Every person in any given city pays taxes as required by law.
- The transportation costs involved in any recycling plan are negligible compared to the costs of operation and the installation costs.
- The proposed recycling system will be designed independently of any existing system, meaning that it will be assumed that no system is currently in place.
- The cost of travel between stops on a recycling truck's route is insignificant compared to the costs of running the program itself.
- The cost of processing the recycled material and the prices of both diesel and electronic trucks will remain constant over the years, unchanged by unpredictable technological advances or inflation.

The Model

The Increasing Rate of the Production and Recycling of Plastic Waste and Its Effects on Landfills

Plastic is one of the most common recyclable materials because of its versatility and inexpensiveness; unfortunately, it often ends up in landfills. In order to predict the amount of discarded plastic which will either be recycled or be placed in landfills, the values from past years were taken from the United States Environmental Protection Agency (EPA) and analyzed.

Year	Plastic generated (million tons)	Recycled plastic (million tons)	% of plastic recycled	Generated - recycled (million tons)
1995	19.8	0.9	4.70%	18.9
1996	18.99	1	5.30%	17.99
1997	19.76	1.06	5.40%	18.7
1998	21.46	1.11	5.20%	20.35
1999	24.17	1.35	5.60%	22.82
2000	24.71	1.34	5.40%	23.37
2001	25.38	1.39	5.50%	23.99
2003	26.65	1.39	5.20%	25.26
2005	28.91	1.65	5.70%	27.26
2006	29.49	2.04	6.90%	27.45
2007	30.73	2.09	6.80%	28.64
2008	30.05	2.12	7.10%	27.93
2009	29.83	2.12	7.10%	27.71
2010	31.04	2.55	8.20%	28.49

Table 1[1]

Table 1 shows that the amount of plastic waste produced each year has gradually increased over time from 19.8 million tons in 1995 to 31.04 million tons in 2010. Plastic recycling has also increased, both in volume and percentage of the whole. These values were plotted and then the linear regression was determined for both variables, thus creating functions that can predict future amounts of plastic waste produced. If x represents the year, then the amount of plastic waste produced that year can be predicted with the following formula:

$$F(x) = (0.8393734124x - 1655.001732)\,.$$

[1] http://www.epa.gov/osw/nonhaz/municipal/msw99.htm

In order to find the linear regression for the amount of plastic wasted, the linear regression of the amount of plastic waste generated must be subtracted by the amount of plastic waste recycled. The linear regression of the amount of plastic recycled was found to be

$$F(x) = (0.0986113463x - 195.8828916) .$$

The linear regression for plastic wasted is the difference between the two functions:

$$(plastic\ waste\ generated\ -\ plastic\ waste\ recycled) .$$

Therefore, the linear regression for the plastic waste ending up in landfills is

$$F(plastic\ waste\ generated) - F(plastic\ waste\ recycled) ,$$
$$F(x) = (0.8393734124x - 1655.001732) - (0.0986113463x - 195.8828916) ,$$
$$F(x) = 0.740762066x - 1459.11884 .$$

This function was then integrated in a 10-year interval from the value 2013 to 2023 to estimate the amount of plastic that will end up in landfills 10 years from now.

$$\int_{2013}^{2023} 0.740762066x - 1459.11884 = 357.3900919\ million\ tons .$$

Approximately 357.39 million tons of plastic waste will go to landfills during the years 2013–2023 based on a function of linear growth. Each ton of plastic waste in a landfill takes up about 7.4 cubic yards,[2] so 357.39 million tons of plastic waste would take up 2644.68668 million cubic yards of space.

