2020 STATEWIDE SOLID WASTE MANAGEMENT PLAN

ADOPTED: February 25, 2021

DELAWARE SOLID WASTE AUTHORITY

FINAL PLAN

TABLE OF CONTENTS

INTRODUCTION: PURPOSE AND HISTORY

Purpose

The enactment in 1975 of Title 7, Chapter 64 of the Delaware Code made the Delaware Solid Waste Authority (DSWA) responsible for developing, adopting, and implementing the Statewide Waste Management Plan for Delaware. DSWA last adopted a Statewide Plan in April 2010. This 2020 Plan represents DSWA's new ten-year Statewide Solid Waste Management Plan, replacing the 2010 Plan.

During preparation of the 2010 Plan, DSWA agreed with the Delaware Department of Natural Resources and Environmental Control (DNREC) that DSWA would develop a statewide solid waste management plan incorporating zero waste principles. A decade later, DSWA has elected to continue incorporating zero waste principals into the development of this 2020 Statewide Waste Management Plan (2020 Plan), as well as to explain and examine the changes that have occurred since the 2010 plan was adopted.

This document represents DSWA's *new* ten-year Plan (2020 Plan), providing the framework for actions to be taken by DSWA and other stakeholders in Delaware to maximize recycling and diversion of materials from landfill disposal, and to help advance sustainable materials management practices and minimize greenhouse gas emissions in the State.

History

Prior to the establishment of DSWA, a disjointed system of public and private collection and disposal existed throughout Delaware. Delaware had no significant public recycling programs and minimal private recycling companies.

The growth in population and development led to an increased quantity and complexity of solid waste generation, which made waste disposal problems acute in the densely populated areas. In less densely populated areas, the protection of the groundwater and wetlands were not a consideration in the disposal of solid waste.

The counties and municipalities turned to the State for solutions to their solid waste disposal problems. The State Legislature established The Delaware Solid Waste Authority (DSWA) on August 12, 1975, based on a recommendation from DNREC in a document entitled, "State Plan for Solid Waste Management".

DSWA is a public instrumentality of the State of Delaware, directed by statute to establish various programs related to the management of solid waste in a manner which best serves the citizens of the State and enhances protection of the environment. The statute included a policy statement (1) "That maximum resource recovery from solid waste and maximum recycling and reuse of such resources in order to protect, preserve and enhance the environment of the State shall be considered environmental goals of the State"; and a purpose statement (2) "that a program for maximum recovery and reuse of materials and energy resources derived from solid waste be established".

However, the policy and purpose statements were confined within a Mission statement "To define, develop, and implement *cost effective* plans and programs (emphasis added) for solid waste management which best serve Delaware and protect our public health and environment".

The establishment and implementation of programs for the management of solid waste must be consistent with DSWA's Statewide Solid Waste Management Plan (Plan). This is the case for this 2020 Plan, which assesses progress subsequent to the 2010 Plan, in light of current and projected changes in technology, markets, and economic conditions.

This 2020 Plan consists of the establishment of policies and goals, together with identification of programs necessary to implement the policies and goals, directed from a State level in order for DSWA to execute them. It is intended to address the roles and responsibilities of DSWA in solid waste disposal and recycling diversion activities as they relate to public bodies (State, counties, municipalities) and private enterprise; and, is based on Zero Waste Principles. According to the Zero Waste International Alliance:

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

This 2020 Plan also recognizes the importance of Sustainable Materials Management (SMM) as a systemic approach to using and reusing materials more productively over their entire life cycles to avoid waste. Both Zero Waste and SMM principals are considered critical in planning for Delaware's future recognizing that materials management is associated with an estimated 42 percent of total U.S. greenhouse gas emissions.[1] Finding ways to extract, use, and manage materials in more sustainable ways, and allow for growth without increasing materials consumption is critical in order to maintain a healthy economy and society.

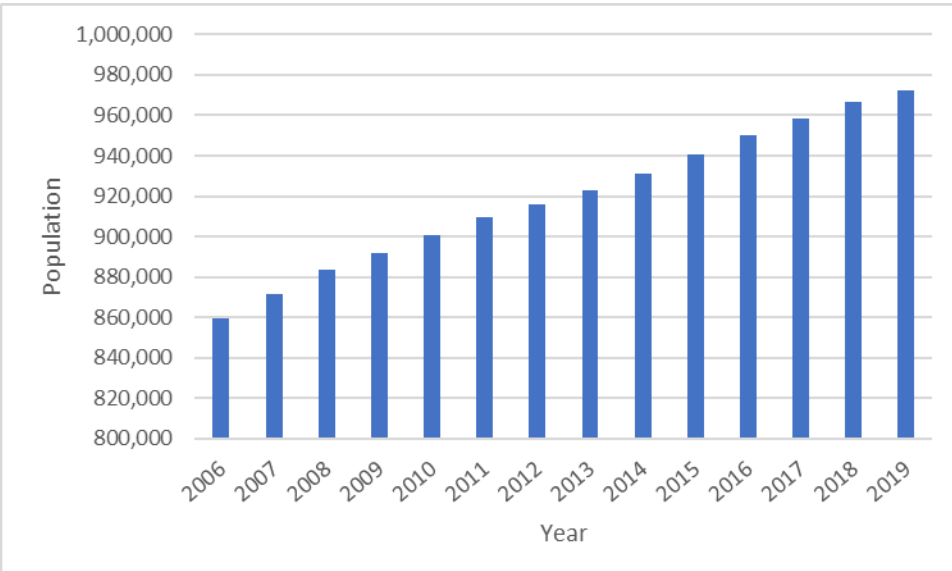
[1] *See U.S. EPA* https://www.epa.gov/smm/sustainable-materials-management-basics

CHAPTER 1: WASTE GENERATION AND DEMOGRAPHICS

Introduction

The previous Plan was published in 2010 and amended in 2015. Since that time the State of Delaware has continued to see growth in many sectors impacting solid waste management associated with increasing population. Figure 1-1 illustrates Delaware's population growth from 2006 to 2019.[2]

Figure 1-1: Delaware Population, 2006 - 2019[3]



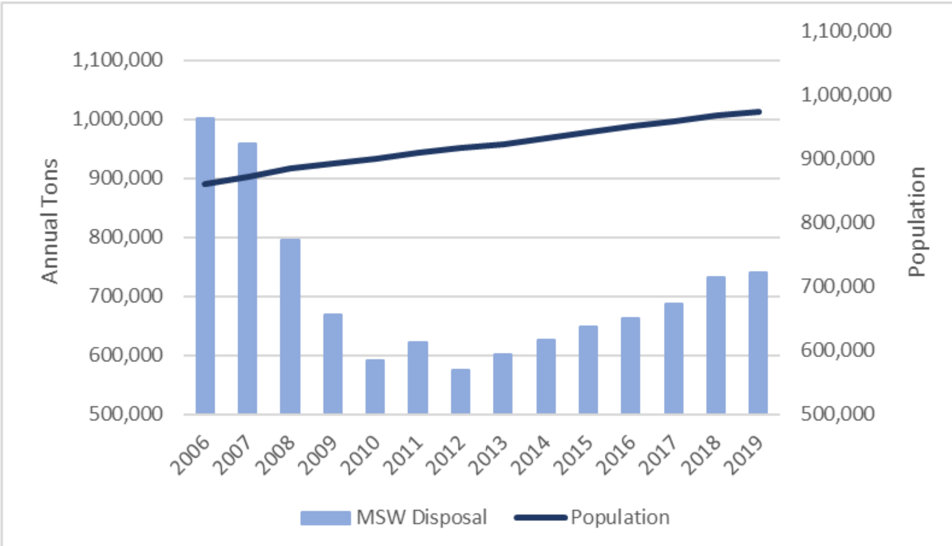
In the past, any increase or decrease in statewide solid waste generation or disposal was believed to depend primarily on the change in population and the economy. However, the recession that took place between 2007 and 2009 and the resulting decline in economic activity highlights the strong impact economic forces have on solid waste generation even as the population grows.

While the 2007 recession was said to have ended in mid-2009, waste disposal rates continued to decline after it ended. Figure 1-2 (on the next page) illustrates the change in municipal solid waste (MSW) disposed in DSWA landfills during this same time period. Figure 1-2 shows that waste disposal peaked at roughly 1.1 million tons in 2006, and began to decline in 2007, falling nearly 40% to a low of roughly 650,000 tons in 2012, all while population grew.

While most of the decrease in solid waste disposal is believed to be a result of the recession, or decreased economic activity, some of it can be attributed to the introduction of single stream curbside collection programs implemented by DSWA and the City of Wilmington.

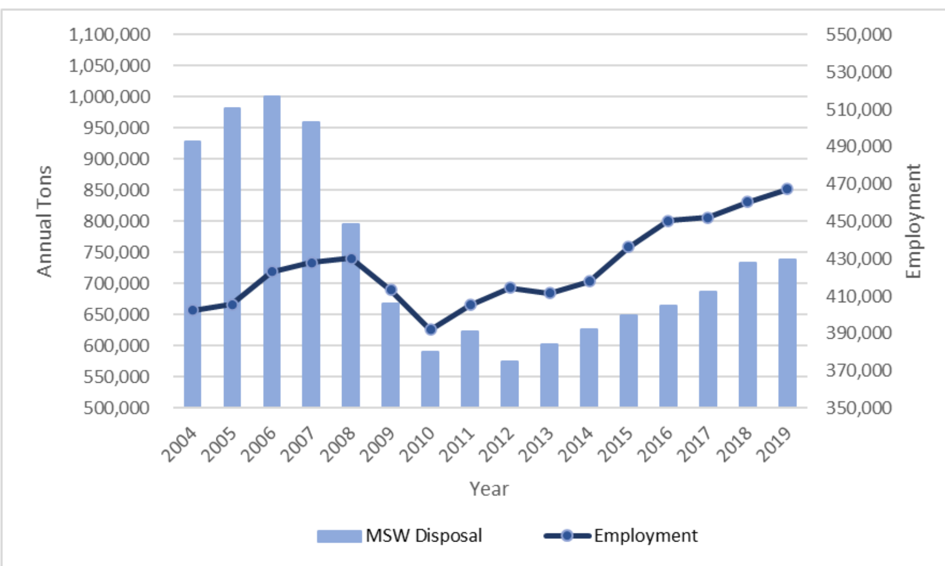
[2] Data in the Plan generally runs through 2018 and is on a CY basis unless CY 2019 data are available.
[3] Delaware Population Consortium, October 31, 2012 for years 2006-2009 and October 31, 2019 for 2010 – 2019.

Figure 1-2: Delaware Population and MSW Disposal (Annual Tons, CY 2006 – 2019)[4]



Since 2012, solid waste generation and disposal has begun to increase again as the economy has recovered. Figure 1-3 illustrates the change in the labor force from 2006 – 2019, showing a drop in 2008 through 2010, more closely in line with the drop in waste disposal than population.

Figure 1-3: Delaware Employment and MSW Disposal, 2004 - 2019[5][6]



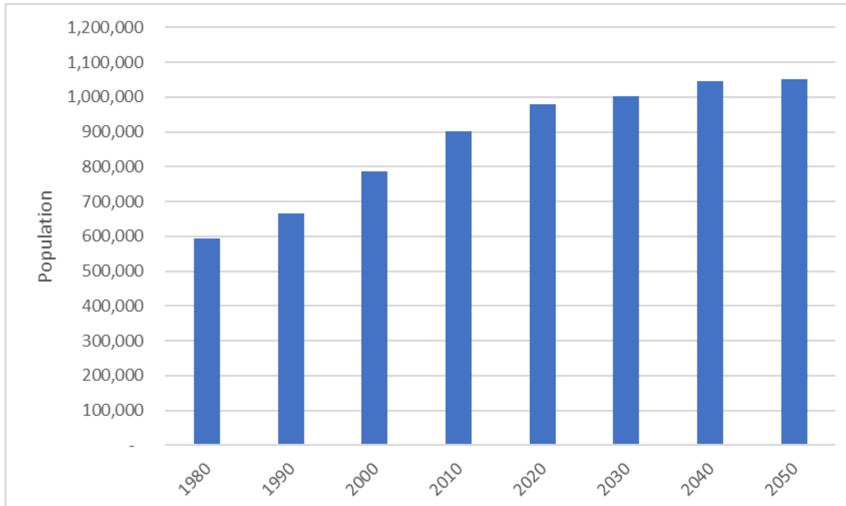
[4] *Excludes C&D disposed at DSWA landfills and any material going into the DRPI landfill located in Delaware. Note that coding of MSW and C&D waste changed subsequent to the FY 2007 Waste Characterization Study resulting in reductions in waste recorded as MSW starting in year 2008.*

[5] *US Bureau of Labor Statistics, Delaware Employment, 2004 - 2019.*

[6] *Note that coding of C&D waste changed subsequent to the FY 2007 Waste Characterization Study.*

Figure 1-4 illustrates actual and projected population growth in Delaware from 1980 (when DSWA began accepting waste) through 2050 (the most recent published projections from the Delaware Population Consortium). From 2010 to 2019, the population of Delaware is estimated to have increased by roughly 8 percent. The Delaware Population Consortium estimates that the population of Delaware will continue to increase but at a lower growth rate in the decades to come as illustrated by the flattening of the increase from 2020 to 2050.

Figure 1-4: Delaware Historic Population and Population Projections, 1980 – 2050[7]



Waste Generation and Diversion

Subsequent to the 2010 Plan, significant changes within Delaware's waste diversion programs have impacted disposal volumes. The Delaware General Assembly passed 7 Del. Code, §6058 (the Universal Recycling Law) in 2010. Implementation of the new "universal recycling" requirements and yard waste disposal bans at DSWA landfills along with the expansion and subsequent closing of food waste composting facilities have resulted in changes to the quantities of waste disposed and diverted. Population growth, economic activity, and construction and renovation of buildings also play a role.

The Universal Recycling Law required every waste hauler in Delaware to also offer curbside recycling to their customers. This added service was to be included in the cost of waste collection to encourage customers to not opt out of recycling collection since they were paying for the program whether they used it or not. The required increased access to curbside recycling was phased in - starting with single-family homes in 2011, apartments and condominiums by 2013, and commercial businesses by 2014. The increased access to recycling resulted in a roughly 72 percent increase in the amount of single stream recyclables being reported as recycled in Delaware between 2011 and 2018 and a 10 percent increase in the overall amount of recycling being reported in Delaware during the same time period.

In 2011, yard waste disposal bans were instituted in Kent and Sussex counties following the ban already in place in New Castle County. These bans prohibited residents of both Kent and Sussex counties from including yard waste in regular trash for disposal at landfills. The goal was to both extend the life of Delaware's landfills and limit the greenhouse gas emissions resulting from landfilling organic waste.

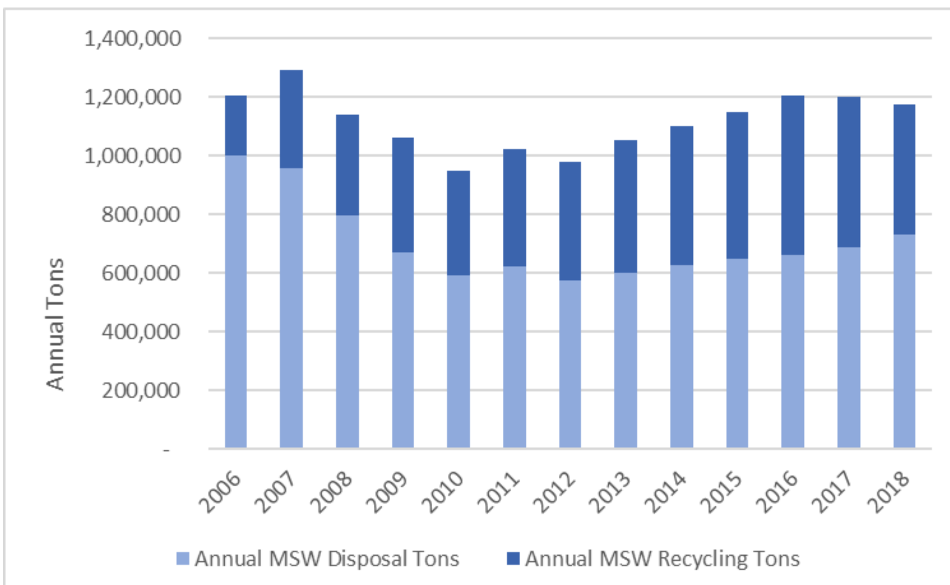
[7] *For 1980 – 1990, US. Census Bureau. For 2000 – 2050, Delaware Population Consortium, Population Projection Series, October 31, 2019. Version 2019.*

In December of 2009 Peninsula Recycling opened the Wilmington Organics Recycling Center (WORC) as the first commercial food waste composting facility in Delaware. The WORC facility had the capacity to process 160,000 tons of organic waste annually. Food waste diversion rose steadily in Delaware with access to the WORC facility and a second facility (Blue Hen Organics in Sussex County) and the 2010 Plan assumed that these facilities would continue to expand diversion of food waste over time. However, contaminants, odor issues, and lack of viable long-term markets for the resulting compost led to WORC's closure nearly five years later in 2014. Shortly following the closure of WORC, Blue Hen Organics began to tighten their specifications for organic material, and eventually stopped accepting all food waste, leaving Delaware businesses and residents without a food waste composting facility in the State.

More recently, as described in Chapter 4, export markets for recyclables have been significantly reduced, impacting the cost and quantity of recyclable material diverted in Delaware. In addition, the composition of municipal solid waste generated continues to evolve with a decline in newsprint, paper and paperboard generation, more light weighting of packaging, and replacement of metal and glass with plastic in many products and packages. These changes not only made a ton of mixed recyclables less valuable but also decreased per capita recyclables generation. Together all of these impacts resulted in a falling MSW recycling rate in the latter years of the decade.

Figure 1-5 illustrates the annual MSW generation tonnages from 2006 to 2018.[8]

Figure 1-5: MSW Generation (Recycling and Disposal, Annual Tons, CY 2006 – 2018)

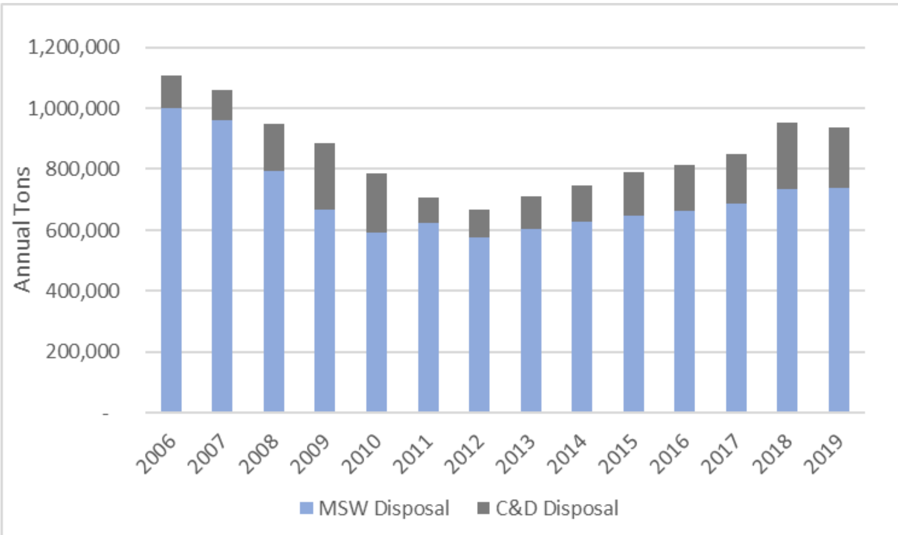


In addition to examining current MSW generation, recycling, and disposal, it is also important to understand how construction and demolition waste (C&D) generation and disposal varies year-to-year and impacts overall disposal rates at landfills within Delaware. Figure 1-6 illustrates combined MSW and C&D disposal at DSWA facilities from 2006 to 2019. The recent increase in C&D materials disposed in DSWA facilities, as illustrated in Figure 1-6, reflect an increase in construction activity associated with growth in population and economic activity. However, there has also been an increase in C&D recycling

[8] *Since 2019 recycling tons are not available at the time of plan finalization, 2019 disposal tons are not included in Figure 1-5.*

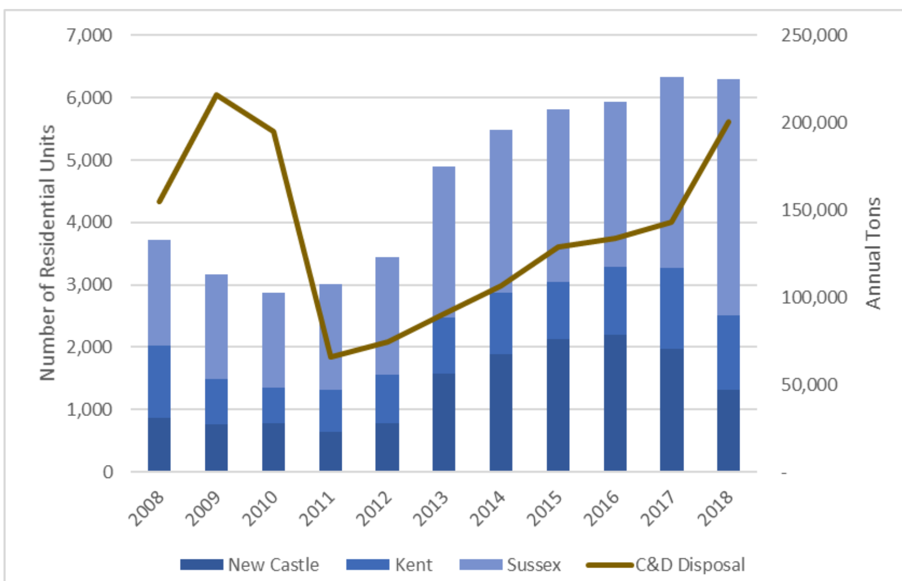
activity in Delaware over the last decade with the opening in April 2012 of the privately operated Revolution Recovery facility in New Castle. This along with continued operation of a private C&D landfill in New Castle County and other out-of-state C&D recycling facilities accepting Delaware C&D materials makes up Delaware's total C&D waste generation, as discussed in more detail in Chapter 4.

Figure 1-6: MSW & C&D Disposal at DSWA Facilities (Annual Tons, 2006 – 2019)



Much of the increase in C&D waste generation has occurred in Sussex County, resulting in increased C&D disposal volumes at the Southern landfill. Figure 1-7 shows the number of residential units approved by building permit issued in each Delaware county from 2008 to 2018.[9] As illustrated by Figure 1-7, roughly one-half of all residential building permits state-wide have been issued in Sussex County over the past ten years.

Figure 1-7: Residential Building Permits (By County) and C&D Disposal Volumes at All DSWA Facilities (Annual Tons, 2008 – 2018)



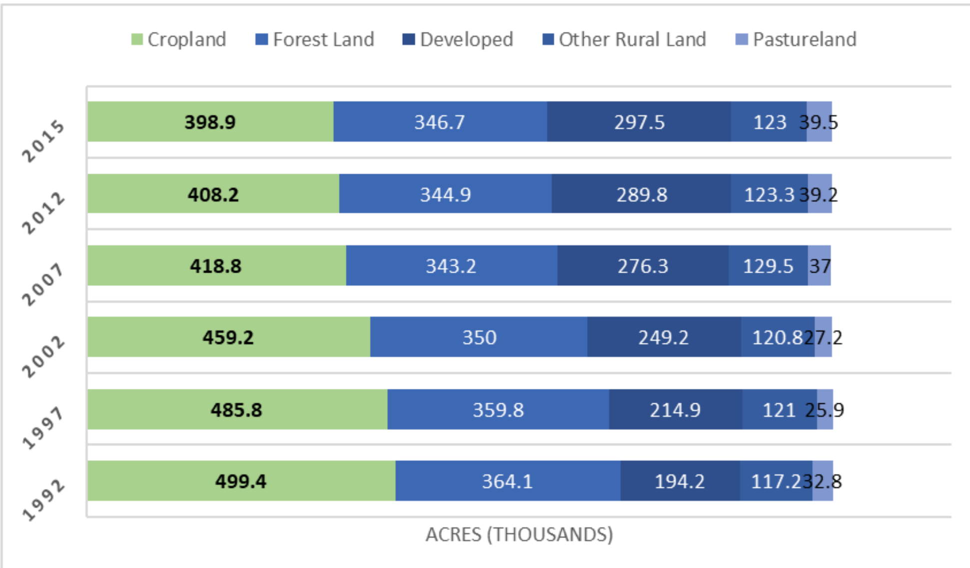
[9] *2014 & 2019 Report on State Planning Issues. Presented by The Cabinet Committee on State Planning Issues. http://www.stateplanning.delaware.gov/publications/index.shtml*

Delaware's Changing Landscape and Economy

As the population increases and the economy continues to grow, the demand for housing and subsequent residential developments and commercial centers creates pressure to develop open land. Between 1987 and 2017 Delaware experienced a loss of nearly 83,000 acres of agricultural land. [10] However, 97 percent of this occurred between 1997 and 2012. And a recent push to preserve agricultural land has seen a net increase of 19,000 agricultural acres.[11]

Figure 1-8 illustrates the land use trends in Delaware from 1992 to 2015. As illustrated by Figure 1-8, cropland has seen the largest decrease in acreage.[12]

Figure 1-8: Delaware Land Use Trends (Acres, in Thousands, 1992 – 2015)



In 2017, Delaware's farms produced $1.5 billion in agricultural sales[13] of which poultry and eggs accounted for $1.1 billion.[14] Poultry wastes are managed under the 1999 Delaware Nutrient Management Program which created regulations on the amount of nutrients that may be applied to Delaware's agricultural lands. As cropland continues to decline and poultry production continues to increase, poultry wastes (among other nutrients) will need to be diverted to other applications, with landfilling the final backup if sufficient capacity to process poultry waste does not continue to grow.

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[10] *Historical Highlights, 2017 Census of Agriculture State Data – USDA, National Agricultural Statistics Data. Note: 1987 and 1992 do not adjust for coverage.*
[11] *2019 Report on State Planning Issues: Appendix A*
[12] *2015 National Resources Inventory, Delaware Land Use.* *https://www.nrcs.usda.gov/Internet/NRCS_RCA/reports/nri_de.html*
[13] *2017 Census of Agriculture.*
[14] *United States Department of Agriculture, Delaware. A Small State that is Big in Agriculture. 2019.* *https://www.usda.gov/media/blog/2019/06/21/delaware-small-state-big-agriculture*

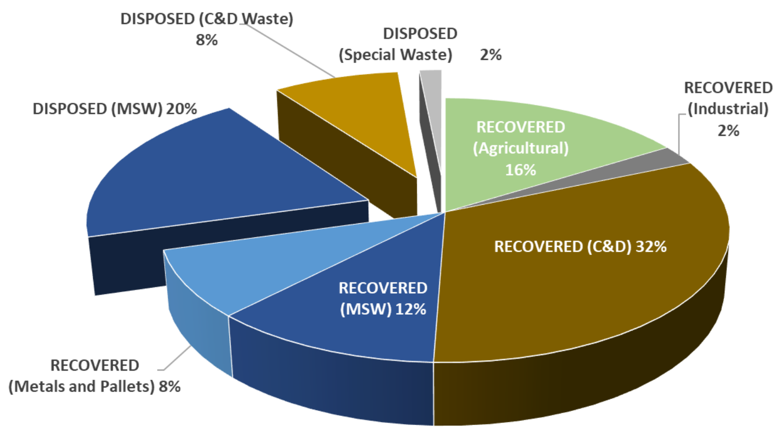
Total Solid Waste Generation and Materials Recovery

This 2020 Plan accounts for all solid waste streams generated in Delaware but focuses primarily on those materials currently managed at DSWA facilities. The Plan draws on data primarily from three sources:

- The *State of Delaware Assessment of Municipal Solid Waste Recycling (2018 and previous Annual Reports)* which is an annual analysis of municipal solid waste recycling activity in the residential and commercial sectors of Delaware. For the most recent report, see: http://www.dnrec.delaware.gov/dwhs/Recycling/Documents/2018-delaware-recycling-report-dsm-environmental-services.pdf;
- The *All Materials Recycling Study: 2018 Total Solid Waste Update (TSW Update)*[15], completed on a five-year basis, which gathers data on materials diversion occurring across all solid waste streams, expanding on the Annual Report to include materials such as construction waste, agricultural wastes, and other non-hazardous industrial solid waste recycling and diversion activity; and,
- Data from DSWA facilities reporting and programs.

Figure 1-9 illustrates the composition of total solid waste (TSW) generation in Delaware in CY 2018.

Figure 1-9: Current Recovery and Disposal of Total Solid Waste in Delaware (Annual Tons, CY 2018)



Roughly 3.7 million tons of solid wastes were estimated to be generated (gross generation) in Delaware in CY 2018, of which roughly 2.6 million tons (70%) were estimated to be diverted from disposal (recovered for other uses) and 1.1 million tons (30%) were disposed at DSWA landfills, or other facilities (such as the Delaware Recycled Products Incorporated (DPRI) landfill and the Indian Point Industrial Ash Landfill). This compares against a baseline of 3.48 million tons generated in 2008[16], an increase of roughly 250,000 tons.[17] But materials diverted from disposal also increased since 2008 by roughly 574,000 tons and total tons disposed dropped (by an estimated 325,000 tons since 2008). And the

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[15] The most recent TSW study online can be found at: http://dswa.com/wp-content/uploads/2015/12/FINAL-REPORT-TO-DSWA-All-Materials-Recycling-Study-October-2015.pdf

[16] Note that the baseline for 2008 was adjusted up to reflect missing disposal data from an industrial ash landfill that should have been accounted for. This increases the estimated generation from 3.15 million tons to 3.48 million tons.

[17] Total Solid Waste Generation for CY 2018 was estimated at 3.73 million tons and adjusted Total Solid Waste Generation was estimated for CY 2008 was 3.48 million tons (including bottom and fly ash disposed and not included in the 2008 estimate) for a difference of .25 million tons (rounded).

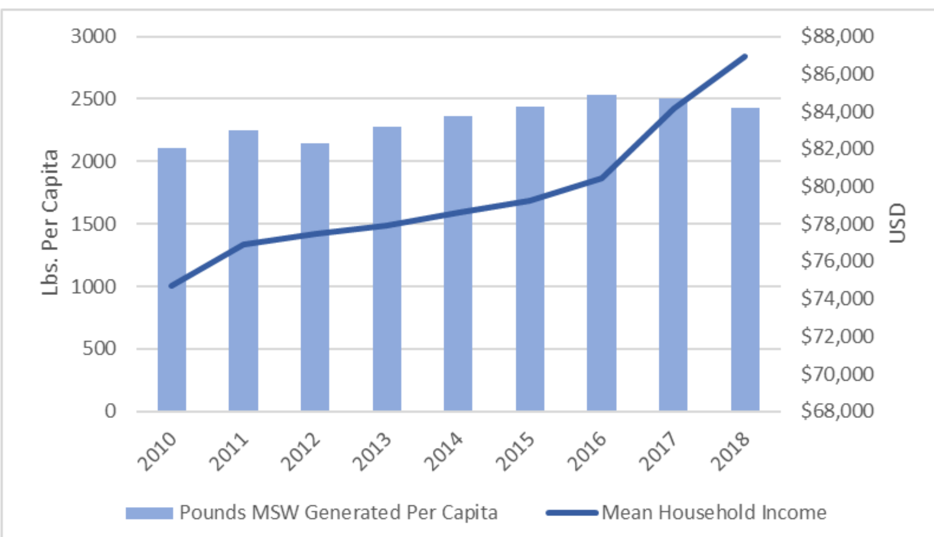
estimated CY 2018 diversion rate of 70% for all types of solid wastes combined represents an increase from the 2008 diversion rate of 59%.[18]

Population and Waste Generation Projections

According to the Delaware Population Consortium's population projections, Delaware will add roughly 25,564 new households between 2020 and 2040 with an estimated population increase of 66,661.[19] This represents an estimated population increase of roughly 7 percent over twenty years.

Traditionally, projections of waste generation are closely associated with population growth. However, as was illustrated in Figure 1-2 (above), population grew as solid waste disposal (and generation) fell between 2008 and 2012. Figure 1-10 tracks mean household income since 2010 to illustrate that it may be tied to the increase in the pounds per capita of municipal solid waste generated in Delaware, and ultimately disposed. Figure 1-10 suggests that as household income increases, there may be an increase in consumption (and therefore waste per capita), resulting in an increase in the total annual disposal of solid waste.

Figure 1-10: Annual MSW Generation and Mean Household Income, 2010 - 2018[20]



Other factors outside of population growth and changes in the economy that may have an impact on disposal rates and ultimately DSWA landfill capacity include:

- Increased occurrence and strength of natural disasters such as hurricanes and flooding due to climate change may result in increased generation of storm debris (trees, branches, and construction debris from building storm damage) putting pressure on landfill capacities. For

[18] *This rate has been corrected from the original 65% estimate shown in the 2010 Plan (which excluded industrial ash disposed in 2008).*

[19] *Delaware Population Consortium, Population Projection Series, October 31, 2019. Version 2019.*

[20] *Selected Economic Characteristics*; American Community Survey 5-Year Estimate.

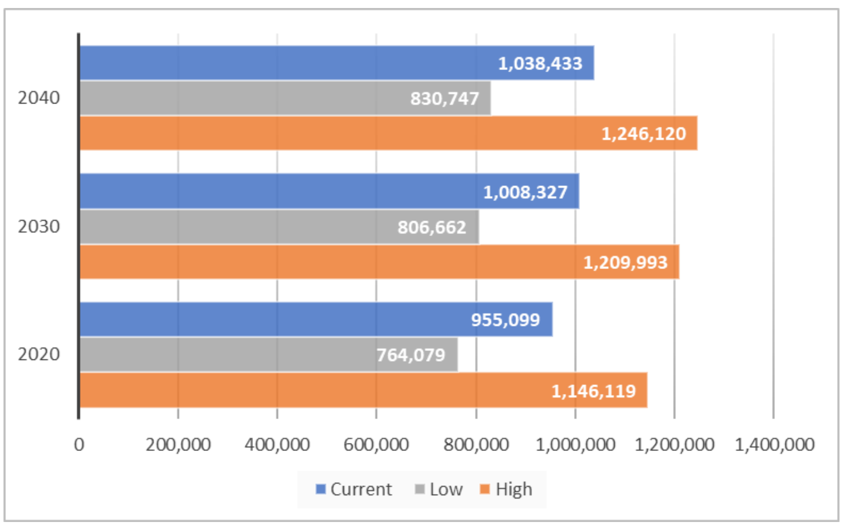
example, Hurricane Katrina generated more than 100 million cubic yards of disaster debris in the New Orleans metro area that ultimately needed management or disposal[21];

- Changes in the recycling marketplace, resulting in an increase or decrease in materials going to landfills;
- Outbreaks of disease in the poultry industry which could lead to the need to safely dispose of large quantities of poultry wastes; and,
- Human disease outbreaks such as the Covid-19 pandemic where significant changes in patterns of MSW and C&D waste generation and disposal occur.

While these factors could result in increased (or decreased) demand for disposal capacity in Delaware, they are hard to predict and, along with the uncertainty surrounding economic growth, cannot be easily used to make projections of future waste disposal requirements. As a consequence, Figure 1-11 provides a range of crude total solid waste disposal projections based on per capita waste generation and projected population growth.

Projections of high, medium, and low volumes of waste disposed at DSWA facilities through 2040 were calculated using the current annual per capita disposal rate for MSW and C&D wastes for CY 2019. The medium annual per capita disposal rate for combined MSW and C&D wastes (current growth rate) was then multiplied by the Delaware Population Consortium's population projections for the years 2020, 2030, and 2040 to project volumes of solid wastes and C&D wastes disposed at DSWA facilities through 2040. As illustrated by the blue bars in Figure 1-11, current disposal at DSWA landfills would rise from 955,000 tons (rounded) in 2020 to 1.038 million tons by 2040.[22] A high rate was assumed to be 20% above the current rate, resulting in disposal of 1.25 million (rounded) tons in 2040. A slower growth rate, 20% below the current rate would result in disposal of only 831,000 (rounded) tons in 2040. These projections illustrate the potential range in potential disposal quantities over the next 20 years.

Figure 1-11: Total Solid Waste Disposal Projections for DSWA Facilities Based on Population Estimates (Annual Tons)



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[21] *CRS Report for Congress, Disaster Debris Removal After Hurricane Katrine: Status and Associated Issues.* https://fas.org/sgp/crs/misc/RL33477.pdf

[22] *At the time of writing this Plan the COVID 19 virus was significantly impacting disposal rates at DSWA landfills. It is likely that the near future will look more like the 2007 – 2009 time period than the 2019 time period. As such, the projections contained here may over-estimate future disposal rates over time.*

Waste Composition

The most recent characterization of MSW disposal at DSWA facilities took place in FY 2016. A total of 210 representative samples of waste were collected and sorted over a two-week period, one week in November 2015, and one week in June 2016. Samples were sorted into up to 54 material types and followed the same sampling methodology as the FY 2007 waste characterization study.[23] [24]

Figure 1-12 presents commercial MSW composition by major material type and compares the results from the FY 2016 waste characterization study to those of the FY 2007 study. As illustrated in Figure 1-12 paper, plastics, and C&D materials decreased as a percent of total disposal when compared to the FY 2007 waste characterization while organics tons disposed increased as a percent of total disposal.[25]

Figure 1-12: Estimated Tons of Commercial Waste by Major Material Category (FY 2016 vs. FY 2007)

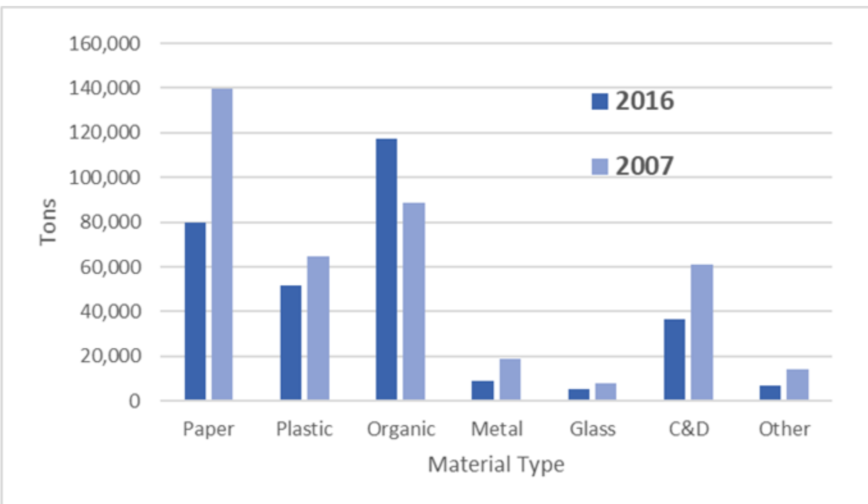
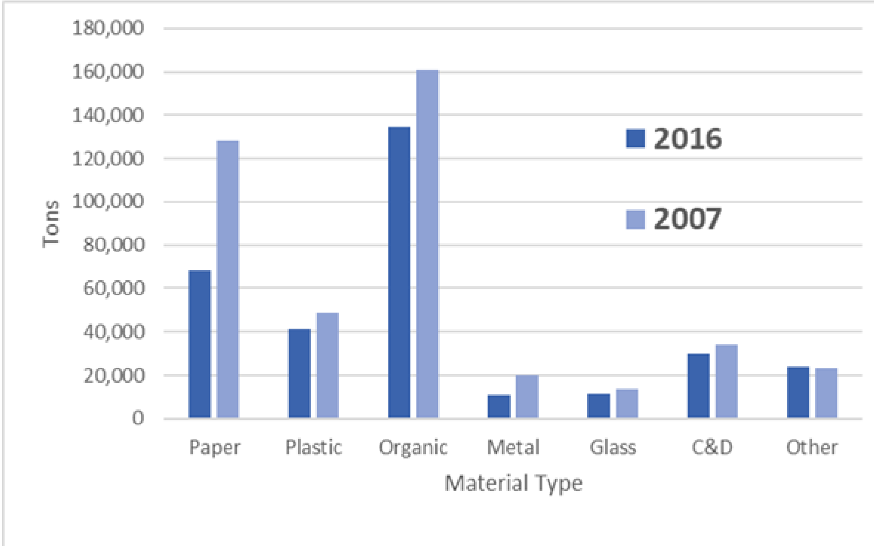


Figure 1-13 presents residential solid waste composition data comparing the results from the past waste characterization study to the more recent FY 2016 waste characterization study. Unlike commercial waste, residential solid waste disposal has seen decreases in most categories, most prominently in paper.

[23] *The FY 2016 Waste Characterization Study is titled: Delaware Solid Waste Authority Statewide Waste Characterization Study, FY 2016. Final Report, January 9, 2017.*
[24] *The FY 2007 Waste Characterization Study is titled: Delaware Solid Waste Authority Statewide Waste Characterization Study, 2006-2007. Final Report, October 31, 2007.*
[25] *The C&D category represents C&D that is set out for collection with MSW as opposed to C&D which is separately collected (and separately characterized). It should be noted that waste characterization studies calculate each material as a percent of the total sampled. As such the tons illustrated in Figures 1-12 through 1-13 represent those percentages multiplied times total tons disposed.*

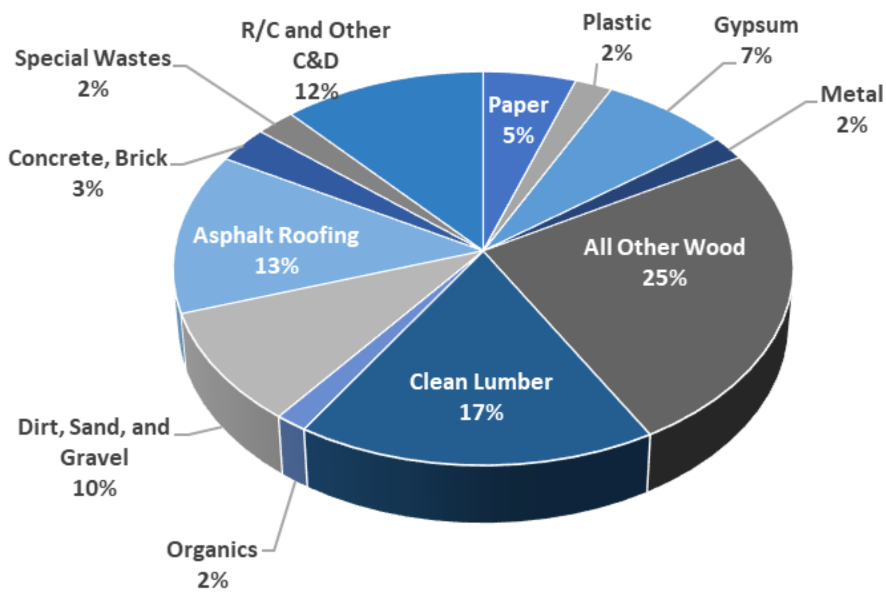
Figure 1-13: Estimated Tons of Residential Waste by Major Material Category (FY 2016 vs. FY 2007)



C&D Waste Composition

DSM also conducted a waste characterization study of C&D waste in 2015 but focused solely on deliveries to the Jones Crossroad (Southern) Landfill in Sussex County (Figure 1-14, below). Since the 2010 Plan, northern Delaware had been well served by the new C&D processing facility in New Castle County but the costs to deliver material to that facility from Sussex County are typically cost-prohibitive for relatively low value mixed C&D wastes. Looking at the composition of C&D at the Southern Landfill enabled DSWA to consider the feasibility of adding a mixed C&D processing facility in Sussex County.

Figure 1-14: Composition of C&D Waste Disposed at Southern Landfill



While Figure 1-14 provides good data on C&D waste disposal at the Southern Landfill, the composition of all Delaware's C&D wastes is difficult to characterize because recent composition data are not available for C&D wastes disposed at other DSWA facilities and no data are available on the C&D wastes disposed at the DRPI landfill, which still accepts a significant portion of Delaware's C&D wastes.[26]

Closing

The growing population and economy as well as the changes in land use will impact the future of solid waste generation and management in Delaware. Waste composition at DSWA landfills also indicate where there is the most opportunity to move toward zero waste goals, including:

- Organics remain as the largest category of waste disposed (on a weight basis) and therefore management options must continue to be pursed to reduce disposal.
- Even though there has been a large reduction in the quantity of paper disposed, it remains a large percentage of waste disposal.
- Poultry and egg production continue to be a significant contributor to the agricultural economy and a large percentage of total solid waste generation, but the majority of these materials are diverted from disposal utilizing land application, and other methods to process and treat sludges and other remains. Continued support should be given to encourage alternatives to landfilling of these materials.
- C&D waste disposal continues to grow at DSWA facilities even though C&D diversion has risen significantly, indicating market development for specific C&D materials needs to continue, particularly in Sussex County where development pressure is the greatest and there is no mixed C&D processing facility.

[26] *Figure 1-14 indicates that C&D waste includes a large percentage of clean wood (clean lumber), however mobile home and poultry house demolition loads were common during sampling and while these load sources were very high in clean wood, it is not clear that all of this wood could be sorted on a processing facilities' conveyor belt as "clean wood" because of its age as workers (or optical sorters) might consider this darker old wood as stained or treated and unsuitable for clean wood markets.*

CHAPTER 2: SOLID WASTE MANAGEMENT INFRASTRUCTURE

Introduction

Delaware's solid waste management infrastructure for solid wastes, recycling, organics, and special waste management includes collection, processing, transfer, and disposal equipment and facilities. This is supported by the administrative and management institutions necessary to maintain and operate the infrastructure. While the transfer and disposal infrastructure for municipal solid wastes are owned and operated by DSWA, the collection infrastructure is primarily owned and operated by the private sector, with some municipal collection infrastructure. DSWA has built a partnership with the private sector to handle critical recycling processing infrastructure in the State.

Administration and management activities are carried out by several parties. DNREC holds the regulatory authority and issues operating permits; DSWA manages the main transfer and disposal facilities (including the state's three MSW landfills); municipal public works departments manage some collection programs and yard waste processing sites; and, the private sector plays a large role in managing not only collection but a variety of processing facilities for handling different materials.

Delaware's solid waste management infrastructure is outlined in this chapter. While this outline does not provide a complete inventory for Delaware, it does provide information relevant to how the current infrastructure can help Delaware institute zero waste principles under DSWA's stated goals.

Collection

Under the 2010 Universal Recycling Law, waste haulers were required to offer weekly single stream recycling collection services to all Delaware single-family residential customers, including "delivery of a container for the purpose of storage and collection of recyclables that is adequately sized for the customers use such that recycling is encouraged and disposal of recyclables is discouraged".[27] This service was to be provided by September 15, 2011.

The Law also required that source separated recycling collection services be provided to businesses who provide on-premise sales, and also required *"delivery of a recyclables container that is adequately sized for the premise being served and a frequency of recyclables collection that shall preclude the recycling containers from overflowing and otherwise causing a nuisance*".

Finally, the Law required that both single-family residential and on-premise sales customers be presented with a single charge for the collection of waste and recyclables inclusive of the combined waste and recycling collection service costs. Municipalities that presently bill separately for the costs of waste collection were exempt from this requirement.

The Law required that multi-family residences be served with recycling collection services by January 1st, 2013 followed by commercial businesses by January 1st, 2014.

The passage and implementation of the Universal Recycling Law increased residents' and business's access to recycling services. Today, all households and businesses in Delaware have access to recycling

[27] *See: An Act to Amend Titles 7 and 30 of the Delaware Code Relating to Recycling and Beverage Containers.*

services either through their private hauler, their municipal collection program, or at a DSWA drop-off facility. All refuse drop-off facilities operated by DSWA also offer recycling drop-off, as well as collection of many special wastes and materials.

There are currently 85 DSWA licensed solid waste haulers in Delaware. The largest serve both households and businesses and offer containerized collection as well as handle special wastes. Most of these haulers offer some type of recycling service. Other haulers (of the 85 licensed) only serve their business or provide bulky waste or containerized collection. And some only provide residential service or serve a very specific population. Many of these specialized haulers collect less than 100 tons per year and are subject to fewer requirements.