[2] http://earth911.com/recycling/plastic/plastic-bottle-recycling-facts/

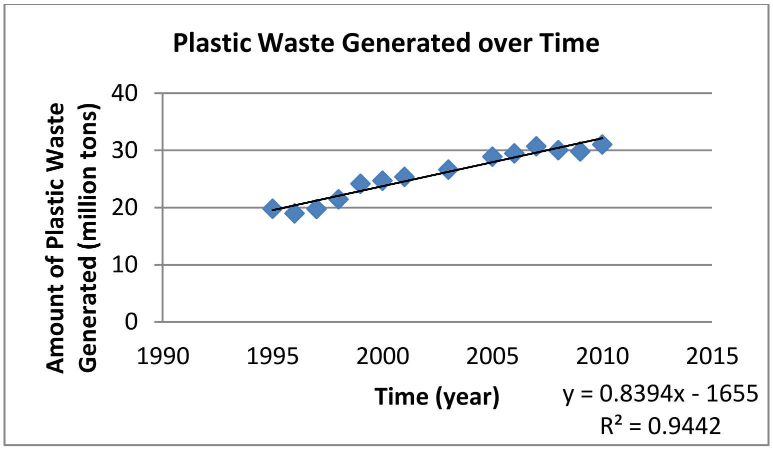


Figure 1

Figure 1 illustrates the amount of plastic waste generated increasing gradually as each year passes but decreasing at a few points due to bursts of increased recycling or decreases in demand for plastic products. Another possible explanation is fluctuating oil prices associated with producing plastic.

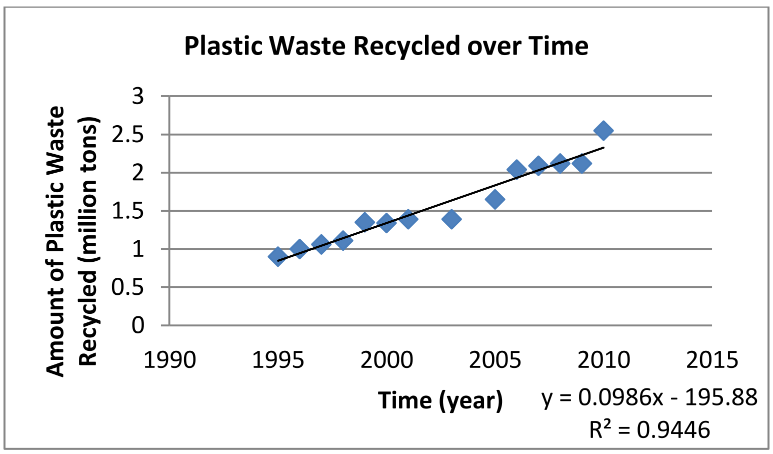


Figure 2

Figure 2 illustrates an increase in plastic recycling due to an increase in plastic waste needing recycling and an increase in awareness and availability of recycling methods.

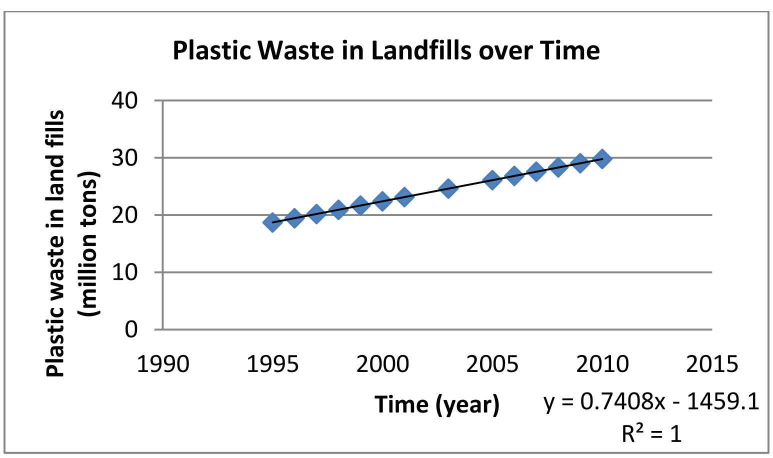


Figure 3

Figure 3 illustrates the increase in the total amount of plastic waste in landfills. It is also a representation of the amount of plastic waste produced subtracted by the amount recycled. The amount increases because, despite how much recycling increases, demand for plastic products continues to increase as populations grow.

Proposing a New Recycling Program in Three U.S. Cities

The proposed new recycling scheme will be judged on its financial feasibility according to a multitude of factors, most prominently the population of the city in question.