Residential Refuse and Recycling

Currently, there are an estimated 369,335 households in Delaware.[28] Roughly 76,000 households receive curbside refuse and recycling collection from their public works department as listed in the communities below.

- Dover (Refuse Only)
- Lewes
- Milford
- New Castle
- Newark
- Rehoboth Beach (Refuse Only)
- Wilmington
- Bethany Beach

In addition, an estimated 38,000 (rounded) also receive refuse and recycling collection through their municipality but under a municipal contract with a private hauler.

Another 21,800 (rounded) households are estimated to bring their waste to one of the five DSWA collection centers or use the self-haul areas at the DSWA transfer stations and landfills.[29]

The remaining 233,300 (rounded) households subscribe for refuse and recycling collection service through one of Delaware's licensed private haulers. Some of these households, primarily those residing in multi-family housing, are served as part of a commercial collection route.

Table 2-1 shows the estimated breakdown of collection service types and providers to Delaware's households.

[28] *Estimate of 369,335 households in 2018 is based on data from the Delaware Population Consortium.*
[29] *Estimated, based on the total tons recorded at the collection centers as well as MSW tons delivered from cars and pickups to the self-haul areas at the transfer stations and landfills.*

Table 2-1: Estimates of Total Households Served by Refuse and Recycling Collection Infrastructure in Delaware, 2019

Refuse and Recycling Collection Service	Estimated Households Served (1)	% of Total Households
Curbside Service		
Subscription Curbside	224,065	62%
Municipal Curbside		
Public Works (2)	76,110	21%
Private (Municipal Contract)	38,135	11%
Subtotal:	***338,310***	***94%***
Drop-off Service		
DSWA Collection Stations	1,611	0%
DSWA Landfills or Transfer Stations	19,618	5%
Subtotal:	***21,228***	***6%***
Total:	**359,538**	**100%**

1. *Household counts are estimated based on best available information.*
2. *The City of Rehoboth Beach and the City of Dover provide refuse collection service through their Streets Department but contract for recycling.*

As shown in Table 2-1, all households now have full access to recycling collection services parallel to their refuse collection service. Under the Universal Recycling Law, there is no separate fee for this service, so while households may choose not to participate in recycling, they all pay for the service, and therefore there is an economic incentive for them to participate. All of the service is single stream, making it easier for households to recycle.

There are also several private facilities where households and businesses can drop off separated recyclables such as metals and cardboard.

This is a significant change from 2010 when only an estimated 22% of households had curbside recycling service, some through a special DSWA collection service. At that time, the balance could use a DSWA unmanned drop-off center or the DSWA transfer stations or landfill to recycle; however, almost all of the drop-off centers did not offer trash drop-off, so households often made a special trip just to recycle.

Residential Yard Waste Collection

Many of the municipalities that offer curbside collection of refuse or recycling also offer the collection of leaves and yard waste. Collection schedules for yard waste often vary depending on the season and seasonality of the population. In some municipalities collection is offered year-round, whereas other areas only offer collection during the growing season and in the fall. Leaf collection is typically offered in the fall with some municipalities utilizing vacuum machines for loose leaves hoping to prevent clogging of municipal stormwater drains.

Residents that do not receive yard waste collection from their municipal public works department, may receive collection through their municipalities' contract with a private collector. Others receive yard waste collection as part of their subscription refuse and recycling collection service. Now that yard waste is banned from DSWA landfills, many haulers offer yard waste collection as a service to their residential (and commercial) customers.

Delaware residents also have the option to take their yard waste to drop-off sites at DSWA landfills and transfer stations for a fee, or to private mulching operations located throughout the state that accept residential yard waste. Private mulching operations may charge a fee for materials dropped off. DNREC also has operated a yard waste drop-off site in New Castle County at no cost to residents, but there has been a continued debate about closing it in the near future.

Commercial Refuse and Recycling Collection

The passage of the Universal Recycling Law in Delaware required all commercial entities to have a recycling program in place by January 1st, 2014. According to the most recent County Business Patterns release, Delaware had an estimated 25,366 establishments in the State in 2016.[30] It is assumed that most of these establishments contract with a private waste hauler that also provides recycling collection. Smaller businesses may self-haul their wastes and recycling to DSWA transfer stations or landfills to avoid the cost of a private waste hauler or recycle additional materials not typically collected by their waste hauler.

Some large chain stores have in-state refuse and recycling collection service, but also backhaul specific recyclable materials out-of-state to centralized distribution facilities where they can either reuse them or broker the materials direct to processors. This type of recycling management is common among many large grocers and retailers where materials such as cardboard, pallets, and shrink wrap are backhauled to a central location for consolidation.

Some large companies contract with a waste and recycling broker (often located out-of-state) who may handle locations (of the same corporation) in many states. The broker often contracts with a large hauler located outside of Delaware who may then subcontract with a hauler/recycler licensed in Delaware.

Special Wastes

Delaware businesses and households have access to a number of businesses operating in the State that accept special wastes for recycling or processing. Depending on the material type and quantity, the special waste may be accepted for free or a fee at drop-off stations or collected through pick up at the generator location for a fee.

Table 2-2 lists the special waste management programs available in Delaware through DSWA or private companies. In cases where the DSWA column is checked, the material can be brought to DSWA facilities (including partner facilities Revolution Recovery and ReCommunity/Republic) for processing and/or recycling.

[30] *Geographic Area Series: County Business Patterns,* 2016 Business Patterns. Released 4/19/2018. *https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF*

Table 2-2: Special Wastes Managed in Delaware and Collection Entity

Material	DSWA	Private Sector
Asphalt	✓	✓
Carpet	✓	✓
Clean Wood	✓	✓
Concrete	✓	✓
Electronics/Electronic Goods	✓	✓
Fats, Oil, Grease		✓
Fluorescent Bulbs	✓	✓
Gypsum	✓	✓
Houshold Hazardous Waste	✓	✓
Land Clearing (e.g. trees, stumps), mulched		✓
Lead Acid Batteries	✓	✓
Mattresses	✓	✓
Mixed C&D	✓	✓
Oil Filters	✓	✓
Other metals	✓	✓
Pallets	✓	✓
Soils and Stone		✓
Solvents (Used)	✓	✓
Textiles		✓
Tires	✓	✓
Used Goods		✓
Waste Oil	✓	✓
White Goods	✓	✓

Materials Processing

The changing materials processing landscape nationally, regionally, and in Delaware has had an impact on the number and type of Delaware businesses currently processing specific materials. It is estimated that Delaware has over 60 businesses located within the State that are processing materials included in Table 2-3 below. These 60 businesses do not include companies that are strictly collecting and hauling materials but not processing these materials (such as waste haulers that only collect refuse, single stream recycling, and/or cardboard or scrap metals.)

Due to the implementation of landfill bans on yard waste in Delaware, and the changing recycling markets, some materials listed in Table 2-3 (below) have seen changes in the number of companies handling that material.

Table 2-3 provides estimates of the number of companies operating in Delaware that currently process residential, commercial, C&D, and industrial waste materials.

Table 2-3: Materials Recycling and Organics Processors Located in Delaware

Processors	Estimated Number of Delaware Based Companies (1)(2)
Agricultural Processing Wastes	1
Asphalt, Brick & Concrete (ABC)	16
Construction and Demolition Materials	3
Batteries (Lead Acid)	6
Carpet	1
Fats, Oil, and Grease	1
Used Oil	-
Pallets	3
Paper and Plastics	7
Textiles	2
Tires	1
Scrap Metal	11
Yard Waste, Mulch and Clean Wood	15

1. *This list includes only those companies processing materials in Delaware and does not include companies that collect or haul materials in Delaware, or companies that process Delaware generated materials outside of the State.*
2. *Some companies may be counted twice under different materials. For example, many scrap metal processors also collect batteries for recycling, and are therefore counted in both the scrap metal category and the battery category.*

DSWA Facilities and Programs

As illustrated in Table 2-2, above, DSWA provides management programs for many waste streams to ensure environmentally sound management. This is particularly the case for wastes generated by households and for which no services are available, or are only available at very high costs, to households by the private sector.

For most commercial wastes, there is some type of private sector involvement, particularly for those wastes which are regulated and require special handling.

Single Stream Recycling

DSWA provided a site and building at the Delaware Recycling Center (DRC) in New Castle for the development of a materials recycling facility that opened in 2013. DSWA operates the scale house and, under the 20-year partnership agreement with ReCommunity/Republic, facilitated the repurposing of the building and construction of the 160,000 tons per year capacity single stream recycling processing facility. Prior to the facility's opening, no large-scale mixed recycling processing capacity existed in Delaware, and commingled recyclables had to be transferred out-of-state for processing and marketing.

The facility opened in September 2013 after ReCommunity invested $15 million in a state-of-the-art automated recycling facility to serve Delaware statewide under the 20-year contract with DSWA. Since that time, hundreds of thousands of tons of recyclables have been sorted and marketed that were generated by Delaware households and businesses. In September 2018 Republic Services acquired ReCommunity and took over management of the 20-year contract.

DSWA provides drop-off for single stream recyclables at all of its collection sites, transfer stations, and landfills and provides transfer of large loads from the Route 5 and Milford transfer stations to the ReCommunity/Republic processing facility in New Castle.

Construction and Demolition Debris Recycling

In April 2012, DSWA sought out and entered into a 20-year agreement with Revolution Recovery to develop a recycling facility to process mixed C&D wastes at the DRC in New Castle in an existing 42,000 square foot facility leased from DSWA. DSWA leased an additional 42,000 feet to Revolution Recovery in 2014. The facility accepts mixed loads of C&D for processing including wood, metals, drywall, rubble, cardboard, plastic, ceiling tile, and paper. DSWA operates the scale house at the site.

Waste Oil and Waste Oil Filters

DSWA has operated an oil filter collection program since 1990 and was the first one started in the United States. While originally DSWA collected waste oil filters from over 400 repair shops in Delaware, private business moved into this niche and DSWA cut back the program. Today, DSWA allows Delaware residents to take their waste oil and waste oil filters to 13 drop off centers located throughout Delaware.

Household Hazardous Wastes

DSWA operates 14 Saturday HHW collection events which move throughout the State each year. DSWA also provides a weekly collection event every Monday in Sussex County, every Wednesday and Saturday in New Castle County, and every Friday in Kent County. Latex paint is also accepted at all of these events.

In FY 19, DSWA collected 891,985 pounds of HHW at a cost of $1.144 million.

Electronic Goods Recycling

DSWA operates 14 Saturday electronic goods collection events which, like HHW, move throughout the State each year to increase statewide access. DSWA also allows residents to drop off unwanted electronics for free at four permanent collection locations, which are open Mon-Sat from 8:30 am – 3:30 pm.

DSWA also provides free pick up service for State Agencies and non-profits. In FY 19, DSWA collected 2,383,215 pounds of electronic goods at a cost of $623,000.

Yard Wastes

DSWA offers yard waste collection at all DSWA drop off facilities, transfer stations, and landfills. DSWA then grinds and mulches all yard waste delivered to the landfills, transfer stations, and collection stations. DNREC permits prohibit DSWA from landfilling yard waste at all three of DSWA’s Landfills.

Document Shredding

DSWA operates 14 Saturday document shredding events which move throughout the State each year. DSWA allows residents to bring up to 2 file boxes of sensitive documents each visit to be shredded free of charge. Additional drop-off times are available monthly at each of the three DSWA landfills.

In FY 19, DSWA collected and shredded 589,838 pounds of paper which was recycled. The cost for this program was $98,000 last year.

Polystyrene Foam

Through a partnership with Dart Container, DSWA collected 18,000 pounds of polystyrene foam in FY 2019.

Household Batteries

DSWA has 13 drop off centers located throughout Delaware where residents can drop off household batteries to be recycled free of charge. In FY 19, DSWA collected 58 tons of household batteries.

Scrap Metal Recycling

DSWA recycles scrap metal at all of the landfills and transfer stations. In FY 19 DSWA collected for recycling empty propane tanks, white goods and various scrap metal which totaled 1,910 tons of metal.

Mattresses

For FY 19, DSWA collected 160 tons of mattresses that would have ended up in the landfill but were sent to be recycled instead.

Dry Wall and Gypsum Board

DSWA kept 1,141 tons of dry wall out of landfills by sorting out drywall from mixed loads of C&D and accepting clean loads of dry wall for recycling. Dry wall that is collected is recycled into various agricultural products.

Educational Programs

DSWA developed and opened an educational center located at the DRC prior to the 2010 plan and still operates it today, using it as a base for facility tours of the ReCommunity/Republic processing facilities, and the landfill. School groups as well as other groups visit the DSWA educational facility which provides a conference room, interactive exhibits, and an education staff that introduce visitors to materials recovery and recycling as well as what happens to trash when it is thrown away in a safe atmosphere before actual facility tours are held.

Institutional Structure

As discussed in the introduction to this Plan, the Act establishing the DSWA made DSWA responsible for developing, adopting, and implementing a Statewide Solid Waste Management Plan. The Act also stated:

> *"That the Authority established pursuant to this chapter shall have responsibility for implementing solid waste disposal and resources recovery systems and facilities and solid waste management services where necessary and desirable throughout the State in accordance with a state solid waste management plan and applicable statutes and regulations".*

In general, responsibilities for solid waste management in Delaware in 2020 can be categorized as follows:

- Private waste management companies and municipalities are responsible for collection of solid waste and recyclables from households in cities and towns and in the unincorporated areas of Delaware.
- Private companies and DSWA are both responsible for processing and brokering the majority of materials diverted from the solid waste disposal stream to recycling and organics recovery activities.
- DSWA is responsible for development, financing, and operation of the majority of transfer and disposal capacity in Delaware and for the safe disposal of solid waste following regulatory requirements.

The Recycling Public Advisory Council (RPAC) was officially established within the Universal Recycling Law. RPAC is charged with advising and assisting DNREC and DSWA in achieving recycling goals established in the Universal Recycling Law. In addition, RPAC was tasked with developing tools to measure and report on waste generation and the State of Delaware's recycling rate.

DNREC has primary regulatory authority over solid waste management facilities in Delaware. DNREC's solid waste division also works with businesses, residents, and local governments to encourage recycling, handle yard waste, and clean up scrap tires, including providing technical assistance to businesses on recycling and waste reduction, and contract operation of a community yard waste drop-off site in Newark.

Funding

Funding of the solid waste management activities summarized in this Chapter come from several different sources.

First, municipal refuse, recycling, and yard waste collection programs are paid for primarily through municipal tax revenues.

Second, collection of solid waste and recyclables from households (at the curb) or businesses by private waste and recycling haulers are paid through subscription or contract user fees which cover the cost of collection, processing, and disposal.

Third, yard waste composting programs are mostly paid for by users, who pay a fee to tip yard waste at the private sites. DNREC provides a free site, but with limited hours for residents only. This cost is covered by State tax revenue.

Fourth, solid waste drop-off refuse collection at DSWA drop-off facilities, transfer stations, and landfills (the self- service areas) are paid for by individuals that use the system on a volume basis.

Fifth, self-haulers bringing their personal or businesses waste to DSWA landfills and transfer stations pay a weight-based tipping fee for disposal.

Finally, provision of the special waste collection programs, including mixed recyclables, provided by DSWA but which carry no fee are subsidized through the landfill tipping fees. For some materials, such as scrap metal and cardboard, there is a small amount of revenue from sale of materials. However, for the remaining single stream recyclables and all of the special waste recycling programs, these programs were subsidized through landfill tipping fees to the amount of $5.9 million in FY 2019.

To assure the proper management of the solid waste and provide sufficient financial support for its programs, DSWA is authorized to control the collection, transportation, storage and disposal of solid waste throughout the State. DSWA has extensive authority to utilize services provided by the private sector and to engage in cooperative arrangements with other State entities, counties and municipalities.

DSWA has also been charged with establishing an extensive recycling program and a public education program. Included in the recycling initiative is the removal of materials from the solid waste stream which are harmful to the environment, and which cannot be recycled, so that they are disposed in an authorized manner. In order to fund these comprehensive activities, DSWA charges user fees for the services it provides and borrows money through bond financing and otherwise. DSWA receives no State or federal funding, and the full faith and credit of the State is not pledged for any of DSWA's debt.

To assure the proper management of solid waste and provide sufficient financial support for its programs, DSWA is authorized to control the collection, transportation, storage and disposal of solid waste throughout the State, and is expressly authorized, pursuant to 7 **Del.C.** §6406 (a)(31) to "control through regulation or otherwise, the collection, transportation, storage and disposal of solid waste, including the diversion of solid waste within specified geographic areas to facilities owned, operated or controlled by the Authority". Also,7 **Del.C.** § 6422(b) authorizes DSWA, by rule or regulation, to "require the owners and occupants of all lands, buildings and premises [in Delaware] to use the services and facilities of the Authority under such rules and regulations as the Authority shall fix and establish."

Beyond assuring a steady and consistent source of revenue, the DSWA has also determined that maximizing disposal of Delaware-generated solid waste in DSWA facilities will better assist DSWA in its efforts to monitor, evaluate and police the system of solid waste management in Delaware, including such issues as proper waste disposal, waste volume reduction, use of recycling programs and the full capture of those recyclables that may become available in the future. Accordingly, in 2015, DSWA adopted amendments to its regulations requiring all licensed solid waste haulers in Delaware to transport solid waste collected in Delaware to a DSWA facility.

CHAPTER 3: SOURCE REDUCTION

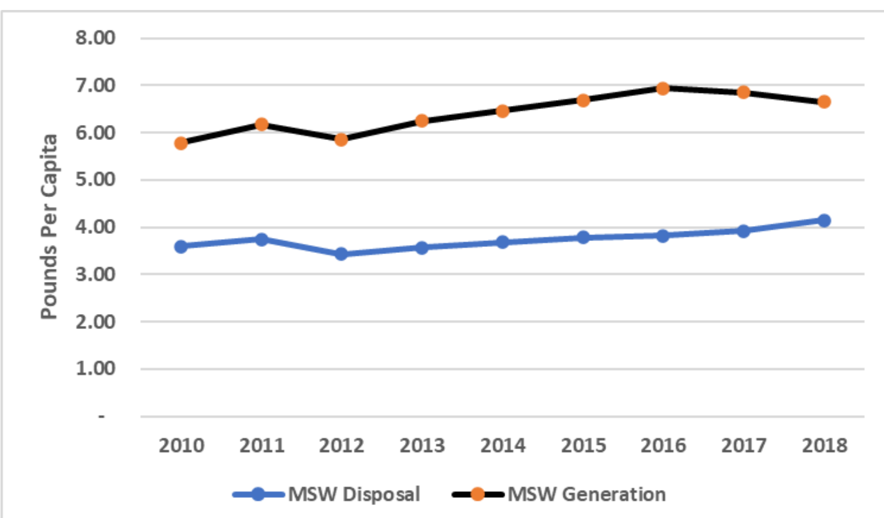
Introduction

According to the U.S. Environmental Protection Agency (EPA) source reduction (also known as waste prevention) means reducing waste at the source, and is the most environmentally preferred strategy. Figure 3-1 displays the waste management hierarchy promoted by the EPA.

Figure 3-1:
US EPA Waste Management Hierarchy

However, despite Delaware's emphasis on source reduction, recycling, and diversion this past decade, waste generation is rising. On a per capita basis, gains in recycling and waste diversion were outpaced by economic factors and consumption patterns impacting waste generation. Figure 3-2 illustrates the initial falling waste generation rate from 2010 - 2012, and a fall in per capita disposal, followed by the rise in both. Even during times of a rising recycling rate (See Table 4-2 in the next chapter) waste generation rose on a per capita basis.

Figure 3-2: Per Capita MSW Generation and MSW Disposal in Delaware, 2010 – 2018 (1)

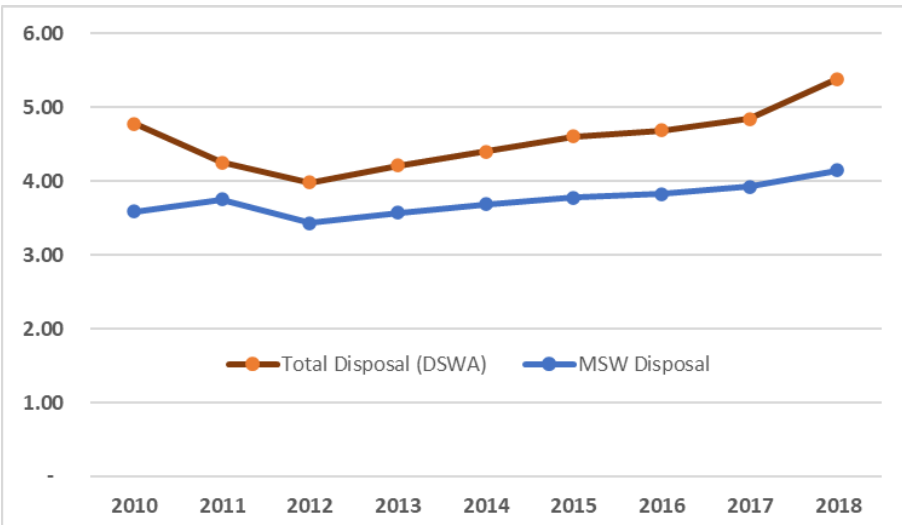


1. *Includes C&D Disposed at DSWA Facilities only but not any C&D recycling.*

This is no different from other states as they try to combat a growing waste stream. For example, Vermont's per capita MSW generation grew roughly 22 percent from 2010 – 2018[31] as Vermont's population grew roughly 0.1 percent. And Oregon's per capita MSW generation grew roughly 8 percent between 2010 – 2016 as the state missed both its goals for no increase in per-capita and total waste generation.[32]

By comparison, Delaware's per capita MSW generation grew roughly 15 percent from 2010 - 2018. However, when looking at per capita disposal at DSWA facilities, C&D disposal has increased 4 percent since 2010 while MSW disposal has increased roughly 16 percent. Figure 3-3 shows per capita disposal at DSWA facilities from 2010 – 2018 with and without C&D waste. Part of this change may be due to better accounting of C&D waste disposal; however overall C&D waste disposal has grown.

Figure 3-3: Per Capita Disposal at DSWA Facilities with and without C&D Waste (2010 - 2018)



Source reduction can take many different forms, including reduced consumption, elimination of products through bans, reusing or donating items, reducing packaging through redesign, light weighting of packaging, and remanufacturing of products. It can also include policies that ban landfill disposal of specific items in order to push them to a higher and better use (when such alternatives or infrastructure are available).

Sustainable materials management embraces these concepts. However, implementing many of these source reduction strategies require involvement of a variety of parties including the legislature.

Table 3-1, on the next page, outlines some potential methods that Delaware might undertake over the next decade to address growing waste generation, and which entity has the primary implementation responsibility (action).

[31] See Table 7 of the 2018 Diversion and Disposal Report, Waste Management & Prevention Division, Solid Waste Management Program, December 2019. This excludes C&D waste.
[32] 2016 Oregon Material Recovery and Waste Generation Rates Report, Oregon DEQ, 2017.

Table 3-1: Potential Source Reduction Strategies

Type	Description	Target Material(s)
Campaign/Education	Public awareness campaign encouraging consumers to think before buying clothes, make smarter choices, and extend the life of their clothing	Textiles
Campaign/Education	Support community-scale education about reuse, repair, and product lifespan extension	Many
Campaign/Education	Promote proper handling of reusable C&D materials, including deconstruction as a strategy to preserve the reusability of building materials	Building Materials
Campaign/Education	Food waste awareness campaign	Food Waste
Funding	Education and support for backyard composting implementation	Food Waste
Funding	Evaluate and expand water bottle filing stations in public settings	Single Use Bottles
Funding	Develop and keep updated Directory of Reuse Organizations	Many
Funding	Develop and operate a materials exchange	Many
Funding	Evaluate price gap between deconstruction and demolition through addressing environmental and health impacts and associated costs	Building Materials
Funding	Research the needs and gaps in priority industries (such as remanufacturing, textiles, building materials) to better understand: technical support needs, machinery, products, infrastructure, capacity and skilled worker development	Many
Funding	Identify opportunities to leverage the successes of local and private-sector programs by providing recognition, grants, and other support for reuse initiatives	Many
Funding	Strategic plan for reuse, repair, and extending the lifespan of products in the State through grants	Many
Policy	Support State "Right to Repair" policies to allow product owners the right to repair at an independent repair organization rather than the manufacturer	Electronics, appliances, many other products
Policy	Engage with stakeholders to develop and expand EPR for materials such as tires, batteries, carpet, and other materials	Tires, carpet, batteries, electronics
Policy	Develop product stewardship programs for consumer packaging	Packaging
Policy	Ban on single use items such as EPS packaging, straws and thin walled plastic bags	Single Use Items
Policy	Fees on single use items such as expanded polystyrene food containers and disposable bags	Single Use Items
Policy	Sustainable Purchasing – Increase the percentage of state purchases that conform to the Environmentally Preferable Products and Services requirements and conform to reuse, repair and durability considerations	Many
Policy	Implement pricing strategies of solid waste that encourage diversion to reuse, recycling, and composting	Many

Backyard Composting and Grass Cycling

The 2010 plan included expansion of the yard waste disposal ban to the other two DSWA landfills which resulted in a change from 67,000 tons of leaf and yard waste disposed in 2008 to 34,000 tons in 2018. However, when total yard waste generation was compared between 2008 and 2018, there was essentially no change between the two estimates. This indicates that while yard waste disposal has decreased rather significantly, there continues to be the practice of removing yard waste off-site for management.[33]

In addition to bans and separate yard waste collection, on-site management of yard waste should be encouraged, either through the use of mulching lawn mowers or encouragement of backyard composting, which can include adding food waste to their backyard composting efforts.

The best method to achieve this might be bulk purchase and discounted distribution of backyard composters to households offered through DSWA and/or DNREC or other qualified agencies along with technical assistance on how to set up and maintain backyard composting sites for yard waste and food waste.

Community based food waste composting should also be encouraged, as discussed further in Chapter 5.

Education

Waste reduction campaigns targeted at consumers can raise awareness about the value of reducing consumption and waste generation. Whether targeting food, textiles (see Oregon's every thread counts campaign), single use products (cups, straws, bags and take out containers), or other items, awareness can be raised, and behavior changed through a well-orchestrated outreach campaign.

In addition, education targeting youth continues to provide an important opportunity to raise awareness about waste generation. Hosting programs at schools and for schools, such as those offered by DSWA at the DRC Environmental Education Center, should be continued.

Reuse

Increasing material reuse may require grants and other funding to create opportunities for storing and exchanging materials if sufficient outlets do not exist for one or more materials. In Delaware, the Salvation Army and Goodwill Industries are leaders in reuse along with many smaller organizations including Green Drop, a new national chain which assists with Home Cleanouts, which can contribute to a large amount of bulky waste disposal.

Building materials reuse can be achieved through salvaging materials before demolition and finding an outlet to donate or take them. The Habitat for Humanity Restore sells new and used building materials, furniture, appliances, and home improvement items at up to 40 to 60 percent off the original retail prices. All items are donated by businesses, building contractors, suppliers, and individuals, and are available for sale to the public serving over 22,000 customers every year.

[33] *Trees and branches are included in the yard waste estimates but not land clearing debris. Note that separating out the category trees and branches would result in similar conclusions.*

One national organization, Build Reuse, turned 25 years in 2019 and has the mission of empowering communities to turn construction and demolition waste into local resources, supporting the development of local restores. See: https://www.epa.gov/smm/organizations-working-reduce-disposal-construction-and-demolition-cd-materials

Mobile homes abandonment creates numerous safety, economic, and environmental concerns in a community. A toolkit (through videos) developed by the EPA demonstrate how to properly deconstruct a mobile home and salvage any reusable materials. See: https://www.epa.gov/smm/toolkit-about-abandoned-mobile-homes

Online materials exchanges can also facilitate reuse of materials but rely on storage being available if a ready outlet is not available.

Reuse is an important component of source reduction but typically needs financial support to sustain operations.

Food Rescue

The redistribution of prepared and other food stuff from groceries, cafes, and restaurants is an important way to reduce food waste and support the food insecure population. The Delaware Food Bank's Food Rescue Program salvages food that would have gone to the landfill and developed an efficient system to get that food back out into the community before it is spoiled.

According to the Food Bank, food safety knowledge, a network of partners, detailed record keeping, and volunteers are all important parts of their system. Supporting these efforts and more are necessary to prevent the disposal of food waste.

Single Use Product Bans and Fees

To minimize the generation of single use product waste, fees, or outright bans have been legislated at the state, county, and local level. The most common product impacted has been thin walled plastic bags but take out containers and utensils, straws, and even coffee stirrers have also been banned.

Delaware's initial plastic bag legislation was a little different from a ban or fee. In 2009 HB 15 (later amended in 2014 by HB 198) encourages the use of reusable bags by consumers and retailers and requires stores to establish recycling programs for customers to return their plastic bags. It also requires all plastic carryout bags to display a recycling message.

The new Delaware law, which takes effect Jan. 2021, bans plastic bags from larger stores (those with more than 7,000 square feet of retail space) as well as chain stores with three or more locations with at least 3,000 square feet each. Those stores can sell reusable bags or provide paper bags at no cost or a cost of their discretion.

Eight other states have banned single use plastic bags with varying thresholds and exemptions. More information is available at: http://www.ncsl.org/research/environment-and-natural-resources/plastic-bag-legislation.aspx

Typically bans or fees result in reducing waste generation of the specific material targeted although in the case of plastic bags, there are arguments that they lead to the purchase of thicker walled garbage bags.

EPR and Right to Repair

Extended Producer Responsibility (EPR) is an environmental policy approach requiring industry to take responsibility for the products and packaging they sell by extending their responsibility to end-of-life management. EPR policies shift financial and management responsibility, with some government oversight, from the consumer to the manufacturer and provide some incentive to manufacturers to incorporate environmental considerations into the design of their products and packaging.

EPR can be achieved through well-crafted state policy designed to create a framework for better overall management of specific products that (1) may pose a threat to the environment or human health if mismanaged (such as electronics, paint, mercury container devices, fluorescent bulbs, pharmaceuticals, etc.) or, (2) that are a growing part of the waste stream but have few outlets for recycling (such as carpets, single use items, and other types of packaging). Currently, California has the highest number of products covered by EPR type laws followed by Vermont and Maine. Seventeen states have no EPR laws and eleven states have just one.

Right to Repair laws are another legislative approach to extend the responsibility and complement EPR systems by requiring electronics (or other) producers to make available the knowledge and tools needed to repair and refurbish their devices. This can extend the life of devices and reduce costs.

EPR laws can also extend to packaging wastes. With these in place, funds might be raised to develop infrastructure to recycle packaging materials with little or no markets along with incentives to design materials for recycling, or waste reduction.

CHAPTER 4: MATERIALS RECOVERY

Definition of Terms

Three separate terms are used in this Chapter to discuss and measure recycling of materials (organics recycling is covered in Chapter 5). The first is *Recycling Rate* which is reported for only those materials defined by the US EPA as part of the Municipal Solid Waste (MSW) stream. RPAC is required to report Delaware's recycling rate each year under the Universal Recycling Law. The recycling rate is calculated by summing all the materials and organics separated from MSW for recycling or composting and dividing this sum by all of the MSW disposed plus the recyclables.

The second term is the *Diversion Rate,* which is calculated the same way as the recycling rate but includes many materials that are not defined as MSW by the US EPA. These include, for example, poultry wastes and construction wastes, including asphalt, brick, and concrete.

The third term used in this Chapter is *Recovery Rate.* The recovery rate is calculated on a material by material basis (or material category) and compares the total amount of a material that is recycled and diverted against the quantity that is disposed. The rate is calculated by dividing the amount of a material diverted or recycled by the total amount of that same material that is recycled plus disposed. Recovery rates are critical to determining how well a program targeting specific materials is performing because the rate is not masked by all of the other waste streams.

Baseline Overall Recycling and Diversion Rates

Under the Universal Recycling Law, recycling generators, brokers, and processors in Delaware are required to report the volume of recyclables they generate or handle on a calendar year and provide detail by material type and source (residential or commercial sector). Using these data, along with data on disposal, an MSW Recycling Rate is calculated for each calendar year.

While RPAC's Annual Recycling Report accounts for all residential and commercial materials recycled that are generated in Delaware and defined by US EPA as part of the MSW stream, it excludes C&D materials, agricultural bi-products, industrial wastes, biosolids, and any other non-hazardous solid waste materials generated in Delaware.

A separate All Materials Recycling Study (Total Solid Waste - TSW) has been prepared every five years (for the last 15 years) to measure the total amount of all materials generated in Delaware that are diverted from disposal for recycling or beneficial reuse, including those excluded from the annual MSW recycling report. The most recent TSW report was completed in 2018 and is used to provide baseline data for this 2020 Plan.

As illustrated in Table 4-1, the MSW ***Recycling Rate*** for CY 2018 was 37 percent[34] and the Total Solid Waste ***Diversion Rate*** was 70 percent.

[34] The MSW Recycling Rate reported in Table 4-1 accounts for outgoing materials marketed from the MRF which is different from the 38% reported in the report to RPAC which accounts for materials collected (as reported on annual recycling reports) and includes some amount of residue or unacceptable materials.

Table 4-1: Municipal Solid Waste (MSW) and Total Solid Waste Recycling/Diversion Rates, CY 2018 *(1)*

	MSW (tons)	All Other Solid Wastes (tons)	Total Solid Waste (tons)
Recycling and Diversion	425,709	2,200,616	2,626,325
Disposal	732,614	371,563	1,104,177
Total:	**1,158,323**	**2,572,179**	**3,730,502**
Recycling Rate (%):	**37%**		
Diversion Rate (%):			**70%**

1. *Recycling tonnages shown in Table 4.1 represent commodities outgoing from recycling processing facilities and therefore differ from incoming CY 2018 recycling tonnages reported which include residuals.*

Historic MSW Recycling Rates

Delaware has been tracking recycling activity closely since 2006. Measurement has improved over time with two significant changes made to the tracking of recycling in Delaware since CY 2006.

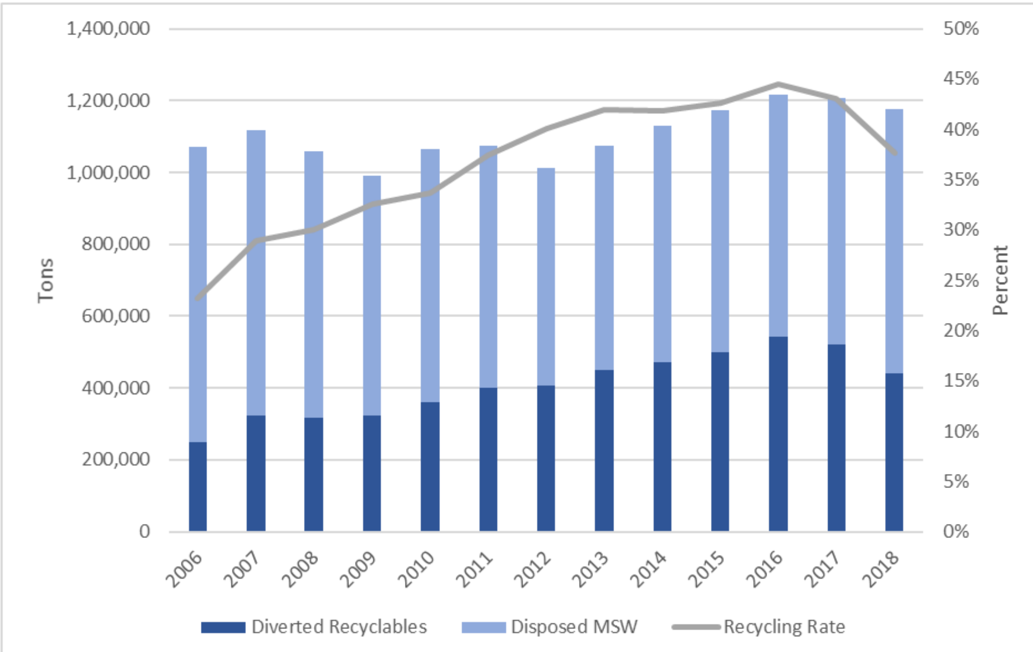
First, RPAC formed a Measurement and Methodology Subcommittee (formerly named Measurement and Reporting) and developed a standardized methodology for measuring recycling rates based upon EPA guidelines.

Second, RPAC and DNREC developed guidelines for the recycling industry to report information as directed by the Universal Recycling Law (7 Del. C., §6056). Reporting became mandatory in 2011 whereas prior to that reporting was voluntary.

Over time, reporters have become accustomed to the mandatory requirement and reporting has become standardized. However, because DSWA does not collect or process the majority of the materials recycled from Delaware generators, and they are instead managed by private sector, with recycling businesses ownership and operations changing over time, it is harder to obtain accurate data on recovery than on disposal. However, because of the Universal Recycling Law reporting requirement, Delaware has some of the better data on both recycling and disposal in the US.

Figure 4-1 (on the next page) shows the MSW recycling rates calculated from CY 2006 through CY 2018 along with the MSW tonnages recycled and disposed for each year. As illustrated in Figure 4-1, recycling volumes and recycling rates grew steadily from 2006 until 2016, peaking at 45 percent in 2016. Since 2016, recycling volumes have fallen along with the rate, which was reported at a combined residential and commercial rate of 38 percent for CY 2018.

Figure 4-1: MSW Recycling and Disposal Tonnages and Recycling Rates, 2006 – 2018 (1)



1. *Recycling tons shown for 2018 are outgoing tons of materials processed.*

In CY 2018, the residential recycling rate was reported to be 40 percent, the lowest since reporting became mandatory. The commercial rate was reported to be 35 percent. Table 4-2 shows the rates since 2012 when reporting standardization seemed to be greatly improved, and universal recycling was in effect. As shown in Table 4-2, both the residential and commercial rates peaked in 2016.

Table 4-2: Residential and Commercial MSW Recycling Rates Measured, 2012 – 2018

	2012	2013	2014	2015	2016	2017	2018
Residential	46%	47%	45%	44%	47%	44%	40%
Commercial	35%	37%	41%	43%	43%	42%	35%

Construction and Demolition Waste Recycling

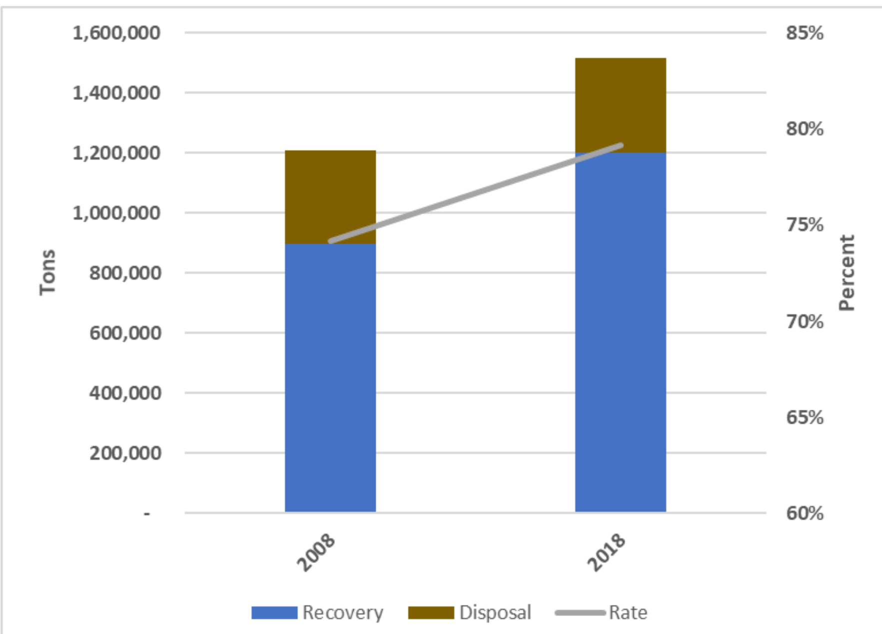
In addition to residential and commercial waste streams, construction and demolition (C&D) waste is a large portion of the overall waste disposal in Delaware. In order to move towards higher diversion goals, it is important that C&D materials continue to be recycled or diverted from the landfill. C&D waste recycling has been a focus in Delaware over the last decade.

While C&D recycling opportunities were available for certain materials like asphalt pavement, concrete, and soils and stones, there were no facilities in Delaware specifically designed to accept mixed loads of C&D materials, which are often generated at construction sites, particularly those in dense areas with space constraints. This changed in 2012 with the opening of the Revolution Recovery facility enabling more mixed C&D waste recycling to occur.

Measuring C&D waste recycling is difficult, mainly because of the different ways in which the end materials are ultimately handled. However, as part of measuring TSW diversion, C&D recycling is surveyed.

Figure 4-2 illustrates the amount of C&D waste generated and diverted in 2008 (the base year for the original Statewide Solid Waste Plan) and 2018; demonstrating both an increase in the gross generation of C&D waste and in diversion, with an increase in the diversion rate from 74 percent to 79 percent.

Figure 4-2: Construction and Demolition Waste Diversion Rates Measured, 2008 vs 2018



The result is that the estimated amount of C&D disposed on an annual basis essentially remained constant over the past ten years, with an estimated 312,000 tons disposed in 2008 compared with 316,000 tons in 2018, despite the increase in generation. This estimate does not include the small amounts of C&D waste that is disposed mixed in with residential and commercial MSW.

Baseline Materials Recovery Rates

Because of the Universal Recycling Law reporting requirements, and the fact that all MSW generated in Delaware must be disposed at DSWA landfills, Delaware is one of the few states in the US that has sufficient data to accurately calculate the recovery rate for each material recycled or diverted in Delaware.

The following tables provide complete baseline data on materials recycling and diversion for total solid waste as well as on estimated waste composition for residential and commercial MSW and for C&D wastes disposed in Delaware. Using this information as a basis, materials recovery rates for residential, commercial, and even C&D wastes can be estimated to measure progress toward zero waste.

Materials recovery rates are calculated to estimate the amount of each type of material generated that is currently being recycled or diverted from disposal, and how much more might be recovered. Materials recovery rates help identify which materials have the most potential to increase overall diversion rates.

Depending on the material type, a recovery rate of 50 percent or more is considered satisfactory and a rate of 70 percent is typically considered very good. For some materials, which are banned from landfills or severely restricted, rates as high as 90 percent are possible.

Tables 4-3 and 4-5 present current recovery rates by major material group for the residential and commercial sectors respectively. Current recovery rates for this plan were estimated using data from the Total Solid Waste Recycling Report (CY 2018) and results from the FY 2016 Waste Characterization Study with disposal material tonnages adjusted to CY 2018. Categories included in both Table 4-3 and 4-5 are materials that have some secondary market potential in the United States, even if there are no current markets in Delaware.

Residential MSW Materials Recovery Rates

Table 4-3 (on the next page) presents estimated recovery rates for residential materials recycled in CY 2018.

Table 4-3: Estimated Recovery Rates, By Material Type, for the Residential Sector (CY 2018) *(3),(4),(5)*

Material Category	Recycling (tons)	Disposal (tons)	Recovery Rate (%)
OCC (old corrugated containers)	19,473	12,600	61%
ONP (old newspaper)	4,629	6,300	42%
Mixed Paper (includes SOP)	23,318	16,800	58%
Subtotal, Paper:	***47,420***	***35,700***	***57%***
Mixed Glass (Bottles)	13,539	9,800	58%
Plastic Bottles & Containers	4,088	11,600	26%
Aluminum Cans	890	1,800	33%
Polystyrene Packaging	12	1,800	1%
Recoverable Film/Retail Bags	284	3,200	8%
Subtotal, Other Packaging:	***18,813***	***28,200***	***40%***
Oil Filters	291	0	100%
Lead Acid Batteries	1,609	0	100%
Tires (1)	7,264	2,100	78%
Subtotal, Vehicle Wastes:	***9,164***	***2,100***	***81%***
Carpet	0	9,800	0%
Textiles	3,776	19,300	16%
Other Batteries	131	0	100%
Mattresses	180	0	100%
Electronics/Electronic Goods	1,253	9,100	12%
Subtotal, Special Wastes:	***5,340***	***38,200***	***12%***
Food Waste	0	70,700	0%
Subtotal, Organic Wastes:	***0***	***70,700***	***0%***
Leaf and Yard Waste	94,413	16,100	85%
Trees and Branches	25,484	1,100	96%
Subtotal, Green Wastes:	***119,897***	***17,200***	***87%***
Steel Cans (2)	138	3,900	3%
White Goods	25,431	400	98%
Ferrous	978	3,200	23%
Non-Ferrous, All Other	965	2,900	25%
Subtotal, Metals:	***27,512***	***10,400***	***73%***
Total Residential Recovery:	**228,146**	**202,500**	***53%***

TABLE 4-3 Notes:

1. *Tires disposed are significantly lower than the tons shown in Table 4-3. Waste sampling for characterization studies record materials delivered even though DSWA operations staff remove tires tipped on the landfill face.*
2. *Aluminum & Steel Can recovery is underreported because much of it is included in ferrous and non-ferrous recovery estimates.*
3. *Single stream materials collected are reported as materials sold in a given year or estimated for that year making totals differ from CY 2018 RPAC reports which report only incoming tons, including residuals.*
4. *Recycling tons are from the Total Solid Waste Report completed in CY 2018 and include residential scrap metal which is not included in the Annual MSW Recycling Report.*
5. *Delaware Solid Waste Authority Statewide Waste Characterization Study, FY 2016, composition data has been applied to CY 2018 residential MSW disposal tonnages to create these estimates.*

As shown in Table 4-3, the overall recovery rate for total residential materials is estimated at 53 percent. Note that this is different from the residential recycling rate (Table 4-2) because ***Recovery Rates*** are calculated differently from ***Recycling Rates*** and because Table 4-2 includes materials that are not counted in an MSW recycling rate. Finally, it is interesting to note here that materials that have some potential for recycling make up only an estimated 58 percent of the residential waste stream.

In CY 2008, information was available on residential material recovery rates but not for all categories. Table 4-4 compares the current recovery rate estimates for each material with those included in the 2010 Plan (using CY 2008 data) to measure progress since the 2010 Plan was adopted.[35]

Table 4-4: Comparison of Estimated Residential Material Recovery Rates, CY 2018 to CY 2008

Material Category	CY 2018 Recovery Rate (1)	CY 2008 Recovery Rate (2)
OCC (old corrugated containers)	61%	10%
ONP (old newspaper)	42%	22%
Mixed Paper (includes SOP)	58%	27%
Subtotal, Paper:	**57%**	**22%**
Glass Bottles and Jars	58%	49%
Plastic Bottles and Containers (3)	26%	14%
Aluminum Cans (4)	33%	10%
Tin/Steel Cans (4)	3%	11%
Subtotal, Other Packaging:	**41%**	**33%**
Leaf and Yard Waste	85%	53%
Food Waste	0%	0%
Subtotal, Organic:	**52%**	**38%**

1. *Rates shown are those calculated in Table 4-3.*
2. *From Table 4-2 of the Statewide Solid Waste Management Plan, 2010.*
3. *Rates shown for Aluminum Cans and Tin/Steel Cans in CY 2018 are lower than actual rates because of cans recycled by scrap metal dealers that are not reported separate from other ferrous and non-ferrous metals recycling.*
4. *Plastic bottles and containers were reported separately in the 2010 Plan, Recovery Rate figures are combined for comparison*

As shown in Table 4-4, recovery rates increased in all categories except for tin/steel cans where data are incomplete. The biggest increase was in the category of paper recycling, where cardboard recycling increased significantly. Yard waste recovery also saw a significant increase while food waste composting among the residential sector continues to be limited to backyard composting activity, which is not measured.

Commercial Waste Materials Recovery Rates

Table 4-5 presents estimated recovery rates for materials that potentially can be recycled by the commercial sector, and shows an overall rate for materials that have some market/diversion potential.