A city's recycling program is typically tax funded, so its budget depends on the number of taxpayers under its jurisdiction. Its expenses are also determined by the number of people participating in the program, which can be assumed to include all the people living in the city. This variable, represented by the word $people$ in the model equations, depends on the city and is equal to that city's population.

Each person in the city produces a certain amount of waste per unit time, measured in $tons\ of\ waste\ per\ person\ per\ year$. A certain percentage of this waste is non-recyclable, so only a portion of this waste per year is run through the recycling system, defined by the $percentage\ of\ waste\ recycled$.

There are a variety of types of residential recycling programs:

- Single-stream recycling places all recyclable materials into a single container for curbside pickup, where a collection truck will bring it to the local recycling center. This program imposes the fewest responsibilities on the individual, which would likely increase the percentage of people who recycle, making it the ideal program under the considerations of this investigation.
- Dual-stream recycling requires citizens to separate paper from all other recyclable materials and place them in two separate containers for curbside pickup, where a collection truck will bring it to the local recycling center. This program requires more of the individual than the single-stream system, but less than drop-off recycling.
- Drop-off recycling requires citizens to separate all recyclable materials by type of material, such as paper, plastic, etc., and to drop off the materials at a local site (outside a courtroom, library, school, etc.), where a collection truck will pick it up and move it to the nearest recycling center. This program requires the most of the individual and tends not to be as popular or as widely used, rendering it the least appealing to this investigation.

Any of these programs (except drop-off recycling) can be run either once weekly or once every two weeks. The biweekly version of the program is less expensive, but may ultimately discourage recycling, as people may be unwilling to hold onto a large quantity of trash before being able to throw it out. The drop-off recycling can run on almost any schedule, as long as the bins do not overflow.

Each of these programs requires a different $cost\ per\ ton$ to process recyclable waste. Each program also has a different $installation\ cost$ used to build the facilities required to process the waste. The installation cost is a one-time fee at the beginning of the program, but the cost per ton of processing waste is a yearly expense, meaning that the cost is cumulative over a range of $years$.

Using the following equation, these factors can be used to calculate the cumulative cost of running each program for a given number of years:

$$\begin{aligned} &cumulative\ cost\ to\ run\ program \\ &\quad = number\ of\ years \\ &\quad * \left(\left(people * \frac{tons\ of\ waste}{person/year} * percentage\ of\ waste\ recycled\right) * \frac{cost}{ton}\right) \\ &\quad + installation\ cost\ . \end{aligned}$$

This cost can be compared with the cumulative budget allowed by the taxpayers' money, which is defined by multiplying the number of taxpayers by the amount of $tax\ money\ per\ person$ that they're expected to pay, as follows:

$$budget = number\ of\ years * \left(people * \frac{tax\ money}{person}\right).$$

Because the initial installation cost is generally going to greatly exceed the budget allowed for that year, the city will be left with a considerable debt that can be paid off using the $surplus\ budget$ given by the difference between the yearly cost to run the program and the original budget:

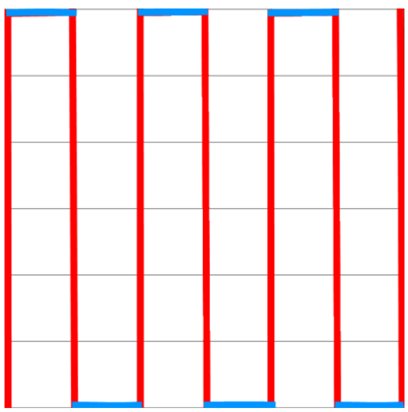
$$\begin{aligned} &surplus\ budget \\ &\quad = number\ of\ years * \left(people * \frac{tax\ money}{person}\right) \\ &\quad - \left(\left(people * \frac{tons\ of\ waste}{person/year} * percentage\ of\ waste\ recycled\right) * \frac{cost}{ton}\right). \end{aligned}$$

This surplus will accumulate over the years that the program is in practice, ideally settling the debt incurred in the first year. This would depend on the magnitude of the debt and the cost of continuing to run the program, which further depend on the population of the city.