[35] *See Table 4-2 of the Statewide Solid Waste Management Plan, April 2010.*

Table 4-5: Estimated Recovery Rates, By Material Type, for the Commercial Sector (CY 2018) *(2),(3),(4)*

Material Category	Recycling (tons)	Disposal (tons)	Recovery Rate (%)
OCC (old corrugated containers)	90,153	31,700	74%
ONP (old newspaper)	6,617	5,400	55%
Mixed Paper (includes SOP)	36,355	17,600	67%
Paper Total	***133,125***	***54,700***	***71%***
Mixed Glass (Bottles)	1,128	5,400	17%
Plastic Bottles & Containers	6,054	11,500	34%
Aluminum Cans	94	1,500	6%
Polystyrene Packaging	4	3,400	0%
Shrink Wrap/Recoverable Film	2,066	3,400	38%
Pallets, mulched and other	3,980	2,700	60%
Packaging Total	***13,326***	***27,900***	***32%***
Oil Filters	73	0	100%
Lead Acid Batteries	402	0	100%
Tires	1,816	0	100%
Vehicle Total	***2,291***	***0***	***100%***
Carpet	78	14,200	1%
Textiles	414	18,400	2%
Fluorescent Blubs	24	0	100%
Other Batteries	15	0	100%
Electronics/Electronic Goods	456	1,100	29%
Special Waste	***987***	***33,700***	***3%***
Food Waste	1,550	83,800	2%
Fats, Oil Grease	3,641	0	100%
Subtotal, Organic Wastes:	***5,191***	***83,800***	***6%***
Leaf and Yard Waste	10,490	13,800	43%
Trees and Branches	25,484	1,100	96%
Green Waste	***35,974***	***14,900***	***71%***
Steel Cans (1)	0	2,300	0%
White Goods	2,826	0	100%
Ferrous	155	5,000	3%
Non-Ferrous, All Other	66	2,700	2%
Subtotal, Metals:	***3,047***	***10,000***	***23%***
Clean Wood (and Mulch)	2,205	5,000	31%
Mixed Plastics	1,417	49,300	3%
Subtotal, Other Wastes:	***3,622***	***54,300***	***6%***
Total Commercial Recovery:	**197,563**	**279,300**	***41%***

TABLE 4-5 Notes:

1. *Steel cans recycled are included in ferrous metals.*
2. *Recycling tons are from the Total Solid Waste Report completed in CY 2018.*
3. *Disposal estimates are made from the Delaware Solid Waste Authority Statewide Waste Characterization Study, FY 2016 (Prepared by: Cascadia Consulting Group, DSM Environmental Services, Inc., and MSW Consultants) and adjusted for 2018 commercial MSW tonnage and rounded.*
4. *Single Stream materials were accounted for on an outgoing material basis when available with the remaining single stream tons allocated based on the composition of single stream materials in the CY 2018 RPAC Report. Contamination in single stream materials is not accounted for and therefore figures do not match in entirety those found in the 2018 Annual MSW Recycling Report.*

Commercial recovery rates vary greatly depending on the material type. For most types of paper rates are relatively high with cardboard leading at 74 percent. Mixed paper and newsprint (ONP) rates are higher than those measured in the residential sector and may indicate workplace recycling programs are in place at many locations. However, rates for containers and plastic packaging are relatively low indicating single stream recycling programs may not be in place at all workplace locations or commercial establishments, or workers and the public are not participating.

The overall recovery rate of 41 percent shown is for those materials that have some potential for recycling and is calculated based on including materials such as all commercial plastic waste. Including this category with the others accounts for 73 percent (by weight) of the commercial waste stream. Excluding the category of mixed plastics drops the percent of commercial waste disposed that has some potential for recovery to 60 percent. If an overall recovery rate were calculated without mixed plastics, it would be roughly 85 percent.

This is important to understand in setting recycling rate goals. If only 73 percent of commercial waste and 58 percent of residential waste have the potential for at least some level of materials recovery, and assuming materials recovery rates above 75 percent are extremely difficult to achieve for most materials (except yard waste and other banned items), then the highest achievable recycling rate for MSW would be 59 percent based on CY 2018 figures.[36] This is discussed in detail in Chapter 8, Management Plan.

Table 4-6 compares the rates calculated in Table 4-5 to CY 2008 estimated rates to measure progress.

Table 4-6: Comparison of Commercial Material Recovery Rate Estimates, CY 2018 to CY 2008

Material Category	CY 2018 Recovery Rate (1)	CY 2008 Recovery Rate (2)
OCC (old corrugated cardboard)	74%	21%
ONP (old newspaper)	55%	26%
Mixed Paper (includes SOP)	67%	31%
Subtotal, Paper:	**71%**	**48%**
Glass Bottles and Jars	17%	0%
Plastic Bottles and Containers (3)	34%	0%
Aluminum Cans (4)	6%	18%
Pallets (5)	60%	43%
Shrink Wrap/Recoverable Film	38%	17%
Subtotal, Other Packaging :	**65%**	**30%**
Leaf and Yard Waste	43%	46%
Food Waste	2%	9%
Subtotal, Organic:	**11%**	**11%**

1. *Rates shown are those calculated in Table 4-5.*
2. *From Table 4-3 of the Statewide Solid Waste Management Plan, 2010.*
3. *Plastic bottles and containers were reported separately in the 2010 Plan, Recovery Rate figures are combined for comparison.*
4. *Rates shown for Aluminum Cans and Tin/Steel Cans in CY 2018 are lower than actual rates because most cans recycled by scrap metal dealers are not reported separate from ferrous & non-ferrous metals recycling.*
5. *Pallet remanufacturing is included in the pallet recycling rate but not accounted for in MSW recycling rates.*

[36] *Complete CY 2019 recycling data were not available when this Plan was finalized.*

As shown in Table 4-6 rates in all material categories improved except for organics, where food waste and yard wastes recovery rates both declined slightly. In the case of yard waste, this may be due to inaccurate reporting of residential vs commercial yard waste, which is done at the facility level and unknown by many grinding operations. For food waste, this is due to the closing of food waste composting facilities in Delaware making food waste separation programs at the commercial level very difficult to implement.

C&D Recycling/Diversion and Materials Recovery Rates

Finally, materials recovery rate estimates were made for C&D waste based on the TSW survey data and the waste composition data (shown in Figure 1-14). While the C&D waste disposal composition shown in Figure 1-14 appears to offer the opportunity for diversion of significant quantities of material (mainly wood), secondary markets for C&D waste materials are very limited. In addition, processing costs are relatively high for mixed C&D loads, which are generally what are delivered to landfills.

Table 4-7 shows estimated recovery and disposal for each of the major material categories that make up C&D waste. The high recovery rate is driven by asphalt pavement recycling and concrete recycling which would be expensive to dispose of and are highly reusable as recycled asphalt pavement (RAP) and through concrete grinding respectively.

Table 4-7: C&D Waste Recovery, Disposal and Recovery Rate Estimates, CY 2018

Material Category	Recovery (tons)	Disposal (1) (tons)	Recovery Rate (%)
Aggregate, Fines (2)	15,718	29,100	35%
Asphalt	543,925	400	100%
Asphalt Shingles	19,000	41,800	31%
Concrete	486,405	9,400	98%
Soils and Stone	81,340	29,600	73%
Wood	17,357	132,600	12%
Gypsum	6,235	15,500	29%
Mixed C&D/Other (3)	12,386	57,200	18%
Landclearing	17,357	0	100%
	1,199,723	**315,600**	**79%**

1. *Disposal represents an estimate of the total C&D waste disposal tonnages but may not accurately represent C&D materials disposed at all landfills, and does not include residential or commercial waste that have small amounts of C&D mixed in with MSW.*
2. *Includes some mixed C&D in the denominator.*
3. *Mixed C&D/Other includes materials such as cardboard and plastics along with materials with no markets.*

Materials that are have the most potential for increased diversion from C&D waste include:

- ***Asphalt Shingles*** – Recycling of asphalt shingles can take a few forms including use in hot mix asphalt (HMA), new roofing shingles, mulch, or as road base. The demand for recycled asphalt shingles is driven primarily by the price of virgin asphalt. When per ton asphalt prices drop below $400, recovered asphalt shingles are in lower demand. Incentives such as rebate programs or subsidized pricing could increase demand. Roughly 60,000 tons of asphalt shingles were estimated to be generated in Delaware in 2018 with 31 percent recovered.

- ***C&D Wood*** – Clean C&D wood includes clean lumber, pallets and crates, and some wood roofing. All other C&D wood includes all other types of wood including engineered wood products as well as painted, stained, and treated wood. C&D wood waste generation may be as high as 150,000 tons in CY 2018 if the composition of C&D waste entering the Southern Landfill is representative of all other C&D wastes generated in the state. However less than 20,000 tons of C&D wood were recovered for markets last year due to the limited markets for many types of wood.
- ***Gypsum*** – Gypsum (drywall) waste is generated from both new construction and demolition work. Clean, unpainted gypsum can be marketed to processors making agricultural products or even new gypsum. Painted and used gypsum is much harder to find uses for.
- ***Mixed C&D –*** Only processors such as Revolution (New Castle) can handle mixed C&D loads and separate materials for recycling. This may include plastics (e.g. 5-gallon buckets, piping, trim and film packaging), as well as fiberglass insulation, some hard to recover metals, contaminated cardboard, and other multi-material products. Markets are harder to find for many of these materials and the level of contamination they bring from construction sites often creates marketing challenges.

Other Materials Recycling and Recovery Rates

Tables 4-3 and 4-5 present the estimated current recovery rates for all materials in the recycling stream. Of these materials there are a few that have low recovery rates and high annual generation figures. Increasing the recovery rates for these specific materials would have a noticeable impact on the diversion rate for Delaware. These include:

- ***Carpet*** – Carpet is generated by the residential and commercial sectors and can be found in C&D waste during demolition and renovation projects. Recovery rates are extremely low (with less than 100 tons reported recycled in 2018) mainly due to the lack of markets.
- ***Textiles*** – Textile generation in Delaware is roughly estimated at 42,000 tons annually with only 10 percent reported as recovered in 2018, compared to the 12 percent recovery rate estimated in the 2010 Plan (but with generation estimated at 26,500 tons). As clothing is becoming increasingly less expensive with a shorter useful life expectancy, it is expected that textile generation will continue to grow.
- ***Electronics*** – Electronics waste generation in Delaware has increased since the 2010 Plan, with the recovery rate (measured on a weight basis) decreasing from 22 percent to 14 percent. A major factor contributing to the decrease was the composition of electronics waste recycled which contained a large percentage of heavy CRT screens and television sets in earlier years. Because electronics recycling is not measured on a unit basis, this decrease may not be reflective of a decrease in the number of items recycled. Electronic waste generation grew appreciably during this time from an estimated 8,600 tons (in 2008) to 12,500 (rounded) tons. The electronics recycling industry has developed over the past decade with relatively sophisticated technology allowing for 70 percent of the material collected to be processed into sellable commodities such as plastics, scrap steel, aluminum, and valuable metals such as gold.[37] It is estimated that nationwide 75 percent of electronics collected for recycling are from businesses and commercial sources[38]

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[37] Institute of scrap Recycling Industries, Inc. Electronics Fact Sheet. 2018. Retrieved From: https://www.isri.org/docs/default-source/commodities/electronics-fact-sheet_2018.pdf?sfvrsn=18

[38] While DSWA offers a comprehensive electronics recycling program accessible to residents, most businesses manage their electronics internally to ensure data security and do not report on electronics recycling activity.

Factors which Have Impacted Recovery Rates and Recycling Rates Since 2010

Introduction

Several important events occurred subsequent to adoption of the 2010 Plan which have significantly impacted the recycling goals contained in the 2010 Plan. Key issues include:

- Closure of the three food waste composting facilities;
- Implementation of China Sword, and the subsequent closure of many export markets for paper and plastic recyclables; and,
- Changes in products and packaging.

Closure of the composting facilities is discussed in detail in the following Chapter 5.

The changes in secondary recycling markets, and changes in products and packaging are discussed below.

Secondary Markets

Assuming the necessary infrastructure is in place for recycling materials, market conditions for secondary materials have a significant impact on the cost and viability of recycling, and affect materials recovery rates. While high demand and resulting prices for secondary materials drive increased recovery, (and lead to infrastructure investments), falling prices reduce demand and eventually lead to lower rates of collection and recycling.

Recyclable markets reached a peak with national exports at an all-time high in 2016, and then exports began to fall, as scrap paper and plastic export markets tightened. The US recycling marketplace had become heavily dependent on export markets, mainly China and Southeast Asia, but with the introduction of China's Green Fence policies in late 2016 and then the implementation of China's Operation National Sword in January 2018, export markets shrunk dramatically. While brokers in the US were initially able to shift sales of paper and plastics to other countries, after 2018 many of these other countries also tightened their specifications for many types of paper and scrap plastics. As these export markets contracted, there was insufficient domestic demand and/or markets to accommodate the increased supply, resulting in dramatic decreases in prices paid for recovered materials.

In addition, many domestic paper manufacturers and plastic reclaimers had much tighter specifications for materials generated. This required recyclers to spend more on cleaning contamination, adding to the cost of recycling, making it even more difficult for recyclers to stay in business. For example, in August of 2017 the average price in the United States for a bale of mixed paper was $67, two years later, in August of 2019 that same bale of mixed paper was worth negative $2.[39] Furthermore, the average commodity value of a ton of single stream material has fallen over the last decade and in particular has fallen sharply since the implementation of China's National Sword. This is illustrated in Figure 4-3, which tracks one of the major recycling processors in the Northeast (Casella) who experienced revenues on June 30, 2018 at 16.9 percent of their peak in 2011.

[39] *See: https://www.wsj.com/articles/states-look-for-new-ways-to-recycle-your-plastic-and-paper-11567935001?shareToken=ste1af036607584a2588048f4370d26280*

Figure 4-3: Trends in Average Commodity Revenue, 2011 – 2018 (1)(2)

1. *Source: Casella website at https://www.casella.com/sustainability/recycling.php*
2. *Average Commodity Revenue (ACR) paid to Casella per ton of sorted and processed recycled commodities and does not include related processing, residue, and transportation costs.*

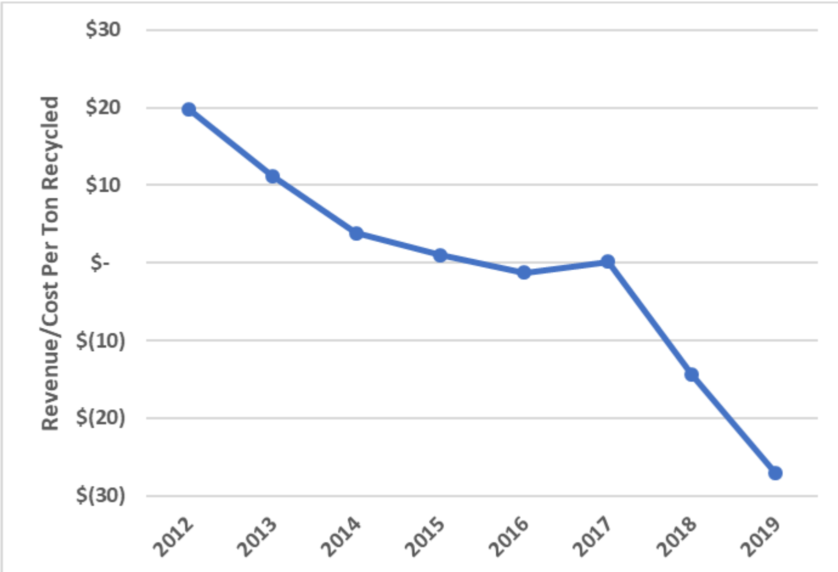
Without a rise in average commodity revenue, recycling programs are threatened. In order to continue the recycling programs Delaware has come to appreciate, and meet recycling and waste diversion goals, DSWA has found it necessary to significantly increase subsidies for recycling over the past several years.

Subsidies

In Delaware mixed recyclables can go to the ReCommunity/Republic materials recycling facility (MRF) for processing and marketing. Material collected in southern Delaware can be transferred through use of either the Route 5 or Milford transfer stations. The tip fee was held at $0 per ton at all locations (MRF or transfer station) through 2015 but under a renegotiated contract between DSWA and ReCommunity /Republic the arrangement changed, and in 2016 ReCommunity/Republic no longer covered the cost of transferring recyclables to their processing facility. The revenue sharing agreement was also changed to address changing market conditions.

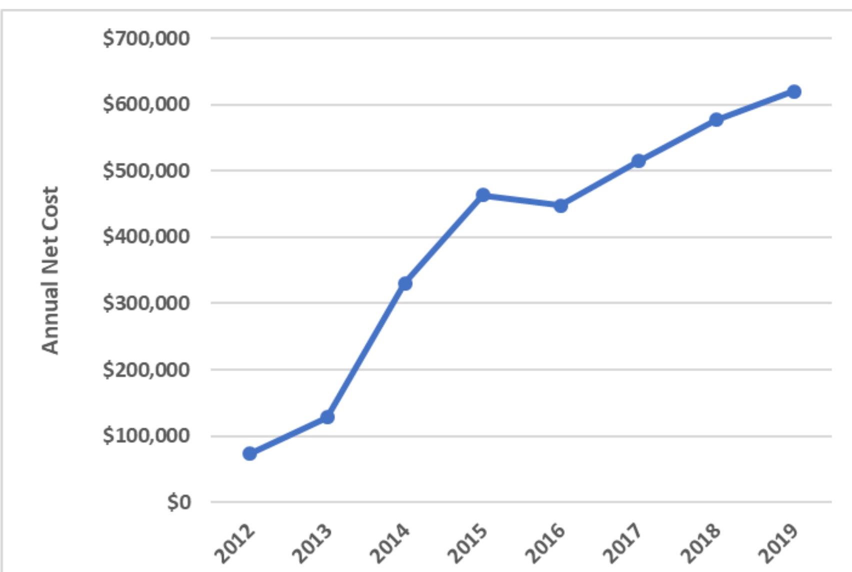
Under the new agreement, DSWA absorbed the majority of the hauling costs of recyclables from their transfer stations and offered ReCommunity/Republic reimbursement under significant secondary market downturns. In exchange for these renegotiations, DSWA was to receive a larger percentage of commodity revenue share when market conditions improve. The added costs resulted in the need to subsidize recycling beginning in 2016. Figure 4-4 illustrates the change in per ton recycling costs to DSWA with net costs falling below zero in 2016, and then falling further in subsequent years requiring a $27 per ton subsidy in FY 2019.

Figure 4-4: DSWA's Annual Revenues/Cost Per Ton Recycled (FY 2012 – 2019)



DSWA has always subsidized recycling programs from landfill revenues. In good markets, this has required little or no subsidy for paper and most packaging. But as market conditions fell, these subsidies became essential. And for some materials such as electronics and special wastes, subsidies were required throughout most or all years of the programs. Figure 4-5 shows the rising annual net costs of operating the electronic goods recycling program.

Figure 4-5: Annual Net Costs to Operate DSWA Electronics Recycling Program



As shown in Figure 4-5, the operating costs of the electronics goods recycling program have risen with any revenue received too low to offset rising operating and processing costs. This is typical of many recycling programs for hard to handle materials.

Over the course of the next ten years the size of the annual subsidies will be determined by the actual market conditions at that time. DSWA remains committed to maintaining these programs despite the need for subsidies. It is hoped that announced plans for expansion of manufacturing infrastructure in the United States to process additional quantities of recovered paper, glass, and plastics in the United States over the next few years, that the subsidies will either hold steady or decline.

Finally, markets for C&D materials are also challenged. With most metals not making their way into mixed C&D loads, the average per ton value of materials found in mixed C&D waste lies mainly in wood. However, Delaware has few markets for C&D wood. While Northeastern states can send clean wood to be recycled into particle board in Quebec, the transport cost from Delaware is too high for that market to be viable and there are no other particle board manufactures purchasing recycled wood available to Delaware.

Improving the quality of wood to expand market opportunities beyond biomass will likely require contractors to separate wood waste onsite to meet higher specifications and to encourage deconstruction in order to salvage the functional wood from structures for reuse.

Mulch and many other products are only an outlet for the cleanest wood, but most C&D wood waste is unable to meet product specifications due to contamination issues. Instead combustion of waste wood in biomass burning facilities is the outlet for most C&D wood. But with the closure of the Evergreen Community Power, a powerplant in Pennsylvania that utilized wood scraps as alternative fuel, regional options for non-treated C&D wood are very limited with the closest biomass plant located 500 miles away.

Changes in Products and Packaging

Another factor impacting recycling rates is the change in the composition of waste generated and in particular, paper and packaging materials and products. Mixed wastepaper generation has been on the decline for some time, with the shift to digital communication. For example, newspaper/mechanical papers[40] waste generation in the United States fell from 14.8 million tons in 2000 to 5.4 million tons in 2017, while other papers such as magazines, commercial printing, office, and marketing mail fell from 24.5 million tons to 11.4 million tons during the same time period.[41] Conversely, electronic waste, which is expensive to recover, is on the rise. Textile waste has also grown significantly with the EPA reporting growth from 6.5 to 12.8 million tons from 2000 – 2017.

Meanwhile the US recycling infrastructure and MRF processing technologies were initially built to process the volume and material mix of single stream recyclables from the 1990s with many

[40] *Newspapers/mechanical papers include newspapers, directories, inserts, as well as some advertisement and direct mail printing.*
[41] *US EPA. Advancing Sustainable Materials Management: Facts and Figures 2016 and 2017.*

technologies used today not necessarily well matched with current material flows that no longer need to capture large volumes of paper and other fiber.[42]

In addition, single stream recycling has brought more contamination and higher volumes of materials not desirable to most recycling markets. This includes many plastics which have been replacing metals, glass, and paper in packaging but may not have accessible recycling markets, along with multi-material laminated packaging, which are harder to recycle because of the need to disassemble materials from one another. This also includes biodegradable packaging that consumers confuse for recyclable packaging, such as cups, bottles, and other foodservice ware and which are generated to replace recyclable packaging.

All of these changes have challenged recycling goals and will continue to challenge materials recycling going forward.

[42] *Green Spectrum Consulting and Resource Recycling, Inc. Making Sense of the Mix: Analysis and Implications of the Changing Curbside Recycling Stream Prepared for: American Chemistry Council. February 2015*

CHAPTER 5: MANAGING ORGANICS

Background

As illustrated by Table 5-1, an estimated 861,000 tons (rounded), or roughly 74 percent, of organic waste generated in Delaware was beneficially reused or recycled in CY 2018. However, an additional 300,000 tons (rounded) were estimated to have been landfilled at DSWA landfills in 2018.[43]

Table 5-1: Organics Waste Diversion Estimate (CY 2018) (1)(2)

MATERIAL TYPE	Tons
Beneficial Reuse and Recycling	
Organics Wastes Categorized as Municipal Solid Waste	
Clean Wood	2,205
Fats, Oil and Grease	3,641
Food Waste	1,550
Leaf and Yard Waste	104,903
Trees and Branches	50,968
Subtotal:	163,267
Other Organic Wastes	
Biosolids (Agricultural and Municipal)	156,135
Poultry Litter	83,060
Poultry Waste	426,723
Food Processing Wastes	14,471
Land Clearing Debris	17,357
Subtotal:	697,746
Total Beneficially Reused and Recycled:	**861,013**
Disposal (1)	
Food Waste	154,255
Yard Waste	32,219
Other Organics (Excluding Compostable Paper)	108,059
Sludges, Street Sweepings and Animal Carcasses (2)	5,000
Total Disposal at DSWA Landfills:	**299,533**
Organics Diversion Rate:	**74%**

1. *Disposal Tons are estimated using waste characterization data from the FY 2016 DSWA Waste Characterization study and CY 2018 MSW disposal figures.*
2. *Estimated Tons of Organics in Special Wastes (Non MSW) Disposed in CY 2018.*

[43] *Based on the results in the Report "Delaware Solid Waste Authority Statewide Waste Characterization Study", FY 2016. Final Report. January 9, 2017.*

Even with this high diversion rate for total organics, food waste, especially, continues to be disposed in large quantities in DSWA landfills. The results of the FY 2016 DSWA Waste Characterization study found food waste to be the largest single material disposed at DSWA landfills (by weight), assuming one sums the categories *"Vegetative Food Waste, Unpackaged"*, *"Food Waste in Plastic Packaging"*, and *"Protein Food Waste, Unpackaged"* together as a single material category (as they were all grouped in one category "Food Waste" in the FY 2007 waste characterization study). [44] Including the fourth food waste category *"Food Waste in Other Packaging"*, estimated at 1.5 percent (and not in the top ten), food wastes accounted for roughly 21 percent of all wastes disposed at DSWA landfills in FY 2016.

Table 5-2 uses these composition percentage data by material type from the Waste Characterization Study and applies it to the MSW disposal data for CY 2018 to illustrate current estimates of the top ten materials found in solid waste, and the estimate of food waste in total for CY 2018.

Table 5-2: Top Ten Materials Found in MSW, by Weight (1)(2) and Total Estimated Food Waste for CY 2018

	Material Type	Estimated Percent (%)	Estimated Tons
	Top Ten Categories		
1	Compostable Paper	9.9%	72,755
2	Vegetative Food Waste, Unpackaged	9.2%	67,433
3	Food Waste in Plastic Packaging	7.0%	51,126
4	Corrugated Cardboard/Kraft Paper	5.9%	43,130
5	All Other Film	5.7%	41,561
6	Textiles	5.2%	37,773
7	Leaves, Grass, and Brush	4.1%	30,021
8	Remainder/Composite Plastic	4.0%	29,037
9	Mixed Recyclable Paper	3.6%	26,563
10	Protein Food Waste, Unpackaged	3.4%	24,687
	Subtotal:	***57.9%***	***424,087***
	Food Waste in Other Packaging	1.5%	11,010
	All Other Materials	*40.6%*	*297,517*
	Total Disposed:	**100.0%**	**732,614**
	Total, Food Waste Only:	***21.1%***	***154,255***

1. *Percentages are taken from FY 2016 DSWA Statewide Waste Characterization Study.*
2. *Tonnages shown are updated for tonnages disposed in CY 2018 and do not account for any single stream materials that are allocated into material groups based on the percentages from the FY 2016 DSWA Statewide Waste Characterization Study.*

[44] *Delaware Solid Waste Authority Statewide Waste Characterization Study", FY 2016. Final Report. January 9, 2017.*

Finally, as illustrated by Table 5-3, and based on a comparison of DSWA's waste characterization studies performed in FY 2007 and in FY 2016, food waste disposed as a percent of total MSW disposed has increased at a significantly greater rate than can be explained by population growth alone.

Table 5-3: Change in Food and Yard Waste Disposal (FY 2007 vs FY 2016)[45]

Material	Tons Disposed (FY 2007)	*Percent (of MSW)*	Tons Disposed (FY 2016)	*Percent (of MSW)*	Percent Change in Tons	Percent Change in Population (1)
Food Wastes						
Residential	50,516	11.8%	64,913	20.2%	*28%*	
ICI	53,970	13.6%	67,088	18.7%	*24%*	
Subtotal:	***104,486***	***11%***	***132,001***	***21%***	***26%***	***8%***
Leaves, Grass, Brush						
Residential	60,807	14.2%	14,709	4.6%	*-76%*	
ICI	7,855	2.0%	10,981	3.6%	*40%*	
Subtotal:	***68,662***	***7%***	***25,690***	***4%***	***-63%***	***8%***

1. *Based on estimated population in 2016, Delaware Population Consortium.*

By comparison, in FY 2007 the category Leaves, Grass, and Brush represented an estimated 7.3 percent of MSW disposed at DSWA landfills and by FY 2016 (the next time the waste characterization study was performed), after expanding the ban on disposal of yard waste to the Central and Southern landfills, it had fallen to 25,690 tons (or 63 percent) to represent roughly 4.1 percent of total MSW disposal.

In 2015 the Delaware Senate, with the concurrence of the House of Representatives created a task force to "*evaluate the best possible way to recycle organic waste in the State of Delaware in an odor free manner.*" In response, DSWA, as the co-chair of the Task Force, agreed to prepare a holistic analysis of food waste generation, reduction, and recycling to serve as a guide for moving forward with diverting organic waste from landfilling, over and above the ban on yard waste disposal already in place. Recognizing that three competent private companies had constructed, operated, and eventually closed food waste composting facilities over the last decade, the *Analysis of Organics Diversion Alternatives* (2017 Organics Analysis) initially concentrated on the potential for DSWA to construct one or more anaerobic digesters or other central food waste processing facilities adjacent to DSWA landfills.[46]

The 2017 Organics Analysis illustrated that the cost to separately collect and transport food waste, together with the cost to separately process the food waste was significantly greater than the cost to collect the food waste comingled with refuse and landfill this material. Equally important was the finding that the Greenhouse Gas (GHG) emissions savings associated with separately processing food and yard waste in an AD facility were relatively insignificant when compared to capturing the methane generated at the DSWA landfills. As stated in the 2017 Organics Analysis, using Version 14 of the US EPA Warm model[47]:

[45] *Delaware Solid Waste Authority Statewide Waste Characterization Study, FY 2016 Final Report ,January 9, 2017.*
[46] *Analysis of Organics Diversion Alternatives, Report to the Delaware Solid Waste Authority, September 2017, Prepared by DSM Environmental Services, Inc.*
[47] *Version 15 is now available, but the results would change only slightly.*

"diversion of 40 percent of ICI food and yard waste and 10 percent of residential food and yard waste from landfilling to anaerobic digestion (or 33,325 tons of food waste and 11,028 tons of yard waste) results in a net reduction in GHG emissions, statewide, of roughly 13,400 MTCO2 equivalent or 5 percent of current total emissions."

These findings are shown below in Table 5-4.

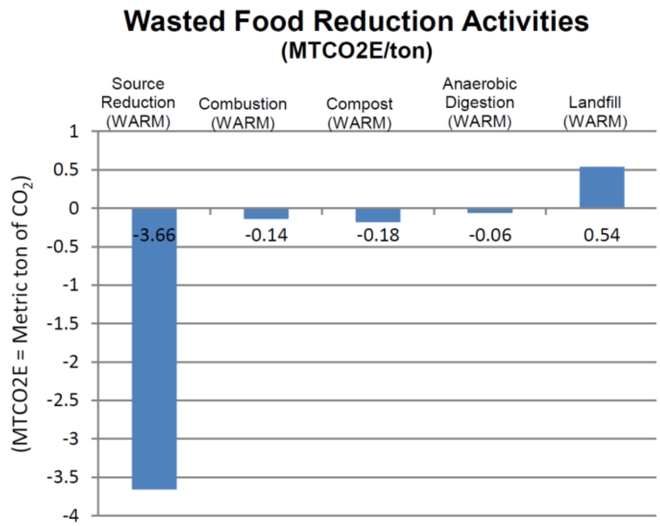
Table 5-4: Estimated Potential Change in GHG Emissions, By DSWA Facility and Statewide by Diverting Food Waste from Disposal to an AD Facility (1)(2)(3)

	Cherry Island (MTC02E)	Sandtown (MTC02E)	Jones Crossroad (MTC02E)	All (MTC02E)
Current Emissions (2016)	188,399	56,843	27,988	273,230
Reductions	(9,030)	(2,265)	(2,119)	(13,414)
Net Emissions:	179,369	54,578	25,869	259,816

1. *Reductions are calculated assuming food waste and yard waste diversion tonnages used in the Organics Diversion Alternatives Report using the US EPA Warm model (and shown in Tables 12 and 18 of that Report).*
2. *Reductions do not account for an increase in transport emissions resulting from additional collection trucks, which are assumed to be relatively small.*
3. *Reductions are subtracted from emissions reported to the EPA for each facility for CY 2016 to estimate net emissions. Actual results will vary over time.*

These findings are consistent with Oregon DEQ's recent conclusions as to the benefits of up-stream food waste reduction activities compared against down-stream processing (once the food waste had been collected). Figure 5-1, taken from the Oregon DEQ's Strategic Plan for Preventing the Wasting of Food is consistent with the analysis conducted for DSWA (as both used the EPA Warm Model) and demonstrates the benefits of source reduction activities compared against composting and other management methods.

Figure 5-1: Change in Per Ton GHG Emissions (MTCO2) From Food Waste Reduction vs. Landfilling[48]



[48] *Oregon DEQ Strategic Plan for Preventing the Wasting of Food. OREGON DEQ Materials Management, March 2017.*

While a recent California study found larger reductions from composting than would be calculated using the US EPA WARM model, source reduction still yields significantly greater benefits.[49] The Oregon Study also concluded that preventing the wasting of food provides the greatest potential for cost savings and environmental benefits relative to approaches in the traditional waste food hierarchy (on a ton for ton basis).[50]

Delaware's 2017 Organics Analysis came to a similar conclusion and examined up-stream strategies to reduce food waste generation and disposal. The 2017 Organics Analysis also recommended consideration of smaller scale composting and anaerobic digestion systems that could be implemented at the community or generator level as a method to address the growing food waste disposal issue. While the full report can be viewed on the DSWA website, the findings are used here to develop a plan for DSWA to improve organics management moving forward.

This Chapter focuses on a description of actions that DSWA (and other state agencies) might take to reduce food waste generation, redistribute food that is still edible (for humans or animals), and reduce the amount that ultimately would be sent to landfill through use of small scale systems.

Reducing Food Waste

Because food losses that occur at the grower level are typically not landfilled (but for the most part handled on-site) and most food manufacturers take measures to address food waste at the plant to minimize costs, the greatest opportunities to intervene at the State level to reduce food waste are more likely to be found by working with businesses and institutions and educating consumers.

However, there are two critical measures that must be taken at the manufacturing level that will significantly help consumers reduce food waste.

The ***first***, which two of the biggest trade groups in the grocery industry promote, is to encourage manufacturers to voluntarily standardize food labeling. The Food Marketing Institute and Grocery Manufacturers Association have been working with retailers and manufacturers to label food with a "Use By" date if it's highly perishable and there is a food-safety concern and a "Best If Used By" date to describe best product quality, but not food safety. While the Food and Drug Administration has supported the food industry movement to regularize use of the "Best if Used By" labels, no federal legislation has passed to standardize labeling. These standardized terms would replace the many different labels currently used including *Sell By, Use By, Expires On, Best Before, Better if Used By, or Best By* which have confused consumers and led to wasting usable food products.

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49 *See the report "METHOD FOR ESTIMATING GREENHOUSE GAS EMISSION REDUCTIONS FROM DIVERSION OF ORGANIC WASTE FROM LANDFILLS TO COMPOST FACILITIES" FINAL DRAFT, May 2017. Industrial Strategies Division, Transportation and Toxics Division, California Air Resources Board, California Environmental Protection Agency. The Report accounts for soil erosion benefits, fertilizer replacement and assumes higher degradation rates before landfill gas collection is in place, no landfill gas collection at the end of 60 years of landfill life (while model runs for 100 years) and apply CA specific waste characterizations.*

50 *Oregon DEQ. Id. Pg. 5.*

The ***second*** would be to work on changes in both food transport and consumer packaging to minimize food waste. Manufacturers create product lines to meet consumer choice for taste, convenience, portion size, and nutrition as well as to ensure food quality and security. Working with manufacturers to design packaging to not only meet customer and safety demands but also extend product shelf life at the store and at home with the customer is critical to minimize waste.[51]

Post manufacturing - at businesses and institutions - food waste reduction requires changes in practices specific to each operation. The ReFED project[52] performed research and consulted with a broad range of stakeholders including food producers, retailers (grocers), restaurants, and food service institutions to identify measures that have high potential for food waste reduction and that are economically feasible. Table 5-5 (next page) summarizes eight leading food waste reduction strategies from the ReFED project research.

In Delaware, technical assistance programs (jointly administered by appropriate State agencies) should be developed that can implement the strategies listed in Table 5-5, and any others that would work with Delaware food waste generators. These programs will need to work closely with, or be managed through, organizations that serve the grocery, restaurant, and foodservice industries as well as food manufacturers and distributers. For example, the Office of Food Protection within the Delaware Health and Social Services Department, could be tasked with integrating food waste reduction strategies into best practices for food handling and preparation, as well as designing educational campaigns and outreach programs targeting those trained in food handling and preparation.

At the consumer level, education is key to reducing food waste. There are many toolkits and technical assistance materials currently available to help in any state-wide food waste reduction campaign focused at consumers. These can be evaluated by DSWA and DNREC for application in Delaware.

DSWA and DNREC should also find appropriate partners to implement effective consumer education campaigns on food waste reduction, including those that focus on reducing consumption. Finally, DSWA and DNREC can also participate in, and support, consumer education on food waste reduction by targeting these campaigns through DNREC's grant cycle, integrating them into greater waste diversion and recycling campaigns taking place in Delaware.

[51] *In creating new types of packaging to extend shelf life, the life cycle analysis of the packaging must also be a consideration including whether it is recyclable or biodegradable after its' useful life and whether it is more prone to littering or other forms of improper disposal.*

[52] *See Refed.com and ReFED's Roadmap to Reduce U.S, Food Waste, 2015.*

Table 5-5: Food Waste Prevention and Reduction Measures (1)

Producers, Retailers	
Change in Specifications for Resale or Purchase	Allow for off-grade produce (cosmetic imperfections, short shelf life, discoloration) to be used in foodservice and restaurant preparation, and allowed for retail sale
Foodservice and Restaurants	
Use Smaller Plates	Provide consumers with smaller plates in self-serve, all-you-can-eat dining settings to reduce consumer waste
Use Trayless Dining	Eliminate tray dining in all-you-can-eat dining establishments to reduce consumer waste
Eliminate Refilling the Buffet	Minimize the need to keep large serving containers full for all buffet diners - do not refill containers toward the end of dining hours
Utilize Waste Tracking & Analytics	Provide restaurants and prepared-food providers with tools to measure wasteful practices and with data to inform behavior and operational changes
Retailers	
Change Cold Chain Management	Reduce product loss during shipment to retail distribution centers by using direct shipments and cold-chain-certified carriers
Improve Inventory Management	Improvements in the ability of retail inventory management systems to track an average product's remaining shelf-life (time left to sell an item) and inform efforts to reduce days on hand (how long an item has gone unsold)
Utilize Secondary Resellers	Identify businesses to purchase unwanted processed food and produce direct from manufacturers/ distributors for discounted retail sale to consumers
Consumers	
Institute Consumer Education Campaigns	Conduct large-scale consumer advocacy campaigns to raise awareness of food waste and educate consumers about ways to save money and reduce wasted food

1. *Most of these strategies listed are from ReFED's Economic Analysis, The Business and Societal Case for Reducing Food, Solutions Evaluation, page 17.*

Reuse of Food Waste through Donations and Redistribution

At the State level incentivizing food waste recovery not only helps reduce food waste but helps to address food insecurity.

The *Bill Emerson Good Samaritan Act* (PL 104-210) provides liability protection in all states for food donors and nonprofit food recovery organizations that distribute food to needy individuals. Donors must meet requirements to receive protection, including that any food donated must: be done with the belief that it is safe to eat; meet certain quality and labeling requirements; and, be distributed to needy individuals without a fee. Protection also extends to premises to allow gleaners or food recovery personnel onto their property.

While the *Bill Emerson Good Samaritan Act* provides liability protection in all states for food donors and nonprofit food recovery organizations, and states cannot reduce these protections, additional protections could help to increase donation and redistribution of food. For example, many states have enacted laws to strengthen these liability protections. Delaware has added state law to reinforce this protection, but Delaware's law still requires the donor to go through a charitable organization to receive liability protection. [53] Protections for donors that bypass a charitable organization could therefore be added to Delaware law to expand opportunities for food redistribution.

Delaware Food Donations

The Delaware Food Bank redistributed 7.6 million pounds of food, including 1.2 million pounds of meat in 2018, of which a high percentage was donated. Many Delaware grocers lead the list of food donations, donating from 100,000 to 500,000 pounds each last year. The Food Bank operates a number of nutrition and hunger abatement programs including a mobile pantry that brought food to nearly 3,800 households last year.

In addition, the Food Bank's food rescue program relied on committed volunteers that salvage food that would have gone into the trash through development of an efficient system to get that food back out into the community before it is spoiled. In 2018, the team collected nearly 108,000 pounds of food.

The Society of St. Andrew operates *The Potato and Produce Project* which salvages and distributes about 10 million pounds of potatoes and other fresh fruits and vegetables each year across the country; and the Gleaning Network saves and distributes another 15-20 million pounds per year. The Gleaning Network operates in the 48 contiguous states, and as of 2018 distributed 319,321 pounds of food in Delaware.[54]

Despite these efforts, food salvage, donation, and redistribution remain a significant opportunity in Delaware based on results of DSWA's FY 2016 *Waste Characterization Study* (Study). The Study sampled targeted business sectors, which demonstrated that groceries, restaurants, and convenience stores had the highest percentage by weight of organic waste disposed based on the sectors included in the Study. While the Study is a few years old, the results are likely still valid today.

[53] *61 Del. Laws, c. 439, § 1; § 8130 Exemption from liability for donation of prepared food.*
[54] *See: https://endhunger.org/distribution-report/.*

While the Study did not quantify total tons by individual business sector, it is useful for targeting technical assistance to reduce or redistribute food waste. For example, based on the data in Table 5-6, there may be opportunities to reduce and even redistribute food waste from convenience stores that prepare food. Without this Study, convenience stores would not have been identified as a target to redistribute food.

Table 5-6: Percentage of Food Waste in ICI Solid Waste Disposed and by Specific Commercial Sectors

Organic Material	Overall ICI (%)	Small Retail (%)	Large Retail (%)	Office (%)	Grocery (%)	Restaurant (%)	Convenience Stores (%)
Food Waste							
Vegetative Food Waste, Unpackaged	10.9%	13.6%	0.8%	4.8%	12.4%	28.3%	26.4%
Protein Food Waste, Unpackaged	3.2%	2.0%	0.7%	2.0%	2.7%	13.3%	4.4%
Food Waste in Plastic Packaging	6.0%	3.7%	3.3%	3.6%	10.6%	5.1%	18.1%
Food Waste in Other Packaging	1.8%	0.7%	2.7%	0.8%	3.0%	1.9%	6.3%
Subtotal:	**21.9%**	**20.1%**	**7.5%**	**11.3%**	**28.7%**	**48.7%**	**55.1%**

Reuse as Animal Feed

Farms can redistribute imperfect or blemished foodstuff directly to animal food. Restaurants and grocers can as well without treatment provided it is pre-plate vegetative food waste. Small hog farmers, especially could benefit from a more robust system identifying generators of pre-plate waste willing to divert this waste to the farmers, in some cases "closing the loop" by purchasing the finished hogs for use in the institutional kitchen or restaurant.[55]

In some cases, post-plate food waste can also be directly fed to animals after it is heat treated and dehydrated. This practice already occurs in many parts of the US where farmers substitute treated food waste for commercial feeds to reduce costs, although in Delaware hog farmers are prohibited from feeding post plate waste to hogs, even if it is heat treated.[56] Households can however feed swine pre- and post-plate food waste, and farmers can feed swine pre-plate vegetative food waste as long as it is not mixed with animal wastes.

On-Site Food Waste Diversion

There are essentially two forms of on-site diversion potentially available to generators in Delaware that will be supported by DSWA during the next ten years:

- Backyard and community-based composting; and,
- Commercial food waste processing systems for large food waste generators.

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[55] *A hog farmer in Bethel, Maine has successfully implemented this arrangement with restaurants in this tourist area of Maine.*

[56] *The law appears to be silent on feeding heat treated food waste to other farm animals.*

Backyard and Community-Based Composting

A recent state-wide survey of Vermont households indicates that 41 percent of Vermont households divert at least some of their food waste to backyard composting, and 18 percent use sink grinders.[57] While Vermont is a more rural state than Delaware, these results (one of the first statistically valid state-wide surveys of backyard composting) would indicate that backyard composting may be more prevalent than commonly assumed, with the potential to divert significant amounts of food waste for use as garden and soil enhancements, particularly in the more rural areas of Delaware.

In more suburban areas, community-based composting may provide the same ability to divert food waste from households without sending it to landfills. For example, the City of Philadelphia is developing a Community Compost Network that would serve 20 to 25 sites in Philadelphia.[58] This plan is modeled after a successful program in the Washington DC area, and will involve city-owned and private parcels where community-scale composting systems.

Such a community-based system already exists in Arden, DE, which could serve as a potential model for additional systems in Delaware.

On-Site Systems

There are many on-site food waste processing systems available for large and medium size food waste generators that reduce off-site disposal, falling into four major categories:

- Pulpers/grinders which pulverize the food waste for discharge to the sewer system;
- Biological/liquification systems that first liquify and then decompose the food waste using microbial activity before discharge to sewer systems;
- Grinders/dewatering systems that grind and dewater (or de-hydrate) to create a dry waste for composting (or disposal) with discharge of liquids to the sewer system; and,
- In-vessel dry waste systems that compost the food waste on-site.

Multiple companies manufacture, sell, and in some cases lease/maintain these in-house systems. Numerous articles and guidance documents describe and categorize these systems, often as a response to proposed or implemented state bans on disposal of organics.[59]

In general, there are three primary reasons to install one of these systems:

- To comply with an organics landfill ban – which often apply only to large generators (e.g., Connecticut, Massachusetts, Vermont, and, proposed in New Jersey);

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[57] 2018 Waste Characterization, Prepared for Vermont Department of Environmental Conservation, DSM Environmental Services, Inc., et al.

[58] Community Compost Network Application, The City of Philadelphia's Greenworks Sustainability Plan and Zero Waste and Litter Plan.

[59] See for example: On-Site Systems for Processing Food Waste, A Report to the Massachusetts Department of Environmental Protection, Isaac Griffith-Owen, Zak Patten, and Jennifer Wong, Northeastern University, 4/26/2013; An Analysis of New and Emerging Food Waste Recycling Technologies and Opportunities for Application, P. Richard M. Cook, Sustainability Consultant, Great Forest, undated; and, Analysis of Biodigesters and Dehydrators To Manage Organics On-Site, Zoe Neale, BioCycle, October, 2013.

- To save money through reducing costs of dumpster rental(s) and either collection and disposal (at a landfill or waste-to-energy facility) or, in a landfill ban state, delivery to an off-site composting or anaerobic digester facility; or,
- To bolster sustainability goals of the generator which are often based on high waste diversion rates or "zero waste to landfill" policies.

Because Delaware does not currently ban disposal of organics at landfills (other than yard waste), the primary goals associated with installing one of these systems would be to either reduce collection and landfill disposal costs, and/or bolster sustainability goals of the generator.

However initial capital investments may keep companies from investing in these systems. Other costs may include special electrical hookups, and site-specific modifications to accommodate the equipment. In addition, most systems have on-going operational water and power requirements that may exceed the amortized capital costs.

To spur the adoption of these on-site systems, a financial assistance program to cover the capital cost of these might be provided by DNREC or DSWA, assuming that the county sewer system and treatment plants could handle any associated increase in the discharge of wastewater. However, before a program of this type is developed, and/or as part of the funding agreement, case studies should be put together that document the potential operating and maintenance costs of these systems to provide specific information on the potential total system costs.

Such an example is currently in place with DSWA participating with a team of engineering researchers at the University of Delaware to operate and study use of these systems, with the goal of learning from implementation what steps could be taken to encourage adoption of these systems for other large generators in Delaware. With DSWA support, the Caesar Rodney Dining Complex now has two BioHiTech digesters, which use a proprietary mix of microorganisms to transform disposed unwanted food — bread crusts, milk at the bottom of the cereal bowls, whatever students leave behind — into liquid waste. The team is studying the composition of food and liquid wastes that are broken down in the digestor, and how the system can work to reduce food waste in UD's campus dining halls. If successful, the project could not only expand at UD, but the example could be used to implement on-site systems at other Delaware locations.