Each city needs not only a facility that can process the recyclable material, but also a fleet of recycling trucks that can transport this material to the facilities. These trucks may be either diesel or electric, with differing $prices$ and $costs\ of\ operation$ depending on type, and with a set linear $range$ of miles that they can cover in one day. The only system that does not depend on a fleet of trucks is the drop-off recycling system, because it features drastically fewer stops than either of the curbside pick-up programs and so can operate on only one truck per city (if the city is small enough to necessitate the drop-off system in the first place.)

Electric trucks are preferable to diesel trucks from an environmental standpoint, so a fleet composed entirely of electric vehicles will be considered the ideal. A certain number of trucks are required from the first year onward to allow the program to operate, which due to the installation cost will likely be diesel out of financial necessity. However, once the debt is settled these trucks may be switched out for electric models.

The $area$ of a truck can be calculated by assuming that a truck must move through a one-mile grid in a pattern that ensures that the grid is covered evenly. The pattern chosen for this investigation resembles a game of snake:



The grid is assumed to be a square. The sides can be expressed using either the short sections of the path (blue) or the longer sections (red).

$$side\ length = number\ of\ blue\ sides\ ,$$

$$side\ length = length\ of\ a\ red\ side\ .$$

The linear range is equal to the total length of the colored path.

$$truck\ range = number\ of\ blue\ sides + (1 + number\ of\ blue\ sides) * (length\ of\ a\ red\ side)\ .$$

Substituting the previous side length definitions,

$$truck\ range = side\ length + (1 + side\ length)(side\ length)\ ,$$

$$truck\ range = (side\ length)^2 + 2 * (side\ length)\ ,$$

which can then be solved for the side length and therefore the area range that each truck can cover. This can be compared to the $city\ area$ to determine how many trucks are needed for each city:

$$\frac{city\ area}{truck\ area} = number\ of\ trucks\ required\ .$$

This model will project the financial viability of the various programs possible in any given city for the next 20 years, based on its population size and its area in square miles. If a program cannot at least repay its initial installation costs by the 20-year mark, it will be deemed unviable and the model will consider the next best option. The programs are ranked by desirability, from most to least preferable, as follows:

1. Single-stream weekly recycling.
2. Single-stream biweekly recycling.
3. Dual-stream weekly recycling.
4. Dual-stream biweekly recycling.
5. Drop-off recycling.

This ranking is based on the level of responsibility the programs require of the individual, under the assumption that the easier the program is for the individual, the more likely he or she is to recycle regularly.

After predicting the best program for any given population size and city area, the model will then calculate how many years will be required to fund an entirely electric fleet. This will be accomplished by checking the current level of debt and comparing it to the price of a new electric truck. If the debt is negative (or, in other words, has been paid off and is now a surplus), then the model will "buy" the number of electric trucks capable of being purchased with this surplus and "retire" an equivalent number of diesel trucks.

$$if \frac{surplus}{cost\ of\ electric\ truck} \geq 1,$$

$$then\ add\ \left\lfloor \frac{surplus}{cost\ of\ electric\ truck} \right\rfloor\ new\ electric\ trucks$$

$$and\ subtract \left(\left\lfloor \frac{surplus}{cost\ of\ electric\ truck} \right\rfloor * cost\ of\ an\ electric\ truck \right)\ from\ the\ surplus\ .$$

This will continue until there are no diesel trucks left in the fleet. The year at which this occurs will, for the purposes of this investigation, mark the completion of the program.