Off-Site Diversion of Organics

As detailed in DSWA's analysis of the feasibility of construction and operation of an AD facility, together with the failure of three large scale composting systems in Delaware; indicates that the costs, and limited GHG benefits are not worth an investment by DSWA in any centralized facility at this time.[60] DSWA will, however, continue to keep the option open for development of a food waste depackaging unit at the Cherry Island Landfill in the event that operators of the Wilmington wastewater treatment facility determine that the introduction of liquified food waste would be beneficial to energy production at that facility.

[60] *See "Analysis of Organics Diversion Alternatives", Report to the Delaware Solid Waste Authority, September 2017, Prepared by DSM Environmental Services, Inc.*

DSWA will also continue to investigate smaller, on-site systems such as the project at UD.

In addition, DSWA would support legislation mandating food waste diversion by large generators if one or more private facilities were to be constructed in Delaware. And, DSWA's flow control provisions do not prohibit food waste generators from contracting with out-of-state AD or composting facilities. One new AD facility, located in Trenton, NJ is expected to come on-line during 2020, and could potentially source material, especially from New Castle County. Other facilities are also under consideration in the Philadelphia region.

Conclusions

Developing a central organics processing facility to divert food waste from DSWA landfills will result in significantly higher costs than continued landfilling, and with relatively minor GHG emission reductions. However, much higher GHG emissions reduction benefits lie in efforts to reduce food waste and redistribute food which also come at lower costs.

Other steps that Delaware can take to increase the diversion of food waste, other than through development of a central organics processing facility include the following:

> ***First***, Delaware state agencies involved in food handling and preparation can assess the potential to both integrate food waste reduction training into their food safety programs, and to team with trade organizations involved in food preparation. Grants might be made available to help achieve this.
>
> ***Second,*** the Delaware State Legislature should consider expanding the already existing liability protection for edible food waste generators to be able to donate their food without having to go through the existing institutions, but under guidelines specified in the legislation and subsequent rule making.
>
> ***Third,*** the Delaware Department of Agriculture could work with DSWA and DNREC to try to expand efforts to work with hog farmers to source pre-plate food waste. A logical way to start would be to develop an exchange where hog (and cattle) farmers as well as generators of pre-plate food waste could list on a free exchange organized by the Department of Agriculture.
>
> ***Fourth***, DNREC and DSWA should work with County and Municipal wastewater treatment authorities to identify the most appropriate on-site treatment systems for food waste that will not negatively impact sewer line clogging or BOD, nitrogen and phosphorous limits. To the extent these systems can be identified, it may make sense to create grant funding that can help large food waste generators justify the cost of on-site installations, given the potential savings in container rental, pull charges, and tipping fees for heavy food waste.
>
> ***Fifth,*** DSWA will meet with the Kent County Public Works Department (and other WWTP operators) to explore collaboration on the potential development of an anaerobic digester for production of energy from WWTP sludge. Co-digestion of wastewater sludge and food waste is one way to lower the cost of AD facilities to the point where it is cost-effective when compared to landfilling of food waste.

Sixth, and similarly, DSWA will continue to discuss with the City of Wilmington the potential for delivery of slurried food waste to the Wilmington WWTP digesters of ICI food waste delivered to the Cherry Island Landfill and processed through a food depackaging machine.

Seventh, DSWA will continue working with the University of Delaware to complete research and develop additional on-site digestion options for food waste. The small on-site digestion project at the Caesar Rodney Dining Hall which diverts pre-plate and post-plate food waste to two small units is a good start. DSWA and the University will continue researching this and other technologies and closely track the results for application elsewhere. This research will include an evaluation of the diversion potential but also O&M issues, contamination levels and tolerance, emissions reductions, and digestate quality and applications.

Finally, DSWA will expand its education program to the public on the benefits of backyard composting and food waste disposal systems. DSWA will further investigate developing a food waste diversion grant program which could provide funding to individuals or businesses that wish to engage in the practice of food waste diversion. DSWA will collaborate with the Delaware Recycling Public Advisory Council (RPAC) and DNREC on the best practices to administer the grant application and review process.

CHAPTER 6: OTHER ALTERNATIVE TECHNOLOGIES

In addition to technologies used to convert organic waste to fuel (gas or electricity) or to animal feed, as discussed in Chapter 5, there are several other existing and emerging technologies that are in operation or being tested to manage municipal solid waste and plastic wastes – which are a growing component of the municipal solid waste. Most are expensive, work best at a small scale, or are still in the development phase.

They are covered briefly in this chapter but are not yet considered viable for implementation by DSWA, as discussed below.

Given the difficulty in siting any new landfill capacity in Delaware, and the demand for renewable energy sources, it is logical that DSWA continue to investigate alternative technologies for processing wastes to reduce the volume going to landfill, and capture the energy inherent in the waste.

Technologies potentially available to DSWA (exclusive of AD and Composting) include:

- Waste-to-Energy
- Gasification
- Chemical Recycling
- Biomass Combustion

Waste-to-Energy (WTE)

According to the Energy Information Agency there were 71 WTE facilities operating in the U.S. in 2015 burning 12.7 percent of the municipal solid waste and generating 2.3 gigawatts of energy. These facilities are concentrated in the Northeast and Florida, which account for 61 percent of all the facilities.[61]

A typical WTE facility reduces the volume of waste by 87 percent, with the remainder (fly ash and bottom ash) typically landfilled. In much of western Europe, where landfill capacity is scarce, WTE facilities consume the majority of waste. However, because of the high capital and operating cost, WTE facilities are not competitive with landfill in much of the US. That is the case in Delaware, which currently has a large amount of landfill capacity.

The primary benefits of WTE facilities are:

- The technology is proven, with many plants having been in operation for over 30 years in the United States.
- Mass burn waste-to-energy facilities can accept mixed MSW as it is currently delivered to a landfill, with virtually no pre-processing.
- The volume reduction of MSW is in the range of 85 to 90 percent, which is the highest of all waste processing technologies, significantly increasing the potential lifetime of DSWA's landfills.

[61] https://www.eia.gov/todayinenergy/detail.php?id=25732

- There is a large database of emissions test results for the existing plants as well as a large body of analysis on the environmental impacts of waste-to-energy plants, both in the United States, and in Europe and Asia; and,
- Waste-to-energy plants produce a significant fraction of their energy using organic waste streams which do not contribute to net greenhouse gas emissions.

Disadvantages of waste-to-energy include:

- Waste-to-energy facilities are very capital intensive, requiring large quantities of waste and long-term financing, typically resulting in tipping fees that are higher than for landfilling.
- There is significant disagreement as to the long-term environmental impacts of waste-to-energy facilities despite the large body of data on operating plants. Many environmentalists argue that dioxin and furan emissions, together with emissions of volatile metals, such as mercury, are a significant environmental risk.
- Waste-to-energy development in Delaware would require legislative action to repeal the S.B. 280, *An Act to Amend Title 7 of the Delaware Code Relating to Incinerators,* which *"prohibits construction of incinerators with any area that is within 3 miles of a school, church or residence".* This restriction makes it practically impossible to site a waste-to-energy facility in Delaware.

Gasification and Chemical Recycling

While WTE facilities rely on sufficient oxygen for complete combustion to recover the energy from the waste, gasification facilities rely on pyrolysis which is a process that subjects waste to high temperatures in the absence, or with limited oxygen, to produce a gas that can be captured to produce energy. Pyrolysis plants have been proposed for municipal solid waste for the past 30 years, including a large facility in Baltimore which was eventually shut down due to technical difficulties and replaced by a conventional WTE facility. Subsequently technical difficulties and high costs have limited its use for solid waste, which is a very heterogeneous material with a relatively high moisture content.

An additional technical difficulty with gasification is that the gases contain high concentrations of tars which must be cleaned before the resulting biogas can run through an internal combustion engine to produce electricity. As a consequence, while gasification is used to produce energy from coal it has not been successfully used in the US to process municipal solid waste.

More recently, however, the low recycling rate for mixed plastics has attracted renewed attention to pyrolysis as a potential way to recycle plastics. Pyrolysis of plastic waste is included in a list of different technologies under consideration for recovery of fuel and/or the building blocks to produce new plastics from waste plastics.

Pyrolysis works well to break down many of the plastics used in packaging into diesel fuels (which can be used to produce energy) and Naphtha. Naphtha can be used to make new polypropylene and polyethylene which are the two most widely used plastics for plastic packaging, thus "closing the loop" on plastics recycling.

Pyrolysis cannot, however, be used for PET (soda bottles and "clamshells) because the PET contains oxygen, which is released in the pyrolysis process, disrupting the process. Instead, the plastics industry has focused its efforts on depolymerization processes designed to break down PET to its fundamental building blocks for production of new PET.

In general, chemical recycling of plastics has been viewed as an opportunity to create feedstock for plastic products from a wider range of scrap plastics and can be defined as any process by which a polymer is chemically reduced to its original monomer form so that it can eventually be processed (re-polymerized) and remade into new plastic materials that go on to be new plastic products.

Chemical recycling processes include: purification, where plastic scrap is dissolved in a solvent to remove additives and purified to a near virgin plastic; decomposition/depolymerization, where the molecular bonds of scrap plastics are broken to create molecules or monomers that can be used to make new plastic; and, conversion, where the molecular bonds are also broken but then recombined to result in hydrocarbons and chemical feedstocks similar to products made by petroleum refining.[62]

However, chemical recycling technologies are slow to scale with an average of 17 years to move from concept to growth and so while many consumer product companies plan to incorporate higher percentages of recycled content into their products and packaging by 2025, technologies still need to be monitored to determine their widescale application.[63] Therefore, while these chemical recycling processes show some potential, they are still in the early years of commercialization, with high capital and operating costs, and significant technological and financial risks. As such these are not projects that DSWA would undertake, but instead would encourage the private sector to undertake as the technologies develop over time.

Biomass Facilities

One area of interest to DSWA are technologies to process the large quantities of wood waste disposed, especially, at the Jones Crossroads landfill as a result of the growth in population, housing, and commercial development in Sussex County. As described in the 2015 report, *Construction and Demolition Waste Characterization, Jones Crossroads Landfill,* 38.5 percent of all of the construction and demolition waste (C&D waste) was wood waste. [64] However, less than one-half of the wood waste was clean wood, which was typically mixed with engineered, and painted and treated wood. As a consequence, it is not economically feasible to separate the clean wood, and instead a market for the mixed wood is necessary.

Typically, this mixed wood waste is sold to a biomass facility which burns the wood waste to create energy. Biomass facilities are located at paper and pulp mills with steam energy going to the mill; or they produce electricity, which is sold to the grid, often under above-market infeed rates.

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[62] *See "American Chemistry Council. What is Chemical Recycling?" at: https://plastics.americanchemistry.com/what-is-chemical-recycling/*

[63] *Phipps, Lauren. The 5 things you need to know about chemical recycling. GreenBiz. April 15, 2019.*

[64] *Prepared for DSWA by DSM Environmental Services, Final Report, 2015.*

Unfortunately, no biomass facilities exist within a reasonable transport distance of southern Delaware, and the quantities generated at the Jones Crossroads Landfill are insufficient for DSWA to construct this type of a facility as a stand-alone facility, so this option is currently not feasible.

Another small-scale technology potentially available for biomass – air curtain burners – can be used to burn landscaping debris and related clean wood waste or crop residues to produce biochar. Biochar may both store carbon from live biomass that is burned to create the char, and stabilize the soil carbon cycle when it is applied as a soil amendment.[65] While this technology may help to reduce clean or live wood waste disposal, or management costs, it would not address the need for markets for much of the construction and demolition related wood waste generated in Delaware.

Conclusion

While DSWA will continue to investigate opportunities as new technologies emerge to manage waste over the next decade, no provisions are made as part of this plan to move forward with additional waste processing facilities.

[65] *Biochar Production for Forestry, Farms and Communities. Northwest Natural Resource Group. 2018.*

CHAPTER 7: LANDFILLS

DSWA's history in taking responsibility for environmentally sound solid waste management has included ensuring landfill capacity for Delaware's growing population as well as operating transfer stations that serve the waste haulers and public to limit the traffic at the landfills. No DSWA facility accepts waste from out-of-state and the DSWA facilities have been designed, constructed, and operated to serve the residents and businesses located in Delaware.

DSWA's efforts to safely operate, maintain, and expand landfill capacity to meet the needs of the State will continue through the next decade. Waste reduction and diversion efforts (as described in this Plan) will help to preserve Delaware's landfill capacity but will not eliminate the need for landfilling. As a result, careful planning and rate setting will help to ensure the financial reserves are available when any DSWA landfills need to close when they reach capacity.

This chapter briefly covers the history, capacity, estimated landfill life, and related greenhouse gas emissions capture at DSWA's landfills. Detailed information on landfill closure and post closure care are filed with DNREC.

Landfill Operation

Three DSWA landfills continue to accept waste from within Delaware and are carefully managed to protect the environment, comply with DNREC regulations, serve the public, and meet Delaware's waste disposal capacity needs.

The Sandtown landfill in Kent County began operations in 1980 and encompasses roughly 835 acres which includes open and closed cells as well as significant buffer areas. It was the first geosynthetic designed MSW landfill in Delaware. The facility is open Monday through Saturday from 7 a.m. until 5 p.m.

The Jones Crossroad landfill in Sussex County opened in 1984 and encompasses roughly 572 acres including open and closed areas and buffer zones. It was the first double lined landfill in Delaware. The facility is open Monday through Saturday from 7 a.m. until 5 p.m.

The Cherry Island landfill in New Castle County opened in 1985 after the close of the Pigeon Point landfill and encompasses an area of roughly 513 acres of active and closed areas and buffer zones. The facility is operated Monday through Friday from 7 a.m. until 5 p.m. and Saturday from 7 a.m. until 3 p.m.

Estimated Landfill Life and Closure Costs

Landfill capacity is based on calculations on permitted and closed areas, annual throughput, average waste densities, engineered design elevations, and throughput projections. These capacity estimates enable DSWA to estimate remaining landfill life and closure dates for each facility, with this information used to estimate landfill closure costs.

DSWA budgeting includes annual operating expenses related to current activities that take place at all of the DSWA landfills and transfer stations, but also must incorporate expenses and related liabilities related to the future closure costs of each of the existing DSWA facilities. While these will not be incurred until near or at the date of closure, they must be included in the cost or fees charged for disposal. In addition, there will be post closure care costs at each site for thirty years after closure.

Under current state regulation, DSWA must monitor closed landfills for 30 years after closure. In contrast transfer stations are expected to incur closure costs but no post closure costs.

DSWA reports a portion of these closure and post closure care costs each year as an operating expense based on landfill capacity used during the year. The accrued landfill closure and post closure care costs of $75,668,849 as of June 30, 2019 represent the cumulative amount reported based on the estimated percentage of landfill capacity used as of those dates.[66]

The remaining estimated cost of closure and post closure care of roughly $142 million will be accounted for each year as the remaining estimated capacity is filled. Currently, total landfill closure and post closure care is estimated at roughly $217.8 million, based on the estimated amount that would be paid if all equipment, facilities, and services required to close, monitor, and maintain all of the landfills were accrued as of June 30, 2019. In reality, actual costs may be higher due to inflation, changes in technology, or in laws and regulations related to landfills.

To make these estimates and create a closure and post closure care reserve, each DSWA facility has a detailed closure plan that includes the costs to implement each facility or landfill closure. These are updated annually.

Table 7-1 details DSWA's estimated capacity at each landfill and estimated remaining life along with the how the accrued costs of roughly $76 million were allocated. It also shows the future costs for each facility estimated to total $142 million to close all facilities assuming the estimated closure dates based on current estimated remaining life of each facility.

Table 7-1: Estimated Landfill Capacity Used, Remaining Life and Related Closure and Post-Closure Costs, FY 2019

DSWA Landfill	Estimated Capacity Used (% of Total)	Estimated Remaining Life	Accrued Costs	Costs to be Recognized in the Future
Cherry Island Landfill	59.86%	19 years	$42,879,121	$26,522,855
Sandtown	22.49%	51 years	$9,457,488	$57,016,369
Jones Crossroads	16.70%	57 years	$23,315,914	$58,611,237
Pigeon Point	100%	Closed 1985	$16,326	
Total:			**$75,668,849**	**$142,150,461**

These estimates are updated annually and can be found in the DSWA Annual Report, Auditors Report section. Note that the estimated capacity is based on current DNREC permitted design capacity for Cherry Island and planned capacity for the Sandtown and Jones Crossroad landfills.

[66] *See 2019 DSWA Annual Report.*

Greenhouse Gas Emissions

DSWA has taken active steps to control and capture methane and other landfill gases generated by operations at the three landfills, with all three landfills currently capturing landfill gases for green power production.

DSWA opened the landfill gas utilization facility at Cherry Island in 1995 which takes landfill gas and sends it by pipeline to Croda, Inc. for use in the production of electricity and heat. Landfill gas is also sent by pipeline to the City of Wilmington Wastewater Treatment Plant for the production of electricity. Croda, Inc has 2 MW of electric generating capacity, plus a boiler that utilizes landfill gas to produce heat. The City of Wilmington Wastewater Treatment plant has a total of 4 MW of electric generating capacity.

Landfill gas to energy plants were constructed at Sandtown and Jones Crossroads landfill in 2007. Both plants have expanded their capacity since 2007 and each site has 5 MW of electric generating capacity.

The energy derived from all three landfill gas projects was the equivalent of over 93 million kWh's in FY 2019, enough energy to power 8,247 Delaware homes.[67] [68] This landfill gas capture and use reduced greenhouse gas emissions by an estimated 607,433 MTCO2E in FY 2019.

[67] *Delaware Solid Waste Authority Annual Report, 2019. Page 8.*
[68] *Estimates determined by use of USEPA 2014 LMOP LFG Energy Benefits Calculator.*

CHAPTER 8: SUSTAINABLE MATERIALS MANAGAMENT PLAN

Introduction

The 2010 Plan was based on zero waste principles that many of the materials disposed could, and should, be diverted for recovery to reduce the environmental impacts associated with the production of new materials. It also recognized that in order to follow many of these principles, significant changes in legislation, policy, infrastructure, services, and programs would need to take place along with changes in the behavior of both consumers and businesses; especially with respect to changes in the design and production of many goods to eliminate waste after use.

The 2010 Plan set some *potentially achievable* diversion goals designed to move toward zero waste, and then created an action plan that would be needed to meet these aggressive goals. Interim goals were established that outlined measures needed, and the tons expected to be diverted through those measures, to achieve the overall goals established in the plan.

While the diversion rate achieved for total solid waste (TSW) and MSW recycling fell short of the 2010 Plan goals, progress was made over the last decade with the management and diversion of a number of materials formerly disposed, as discussed in Chapter 4.

However, subsequent to adoption of the 2010 Plan it has become clear that in some cases high diversion of some materials to meet zero waste goals – especially certain scrap plastics and lower grade mixed paper – was driven by the economics of export of these materials to lower income countries, especially China and other Asian countries. By 2016 the United States exported an estimated 1.94 million metric tonnes of scrap plastic, primarily to China and Hong Kong, but also to other countries (e.g. India, Vietnam, Indonesia).[69] Many of these exported loads composed of baled plastics contained high percentages of low value, or potentially un-recyclable plastics (and other wastes) which were sorted out and discarded in the receiving country. Because of a lack of waste management infrastructure, significant amounts of these discards were burned, disposed in open dumps, or disposed in unregulated landfills. As China began to recognize the impacts of these imported scrap plastics and paper, it began to severely restrict imports, and the US shifted these exports to other lower income countries, also with poor waste management infrastructure.

Further, and equally important, the US exported roughly 19.7 million metric tonnes of waste paper to most of these same countries in 2016.[70] While a majority of this waste paper was recycled, there was a significant amount of non-paper waste (or residuals) contained in these bales which further overwhelmed the importing countries waste disposal system contributing to environmental problems in those countries.

As these countries began to restrict imports, the lack of sufficient manufacturing capacity in the US to absorb these recycled plastics and paper contributed to steep drops in commodity prices and significant increases in the costs to reduce contamination of these recycled commodities produced at US MRFs (as discussed in Chapter 4). This led to much higher recycling costs and a re-examination of the merits of

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[69] *UN Comtrade database, 2016, US Exports of Commodity "3915 Waste Parings and Scrap".*
[70] *UN Comtrade database, 2016, US Exports of Commodity "4707 Waste and Scrap of Paper and Paperboard".*

using high diversion rates as the primary metric for evaluating zero waste benefits, and an increased emphasis on *Sustainable Materials Management* (SMM).

SMM is defined by the US EPA as "*a systematic approach to using and reusing materials more productively over their entire life cycles. It represents a change in how our society thinks about the use of natural resources and environmental protection. By looking at a product's entire life cycle, we can find new opportunities to reduce environmental impacts, conserve resources and reduce costs".*

DSWA's 2017 Organics Analysis is an example of SMM in that the overall conclusion was that higher food waste diversion through centralized composting or AD facilities did not achieve significant reductions in GHG emissions; instead looking up-stream to reducing food waste and diverting additional food to productive uses was more environmentally sound even though the overall increase in diversion rates would be lower.

Similarly, led by detailed studies by the Oregon Department of Environmental Quality, there has been a realization that many of the light-weight plastic films and multi-laminates used to package and protect foods and other products are not likely to be recycled, but yet may still have significant life cycle benefits.

This 2020 Plan takes a realistic look at the current state of recycling and the potential to continue to incorporate zero waste principles into solid waste management practices in Delaware, and endeavors to create a path forward to continue to embrace source reduction, waste diversion, and materials recovery targets with an emphasis on sustainable materials management.

Current State of MSW Recycling and Potential Recovery

As stated in Chapter 4, residential and commercial MSW recycling rates peaked in 2016 at 47 percent and 43 percent, respectively, for a combined rate of close to 45 percent. These rates then fell in 2017 and 2018 with a combined MSW recycling rate of 38 percent measured for CY 2018.[71]

For Total Solid Waste (TSW), an estimated diversion rate of 72 percent was measured for CY 2014 but was remeasured in CY 2018 for this Plan and estimated at 70 percent.

The 2010 Plan established an MSW recycling rate goal of 55 percent and for TSW, a diversion rate goal of 82 percent. Both of these goals were aspirational, driving a careful tracking of MSW recycling annually and of TSW, every five years.

However, subsequent to 2010 it has become clear that these aspirational goals for recycling and diversion were unrealistic given the changing costs and impacts of these high goals.

Similar analyses and decisions have been made in many other states in the past several years.

A number of factors contributed to this rise and then drop in materials recycling throughout the US over the past decade, as discussed throughout this Plan. Three major factors which have impacted the ability for Delaware to reach a 55 percent MSW recycling rate goal are summarized below.

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[71] *The 38% rate for CY 2018 was reported by RPAC using their methodology. This 2020 Plan calculated MSW recycling based on materials sold/sent for recycling, which lowered the rate to 37% as reported in this Plan.*

- First, there was continued light-weighting of packaging and reductions in the consumption of paper – reducing the amount of material (by weight) available for recycling.
- Second, the three food waste composting facilities that were accepting large quantities of food waste and compostable paper in 2010 have since closed.
- Finally, many export markets for low value scrap plastics and mixed paper closed without subsequent increases in the capacity of US manufacturers to absorb these materials. This resulted in dramatic decreases in the value of the outputs of single stream MRF's and steep increases in processing costs to clean up incoming contamination.

Recycling Goals Going Forward

Since 2010, Delaware has reported an MSW recycling rate annually, and a Total Solid Waste (TSW) materials diversion rate every five years. In addition, DSWA has performed waste characterization studies at regular intervals. Using both sets of data (materials recovery and composition of waste disposal) enables estimation of recovery rates for specific materials found in the MSW stream and in the TSW stream.[72]

Using available waste characterization data, disposal quantities of each recyclable material were estimated for CY 2018 and matched with estimated recycling or diversion data to provide an estimate of the current recovery rate by material, with an assessment of how much more material might be recovered over time.

Two sets of goals were then established based on current and potential recovery rates by material. Realistic recovery rates reflect materials for which markets currently exist and for which increasing separation and recycling of these materials could potentially increase the recovery rate. Aspirational recovery rates would require much larger DSWA subsidies as well as significant technological changes, often beyond DSWA's control. In many of these cases source reduction, as opposed to increased recycling, would be more cost effective.