The data used in the model's calculations is displayed in the following chart:

Variable	Specific Values	
Population	Price, Utah	8,730[3]
	Fargo, North Dakota	105,884[3]
	Wichita, Kansas	383,085[3]
Pounds of waste per person per day	4.5[4]	
Percent waste recycled	34.1%[5]	
Tons of waste recycled per year	0.272576375[5]	
Installation cost	Single-stream	$ 9,000,000[6]
	Dual-stream	$ 4,500,000[6]
Cost per ton	Single-stream weekly	$139[6]
	Single-stream biweekly	$89.38[6]
	Dual-stream weekly	$141[6]
	Dual-stream biweekly	$103[6]
Tax money per person	$42.3750[7]	
City area in square miles	Price, Utah	4.24[3]
	Fargo, North Dakota	37.9[3]
	Wichita, Kansas	135.8[3]
Truck range in miles	60[8]	

[3] http://www.city-data.com/city
[4] http://www.cleanair.org/Waste/wasteFacts.htm
[5] http://www.epa.gov/epawaste/nonhaz/municipal/index.htm
[6] http://www.epa.gov/osw/conserve/tools/localgov/economics/collection.htm
[7] http://www.lincolninst.edu/subcenters/teaching-fiscal-dimensions-of-planning/materials/huddleston-guide.pdf
[8] http://www.sustainablebusiness.com/index.cfm/go/news.display/id/24294

The results of the model, complete with the predicted most efficient program and the estimated year of completion, are as follows:

Price, Utah
Drop-off recycling

20 year projection - Cal

1 trucks

Year	Surplus	Defecit	Diesel	Electric
0	369933	4670000	1	0
1	369933	4300067	1	0
2	369933	3930134	1	0
3	369933	3560201	1	0
4	369933	3190268	1	0
5	369933	2820335	1	0
6	369933	2450402	1	0
7	369933	2080469	1	0
8	369933	1710536	1	0
9	369933	1340603	1	0
10	369933	970670	1	0
11	369933	600737	1	0
12	369933	230804	1	0
13	369933	-139129	1	0
14	369933	-509062	1	0
15	369933	-878995	0	1
16	369933	-578928	0	1
17	369933	-948861	0	1
18	369933	-1318794	0	1
19	369933	-1688727	0	1
20	369933	-2058660	0	1

Program complete at year 15

Fargo, North Dakota
Dual-stream weekly recycling

20 year projection - Cal

6 trucks

Year	Surplus	Defecit	Diesel	Electric
0	369779	5520000	6	0
1	369779	5150221	6	0
2	369779	4780442	6	0
3	369779	4410663	6	0
4	369779	4040884	6	0
5	369779	3671105	6	0
6	369779	3301326	6	0
7	369779	2931547	6	0
8	369779	2561768	6	0
9	369779	2191989	6	0
10	369779	1822210	6	0
11	369779	1452431	6	0
12	369779	1082652	6	0
13	369779	712873	6	0
14	369779	343094	6	0
15	369779	-26685	6	0
16	369779	-396464	6	0
17	369779	-766243	5	1
18	369779	-466022	5	1
19	369779	-835801	4	2
20	369779	-535580	4	2

Program complete at year 26

Wichita, Kansas
Single-stream weekly recycling

20 year projection - Cal

20 trucks

Year	Surplus	Defecit	Diesel	Electric
0	1549133	12400000	20	0
1	1549133	10850867	20	0
2	1549133	9301734	20	0
3	1549133	7752601	20	0
4	1549133	6203468	20	0
5	1549133	4654335	20	0
6	1549133	3105202	20	0
7	1549133	1556069	20	0
8	1549133	6936	20	0
9	1549133	-1542197	18	2
10	1549133	-1751330	16	4
11	1549133	-1960463	14	6
12	1549133	-2169596	11	9
13	1549133	-1708729	9	11
14	1549133	-1917862	7	13
15	1549133	-2126995	4	16
16	1549133	-1666128	2	18
17	1549133	-1875261	0	20
18	1549133	-2084394	0	20
19	1549133	-3633527	0	20
20	1549133	-5182660	0	20

Program complete at year 17

The switch from positive to negative numbers in the "Defecit" column represents the point at which the debt is fully paid off and the fleet conversion can begin.

In the Fargo projection, the fleet conversion was not completed by the end of the 20-year projection. For cases such as this, a secondary algorithm was created to loop through each year until budget surpluses allowed the number of diesel vehicles to reach 0.