Finally, there are some materials found in both MSW and TSW for which there are no end uses – these materials will require disposal under all circumstances.

Tables 8.1 and 8.2 utilize the recycling and waste characterization data for CY 2018 to provide a snapshot of current recovery rates and what realistic and aspirational recovery rates might be. These data enable a calculation of a recycling rate and a diversion rate for the entire MSW and TSW stream and demonstrate the challenge of meeting goals with high recycling/diversion rates.

[72] *Because C&D waste characterization data are limited, composition of the Total Solid Waste stream and recovery estimates are less accurate.*

MSW Recycling Goals

Table 8-1, on the next page, outlines estimated current recovery rates for MSW materials (see the column "2018 Recovery Rate") and then estimates the potential to increase recovery rates for each material over the next ten years (realistic and aspirational) given the challenges facing recycling and markets today.

Each material is color-coded to indicate the current level of challenge associated with reaching a high recovery rate. Color coding is based on the availability of markets for each material, as follows:

(green)	Markets Exist
(yellow)	Market Support Needed
(orange)	Significant Market Support Required

Summing the individual material recovery rates results in an overall MSW recycling goal over the next ten years. The total for the green category (markets exist) also includes all materials in rows that are not color coded (white) because these materials are currently recovered, but DSWA has no data to assess what the current recovery rate is (or how much more is found in the waste stream), but expects recovery at these same levels to continue.

As illustrated at the bottom of Table 8.1, summing the realistic and aspirational material recovery rates results in a potential goal ranging from 36 to 40 percent.

For the yellow level, all of the materials coded green and white are included plus those highlighted in yellow. At this level, DSWA would expect a rate of 39% could be reached with some support with an aspirational target of 44%. Note that glass is included in this category because recycling this material has typically come at a cost after processing and so it needs a subsidy.

Finally, to reach the orange level, all materials are included, and it is assumed that significant market support would be necessary to recycle higher levels of materials such as polystyrene, electronics, and carpet, as well as to divert significant quantities of food waste.

Table 8-1: Estimated Current and Potential Recovery Rates for MSW Materials Recycling *(5)*

	MUNICIPAL SOLID WASTE Material Category	2018 Recovery (Tons)	2018 Disposal (Tons)	2018 Recovery Rate (%)	Potential Recovery - Low (Tons)	Potential Recovery - High (Tons)	Realistic Recovery Rate (%)	Aspirational Recovery Rate (%)
PAPER	OCC (old corrugated containers)	109,626	44,300	71%	115,400	123,100	75%	80%
	ONP (old newspaper)	11,246	11,700	49%	13,800	16,100	60%	70%
	Mixed Paper	59,674	34,400	63%	61,100	70,600	65%	75%
OTHER PACKAGING	Mixed Glass (Bottles)	14,667	15,200	49%	16,400	19,400	55%	65%
	Plastic Bottles & Containers	10,141	23,100	31%	11,600	16,600	35%	50%
	Aluminum Cans	984	3,300	23%	2,600	3,400	60%	80%
	Polystyrene Packaging	16	5,200	0%	100	500	2%	10%
	Shrink Wrap/Recoverable Film	2,066	6,600	24%	3,000	3,900	35%	45%
	Pallets, mulched and other	3,980	2,800	59%	4,400	5,100	65%	75%
	Retail Bags	284	na		284	284		
VEHICLE WASTE	Oil Filters	364	0		364	364		
	Lead Acid Batteries	2,011	0		2,011	2,011		
	Tires	9,080	2,100	81%	9,500	10,100	85%	90%
SPECIAL WASTES	Carpet	78	24,000	0%	1,200	7,200	5%	30%
	Textiles	4,190	37,700	10%	8,400	16,800	20%	40%
	Fluorescent Blubs	24	0	100%	24	24		
	Other Batteries	146	0	100%	146	146		
	Mattresses	180	0	100%	180	180		
	Electronics/Electronic Goods	1,709	10,200	14%	3,000	5,400	25%	45%
ORGANICS	Fats, Oil Grease	3,641	0		3,641	3,641		
	Food Waste	1,550	154,500	1%	7,800	39,000	5%	25%
	Leaf and Yard Waste	104,903	29,900	78%	107,800	121,300	80%	90%
	Trees and Branches	50,968	2,200	96%	51,000	52,100	96%	98%
	Waste Wood	2,205	11,000	17%	1,300	2,600	10%	20%
METALS	Steel Tin Cans, Other Aluminum (1)	138	6,200	2%	3,200	4,800	50%	75%
	Ferrous	1,133	8,200	12%	2,300	3,300	25%	35%
	Non-Ferrous, All Other	1,031	5,600	16%	1,700	2,300	25%	35%
	White Goods	28,257	400	99%	28,300	28,700	99%	100%
OTHER WASTES	Mixed Plastics (2)	1,417		na	1,417	1,417		
	C&D Wastes in MSW (3)	-	46,200	na	2,300	9,240	5%	20%
	All Other Wastes (4)	0	247,814					
	Total MSW:	425,709	732,614					
	Potential Recovery:				**420,767**	**465,567**	**36%**	**40%**
	Potential Recovery:				**449,867**	**508,267**	**39%**	**44%**
	Total MSW Recycling Rate:				**464,267**	**569,607**	**40%**	**49%**

1. *Includes aluminum products but not cans and does not reflect actual steel can recovery rates.*
2. *Covers non-bottle plastics recycling by the commercial sector and cannot be matched to the same categories of plastics disposed.*
3. *C&D wastes mixed with MSW and is unlikely to be recycled due to the small quantities found in loads.*
4. *All other materials disposed of which none have established recycling markets.*
5. *Note that the "Potential Recovery" shown for each group of materials is totaled only for the materials in that color-coded category (plus those with no color-coding), even though there are a few materials* ***currently diverted*** *which are coded as yellow and orange.*

As shown in Table 8-1, the 55 percent MSW recycling rate goal set in 2010 is unrealistic given the state of today's recycling markets, the cost of separately managing many of these materials, the absence of food waste composting infrastructure in Delaware, and the lack of markets for some materials (carpet, certain types of electronics, etc.).

However general improvements in materials recovery can still occur for many materials under the proposed steps outlined in this Plan. The range of rates that might be achieved indicate that a goal of 40 to 49 percent is a more reasonable target for MSW recycling, assuming that total generation remains constant (and waste composition remains constant). Note that to reach the high end of this range, significant subsidies are necessary. And given the cost associated with subsidizing higher recovery, source reduction efforts may be a more sustainable approach.

It should also be noted that these rates and goals are all based on weight, which is not necessarily the best approach to measuring success in materials diversion. There should also be a focus on diverting materials to higher and better end uses that avoid greenhouse gas emissions by replacing virgin materials; and/or to the most environmentally sound management option. This approach is more in line with sustainable materials management.

TSW Materials Diversion Goals

In addition to MSW recycling, many other non-hazardous solid waste materials generated in Delaware need to be managed in an environmentally sound way, or properly disposed if recycling or beneficial use outlets are not available for these materials.

As illustrated in the next table, Table 8-2 there are large volumes of non-MSW solid wastes that are currently recycled, beneficially used, or otherwise diverted from disposal facilities. Many of these materials are unlikely to ever enter DSWA landfills in large quantities because they have and will continue to have other uses. However, some of these materials could potentially end up in a DSWA facility because handling/management practices change or become limited, and/or beneficial use opportunities are diminished, and a disposal outlet is required.

For example, biosolids or poultry wastes may need to be landfilled should land application sites, composting facilities, or other beneficial uses become unavailable or unable to handle all of the material generated. In these cases, the availability of a permitted disposal facility in Delaware is critical.

In order to increase the current estimated rate of 70 percent diversion, assuming total generation remains constant, recovery rates would need to rise for most materials. Like Table 8-1, Table 8-2 illustrates the potential range of recovery that might be feasible for materials that have markets (green), and then including materials that likely need some level of market support to reach the recovery rates noted (yellow) and finally, including those materials that would need significant market support (orange) to increase recovery. Note that the materials that are not color coded are included in all totals as there are no data to use to estimate current recovery of these materials (as well as the potential to increase recovery).

MSW materials (from Table 8.1) are included in each color-coded category to calculate a Total Solid Waste Recovery Rate. For example, for the Green or “Markets Exist” TSW target, the total MSW recovered tonnages in the Green category from Table 8-1 (or roughly 421k – 466k tons) are included in the Green totals for shown in Table 8-2.

As shown in Table 8-2 a 69 percent overall diversion rate is realistic with an aspirational rate 76 percent, assuming steps can be taken to support markets and materials diversion efforts as outlined in this management plan.

Note that material categories shown in Table 8-2 such as carpet and electronics are those found in C&D, industrial and other non MSW streams.

Table 8-2: Estimated Current and Potential Recovery Rates for All Other Materials (Non - MSW)[73] *(3)*

	ALL OTHER MATERIALS: TOTAL SOLID WASTE Material Category	2018 Recovery (Tons)	2018 Disposal (Tons)	Recovery Rate (%)	Potential Recovery - Low (Tons)	Potential Recovery - High (Tons)	Realistic Recovery Rate (%)	Aspirational Recovery Rate (%)
PACKAGING	OCC and Mixed Paper	2,272	16,617	12%	2,835	4,725	15%	25%
	Plastics	551	1,691	25%	660	880	30%	40%
	Pallets, mulched and other	20,855	11,300	65%	22,540	24,150	70%	75%
SPECIAL WASTES	Carpet		3,123	0%	155	930	5%	30%
	Electronics		586	0%	150	240	25%	40%
AGRICULTURAL	Poultry Litter	83,060	0	100%	83,100	83,100	100%	100%
	Poultry Waste	426,723	0	100%	426,700	426,700	100%	100%
	Food Processing Wastes	14,471	0	100%	14,500	14,500	100%	100%
	Ag Biosolids	74,883	0	100%	74,900	74,900	100%	100%
CONSTRUCTION AND DEMO WASTES	Land clearing and Yard Waste	17,357	1,729	91%	17,572	17,954	92%	94%
	Ferrous	269,992	4,637	98%	269,992	271,854	98%	99%
	Non-Ferrous, All Other	18,928	1,104	95%	19,000	19,200	95%	96%
	Aggregate	3,887	0	100%	3,900	3,900	100%	100%
	Asphalt (ABC for MSW/Comm)	543,925	422	100%	543,925	544,300	100%	100%
	Asphalt Shingles	19,000	41,804	31%	21,280	27,400	35%	45%
	Concrete (C&D Only)	486,405	9,444	98%	486,405	490,842	98%	99%
	Soils and Stone	81,340	29,586	73%	83,175	94,265	75%	85%
	Waste Wood (1)	17,357	132,613	12%	30,000	45,000	20%	30%
	Fines	11,831	802	94%	11,831	12,600	94%	95%
	Gypsum	6,235	15,478	29%	7,595	8,700	35%	40%
	Mixed C&D	12,386	28,326	30%	14,245	16,300	35%	40%
OTHER WASTES	Biosolids	81,252	0	100%	81,300	81,300	100%	100%
	Bottom and Fly Ash	7,906	51,333	13%	7,906	7,906	13%	20%
	All Other Wastes (2)	-	20,967		0	0		
	Total Non MSW:	**2,200,616**	**371,563**					
	MSW, FROM TABLE 8-1							
	Current MSW:	**425,709**	**732,614**					
	Potential Recovery:				420,767	465,567		
	Potential Recovery:				449,867	508,267		
	Potential Recovery:				464,267	569,607		
	Total Solid Waste (TSW):	**2,626,325**	**1,104,177**					
	Potential Recovery:				**2,562,442**	**2,629,857**	**69%**	**70%**
	Potential Recovery:				**2,621,388**	**2,708,743**	**70%**	**73%**
	Potential Recovery:				**2,687,933**	**2,841,253**	**72%**	**76%**

1. *Waste wood includes clean lumber as well as C&D wood.*
2. *All other material categories found in disposed waste.*
3. *Note that the "Potential Recovery" shown for each group of materials is totaled only for the materials in that color-coded category (plus those with no color-coding), even though there are a few materials* ***currently diverted*** *which are coded as yellow and orange.*

[73] *Recovery rates are based on best available data on materials diversion and waste characterization data from one landfill and estimated to represent all Delaware disposal facilities.*

Action Steps

The following action steps, as outlined throughout this Plan, are summarized here and will be necessary to reduce waste generation and increase materials diversion, as well as reduce GHG emissions. They are organized by major category below.

Source Reduction and Reuse

Under almost all circumstances, source reduction and reuse remain the best pathways to meet zero waste goals and reduce GHG emissions. The following action steps should be taken over the next decade.

1) Support the more widespread implementation of backyard composting and grass cycling through encouraging households to manage yard waste on-site as feasible and to add food waste to their backyard composting efforts. This may include subsidized distribution of backyard composters to households through DNREC or other qualified agencies along with technical assistance on how to set up and maintain backyard composting sites for yard waste and food waste.
2) Implement waste reduction campaigns targeted at consumers to raise awareness about the value of reducing consumption and waste generation. Materials with the greatest potential for reduction include food, textiles, single use products.
3) Support educational programs targeting youth to raise awareness about waste generation. Hosting programs at schools and for schools, such as those offered by DSWA at the DRC Education Center, should be continued.
4) Develop grant programs and other funding to support organizations and outlets that store, sell, and exchange used materials. This includes building materials as well as household items and textiles.
5) Develop educational programs that support materials reuse activities and salvage. This includes seminars with demolition contractors on salvage and utilizing the EPA toolkit on how to properly deconstruct a mobile home.
6) Support the development of Right to Repair legislation to require electronics (or other) producers to make available the knowledge and tools needed to repair and refurbish their devices. This can extend the life of devices and reduce costs to consumers (reducing the number electronics requiring recycling).
7) Support the development of Extended Producer Responsibility laws that create some incentive to design materials for recycling, or waste reduction.
8) Support the widespread practice of drink container reuse, including programs with discounts for bringing your mug combined with access to water bottle filling stations.
9) Support the development or expansion of single use product waste fees or bans through legislation for materials such as thin walled plastic bags, take-out food containers and utensils, or other products that have a single use and no recycling markets.

Organics Recovery

Organics remain a large part of Delaware's waste stream and source reduction and redistribution of food are the most cost effective and environmentally favorable actions from a GHG emissions standpoint. Strategies that DSWA and other Delaware agencies should pursue include:

1) Provide support to Food Rescue organizations that work to redistribute prepared and other food stuff from groceries, cafes, and restaurants to the underprivileged population.
2) Develop a program that works with state agencies involved in food handling and preparation to assess the potential to both integrate food waste reduction training into their food safety programs, and to team with trade organizations involved in food preparation. Grants might be made available to help achieve this.
3) Review the potential to expand the already existing liability protection for edible food waste generators to be able to donate their food without having to go through the existing institutions, but under guidelines specified in the legislation and subsequent rule making.
4) Work with DSWA and DNREC to expand efforts to work with hog farmers to source pre-plate food waste. A logical way to start would be to develop an exchange where hog (and cattle) farmers as well as generators of pre-plate food waste could list requirements on a free exchange organized by the Department of Agriculture.
5) DNREC and DSWA should work together with County and Municipal wastewater treatment authorities to identify the most appropriate on-site treatment systems for food waste that will not negatively impact sewer line clogging or BOD, nitrogen and phosphorous limits. To the extent these systems can be identified, create grant funding that can help large food waste generators justify the cost of installation, given the potential savings in dumpster rental, pull charges, and tipping fees for heavy food waste.
6) Meet with the Kent County Public Works Department to explore collaboration on the potential development of an anaerobic digester for production of energy from their WWTP sludge. Co-digestion of WWTP sludge and food waste is one way to lower the cost of AD facilities to the point where it might be cost-effective when compared to landfilling of food waste.
7) Similarly, continue to discuss with the City of Wilmington the potential for delivery of slurried food waste to the Wilmington WWTP digesters of food waste delivered to the Cherry Island landfill, processed through a food depackaging machine, and then pumped through a pipeline to the Wilmington's digestors.
8) Continue working with the University of Delaware (UD) to complete research and develop additional on-site digestion options for food waste, including researching other on-site technologies and their costs and O&M needs for application in other settings.

Residential Recycling

While residential recycling has advanced significantly over the last decade, with recovery rates rising through implementation of the Universal Recycling Law, further work is necessary to increase the MSW recycling rate including:

1) Continued education of consumers to both look for packaging that can be recycled and to only set out materials accepted in mixed recycling collection programs. This will improve the quality of materials delivered to processing facilities (for sorting) and help Delaware's recyclables meet end market specifications. This may also help reduce the generation of packaging waste that cannot be recycled.

2) With the relatively low plastic recovery rates in Delaware (26 percent), the growth in plastics waste generation overall in the MSW stream, and the limits placed on what plastics can be recycled, waste reduction measures for MSW plastics are more critical now than ever.[74] DSWA will continue to work with and encourage consumer products companies and plastic resin producers to improve the recyclability of current plastic packaging and develop new technologies for mechanically and chemically recycling hard to recycle plastics.

3) The growing quantities of textiles found in the waste stream (an estimated 19,300 tons disposed in 2018) amount to one of the single most potentially recyclable items still found in the waste stream after food waste. Companies like Planet Aid and Mid-Atlantic Clothing Recycling (MAC) are already active in Delaware, providing free collection of textiles. Directing Delawareans to these resources as well as physical locations like Salvation Army and Goodwill may help to educate residents and reduce the number of textiles sent to landfill. Campaigns to buy second hand and consume less should also be targeted at textiles.

4) Consider the implementation of a glass container only bottle deposit requirement to address some of the challenges to ensuring the recycling of residential glass containers that are now typically collected through single stream recycling programs. Glass containers are hard on the recycling equipment at the MRF and are a relatively low value output of the MRF.

5) Continued work on true parallel access to recycling collection at multifamily buildings should be undertaken along with an education program so that materials recovery rates from these households eventually match those of single-family households.

6) Continue to work with ReCommunity/Republic to install updated materials processing equipment at the single stream MRF to improve contaminant removal and expand recovery of new materials as markets develop.

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[74] *US EPA reports national plastic waste generation at 35.4 million tons in 2017 compared with 31.29 million tons in 2010. In Delaware, residential waste disposed (not generation) was 12.9% plastics (in 2016/17) compared against 11.4% a decade earlier despite an increase in plastics recycling.*

Commercial Recycling

Commercial recycling has also suffered recently with the challenged recycling markets. Increasing the commercial diversion rate will require the following strategies:

1) While paper recovery is estimated at 71 percent, an estimated 54,000 tons of recyclable paper and OCC were still disposed in 2018. While economics likely play a large role in commercial materials recovery rates, access to recycling collection for smaller entities should be given more attention - including more technical and financial support.

2) Like residential waste, there is still a significant amount of plastics found in the commercial waste stream. As with residential plastic waste, market development and industry support are essential. In addition, an effort to increase the addition of recyclable plastic and aluminum drink containers to paper recycling at commercial businesses or industry is important to improve these recovery rates.

3) A glass container only bottle deposit requirement could also significantly increase glass recycling at bars and restaurants.

4) Finally, carpet and textiles are also found in commercial waste. Textiles can be addressed through the programs discussed under residential recycling; and carpet is typically generated in C&D loads as discussed below.

C&D Waste Diversion, and Recovery of Other Special Wastes

To increase the diversion of C&D wastes and recovery of other special wastes, the following strategies will be pursued:

1) Recovery of both clean and C&D wood will require market development and subsidies. Only the cleanest wood can be made into mulch due to concerns of contamination. For example, pallets and crates often are used to move products that may spill and leach into the wood so most mulchers will not accept this material as a feedstock even though it is classified as clean wood. Efforts to increase recycling of damaged pallets through the remanufactured pallet industry in important, as are continued efforts to find new biomass combustion markets for waste wood.

2) To increase the recycling rate of asphalt shingles and gypsum, market development and support is also necessary along with incentives to contractors to keep these materials separate from other C&D waste materials.

3) Carpets are primarily made from nylon or PET. While nylon fiber has high value, there are few processing facilities that can economically recover nylon fiber from carpet. PET fibers in carpet are even less valuable then nylon. Variance in the types of fibers used to make carpets, together with the amount of dirt in the fiber has contributed to the stagnation of the carpet recycling industry. Because of this, industry support is necessary to design carpet for recycling and support the development of technologies to efficiently recover the fibers.

4) Recovery of electronics waste (e-waste) comes at a cost and will continue to without industry support. While some components/materials hold value, these items are typically accepted in many retail or commercial take back programs, leaving the less valuable e-waste for municipality or publicly funded programs. Currently twenty-five states plus the District of Columbia have legislation establishing industry support for electronic waste (e-waste) recycling programs. DSWA will work with the Legislature to determine if producer support for the costs of electronics recycling can be introduced.

Landfills

DSWA will continue to monitor methane recovery at the three landfills and will work to adopt more aggressive methane recovery techniques as data and technology allows.

Legislative Actions

Many of the paths to significantly reduce the waste stream and increase materials diversion will require input from the legislature. These include:

- EPR programs for certain waste streams with few or no markets are essential to boost recycling rates. These include mandatory programs or industry funding support for carpet, electronics, and even some HHW currently managed by DSWA.
- Single use product fees or bans may be the only method to reduce the growth of single use product waste generation in Delaware. While these fees or bans will not significantly impact the MSW recycling rate, because of the lightweight nature of these materials, they will reduce litter including clogging of storm drains and waterways and marine plastic litter.
- A bottle deposit and redemption program for glass containers only may be the best method to ensure high recovery rates of cleaner glass that ultimately would be easier to find markets for and help ensure the recycling of glass.
- Right to repair legislation requiring electronics (or other) producers to make available the knowledge and tools needed to repair and refurbish their devices. This is vital to extending the life of devices, while reducing electronic waste generation.

Greenhouse Gas Emissions Reductions

In addition to the benefits of waste reduction, the benefits of recycling to reducing greenhouse gas emissions are clear. Reductions from the most recent year of recycling activity (CY 2018) have been estimated and are show in Table 8-3, together with the increased benefits of reaching the aspirational goals outlined in Table 8.1 above.

As illustrated by Table 8.3, on the next page, GHG emissions reductions associated with current MSW diversion[75] represent a total GHG emission reduction of 784,000 (rounded) Metric Tons of Carbon Dioxide Emissions annually. Achieving the aspirational goals outlined in this 2020 Plan would further reduce GHG emissions by an additional 182,000 (rounded) metric tons annually.

Table 8.3: GHG Emission Benefits of Current and Increased Diversion of MSW Materials from DSWA Landfills

MATERIAL	Current Recovery (MTCO2E)	Aspirational Recovery (MTCO2E)	Change from Additional Recovery (MTCO2E)	Percent of Emission Reductions (%)
Corrugated Containers	(344,814)	(385,960)	(41,146)	23%
Newspaper	(35,140)	(43,603)	(8,463)	5%
Mixed Paper	(213,510)	(250,314)	(36,804)	20%
Food Waste	12,282	(6,864)	(19,146)	11%
Yard Trimmings	(19,853)	(17,748)	2,105	-1%
Branches	(8,214)	(7,623)	592	0%
LDPE (1)	(1,968)	(3,569)	(1,602)	1%
Mixed Plastics	(11,792)	(19,090)	(7,298)	4%
Mixed Electronics	(1,270)	(4,419)	(3,149)	2%
Aluminum Cans	(8,932)	(31,033)	(22,101)	12%
Steel Cans	(158)	(8,794)	(8,636)	5%
Mixed Metals (2)	(143,934)	(161,046)	(17,112)	9%
Glass	(3,954)	(5,356)	(1,403)	1%
Carpet	(42)	(17,148)	(17,106)	9%
Tires	(2,907)	(3,801)	(894)	0%
Total:	**(784,205)**	**(966,367)**	**(182,163)**	100%

1. *The LDPE material category includes shrink wrap and plastic retail bags.*
2. *The Mixed Metals material category includes appliances as well as all other metals.*

[75] *Does not include the following MSW materials diverted because they could not be matched up in the Warm v.15 model: Pallets, mulched and other; Textiles; Other Batteries; Mattresses; Fats, Oil and Grease; and, Waste Wood found in MSW.*