Expanding the Propositions to Apply on a Nationwide Level

In order to maximize both financial feasibility and environmental benefits, this model may be applied on a national scale to individual cities. With a more rigidly structured schedule for the program goals, the model could be used to select the most efficient program for any given U.S. city.

The proposed benchmarks for this plan are as follows:

- Within 15 years of commencing the program, the initial debt should be fully paid off via the yearly surplus budget.
- Within 20 years of beginning the program, the city should begin converting its fleet to electronic models. At least one electric truck should be purchased by this point.
- Within 30 years, the fleet should consist solely of electric vehicles and the debt should be fully settled. The program should now be self-sufficient and capable of handling maintenance and any further improvements without incurring more debt.

The first benchmark was set at 15 years because the data from the first three projections suggested that this was an entirely feasible deadline given the investment size of any given program.

The second benchmark was chosen to ensure that the surplus budget is high enough to result in a total conversion in a reasonable amount of time. If the city has not yet begun the conversion by year 20 given the first deadline at year 15, then it is not likely to ever make enough surplus to convert the entire fleet. This benchmark accommodates both larger and smaller cities by only requiring the conversion to begin by this date, not to be completed, because although larger cities produce a higher surplus, they must purchase more trucks than the slower-to-profit smaller cities.

The third benchmark was chosen to provide a reasonable turnover date for the completion of the program.

The model will begin by testing the most desirable program (as described in the previous section) to see if it complies with the first benchmark. If it does not, the program is deemed unviable and the next program on the list is assessed. When a program that passes the first test is identified, it is then tested for the second benchmark using the same process. When a program is found that passes all three benchmarks, that program is named the most efficient for that city.

Years	Surplus	Defecit	Diesel	Electric
1	341743	4838257	4	0
2	341743	4496514	4	0
3	341743	4154771	4	0
4	341743	3813028	4	0
5	341743	3471285	4	0
6	341743	3129542	4	0
7	341743	2787799	4	0
8	341743	2446056	4	0
9	341743	2104313	4	0
10	341743	1762570	4	0
11	341743	1420827	4	0
12	341743	1079084	4	0
13	341743	737341	4	0
14	341743	395598	4	0
15	341743	53855	4	0
16	341743	-287888	4	0
17	341743	-629631	4	0
18	341743	-301374	3	1
19	341743	-643117	3	1
20	341743	-314860	2	2
21	341743	-656603	2	2
22	341743	-328346	1	3
23	341743	-89	0	4
24	341743	-341832	0	4
25	341743	-683575	0	4
26	341743	-1025318	0	4
27	341743	-1367061	0	4
28	341743	-1708804	0	4
29	341743	-2050547	0	4
30	341743	-2392290	0	4

As an example, take the data for Albany, New York:

Population: 97,856

Area in square miles: 21.8

Most efficient method: Dual-stream weekly recycling

By the 16th year, the debt has been paid off entirely and there is a surplus budget.

By the 18th year, the fleet conversion has begun.

By the 23rd year, the program has been completed.

Conclusion

Based on the results produced by the functions and models, it can be concluded that the amount of plastic produced and of plastic recycled will both increase over the next decade. As long as the population continues to grow, consumer demand for plastic products will continue to rise, thus increasing the amount of plastic waste accumulating in landfills. Although the linear regression function depicts a constant growth of plastic in landfills over time, the actual value could be exponential or even less than predicted due to unexpected increases in recycling. After a decade from the year 2013, about 357.3900919 million tons of plastic waste will fill landfills. This is the equivalent to 2644.68668 million cubic yards of landfill space occupied by plastic waste. Thus the importance of initiating a nationwide recycling program is shown.

The base model predicted the best method of recycling per city dimensions for our initial cities. The smallest city, Price, Utah, should use drop-off recycling methods. The medium-sized city, Fargo, North Dakota, should use dual-stream weekly methods. The largest city, Wichita, Kansas, should use single-stream weekly. The model takes into consideration the cost of building a recycling center, population and area, purchase of trucks (and eventual conversion from diesel- to electric-powered trucks), and upkeep costs. The funds for these expenses come from the average tax per person allocated to waste collection.

Further implications of this model will then yield reasonable methods for any region in the United States dependent on the square mileage, population, and population density. Instituting this program will transition every American city into the practice of recycling, eventually even using electric instead of diesel trucks to minimize environmental impacts. Various monetary checkpoints will serve as a guide for the type of system in each city or town in order to ensure a reasonable completion of this program.

Some assumptions may have led to errors in the model. The data used in the section "The Increasing Rate of the Production and Recycling of Plastic Waste and Its Effects on Landfills" may not have been linear in nature, though a linear regression model was used. The available data suggested a linear relationship, but further data might prove an exponential or logarithmic relationship instead.

Bigger cities might need more than one facility to handle all of the recyclable waste. While this is a nonissue considering the populations of the cities on which we based our model, a drastically larger city such as New York might require two or three more facilities. Little data was available on the matter, so the model does not take this factor into account. However, the larger the city, the quicker it tends to settle its debt, so a higher installation cost would be financially feasible.

Population density was not taken into account and likely would affect the number of trucks required to cover any given area, again as might become apparent in small yet densely populated city like New York. The model calculates everything involving the trucking system based on a hypothetical pattern of traversing a one-mile grid, as explained in the section "Proposing a New Recycling Program in Three U.S. Cities." No data was available on the way that the pickup routes are planned, but they likely depend heavily on population density and the ratio of residential to commercial buildings in any given area.

Overall, the model is capable of predicting the plastic production and waste into landfills per year. The second model is then capable of predicting the most efficient method of recycling in any given city, and further expanding this to a national scale. Between these two models, the recycling system can be improved throughout the United States.

Works Cited

"Census 2000 Population Statistics." [Archived] U.S. Population Living in Urban vs. Rural Areas. 02 Mar. 2013 <http://www.fhwa.dot.gov/planning/census_issues/archives/metropolitan_planning/cps2k.cfm>.

"Chicago Buys Fleet of Electric Garbage Trucks." Chicago Buys Fleet of Electric Garbage Trucks. 02 Mar. 2013 <http://www.sustainablebusiness.com/index.cfm/go/news.display/id/24294>.

"Collection Costs." EPA. Environmental Protection Agency. 02 Mar. 2013 <http://www.epa.gov/osw/conserve/tools/localgov/economics/collection.htm>.

Huddleston, Jack R. "AN INTRODUCTION TO LOCAL GOVERNMENT BUDGETS: A Guide for Planners." University of Wisconsin-Madison. 02 Mar. 2013.

"INFORM - Fact sheet - Greening Garbage Trucks Fact Sheet." INFORM - Fact sheet - Greening Garbage Trucks Fact Sheet. 02 Mar. 2013 <http://www.informinc.org/fact_ggt.php>.

"Is Recycling Worth It?" Popular Mechanics. 02 Mar. 2013 <http://www.popularmechanics.com/science/environment/recycling/4291566-3>.

"Municipal Solid Waste (MSW) in the United States: Facts and Figures." EPA. Environmental Protection Agency. 02 Mar. 2013 <http://www.epa.gov/osw/nonhaz/municipal/msw99.htm>.

"Numbers: Plastics, From Manufacturing to Recycling to Long Death in a Landfill." Discover Magazine. 02 Mar. 2013 <http://discovermagazine.com/2009/oct/21-numbers-plastics-manufacturing-recycling-death-landfill>.

"Plastics in the Food Industry." NH Department of Environmental Services. U.S. National Park Service. 02 Mar. 2013.

"Research." U.S. Plastics Production and Carbon Dioxide Emissions Capacity. 02 Mar. 2013.

"Stats About All US Cities." City Data. 02 Mar. 2013 <http://www.city-data.com/>.

"Time It Takes for Garbage to Decompose in the Environment." US National Park Service. 02 Mar. 2013 <http://des.nh.gov/organization/divisions/water/wmb/coastal/trash/documents/marine_debris.pdf>.

"Waste and Recycling Facts." Clean Air. Clean Air Council. 02 Mar. 2013 <http://www.cleanair.org/Waste/wasteFacts.html>.